No. 680,590. Patented Aug. 13, 1901.

F. B. HERZOG & S. S. WHEELER.

ELECTRICAL SIGNALING APPARATUS.

(Application filed Jan. 25, 1886.)

(No Model.)

Fig. 2.

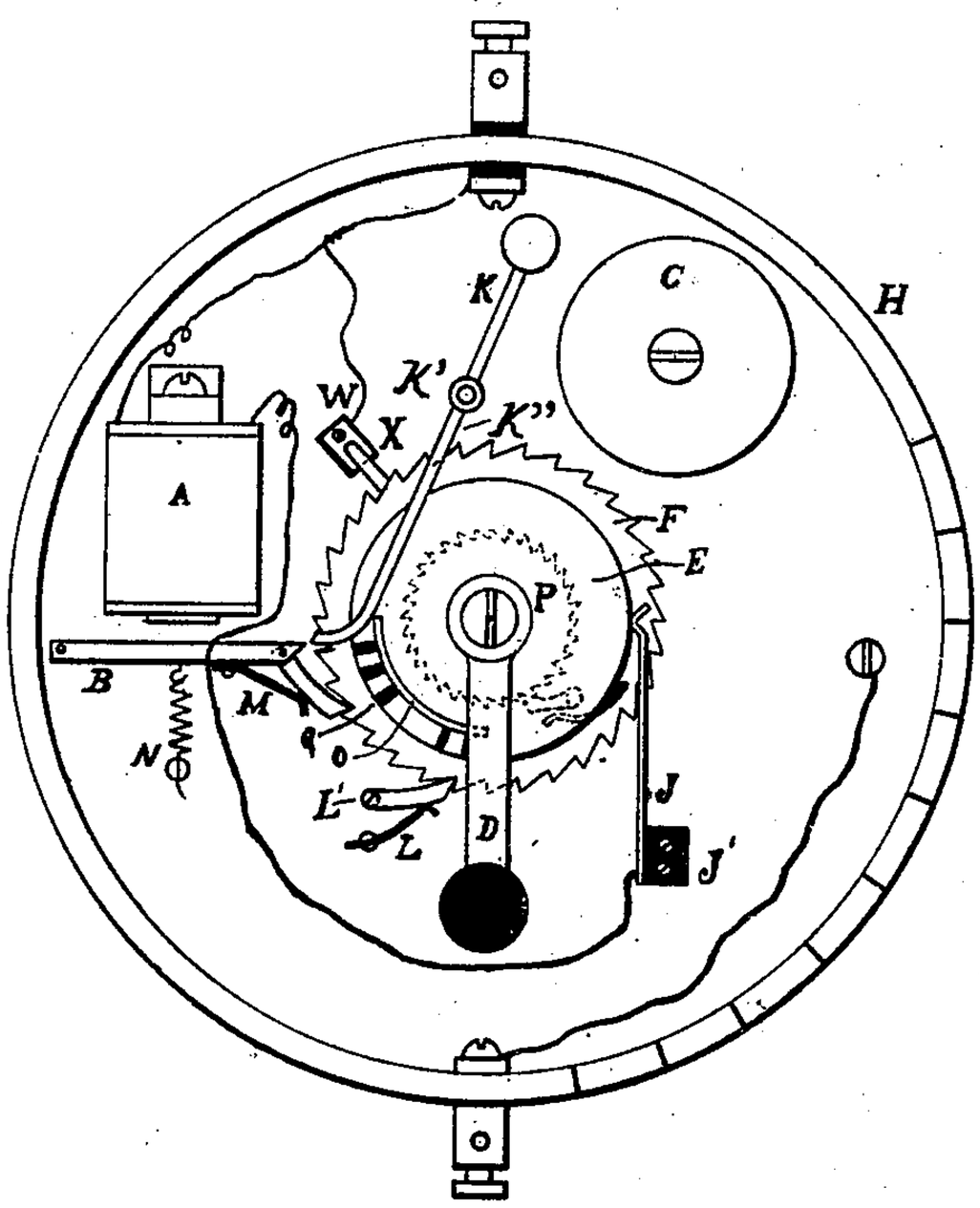


Fig. 3.

