No. 626,131. Patented May 30, 1899.

J. A. BARRETT.

SELECTIVE ELECTRIC SIGNAL.

(Application filed July 28, 1898.)

(No Model.) 4 Sheets—Sheet 1.

Fig. 3.

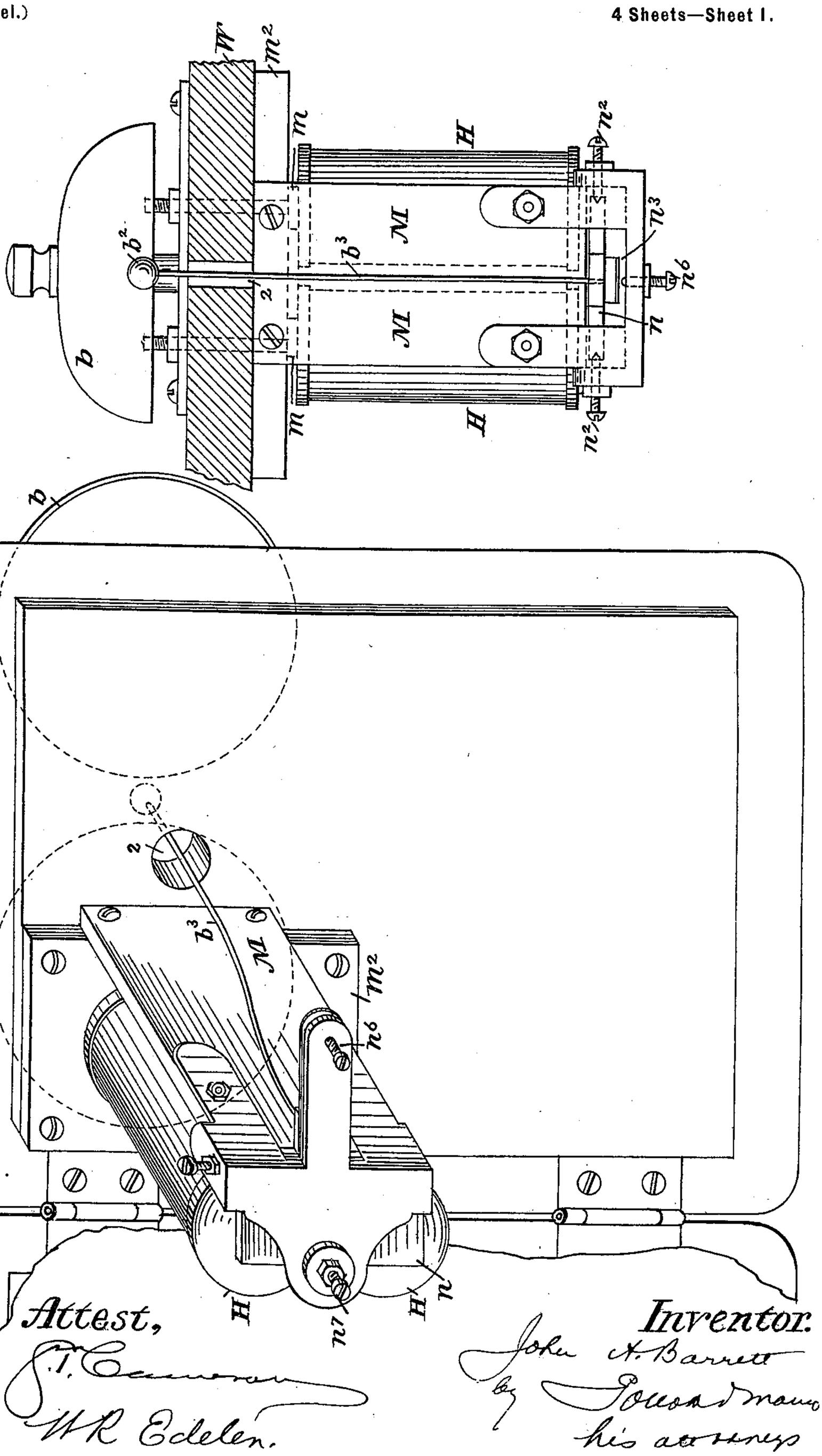

Fig. 1.

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his attorneys

No. 626,131. Patented May 30, 1899.

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SELECTIVE ELECTRIC SIGNAL.

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(No Model.) 4 Sheets—Sheet 2.

