(No Model.)

S. D. FIELD.

ELECTROMAGNETIC APPARATUS.

No. 529,373. Patented Nov. 20, 1894.

Fig. 1.

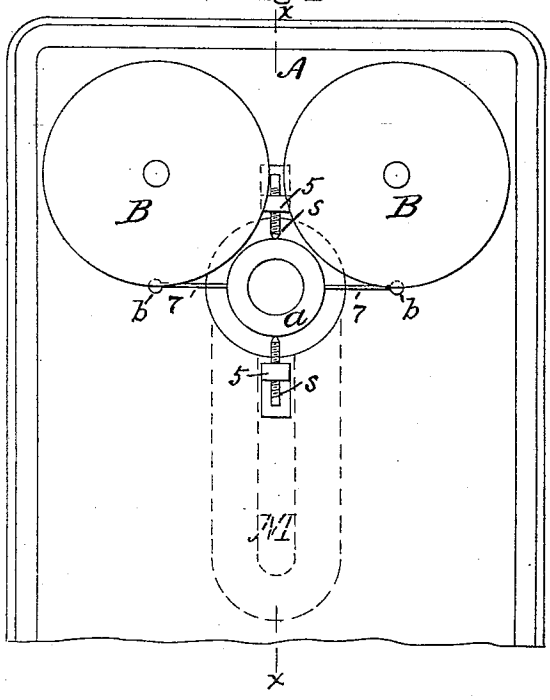


Fig. 2.

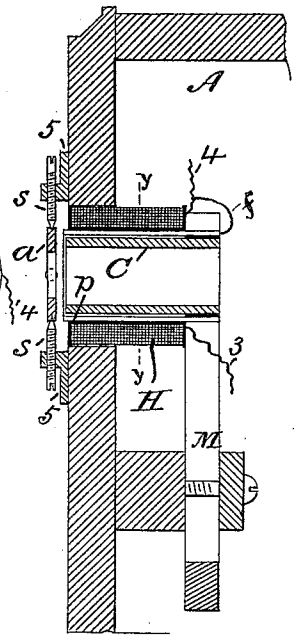


Fig. 3.

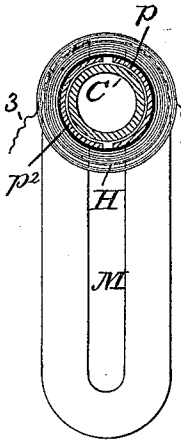


Fig. 4.

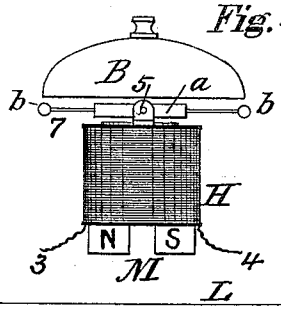


Fig. 5.

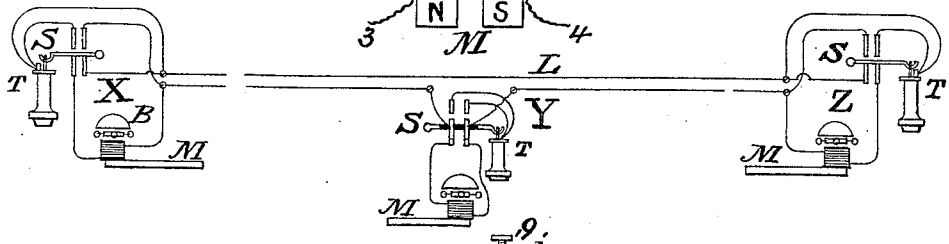
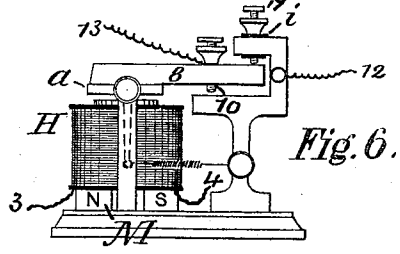


Fig. 6.



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UNITED STATES PATENT OFFICE.

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ELECTROMAGNETIC APPARATUS.

SPECIFICATION forming part of Letters Patent No. 529,373, dated November 20, 1894.

Application filed July 24, 1894. Serial No. 518,480. (No model.)

To all whom it may concern:

Be it known that I, STEPHEN D. FIELD, residing at Stockbridge, in the county of Berkshire and State of Massachusetts, have invented certain Improvements in Electromagnetic Apparatus, of which the following is a specification.