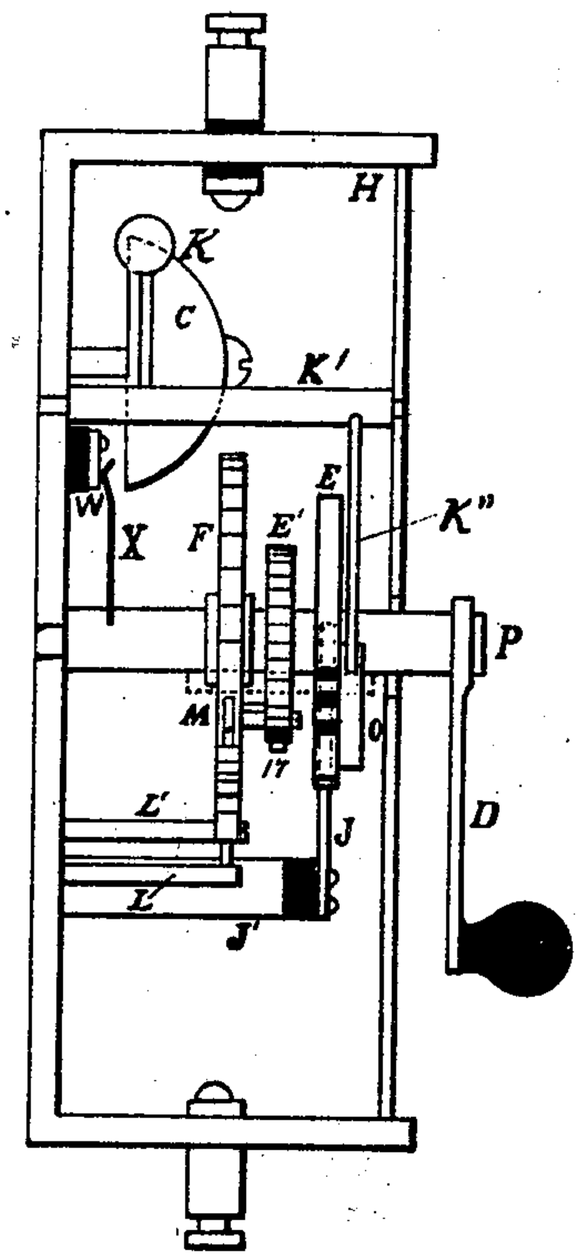


Fig. 4.