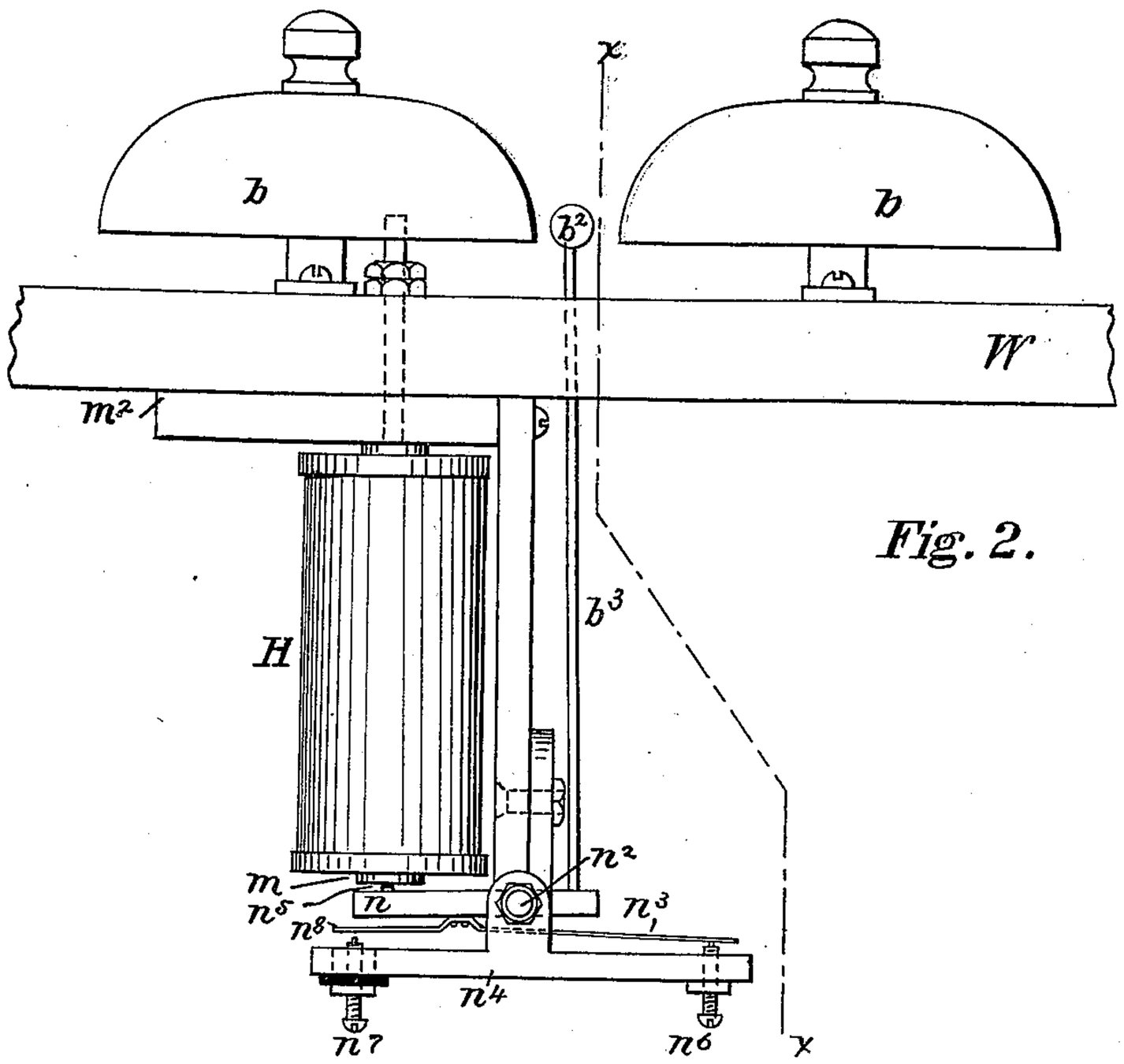

Fig. 2.

Fig. 4.

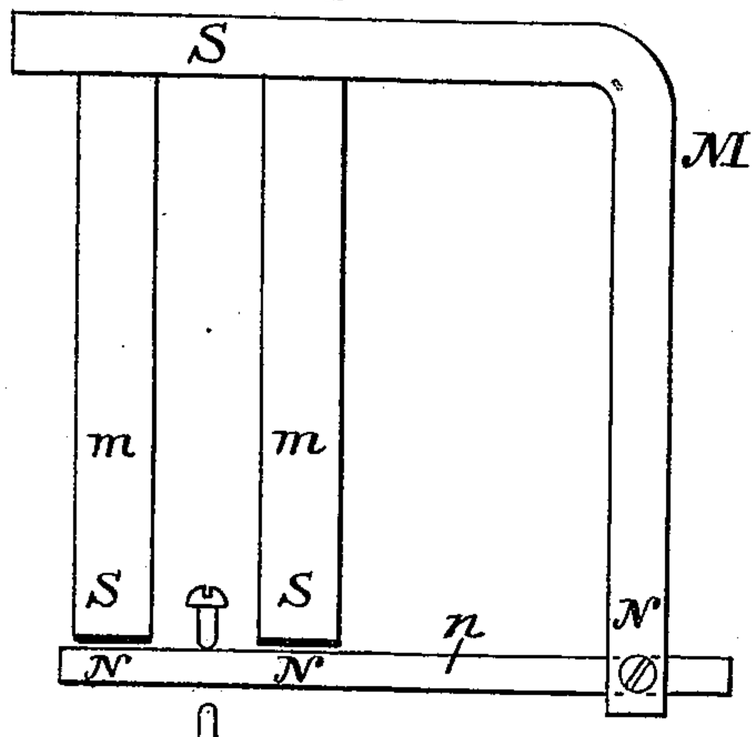

Fig. 4a.

	Current.		
	Line A	Line B	Ground
1	+	o	—
2	—	o	+
3	o	+	—
4	o	—	+
5	+	—	o
6	—	+	o
7	+	+	—
8	—	—	+

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No. 626,131. Patented May 30, 1899.

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SELECTIVE ELECTRIC SIGNAL.

(Application filed July 28, 1898.)

(No Model.) 4 Sheets—Sheet 3.

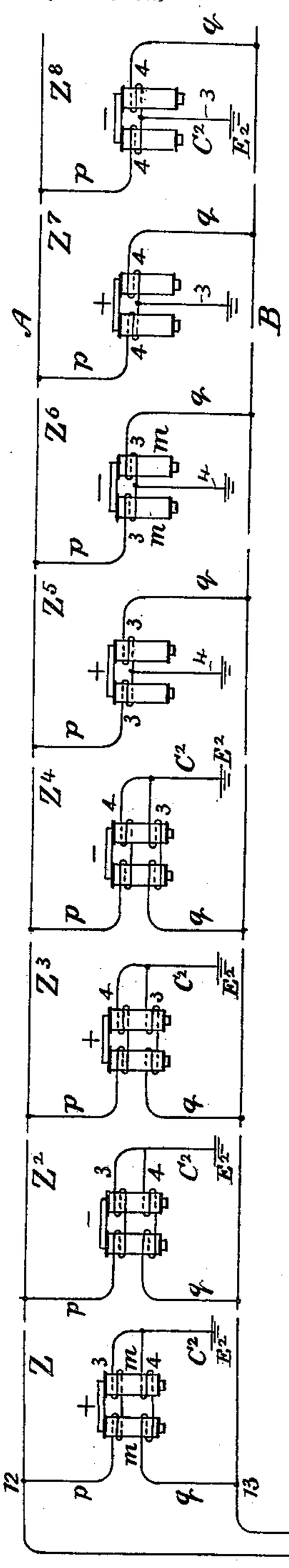

Fig. 5.

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(Application filed July 28, 1898.)

(No Model.) 4 Sheets—Sheet 4.