In vibratory telegraphy or telephony, or in compound systems where both slowly and rapidly succeeding electrical impulses traverse the circuit, it has always been a difficult problem which, so far as I am aware, has never been fully, or satisfactorily solved, how to design and construct the necessary and suitable electromagnetic instruments, which with maximum efficiency possess a minimum self-inductive reactance, or wattless resistance. An ordinary telephone line, having way stations, is a well known example of a circuit operated by two classes, or forms of transmission. Such a line must be fitted at its way stations with signal bells whose electromagnets necessarily are required to be always in the circuit; so that at any time the said stations may be signaled through the operation of their respective bells. Such bells efficiently respond to electric currents having a relatively slow rate of change, and the act of sending from any station such signaling currents, may properly be regarded as one form of transmission; but in the transmission of voice currents, as in telephonic conversation between any two stations through one or more intermediate, or way stations, which is a distinct form or class of transmission, it is well known that the electromagnets of the call bells at the said way stations powerfully oppose by their self-inductive reactance, or counter-electromotive force, the passage of the voice currents which have a relatively high rate of change; so strongly in fact, that by a form of speech, it has been said that electromagnets are opaque with respect to voice currents. This is purely an illustrative example, and it is obvious that a great variety of instances may occur, in which the self induction effects of electromagnets in electric circuits are subversive of satisfactory work, both in the obstruction which they oppose at way stations to the passage of through currents and in a phase of such obstruction which in the instruments actually engaged in the manifestation of the desired signals, tends to distort and obstruct the said manifestation. A number of expedients have been suggested for the elimination of these effects, but their application has usually involved a considerable depreciation of the working efficiency of the instruments to which such application is made.

The object of this invention is to provide a construction and arrangement of the essential elements of electromagnetic signaling and other instruments, or appliances, suitable to be embodied in a great variety of such instruments, irrespective of their specific character or function, which, without diminishing their efficiency for the manifestation of their appropriate electrical impulses, shall to the greatest possible extent, suppress in such instruments the disturbing and opposing phenomenon known as self inductive obstruction, or reactance. To attain this object, I combine a structure which itself possesses between its terminals a high electrostatic capacity with a reactionary dynamic induction circuit, on which the electromagnetic portion of the said structure may expend its inductive energy, as on an external circuit, instead of employing the same in itself in the form of opposing self induction; and I locate this auxiliary, or secondary circuit in such a way, that the currents inductively excited therein, shall actually assist the original current in its legitimate function of efficient operation upon its associated magnetic poles. By this fundamental arrangement, I am enabled to provide electromagnetic organizations which will permit the free passage of extremely rapid vibratory impulses, or reversals; and which likewise are in the highest degree efficiently responsive to slow impulses.

The essential features of the invention are as follows: Upon the poles of a horse-shoe permanent magnet, I erect and secure two pole pieces, or polar projections, semicircular, or more accurately speaking, semi-annular, in shape; and embraced between these, I place a peripherally continuous cylinder of metal, preferably copper, which in itself forms a complete and closed circuit. Outside and surrounding the polar projections is placed or

wound a helix, coil, or winding of fine insulated wire, the terminals of which are incorporated in, or adapted to be connected in the line circuit. Changing, or alternating currents, circulating through the line circuit induce currents in the interior closed circuit of low resistance, formed by the copper cylinder; and while these are in the right direction to assist the original or line currents in their magnetizing or demagnetizing influence on the poles of the magnet, they are of a direction reverse with respect to that of the said line currents, and consequently exercise upon them a mutually reactionary inductive influence, causing them to traverse the line helix convolutions with little, or no retardation; provided of course that the initial impulses are of a frequency too great for responsive action by the armature with which the mechanism is provided. As both pole pieces are extended through the same helix, it is evident that currents circulating in the main circuit or line, and through the said helix will strengthen one pole and weaken the other, in accordance with their direction of flow. In order that this action may be enabled to influence an armature, the said armature is made peculiar in form. Trunnions are suitably mounted on opposite sides of the polar projections, and hung in these, is a ring armature which thus is suspended immediately opposite the two semi-annular poles; the said armature being preferably electro-plated, or otherwise coated with copper, or some other good conducting metal, for the purpose of causing its changes of magnetism to occur rather sluggishly. This armature being centrally pivoted between the poles, is attracted indifferently by either, until a current impulse, at any given moment, causes a bias toward one pole or the other, and tilts the armature toward the pole having the greatest attraction. It can be fitted with suitable levers or rods, through which its movements can produce the useful effect for which they are designed. It can for example be fitted with a rod, or rods, extended at right angles to its pivotal mounting and terminating in hammers which can readily be arranged to strike against a bell for signaling purposes; or the said rod may carry contact points, and thus be adapted to operate as a relay, and to control the circuit of a local battery, thereby manifesting signals in a well understood manner.