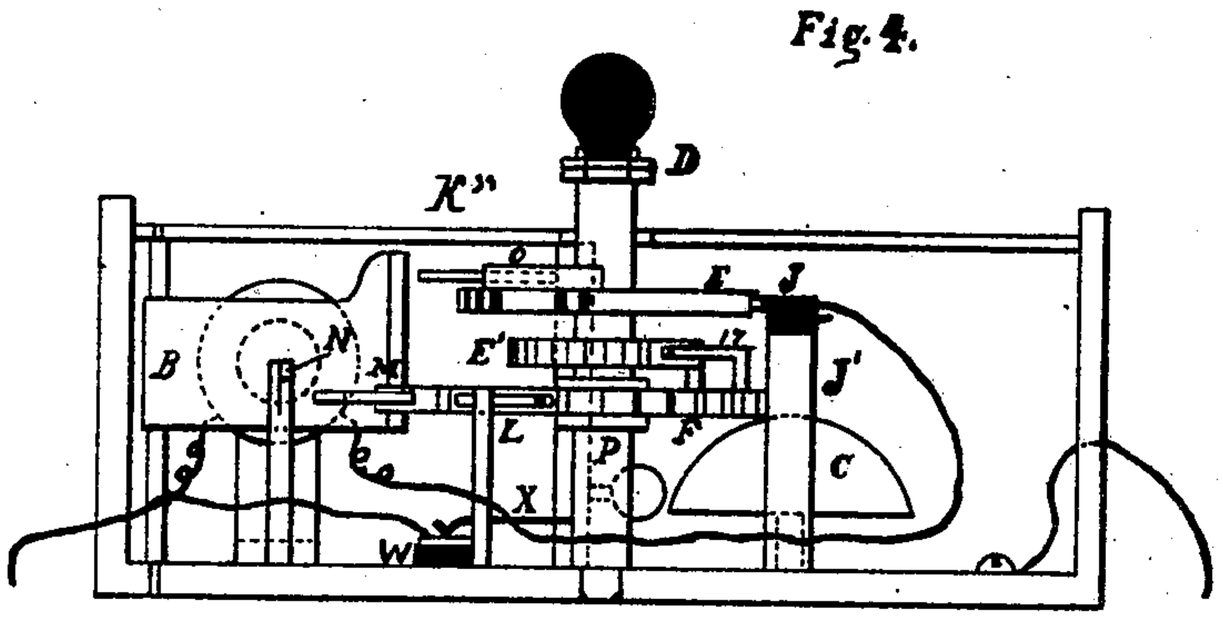
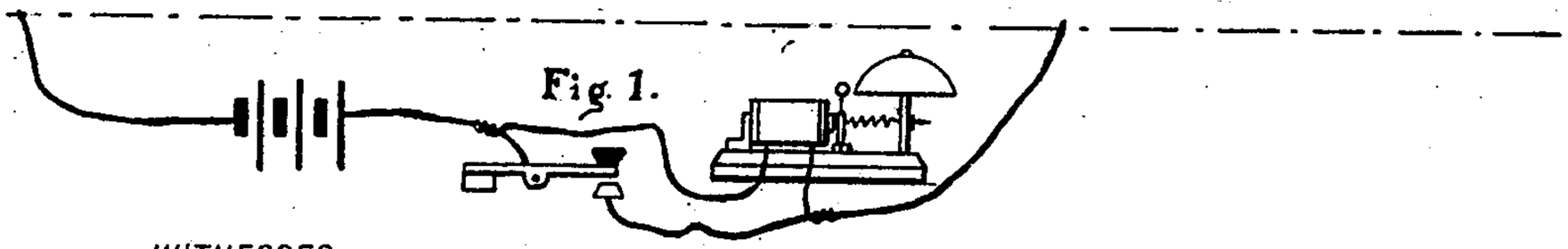


Fig. 1.



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ELECTRICAL SIGNALING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 680,590, dated August 13, 1901.

Application filed January 25, 1886. Serial No. 189,668. (No model.)

To all whom it may concern:

Be it known that we, FELIX BENEDICT HERZOG and SCHUYLER SKAATS WHEELER, citizens of the United States, and residents of the city of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Electric Signaling Apparatus, (Case No. 29,) of which the following is a specification.

Our invention relates to electric signaling apparatus, and has for its principal object the production of a signal-box which shall be reliable in operation and far simpler and cheaper than any other heretofore invented.

A further object is to improve generally upon various parts and constructions in apparatus of this general character.

To this end our invention, broadly stated, consists in combining transmitting mechanism of the general character first shown in Patent No. 292,115 to F. Benedict Herzog, with means for producing a characteristic or location signal in addition to the variable or want signal therein described, and, furthermore, in combining therewith means for sending a return, answer-back, or respond signal.

Referring to the drawings, Figure 1 shows the organization of the apparatus at the receiving-station; Fig. 2, a front view, with outer face removed, of the transmitter, of which there may be a number in series on the line, in its normal position of rest; Fig. 3, a side section, the magnet and armature shown in Figs. 2 and 4 being omitted; Fig. 4, a section as seen from the bottom of Fig. 2.

Referring to Figs. 2, 3, and 4 in detail, these show the transmitter, in which A is a magnet attracting armature B, mounted on suitable bearings. The main shaft P, mounted in suitable bearings and controlled by the crank-arm D, has rigidly fixed to it signal-wheel E and ratchet-wheel E′, and in any suitable manner, as by a collar bushing in such manner that it is retained in the proper plane, but is not locked to the spindle except indirectly by the connection or engagement of the pawl, next mentioned, with the ratchet E′, which, as stated, is rigidly fixed or locked to the spindle, there is mounted on the shaft the step-wheel F, bearing a click and spring 17, which connect the wheel with the teeth of ratchet E′. The step-wheel F, coöperating with the armature-pawl M and the retaining-pawl and spring L and L′, is rotated electrically in one direction for one step at each retraction of the armature, and then carries with it the circuit-wheel E, in the manner described hereinafter. These wheels may be rotated manually in either direction. When rotated clockwise, the wheels E and E′ will turn without the wheel F, because the latter is locked by the thrust of the armature-pawl M, so that when the tension of spring-click 17 is overcome by the force of the manual rotation the click on the wheel F will idle over the face of the teeth of the ratchet-wheel. When rotated in the reverse direction, that wheel is carried with them, whether such rotation is manual or the step-by-step rotation produced by the armature already referred to. The combination described enables the operator who sets the apparatus to rotate the pointer, and hence the signal-wheel, in either direction at starting or to correct the position of the pointer when this has been moved to some signal other than the one intended, whereas the electrical operation, due to the retraction of the armature as controlled from the distant station, carries the parts in one direction at all times.