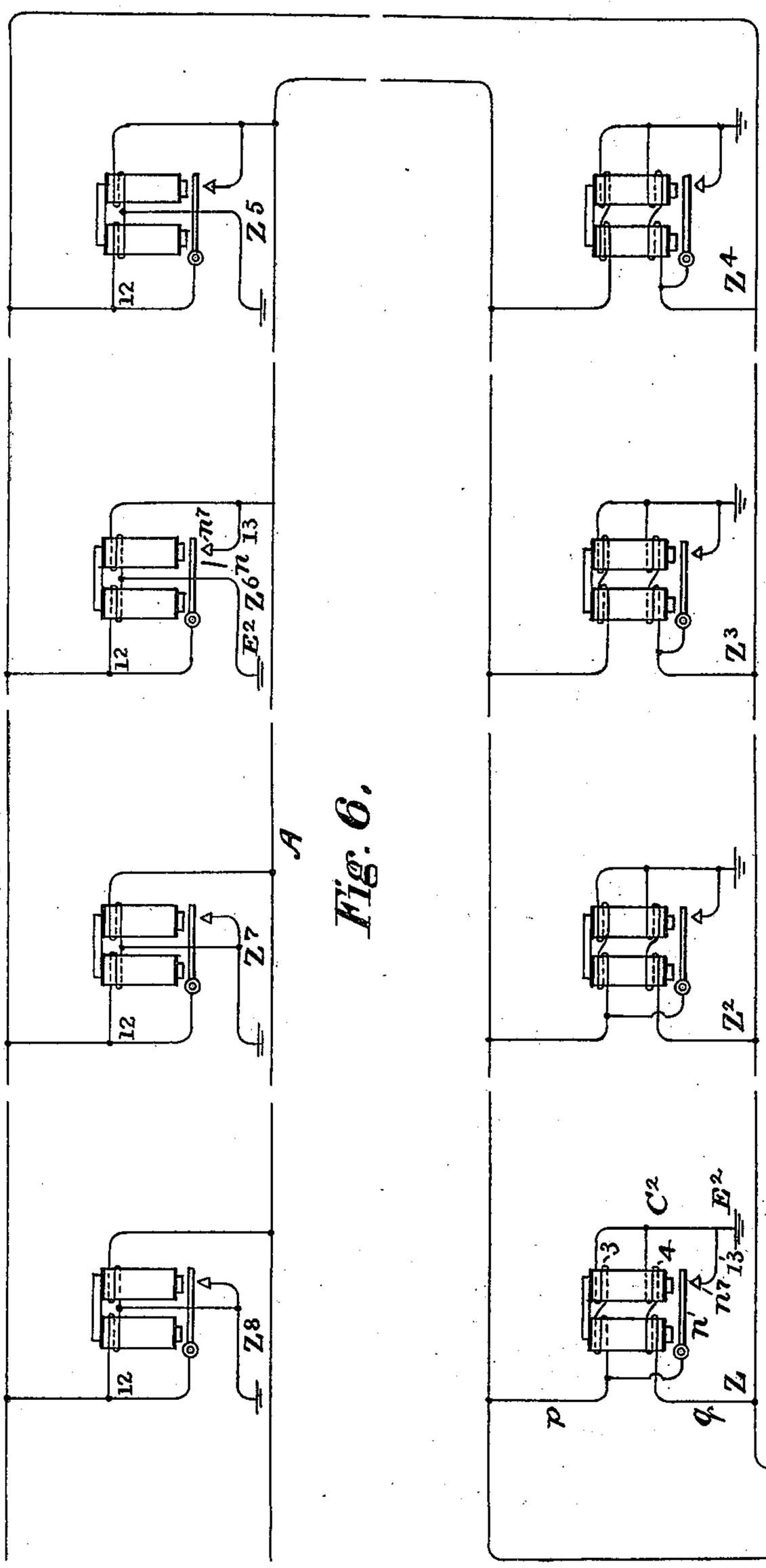

Fig. 6.

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UNITED STATES PATENT OFFICE.

JOHN A. BARRETT, OF SUMMIT, NEW JERSEY, ASSIGNOR TO THE AMERICAN TELEPHONE AND TELEGRAPH COMPANY, OF NEW YORK.

SELECTIVE ELECTRIC SIGNAL.

SPECIFICATION forming part of Letters Patent No. 626,131, dated May 30, 1899.

Application filed July 28, 1898. Serial No. 687,104. (No model.)

To all whom it may concern:

Be it known that I, JOHN A. BARRETT, residing at Summit, in the county of Union and State of New Jersey, have invented certain Improvements in Selective Electric Signals, of which the following is a specification.

This invention relates to selective signaling systems, and more particularly to that branch thereof wherein main-line currents of either or both directions are transmitted in different ways over the two main conductors of a metallic circuit for the operation of polarized receiving instruments connected with the said main conductors at different stations of the circuit.

In Letters Patent of the United States No. 582,107, granted May 4, 1897, to George W. Whittemore, Warren M. Craft, and myself conjointly, assignors to the American Telephone and Telegraph Company, is disclosed a system of selective signaling in which the two main conductors of a metallic telephone-circuit extending between a central station and a number of substations have at each substation a call-bell or signal-receiving instrument in a local circuit controlled as to its continuity by two relays, so that the bell can ring only when the local circuit is closed at two normally open points by the said relays acting at the same time. In that system the relays are connected in derived circuits between the said main conductors or between either or both of the said conductors to earth or other return, and the closing of the local bell-circuit at the several stations by the simultaneous operation of both of the relays there and the consequent operation of the several station-bells is selectively accomplished by so adapting the construction and connections of the relays that the several pairs of the said relays shall be respectively responsive to electrical currents produced by a source placed at the central station and traversing the main conductors, the said currents differing from one another in direction and being transmitted through the two main conductors severally, the two conductors joined up as a metallic circuit or the two conductors connected in parallel with each other. At the central station is a group of keys each representing one of the substation call-bells, and each of the said keys is adapted to transmit the particular current over such a circuit combination as is required to ring the bell of the station represented by such key and no other.

My present invention looks to the accomplishment of the same general result, but aims to achieve such result by greatly-simplified substation apparatus, dispensing altogether with local batteries and circuits and also with relays and introducing in place of such devices a single electromagnetic call device extremely simple and compact in structure and adjustment and adapted for direct connection with the main conductors, and, furthermore, to accomplish the desired operation with greater certainty, less chance of becoming disordered, and with great economy in cost of installation, operation, and maintenance.