The polar projections of the magnet are superficially large, and are intimately associated with the inner layer of convolutions of the line helix. This construction of itself imparts to the instrument a high electrostatic capacity, and in some cases this may be still further increased, if desired, by providing an electrical connection between the outer terminal of the line helix and the substance of the polar projections. By this construction the transmission of feeble, but rapidly recurring impulses is greatly facilitated, and a very minute impulse will thus be transmitted by static induction through the apparatus, from one terminal to the other, without the necessity of traversing but a relatively small portion of the coiled wire.

Referring to the drawings which accompany this specification, Figure 1, is a front view of an apparatus indicative of the application of my invention to an electric call bell. Fig. 2, is a vertical section of an apparatus embodying the invention. Fig. 3, is a cross sectional plan view of a portion of such an apparatus on the line *y*, *y*, of Fig. 2, showing the characteristic features of the invention, the armature being removed. Fig. 4, is an end view of a call apparatus in which the invention is associated with a single bell. Fig. 5, is a diagram of a three station telephone circuit fitted with call bells, constructed in accordance with my invention, and Fig. 6 illustrates the invention applied to a relay.

Considering in the first place, Figs. 1, 2 and 3, A represents a baseboard which may be a portion of the casing of an electric call bell. M, is a horse-shoe permanent magnet and *p*, p^2 are respectively pole pieces, or polar projections (preferably of soft iron) mounted on and secured to the poles N, S of the said magnet, and projecting therefrom as shown. These are semi-circular and semi-annular in shape, as if formed by bisecting a hollow cylinder longitudinally, and both are surrounded by a single coil, helix, or winding, H, of fine insulated wire, whose terminal connections 3, 4, are adapted for connection in a line or working circuit, as L, in Fig. 5. Between the semi-annular poles *p*, p^2, and within the tubular chamber formed by their peculiar shape, I place a circumferentially continuous hollow cylinder, sleeve, or hoop, C, of copper which, so located, constitutes an independent electric circuit lying wholly between the magnet poles, and closed on itself, which is auxiliary to the external circuit and helix H, and arranged as a secondary circuit thereto, within which electric currents are induced by the variations of the currents traversing the said helix; and which in turn acts as a reactionary circuit operating upon its primary, and also aiding the said primary in carrying out its proper functions. In its application to intermediate instruments, while vibratory currents are being transmitted from a station on one side, to one on the other side of the said intermediate station, my invention as described, is already complete. This magnet is even before the addition of the cylinder C one of high static capacity, which capacity may be increased by providing an electric connection *f*, between the outer terminal of the helix H, and the magnet pole pieces; but that it may be fitted for use as an electromagnetic translating device, and enabled on its own account to manifest signals, I provide a ring shaped armature *a*, which is hung in pivots, *s*, these being indicated as adjustable screws mounted in brackets, 5, fixed at diametrically

opposite points, at the ends of the line separating the polar projections. The armature ring is thereby placed opposite the semi-annular polar ends and oscillates on its pivots between them, when appropriately slow alternations pass through the coils. If the movements of the said armature are to operate a bell, one or more gongs or bells, B, may be mounted, as shown at a suitable distance from the armature which then is provided with rods, 7, terminated by bell hammers, *b*, arranged to strike the said bells, as in Figs. 1 and 4; or if the apparatus is to be used as a relay, as in Fig. 6, the armature lever or rod, 8, is extended to move at its end between limit stops 9 and 10, one or both of which may also be contact stops to which are attached terminals 12, 13 of a local circuit. In the figure, the stop 10 alone, is a contact stop; and the complementary stop 9 is insulated by a non-conducting bushing, *i*.

My invention is peculiarly applicable to signaling purposes in association with an electric speaking telephone system, where a number of substations are placed sequentially on a single circuit, and where any two stations are in consequence compelled to communicate through the electromagnets of the call bells between them. Prior to my invention, the best way to arrange such a system has been to use the so-called "bridging bell," the several bell magnets at the several stations being connected in parallel branches of the line. Telephonically this arrangement has given great satisfaction, but it presents difficulties in maintenance.

By my invention the necessity of the parallel mode of connection is avoided.

In Fig. 5 X, Y, Z, are three telephone stations, all connected with a single telephone circuit L. At each station is the usual automatic switch S, the telephone instruments T, and a bell organized on the principles enunciated herein, so that the end stations may in virtue of the presence of my invention at the way stations converse without difficulty without regard to the number of such way stations.

Actual tests made to determine the relative value of the self inductive discharges of an ordinary polarized telephone bell magnet and of one in which the hereinbefore described structure is incorporated, show that by employing a discharge key and mirror galvanometer, where the ordinary bell magnet gives a deflection of thirty-five divisions, the deflection produced by the mechanism described in this specification is scarcely perceptible.