The tension of the spring-click 17 and the depth and angle of the click against which it presses, as well as of the teeth of the ratchet-wheel, are such that the weight of the arm of the pointer D and other parts joined thereto, and the friction between the signal-wheel E and the brush J, next to be described, will not be sufficient to disengage the click from the tooth with which it connects at any one instant, except when the operator forces the pointer, and hence the parts connected with it, in the clockwise direction, and thus against the thrust of the impelling-pawl M, and therefore the various wheels grouped upon the shaft are all carried around during the step-by-step motion given to the first wheel.

The signal or circuit wheel E bears insulated points Q on its edge or in any other suitable position, and placed to coöperate with these during the rotation of the wheel is a suitable terminal, as brush J, insulated

from the rest of the movement by post J'. This circuit-wheel as constructed is adapted to transmit a number of variable signals, and in addition thereto a box-number or characteristic signal, which in the box chosen for illustration is the number "23," and this wheel, or rather box, as a whole is adapted for use in combination with a number of similar boxes coöperating in any suitable manner with circuits. For instance, a number of such boxes may be used and are in my invention arranged in series on a single circuit, through which a current is normally flowing, although I do not limit my invention to this use of such boxes on such a circuit.

The normal position of the boxes is as shown in Fig. 2, the magnet being shunted by contact between the fixed contact W and the spring X of the main spindle, and through it connecting with the metal base and out to line, which enters through the insulated post and branches to the magnet and to the shunt through W, as described.

At the receiving-station the apparatus required to control and receive a signal from a box or boxes of this character comprises a high-resistance bell, operating on the back stroke, and a short-circuiting key, all arranged so that the magnet of the bell is cut out at each closure or depression of the key, (or, if preferred, a battery other than the normal battery, which may be located at any suitable point, as at the office, may be cut in by the operation of the key.) The relations between the resistances of the two magnets and the respective tensions of their armatures and of the other parts opposing the action of the armature are such that the armature of the transmitter cannot be attracted to its magnet by the current that suffices to hold the armature to the bell of the receiver. In this normal position of rest the cut-out terminals W and X are in contact and the contact-brush J rests against the circuit-wheel at a point just in advance of all of the insulated spots, so that when this wheel is rotated manually during the operation of setting it all of the spots will be carried around, so as to pass under the brush in succession.