The characteristic feature of my invention is an electromagnetic apparatus composed of two bar-electromagnets or electromagnetic cores normally so magnetized that their free ends shall have polarity of the same sign and an associated iron armature having permanently magnetic polarity of opposite sign, and therefore held attracted to the said cores. These cores may be attached to the same iron yoke or heel-piece, and thus arranged will together superficially resemble an ordinary U-shaped electromagnet, and the initial magnetization of the cores and armature is in practice inductively imparted to them by attaching the common yoke of the cores to one pole and the armature to the other pole of a permanent magnet. It will be seen that this electromagnetic apparatus is a tripolar combination, the outer or free ends of the electromagnetic cores forming two adjacent poles of like sign, while the other or free end of the inducing-magnet, and therefore the armature as a whole, forms the third pole, which is of opposite sign—that is, of polarity opposite to that of the two core ends. The armature is pivoted or hung in a position in front of and extending across the core-poles, and in virtue of the induced polarities of it and them is strongly attracted toward them, and to cause it to move away from them it is necessary to produce simultaneous repellent po-

larity in both of the core ends. It is not sufficient for the release of the armature to neutralize the normal polarity of the said cores or to reverse the normal polarity of one of them. To cause a repellent or backward movement of the armature, the polarity of both poles must be reversed together. This principle may otherwise be stated by saying that all three poles of the electromagnetic apparatus must have like polarity in order to produce a movement of the armature. If any one of the three is opposite to the other two, the armature will not move. A bell-hammer rod is attached to the armature of this device and one or more bells mounted within range thereof to be struck thereby to produce an audible signal when the armature is repelled from the electromagnetic poles or again attracted toward them. The electromagnetic cores are wound with exciting-helices, or, as in the present case, it may be said that the coils are used not so much to excite magnetism in the cores as to modify or reverse their normal polarity, the said coils with possibly greater accuracy may be termed "magnetization-modifying" coils, and to produce the reversal in the cores of magnetic polarity required for the repulsion of the armature and the consequent operation of the bell an electric current of direction adapted to develop in the cores a polarity opposite to that normally induced is transmited through or caused to traverse the said coil. Assuming that the free ends of the electromagnetic cores have both normally south polarity and the armature north polarity, it is now manifest that to cause the armature to move backward from the poles the direction of the current must be such as to produce north polarity in both of the said cores—that is, the current must circulate around both cores in a non-clockwise direction—and it is a fact, still assuming the same normal polarity, that the armature cannot be set in motion by currents passing around both cores in a clockwise direction, for such currents will tend to emphasize the normal core polarity, or by currents which tend to reverse the polarity of either core alone, leaving the other one unchanged, or by a current passing around either core alone when no current is traversing the coils of the other. The normal magnetic attraction exercised between the two core-poles and the magnetized armature is partly counterbalanced by a spring attached thereto and tending to act thereon in opposition to the said induced normal attraction, which spring is made preferably adjustable, and I have found that by thus associating such a spring with the armature the promptness in operation, the sharpness of the produced sound, and the range of circuit-resistance through which the bells will ring satisfactorily are all materially increased. When in response to the passage through the coils of both of its cores of a current capable of reversing the polarity of the said cores the armature of an electromagnetic apparatus constructed in accordance with these principles is repelled and moves backwardly from the core-poles, a bell within range of the hammer carried by the said armature will be struck and a signal given, and if another such bell is mounted adjacently at the opposite end of the hammer-range this also will be struck by the said hammer when the polarity-reversing current ceases to circulate in the coils, for on the cessation of cuch current the armature returns to its normal or forward position, the tension of the counter-spring not being sufficient to overcome the normal pull of the induced magnetic attraction. Such a bell apparatus as this may manifestly be operated by placing its electromagnetic coils in circuit with a suitable source of electrical current and a key or other simple circuit-closer which when manipulated closes the said circuit-closer and transmits through the circuit a current of appropriate direction, for when the key is pressed the current will flow through the bell-magnet coils, the normal magnetism of the cores will be reversed, and the armature being repelled by the new polarity imparted to such cores will move on its pivots, causing its hammer to strike the bell. When the pressure on the key is discontinued, the circuit is again opened, the current ceases to flow, and the normal polarity of the cores being resumed the armature is again attracted to them and moves on its pivots to its original position, striking the second bell, if there be one. Thus the bells may be caused to give a continuous series of such strokes by alternately applying pressure to and withdrawing pressure from the key, or, in other words, by pressing the key intermittently the circuit is closed and the current caused to flow intermittently, producing instead of a single stroke a series of single strokes on the bell. In arranging bells of this type for selective operation, as the call-receiving appliances of the several stations of a polystation or party-line circuit I associate them with the two main conductors of a metallic circuit and an earth or return auxiliary conductor which is adapted to complete the circuit of either or both severally. These conductors and their circuits do not of themselves differ from those employed in the system of selective signaling disclosed in the patent of Whittemore, Barrett, and Craft, to which I have hereinbefore adverted, and the means for and manner of sending the requisite call-current combinations over the necessary conductor combinations for the operation of any particular station-call selectively, described in that patent, are also well adapted for use in connection with the station devices of my present invention.

As many as eight stations may by means of this invention be placed on a metallic circuit and signaled selectively, and the selective bells at all stations are substantially alike in structure, each and all embodying the principles hereinbefore recited. At each station,

however, the electromagnetic coils of the bell apparatus require to be either wound or connected differently in their relation to the main and auxiliary circuit conductors, so that the several different current and circuit combinations, each adapted for the operation of some one of the bells, by reversing the magnetic polarity of both of the electromagnetic cores thereof, and thereby effectuating the repellant movement of the armature, shall be incapable of producing any effect whatsoever on any other station-call apparatus of the same circuit.

For the sake of simplicity and order I prefer in all cases to so construct the electromagnetic apparatus of all stations with the same arrangement of normal and permanent polarity, and in this specification it is assumed that for all station-bells the normal magnetism of the two electromagnetic cores is of south polarity and the permanent magnetism of the armatures of north polarity.

If there are but four stations on the circuit, the electromagnetic cores of the call apparatus at the said stations will then preferably be all so wound or connected as to have their normal south polarity reversed, respectively, by currents of like direction, but transmitted for one of the stations over a definite one of the two main conductors to the ground or return auxiliary conductor; for a second, over the other one of the two mains to the auxiliary conductor; for the third, over the two main conductors in series, one serving as the outgoing line and the other as the incoming line of a metallic circuit, and for the fourth over the two main conductors coupled in parallel or multiple arc to serve as a single conductor, returning by way of the auxiliary conductor. It is evident that under these conditions the bells will be selectively operated to give each a continuous ring either by a periodically-interrupted current of appropriate direction or by a periodically-reversed current. It is obvious, therefore, that if but four stations are required we may readily operate bells constructed, adjusted, and connected as described herein selectively by means of the ordinary alternating-current magneto-generator provided, of course, with suitable switches or call-buttons at the central station for connecting it with either main conductor separately and with both connected in series and in parallel.