Having thus described my invention and stated how it may be carried into effect, I claim—

1. A polarized electro-magnet possessing high electrostatic capacity between its terminals, and consisting of a horse shoe permanent magnet with superficially large pole pieces, and a single main circuit coil, or helix surrounding both of the said pole pieces; in combination with means, substantially as indicated, for reducing the self inductive reactance, and aiding the working efficiency of said main line coil.

2. In an electro-magnet and in combination with the poles thereof, a helix or magnetizing coil adapted to form a portion of an electric circuit, surrounding both of the said poles; and an auxiliary electric circuit closed on itself and located entirely between the said magnet poles; substantially as described.

3. The combination, substantially as described, in an electromagnetic instrument, of a primary helix adapted for inclusion in an electric circuit; an auxiliary, or secondary circuit, of relatively low resistance closed on itself and placed in inductive relation to the said primary helix; and a magnet having its poles surrounded by the said helix and interposed between the said helix and the closed auxiliary circuit.

4. In an electro-magnetic instrument the combination of a permanent magnet; semi-annular pole pieces, or polar projections therefor; an electro-magnetic helix or winding adapted for inclusion in an electric circuit surrounding both polar projections; and an inductive electric circuit closed on itself placed between the said polar projections, substantially as described.

5. In an electro-magnetic instrument, the combination with a permanent magnet; semi-annular polar projections secured thereto; and an electro-magnetic or inducing coil, or winding, adapted for inclusion in an electric circuit surrounding the said polar projections; of a metal cylinder or sleeve constituting a closed reactionary or secondary circuit placed between the semi annular polar projections in inductive relation to the said inducing coil, substantially as specified.

6. The combination with an electro-magnet of high electrostatic capacity comprising two semi-annular polar projections, secured respectively to the two poles of a permanent magnet and surrounded by a single magnetizing or inducing helix of insulated wire; of a secondary inductive or reactionary circuit, consisting of a cylinder or hoop of metal placed between the said polar projections in inductive relation to the said inducing helix as described herein.

7. An electro magnetic instrument, comprising a permanent horse shoe magnet; semi-annular pole pieces therefor secured thereto; a magnetizing or inducing coil adapted for inclusion in an electric circuit wound round, or placed over both of the said pole pieces; and a ring armature suitably supported in front of the said pole pieces, and adapted to be responsive to the magnetic variations thereof; substantially as described.

8. In an electro magnetic instrument, a permanent magnet provided with semi-annular polar projections of large external surface; and an inducing coil or winding adapted for connection in an electric circuit, wound, or

placed over both polar projections so as to produce between its terminals a high electrostatic capacity; combined with a closed reactionary or induction circuit placed wholly between the said semi-annular polar projections; substantially as and for the purposes specified.

9. An electro magnetic instrument of low self induction and high efficiency consisting of a permanent magnet having semi-annular polar projections, one secured to each pole; a magnetizing or inducing coil surrounding both polar projections and arranged to form part of the working circuit; a ring armature suitably hung in pivots in front of the said polar projections and adapted to be actuated thereby; and a secondary electric circuit closed on itself and placed wholly between and embraced by the said polar projections, substantially as specified.

10. An electro magnetic instrument, comprising a permanent horse shoe magnet, having a semi-annular pole piece projecting from each pole; an inducing coil adapted to form part of a working circuit surrounding both pole pieces; a ring armature plated with copper or similar highly conducting metal hung within operative range of the said pole pieces; and a secondary circuit closed on itself placed in the recess formed between the said semi annular pole pieces, substantially as described.

11. The combination in an electro magnetic instrument of a permanent magnet; semi annular polar projections secured to the poles thereof; a suitable annular armature mounted in front of the said polar projections; a helix of insulated wire adapted for inclusion in an external circuit surrounding both polar projections; an electrical connection between the said helix and the said polar projections; and a metallic cylinder, ring or sleeve, constituting an independent or secondary circuit closed on itself, and fitted between the semi annular magnet poles, substantially as described herein.

12. A polarized induction coil having both poles of the inducing medium inclosed within the primary and placed outside of the secondary circuit.

13. A polarized electric bell comprising in a single organization a horse-shoe permanent magnet, with semi-annular polar projections, both surrounded by a single electro magnetic helix adapted for connection in a main electric circuit; a secondary or induction circuit closed on itself and placed wholly between, and in close proximity to the said pole pieces; a ring armature mounted in pivots in front of the said annular pole pieces, and adapted to oscillate in response to alternating currents passing in the main circuit helix; a bell hammer secured to the said armature; and a bell adapted to be struck by the said hammer, substantially as described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 17th day of July, 1894.

STEPHEN D. FIELD.

Witnesses:
THOMAS D. LOCKWOOD,
CHAS. E. EVANS.