The manner of operating this transmitter is that as the operator begins to turn the pointer or crank, and with it the wheels, he instantly separates the cut-out terminals which normally shunt the magnet, and the magnet A is thereupon cut in circuit, where it remains until normally cut out again by the return to its normal position of the spring X, when it is carried around by the shaft with which it moves. The action of the magnet which produces this motion of the spring is described later, it being remembered that the final step of the operation, as well as all the other steps, is produced on the back stroke of the armature, and hence when it is no longer necessary for the magnet to be in circuit. All of these reverse movements are electrically caused and are subject to the control exercised from the distant station. As the sending operator turns the wheel still farther in the clockwise direction all of the insulated spots as they pass in sequence under the brush J will cause interruptions in the circuit equal in number to the spots. When this rotation is continued sufficiently to carry the pointer opposite the first one of the marks or lines on the dial or index, all of these spots mentioned will first have to pass under the brush, because these index lines or locations are placed relatively so as to necessitate this effect, although, of course, their actual location may be varied, provided that the position of the pointer as it is fixed on the shaft is varied in accordance. Each of the interruptions of the circuit caused by this passage of the spots will cause the receiving-station bell to tap; but the operator at that station need pay no attention to the number of such taps, which, in fact, may not be readily distinguishable, because the speed with which this is performed by the setting operator may be such as to make such accuracy in count impossible; but in any event the tap caused by the first of these spots informs the receiving operator that a signal is awaiting his action, although he does not as yet know which box it is when a number of such boxes are organized in one system suitably arranged in the circuit—as, for instance, in series—until he performs the following actions: When the receiving operator is ready to control and receive the signal, he depresses the key, counting each depression, and at each depression listening to the effect upon his bell. The electrical effect of a number of these depressions will be as follows: At each downstroke of the key the bell-magnet is cut out, whereupon its armature flies back, thus producing a tap upon the bell, but producing also in the transmitter an energization of the transmitter-magnet, because the resistance of the circuit is decreased by the cutting out of the receiver-bell to an extent sufficient to increase the current to the point required to energize the magnet sufficiently to attract its armature against the tension of its retracting-spring. Each such retraction of the armature of the transmitter produces two effects. One effect is the step-by-step advance of the step-wheel, (carrying with it the other wheels.) The second effect is the progression of the signal wheel or disk, so as to bring under the contact-brush J in succession the various units of space upon the periphery of the wheel which are proportionate to the space of the step-wheel. Some of these units are unmarked, and others are identifiable, because they include the insulated spots already referred to. Each depression of the key therefore energizes the transmitter-magnet and deënergizes the receiver-magnet, thus producing a bell-stroke, while each subsequent or intervening upward motion of the key and consequent reinclusion of the re-

ceiver-magnet in the circuit produces a retraction of the transmitter-magnet armature, thus causing an advance of the wheels and at the same time reënergizes the receiving-bell magnet, which does not then produce a tap, because its armature only strikes in the back stroke. The result of the arrangement described is that for every complete "up-and-down" movement of the key the wheels are advanced one step during the down movement of the key and the bell gives one stroke during the upward motion of the key, thus enabling the operator by counting his bell-strokes (or the number of depressions of the key) to be informed of the number of steps made by the transmitter-wheels. This is the only way in which the progression of the signal-wheel in the transmitter may be noted at the receiving-station and would of course suffice merely to show the extent of the motion of the wheels without, however, indicating the absolute position at any step, or after any number of steps with reference to any given starting-point, or, what is equivalent thereto, any indication on the dial. The function of the insulated spots on the signal-wheel, or rather of the first of such spots, is to produce a distinct effect on the receiver-bell at the precise instant of the passage of that spot under the brush J, and as this brush is fixed with relation to the dial and as the crank-arm or pointer of the transmitter moves with the wheels it follows that the recognition of the step or tooth which was in engagement with the transmitter-armature click at the instant or step at which this moving insulated spot passed under the fixed brush J will also serve to make recognizable the step or position in which the movable pointer passes in a contraclockwise direction beyond the last of the dial indications, and the recognition of this point makes it simply a matter of count to deduce therefrom the position of the pointer, and hence of the wheels, at the starting-step, and as these positions vary according to the signal selected upon the index it follows that the variable signal chosen can be thus recognized at the receiving-station. All of the above is practically equivalent to the manner of operation of the apparatus described in the beforementioned Herzog patent, No. 292,115. The passage of this insulated spot is recognized at the receiving-station by the fact that it is only at steps which include such an insulated point in a unit of progression that the receiver-bell strikes upon the lifting of the key, all the other bell-strokes having been produced at the depression of that key. It is obvious that instead of cutting out the bell-magnet as the resistance another resistance may be substituted and the bell merely shunted, in which event the bell may be adjusted so that it will not ring at the depression of the key, because its armature may be adjusted to remain attracted even though the current be weakened enough to deëner-gize the transmitter-magnet. Whether or not the bell does tap during the depression of the key is quite immaterial for the broad purposes of this invention, because the counting of the steps preceding a step which is coincident with the break produced by an insulated spot may be easily made in other ways — as, for instance, by counting the strokes of the key. This exceptional effect of the bell-tap on the upstroke is produced because it is only at steps which bring an insulated spot under the brush J that the circuit is actually broken, as at all other steps the circuit remains complete, although the current flowing in the circuit is varied by the successive strengthenings as the resistance of the bell-magnet is shunted at each depression. The insulated spots are, moreover, made so small that the break only takes place during a fraction of the step, and in this manner provision is made for the automatic restoration of the normally-closed condition of the circuit at the end of each complete operation. The receiving operator thereupon counts the number of bell-taps produced during the key depressions (or the number of such depressions) from the first of these until the one which is followed by a tap upon the lifting of the key. In the example given, in which the transmitter has been set to, say, the seventh signal, this tap will be given at the eighth upstroke of the key. The operator now knows for what signal the transmitter was set, and in order to enable him to know the box-number (when the boxes are grouped in a system comprising more than one such box) a variation and extension of this procedure are as follows: He continues to depress his key, at each depression listening for a succeeding bell-tap on the upstroke. In the case of the box shown, which is set to send characteristic or box-number "23" at all times, a bell-tap will occur at the upstroke following the first downstroke following the tap already received and noted as the one which terminates the variable-signal group. He thus knows that the first number of the characteristic is "2," there having been two bell-taps in succession. It is to be noted here that the first of the upstroke taps which he heard thus operates both to mark the end of the variable signal and the beginning of the invariable signal or box-number. He then continues his depressions for as many strokes as may be required to bring the wheel far enough around to send the first of the succeeding group of insulated spots under the brush J, and the number of such depressions will depend upon the number of units of progression which the wheel has been constructed for. Two would practically be sufficient, as the sole object is to make it possible to note the interval which separates the two groups composing the box-number. When the first of the spots corresponding to the second group of the box-number passes under the contact-brush, he will hear a tap