To operate eight station-bells selectively by my system, I substitute for the alternate-current generator a source of current—a battery, for example—from which current pulsations or emissions of either positive or negative direction may be transmitted at will, and thus by making available plus currents for four stations and minus currents through similar circuit combinations for a second four I am enabled to operate selectively two station-bells with similar connections, but with reversed terminals in place of each one of the four previously considered. Accordingly I place at the central station a source of current and eight keys, each of which represents some one of the eight selective bells, and all of which when manipulated act to establish relations of the terminals of the two main and auxiliary conductors and the source of current differing from that of any of the others and to form a combination of circuits and currents adapted to operate the station-bells represented by them. To produce the interruptions of current which are desirable for the efficient operation of the bells, I may employ any suitable interrupting device placed at the central station and operating automatically or otherwise in such a portion of the calling-circuit as to affect the current without regard to the particular key which at any moment is being operated. An electromagnetically-operated vibratory circuit-breaker may conveniently be used, and this, if desired, may take the form of a polar relay-magnet having an oscillatory armature whose lever acts as a key to rapidly make and break the main circuit and whose electromagnet may be excited by an alternating-current generator. I have found, however, that the bells of my system act more efficiently under a wider range of conditions and that their coöperation with associated telephone-station devices is more easy of attainment when the several combination circuit-currents are transmitted from the central station as continuous or uninterrupted currents and when each bell apparatus is provided with some form of vibratory circuit-changer actuated by the movement of its own armature and controlling the admission of the circuit-current to the electromagnetic helices. Such a device attached to the several bell mechanisms may, if desired, take the form of the well-known vibratory circuit-breaker, which holds the main circuit closed while the armature is in one position and opens the circuit when the armature is in another position, in the manner common in vibrating bells. I find it preferable, however, to provide each bell apparatus with a normally open shunt-circuit around both of its helices and a vibratory circuit-changer actuated by the movements of the armature and acting automatically to close the shunt and short-circuit the helices when the said armature is repelled, and thus to withdraw the working current from the coils without breaking the circuit and to again open the said shunt and readmit the current to the coils, when by such withdrawal the cores resuming their normal polarity again pull the armature forward. By adopting this device while the current through the coils is interrupted, as required, the currents in the main circuits are not interrupted and remain continuous.

In the drawings which illustrate this specification, Figure 1 is a perspective view of the working parts of my selective bell apparatus mounted on the cover of a bell-box of ordinary form. Fig. 2 is a plan view of the said

bell apparatus. Fig. 3 is a side view of the same on the line $x\,x$ of Fig. 2, showing both electromagnetic spools and the inducing permanent magnet. Fig. 4 is a skeleton representation of the electromagnetic cores, armature, and inducing-magnet illustrative by the principles involved in the operation of the bell. Fig. 4^a is a tabulated representation of the current combinations employed in the operation of the system. Fig. 5 is a diagram indicating a system of eight station-bell mechanisms associated with a single metallic circuit and adapted for operation with currents interrupted in the main circuit by a central-station interrupter, and Fig. 6 is a diagram of a similar circuit having its several station-bells provided each with a self-shunting device in lieu of an interrupter common to the circuit.

The principle of the tripolar magnet employed in my bell apparatus at each station may be understood by a consideration of Fig. 4, where M represents the permanent magnet as a whole; $m\,m$, two soft-iron cores attached thereto and inductively polarized thereby and both extending the polarity of its south pole to their ends, which thus themselves both become south poles also, and n the soft-iron armature, which, being pivoted in or near the north pole, is inductively polarized thereby, becoming itself the north pole of the system. Here, therefore, we have a magnetic system closed except at the narrow gap between the armature and the core ends and having two south poles and one north pole lying across them. In utilizing this device electromagnetic coils are at each station placed around the cores m, each, however, being so connected that with a peculiar circuit and current combination which will not operate any of the others the normal south polarity of its cores will be reversed. As long as either core maintains its south polarity the armature (which is always of north polarity) will remain attracted; but when from any cause both of the cores m lose their south polarity and assume north polarity the armature can no longer be attracted, but, on the contrary, is repelled from the cores. The preferred form of bell apparatus involving this magnetic system is illustrated by Figs. 1, 2, and 3, wherein W is the cover or door of a bell-box W^2 of ordinary form; $b\,b$, bells mounted on the outside thereof; H H, electromagnetic spools each composed of an electromagnetic core m and a magnetization exciting or modifying coil surrounding the same; m^2, an iron plate to which both cores are secured and which is itself secured to the base W; M, a permanent magnet having its south pole mounted in magnetic connection with the said iron plate and cores to induce like polarity in both; n, an iron armature mounted in pivots n^2 on a bracket n^4, attached to the north pole of the magnet M, the said armature being thus in such inductive relation to the said magnet as to receive a permanent polarity therefrom; b^2, a bell-hammer, and b^3 the bell-hammer rod secured to the said armature and extending through the hole 2 in the base-board to support the hammer between the bells b.

Studs n^5, of non-magnetic metal, may be soldered, as shown, to the face of the armature, and these, striking on the ends of the cores, answer the purpose of a front stop.

A flat spring n^3 is attached to the armature n and bears at its free end upon the adjustable screw n^6. The tension of the said spring operates against the normal attraction between the cores and the armature, so that by means of it and the screw the sensitiveness of the bell may readily be adjusted. As stated, this spring acts generally in opposition to the magnetic attraction; but it is adjusted to such a tension that its operation imparts promptitude to the responsiveness of the armature to repellant forces and does not in the slightest degree hinder the return of the said armature to its original position in contact with its front stop when the original polarity of the cores is restored.

Fig. 5 illustrates an application of my invention to a party-line of eight substations. O is the central station, and the substations are represented by the letters Z Z^2, &c., the outermost station being marked Z^8. Two main line conductors A B extend from the central station to all of the substations, and at each substation there is an auxiliary conductor C^2, terminating generally in an earth-wire E^2. At the central station there is likewise an auxiliary conductor C, united to an earth-wire E. These earth-connected auxiliary conductors are adapted to complete the circuits of either or both of the main conductors A B, and they are therefore properly regarded as a return-conductor common to the said mains and branching into each substation. Of course, if desired, a wire conductor may take the place of the earth. At the central station there is a source of calling-current G, which conveniently may be a battery, and a bank of signaling-keys K, numbered from "1" to "8." Key 1 represents station Z, key 2 station Z^2, and so on, and generally it may be stated that each key represents some one of the stations, that when it is pressed the call apparatus of the station represented by it responds, and that no call apparatus responds to any other key than its own. The bank of keys is associated with the central-station ends of the two main conductors A and B, with the auxiliary conductor E, and with conductors I and J, directly connecting, respectively, with the plus and minus poles of the source G, and these conductor-terminals are connected in different ways with the several keys. Thus with key 1 are associated a branch v from main conductor A, a branch e from the auxiliary conductor C, and branches y and z from the plus and minus poles of the battery, and when this key is depressed its action is to bring the branch v of the main conductor A into contact with the branch y of the battery-

conductor I and the branch *e* of the auxiliary conductor C into contact with the branch *z* of the battery-conductor J. As a result of this operation a current passes in a positive direction over the main conductor A. Key 2 operates the same set of connection-terminals, but reversely, and in operation sends a negatively-directed current over the main conductor A. In keys 3 and 4 branches *r* of main conductor B replace the branches of conductor A, and thus when these keys are manipulated the currents are plus and minus, as with keys 1 and 2, but pass over B alone instead of A alone. Keys 5 and 6 have the branches *v* and *r* of both main conductor A and B, but no auxiliary-conductor branch, so that when 5 is operated the current from the plus pole of the battery goes out over A and returns over B, this action being reversed by the operation of key 6. Keys 7 and 8 each receive the terminals *v* and *r* of both mains, as well as a terminal *e* of the auxiliary conductor and the battery branches *z* and *y*, and these are so disposed that the depression of key 7 sends the positive current out over the both main conductors A and B in parallel, the negative pole of the battery being connected with the auxiliary conductor, and that the depression of 8 will reverse these connections and send out a negatively-directed current over the mains in parallel. The circuit combinations represented by the several keys, respectively, and the line-currents resulting from such combinations are symbolized by the table, Fig. 4ª. The form of the electromagnetic bell apparatus of the substations being shown in other figures, it is not considered necessary to indicate anything more in Fig. 5 than the cores and coils of such apparatus.

At the first and second stations Z Z^2 the cores *m* are wound with two sets of coils 3 and 4. One set 3, passing around both cores in like direction, are in branch *p*, leading from point 12 on main conductor A to the ground or return connection C^2, while the other, 4, passing around both cores, but in different directions, are in branch *q*, which leads from main conductor B at point 13 to the return-conductor C^2; but the coils of the first set at station Z^2 are wound or connected oppositely to those of station Z, so that a current which will reverse the normal magnetic polarity of the cores *m* at Z will emphasize the said polarity at Z^2, and vice versa. The same is true of the apparatus at stations Z^3 and Z^4, except that at these stations the set of coils 3, which pass around both cores in the same direction, are in the branches *q* of main conductor B, and the set which pass around the cores diversely are in the branches *p* from conductor B. At station 5 the core and coil arrangement are in like manner generally similar to those of station 6, there being at each but one set of coils or its equivalent for each core and the coils of the two cores being both so wound that a current passing through both coils in series, forming the operative coil 3 from A to B, will reverse the polarity of the cores and operate the bell apparatus at station 5, while a similar current passing from B to A will operate the bell apparatus at station 6. At these stations, therefore, while the coils of both cores are marked 3, the earth or auxiliary conductor is marked with the numeral 4 to indicate that current passing through either coil alone or through both in parallel to such auxiliary conductor will not operate the apparatus. Again, at stations 7 and 8, if a positively-directed current be sent over A and B jointly in multiple, it will pass through the coils 4 of both cores at station 7 in such a direction as to set up north poles in each in place of their normal south polarity and will operate the bell; but this current will merely strengthen the south polarity at station 8. On the other hand a current from the negative battery-pole will reverse the polarity at 8 and repelling the armature will ring the bell there, but will strengthen the normal polarity at station 7, and as for these two stations the operative currents pass from the coils of both cores to the auxiliary conductor E^2. This path is indicated by the numeral 3 and the coils in series by 4.

It will be noted that at the four stations Z to Z^4, which require for the operation of their signals a plus or a minus current on one or the other of the main conductors and no current on the other, the auxiliary-conductor connection is made with both coils 3 and 4 after each has passed around both cores, while at the remaining four stations, which require for the operation of their signals a current on both main conductors A and B, the connection C^2 of the auxiliary conductor E^2 is made between the coil portions of the two cores.

The current which operates the apparatus at station Z by reversing the polarity of its electromagnetic cores, and thus repelling its armature, will not operate that of station Z^2, because it tends to strengthen the normal polarity of both cores there, or station Z^3 and Z^4, because there, though it passes around both cores, it acts to reverse one core only, and it cannot operate the apparatus at the remaining four stations, because at each it only circulates in the winding of one of the cores, and hence has no action whatsoever on the other. The same reasoning applied to the currents which operate the bells at Z^2, Z^3, and Z^4 shows why these currents also cannot operate the bells at any other station. The current circulating through both mains in series to operate the apparatus at stations Z^5 or Z^6, according to its direction, neutralizes its own action in stations Z to Z^4, because in each, while it passes around the cores in one set of coils in the direction required to reverse them, it also passes around them through the other set of coils in a direction adapted to sustain the normal polarity of one core and to reverse that of the other, the combined effect, so far as the movement of the armature is con-