on the upstroke of his key, and he will in like manner hear such a tap for the two succeeding upstrokes for the group "3." After the next downstroke there would be no such tap for the corresponding upstroke, because these taps are only coincident with the passage of the insulated spot.

Summarizing what has happened from the moment when the receiving operator began his operation until now, he has given fourteen downstrokes and has heard a bell-tap on the upstroke of the seventh, eighth, eleventh, twelfth, and thirteenth of the upstrokes following these strokes and has interpreted this result to mean that there were seven units of progression between the starting-point and the zero-point, thus that the transmitter had been set at the seventh possible position at the moment of starting and that the group numbers were "2-3," separated by an interval which was predetermined by the construction of the box. As a modification of the method of giving group-numbers it is evident that units of progression or steps bearing no insulated marks might have sufficed equally well, because such groupings would be made recognizable by a back-stroke tap at the dividing point between the first and second groups of steps and the termination of the second group. The grouping of the two sets of units in a box-number is of course merely a more convenient form where the box-number consists of large units. Thus, for instance, it is obviously more simple and requiring a smaller machine to make the box-number "23" consist of two steps for the tens and three steps for the units, with two steps for the pause between them, making seven steps in all, than it would be to require twenty-three steps. This arrangement for controlling groupings is, however, of itself a notable part of this invention.

It will be seen that what has just been described may be considered in part as an amplification, both of the method and apparatus first shown in the above-mentioned patent to Herzog, but commercially a very great improvement thereon, as no arrangement of that apparatus could meet the requirements of a characteristic signal-sending box.

The parts thus far described constitute in themselves a very important improvement in the art and relate entirely to the transmission of the signal, and we shall now describe the further feature by which an answer-back signal may be given. The insulated spaces Q are so placed with respect to the normal resting position of the wheel E that after the last space of the characteristic a number of impulses given by the receiving operator will cause a number of steps to be made by the wheel before the brush X on its shaft again cuts out the box-magnet. This number may be made anything desired, but it is preferably made to amount to the sum of the impulses which form the different groups added to the total of possible variable signals which the box is constructed to send—as, for example, if the box-number is 23 and the total number of wants ten then these supplemental steps or teeth should be ten plus two plus three, or fifteen in all. In order that the sound made by the armature during the answer-back steps may differ from that made during the steps which control the transmission of the signal, a bell is added, together with a hammer, so arranged that these will coöperate only during the answer-back period, or rather during the rotation subsequent to the signal transmission. A rock-shaft K′, bearing hammer K, adapted to strike bell C whenever an extension K″, which is fitted to the shaft K′ and has been moved into the path of the armature motion and has been lifted by the armature, is so pushed within the range of the armature's action by guide or flange O on wheel E. The fulcrums of B and of K″ are so placed that at the retracted position of the armature K″ will of itself gravitate out of the path of the armature; but when it is held in position by the flange it can only fall so far as to keep the hammer away from the bell, so that although the bell is struck at each attraction of the armature the hammer will fall away (just enough to give a good bell-tap) whenever the armature drops. The flange O should be so placed and proportioned that it will push the hammer into its operative position during the entire number of units of time during which the answer-back is given. The apparatus being thus organized the receiving operator can signal back both the characteristic signals and the variable want-signal above described by sending say, first, two taps, then pausing, then sending three more, then pausing again, (a longer pause would here be preferable,) then giving seven taps in addition, thus indicating to the sending operator that the box-number has been correctly received. To restore the box to the normal position, and thus prepare the box for the next operation, and at the same time to reduce the resistance of the line, the receiving operator then sends a number of impulses, thus causing X to be revolved until it again cuts out the magnet. The receiving operator need pay no attention as to how many such operations he performs, provided that he performs at least enough to cut out the magnet, all subsequent to that being inoperative.