cerned, being *nil*. So, also, as regards stations Z^7 and Z^8, these currents are adapted to reverse the polarity of one core and reinforce that of the other. These stations therefore are also irresponsive. And the current circulating in both mains A and B in parallel to operate the apparatus at Z^7 or Z^8, according to its direction, for like reasons cannot operate that of any other station, for, as easily may be traced, it does not at any other station traverse the coils of both cores in such a direction and in such manner as to effectuate a reversal of their magnetic polarity simultaneously. It being desirable to give a continuous and protracted ring at any station signaled, the ringing-current is an interrupted one. This may be provided for in a variety of ways. A convenient arrangement of means for the purpose is that shown in the drawings. An electromagnetic interrupter D, comprising a polarized electromagnet D^2, an armature *w*, poised to oscillate between its pole-pieces, and a contact-stop *x*, has the armature and stop connected in the circuit of the source of current G. The magnet-coils of this device are in circuit with a periodic alternating-current generator G^2, which may be maintained in continuous operation by any suitable source of power. By the continual change of polarity brought about by the alternations of current in the magnet-coils D^2 the armature *w* is kept in a state of constant vibration, and thus rapidly and continuously interrupts and closes the circuit. Thus each calling-current that flows over any of the circuit combinations whenever any of the keys is pressed is an intermittent current and will cause the appropriate station-bell to give a continuous ring. I have, however, found it more satisfactory under conditions of practice to localize the make and break for the production of the desired interrupted current by transmitting the calling-current from the central station uninterruptedly and by providing each station-bell apparatus with an automatic vibratory circuit-interrupter. The usual circuit-breaking device of the ordinary vibrating bell may be employed for this purpose, but I find that a self-shunting attachment is preferable. This device is shown in Fig. 6, which represents a metallic circuit connecting a keyboard K and source of current G with a series of selective signals at eight substations Z.

The electromagnetic bell apparatus at each station has its armature *n* connected by a branch wire 12 with one side of the reversal-effecting bell-coils, and an insulated back-stop n^7, with which the armature comes in contact when repelled, is united by a branch 13 with the other side of the said coils. The branches 12 and 13, the armature *n*, and the stop n^7 constitute a normally open shunt, which is closed and the operative coils short-circuited when the armature makes its backward movement. When this appliance is employed, the line-current remains unbroken, but each bell produces its own desired pulsatory effect. When any bell is rung by its appropriate circuit and current combination, the armature *n* is repelled until the spring n^8 touches the tip of the contact-screw n^7. A short circuit being thus established around the active windings of the magnet-coils, the armature impelled by the normal magnetic attraction of the cores which now reasserts itself returns toward the cores. The vibratory effect of this arrangement on the armature is rapid and vigorous.

I have in this system attained good results by providing a total bell-magnet-winding resistance at each station of one thousand ohms, so arranged that in the bell apparatus of the first four stations there are four windings of two hundred and fifty ohms each and in the others two windings each of five hundred ohms.

Having thus fully described my invention and its mode of operation, I claim—

1. An electromagnetic appliance consisting of two iron cores normally and permanently magnetized with like polarity; and magnetization-modifying helices or windings surrounding the said cores respectively; combined with a permanently-magnetized armature common—and as a whole polarized oppositely—to the poles of both of the said cores; the said armature being normally attracted to the said poles by these coöperatively-opposed polarities, and adapted to be repelled therefrom only when such currents are caused to pass through the windings of both cores, as to reverse the polarity of the poles of both simultaneously.

2. The hereinbefore-described electromagnetic apparatus, comprising a permanent inducing-magnet; two iron cores with surrounding magnetization exciting or modifying coils, having their heels or fixed ends secured in inductive relation with one pole of the said permanent magnet, and having their free or polar ends initially and similarly polarized thereby; and an iron armature mounted in front of the said polar ends of the said cores, upon, or in inductive relation with the other pole of the said permanent magnet, and receiving a magnetization therefrom opposite in polarity to that of the poles of the said cores; the said armature being attracted to the said poles by the induced magnetism of the bar-magnet at all times, except during the presence in the modifying-coils of both cores of an electric current adapted to reverse the normal polarity of both poles, and being repelled therefrom when such a current traverses the said coils.

3. The combination in an electromagnetic apparatus, of two bar-electromagnets placed side by side adjacent to each other; an iron armature hung immediately in front of the polar ends of both of the said electromagnets; a permanent inducing-magnet having its poles in inductive relation with the heel ends of the two electromagnet-cores and the armature,

respectively, and thereby imparting magnetization of like polarity to the polar ends of the said cores, and magnetization of opposite polarity to the armature; the said armature in virtue of such induced magnetization being normally attracted to the said electromagnet-poles, and adapted to be retracted therefrom when the induced magnetism of both poles is simultaneously reversed; and a counter-spring associated with the said armature, acting against the normal attraction thereof; substantially as set forth.

4. The combination of two bar-electromagnets with normally-magnetized cores of like polarity, mounted close to each other and side by side; a single oppositely-magnetized armature for both magnets, hung in front of the polar ends of the said cores, and normally attracted thereto in virtue of the said initial magnetizations; a permanent magnet having its poles in magnetic connection, one with the heel of the said two electromagnet-cores, and the other with the said armature, to impart and restore the initial polarity of the former, and to maintain that of the latter; an adjustable counter-spring associated with the said armature and acting in opposition to the normal attraction thereof; and means for temporarily establishing a reversed magnetic polarity in both electromagnet-cores simultaneously, whereby the armature may be repelled therefrom; substantially as set forth.

5. In an electromagnetic bell apparatus, the combination of two adjacently-mounted bar-electromagnets; an inducing permanent magnet having one of its poles attached to and in magnetic connection with the heels of the said electromagnet-cores, and imparting an initial magnetization of like polarity to both; an armature in magnetic connection with the other pole of said permanent magnet, and polarized permanently and oppositely thereby, the said armature being hung in front of the free polar ends of the said electromagnet-cores and normally attracted thereto; an adjustable counteracting spring tending to retract the said armature; means for establishing a temporary reversal of the initial polarity of both electromagnetic cores simultaneously, and for the consequent repulsion or liberation of the armature; a bell-hammer secured to the said armature; and a bell mounted in such position as to be struck by the said bell-hammer when the said armature is thus liberated; substantially as set forth.

6. An improved signal-receiving device, consisting of a permanent magnet; two electromagnetic spools and cores associated therewith, the cores being mounted upon, and polarized by one of the poles thereof; an armature of permanent opposite polarity, mounted opposite the polar ends of said cores, and supporting a bell-hammer, normally attracted to said cores, and adapted to be repelled therefrom when the polarity of both is reversed; a rear contact-stop for the said armature; and a normally open shunt-circuit around the said electromagnet adapted to be closed by the contact of said armature and contact-stop.