We do not limit ourselves to the specific form of apparatus shown for impelling or actuating or for differentiating between the signals or for operating the return-signal or for receiving the signal.

We claim—

1. An electric step-by-step motor, a wheel driven thereby, circuit connections, normally through the wheel thereof and two or more insulated points thereon, each arranged and adapted to control an effect at the receiving-station, substantially as described.

2. An electric step-by-step motor, a wheel driven thereby, circuit connections, normally

through the wheel thereof, and three or more insulated points thereon, each arranged and adapted to control an effect at the receiving-station together with a pointer driven by the wheel and indications on a coöperating index, said indications equaling in number the number of steps on the wheel between two of the spots, substantially as described.

3. A series of signal-transmitters each comprising a magnet and a device driven thereby step by step and bearing insulated points; a circuit-terminal in position to be passed by those points during the step-by-step movement, additional points of contact in alinement with the terminal, the insulated points and the additional points each corresponding to a step-by-step unit of motion of the driven device, and the said insulated points being arranged to form groups of the uninsulated points by marking the divisions between two or more of such groups.

4. A signal-transmitter comprising a step-by-step wheel, circuit-controlling devices moved thereby and a magnet controlling an armature and adjuncts adapted to control the operation of the wheel; the whole so adjusted that the wheel and the circuit are controlled at the deënergization of the magnet.

5. A signaling instrument comprising a moving shaft, bearing step-by-step signal-controlling and step-by-step signal-receiving elements, substantially as described.

6. A signaling instrument comprising a bell, a hammer normally out of range of the bell, an armature, and a guide, adapted at some part of the operation of the instrument from a distant point to push the hammer into an operative position with respect to the armature, substantially as described.

7. A signal-transmitter comprising a step-by-step wheel coöperating during the manual act of setting the signal with a click and ratchet-wheel, and a circuit-interrupting wheel all on the same shaft.

8. A signal-transmitter comprising a movable device, a magnet controlling the motion of the same and circuit-controlling parts comprising means for interrupting the circuit conditions several times, the relative adjustment and arrangement of the parts being such that a separate energization of the magnet is required to produce each of the circuit interruptions and to complete the operation of the transmitter.

9. A signal-transmitter including movable devices, a magnet controlling the same and being intermittingly controllable from a second station; and signal-producing parts adapted to divide the entire signal into two or more portions and arranged to be separately controllable by way of the magnet.

10. A signal-transmitter adapted to produce a signal which controls two or more different effects at the receiving-station, a magnet controlling the transmitter so that it cannot operate until the energization of the magnet from the receiving-station, and two or more parts adapted to produce one of the effects at the receiving-station.

11. A signal-transmitter comprising a movable device, a magnet for controlling its motion by means of successive energizations and signal-producing parts including several elements fixed with reference to each other, and additional signal-producing parts; together with means for varying their relative positions.

12. A signal-transmitter comprising a step-by-step wheel, a magnet and adjuncts controlling the step-by-step motion through successive energizations produced outside of the transmitter; and signal-controlling parts including two or more elements fixed with relation to each other; together with means for producing a variable signal without the cooperation of the last-named parts.

Signed at New York, in the county of New York and State of New York, this 22d day of January, A. D. 1886.

F. BENEDICT HERZOG.
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