7. An electromagnetic bell comprising a permanent magnet; two electromagnetic cores attached to, and inductively magnetized with the same polarity by one of the poles thereof; magnetization-modifying helices arranged for inclusion in an electric circuit, wound upon the said cores, and adapted with a definite current flowing through them to reverse the said polarity of both poles simultaneously; an armature overlapping the poles of both cores, permanently and oppositely magnetized by induction from the other pole of said permanent magnet; the said armature being normally attracted to said cores, but adapted to be repelled by, and move away from them on the said reversal of their polarity, and to be again attracted thereto on the cessation of such reversal; a counter-spring therefor, acting against such normal attraction; a bell-hammer mounted on the said armature; a bell mounted in position to be struck by the said hammer on the repellent movement of said armature; and a vibratory circuit-changer actuated by the movements of the said armature, and controlling the flow of the circuit-current to the said electromagnetic helices, whereby the bell may be rung continuously, substantially as specified.

8. In an electromagnetic bell apparatus, the combination with a magnetic system comprising a permanent magnet, two electromagnetic cores mounted on, and normally polarized by the induction of one of the poles thereof, magnetization-modifying coils surrounding the said cores, an armature permanently polarized by the other permanent magnet-pole suspended in front of the polar ends of both cores, and normally attracted thereto, and a counter-spring therefor acting in opposition to such normal attraction; a bell; and a bell-hammer actuated by the said armature; of a normally open shunt-circuit around both of the said helices, and a vibratory circuit-changer therefor, adapted to close and open the said shunt on the repulsion and attraction respectively of said armature, and thereby to control the flow of the working current to the electromagnetic coils without breaking their circuit; substantially as set forth.

9. In a system of selective electric signals, the combination of the two main line conductors of a metallic circuit extending between a central station and a number of substations; an electromagnetic bell apparatus at each substation having electromagnet-poles and an armature normally attracted by induced magnetism to its said poles and provided with a bell-hammer arranged to strike a bell when repelled from said poles, the said bell apparatus being organized to respond by the repulsion of the armature, only when its magnet-coils are traversed by a definite current adapted to reverse the normal polarity of both of said poles, and having magnet-coils

diversely connected at the several stations, in such manner that the definite current required for the operation of each station-bell shall differ from that of any of the others; a source of call-current supply located at the central station; means for directing the currents from the said source over both main conductors severally, jointly in series, or jointly in parallel, at will, and for thereby producing the said definite current combinations; and means for vibrating or pulsating the currents of the said several combinations, and thereby producing a continuous signal in the bell selectively rung.

10. In a system of selective electric signals, the combination of the two main line conductors of a metallic circuit, connecting a number of substations with a central station; an earth connection at two or more of the said substations; an electromagnetic bell apparatus at each substation having electromagnet-poles and an armature normally attracted by induced magnetism to said poles, and organized to respond by the repulsion of said armature, only to the passage through the electromagnet-coils, of a definite current adapted to reverse the normal polarity of both of said poles; the bell-coils of the several stations being diversely connected in such manner that the definite current required for the operation of each shall differ from that of any of the others; and central-station apparatus, comprising a source of current-supply; an auxiliary earth connection; and a series of keys or buttons representing the said substations respectively, and controlling the connection of the main conductor, the current source, and the earth-connection terminals, each key being arranged to establish a different relation of the said terminals, and thereby to transmit the definite call-current required for the operation of the call-bell represented by it, and no other; substantially as specified.

11. A system of selective electric signaling comprising the following elements in combination; the two main conductors of a metallic circuit extending between a central station, and a number of substations; apparatus at the central station consisting of a source of current; an earth connection; and a transmitting device adapted to interconnect the terminals of the said main conductors, source, and earth connection, in differing combinations, and thereby to transmit current combinations of either direction from the said source over both main conductors severally, jointly in series, or jointly in parallel; an electromagnetic bell apparatus at each substation having electromagnet-poles and an armature normally attracted by induced magnetism to said poles, and adapted to be repelled therefrom, only when the main-line current traversing the electromagnet-coils is such as to reverse the normal polarity of both of said poles; the said coils of the several station-bells being diversely connected in relation to the said main conductors and thereby adapted to effectuate such reversal each in response to a different one of the said current combinations; and means for interrupting or shunting the call-current when any bell is being actuated, whereby the ringing of the said bell may be made continuous.

12. In a selective-signaling system the combination of the two main conductors of a metallic circuit and an earth or return auxiliary conductor common to both, extending between a central station, and a number of substations; a source of signaling-current, and a transmitting device controlled by a series of keys, one for each substation, adapted to interconnect the terminals of the said conductors and source in differing combinations, and thereby to transmit currents of either direction from the said source over both main conductors severally, jointly in series, or jointly in parallel according to the key operated; and a number of main-line polarized bells one for each substation, having electromagnetic coils wound or connected differently with the said main and return conductors, at each station, and thereby adapted to selectively respond each to the transmission of a different one of the said current combinations; each of the said bells having electromagnet-poles corresponding to said electromagnet-coils respectively, and a bell-actuating armature normally attracted to said poles by induced magnetism, and adapted to be repelled therefrom, when the normal polarity of both poles is reversed by the passage through the magnet-coils of the appropriate current combination; each also having an associated shunt or short circuit around its coils, the terminals of which are connected with the armature and its back contact-stop respectively; substantially as and for the purposes specified.

13. In a system of selective signals, two main conductors constituting a metallic telephone-circuit, and an earth or return auxiliary conductor, extending between a central station and a plurality of substations; a source of current; and a plurality of signal-sending keys at the central station, each of the said keys being adapted, when operated, to connect the terminals of the source and of the said conductors in a definite and different way; and signal-receiving devices at the substations each having three magnetic poles, two formed of the iron cores of bar-electromagnets, whose helices are respectively connected each with one of the two main, and the auxiliary conductor, and the third formed of a pivoted armature supporting a bell-hammer; a permanent magnet having one pole in inductive relation with the two electromagnet-cores inductively imparting magnetism of like normal polarity thereto, and the other pole in similar relation to the iron armature permanently magnetizing the same with opposed polarity, and thereby holding the said armature normally attracted to the said electromagnet-poles; and means for reversing

the two electromagnetic poles at the several stations selectively and thereby repelling therefrom the third or armature pole, the said means at any station being actuated by operating the key representing such station, substantially as specified herein.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 21st day of July, 1898.

JOHN A. BARRETT.

Witnesses:

ARTHUR A. MARSTERS,

HARRY H. BRIGHAM.