(No Model.) 2 Sheets—Sheet 1.

F. R. McBERTY.

ELECTRO MAGNET.

No. 512,386. Patented Jan. 9, 1894.

Fig. 1

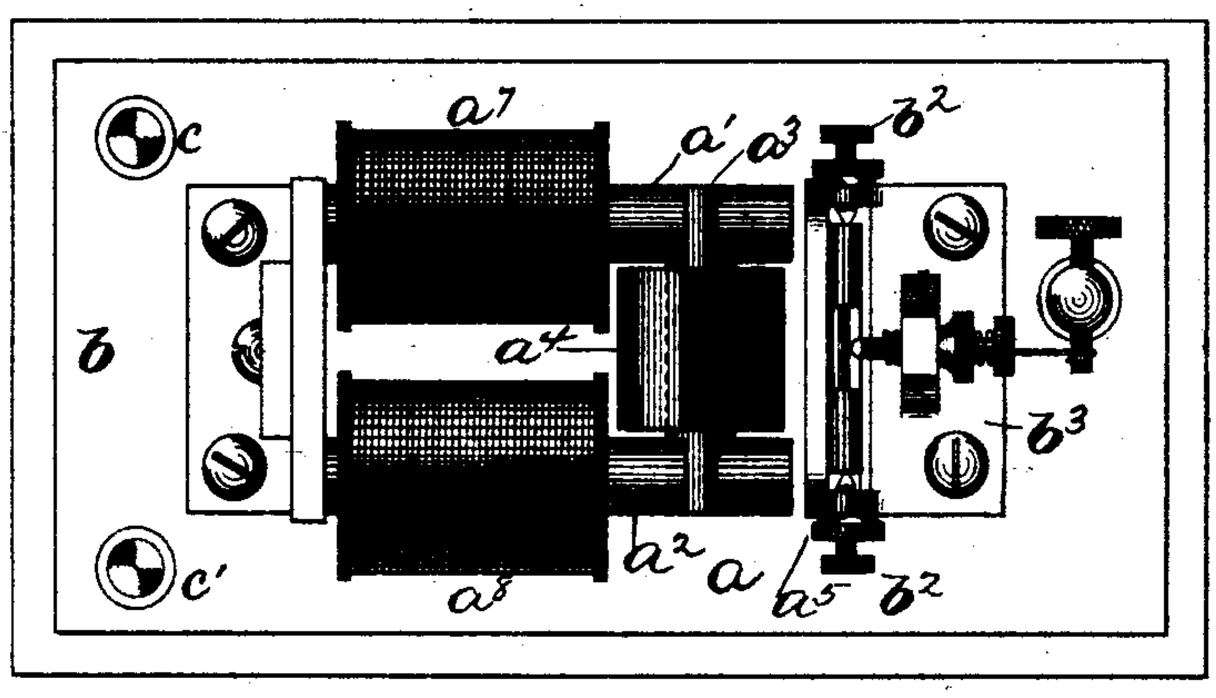


Fig. 2

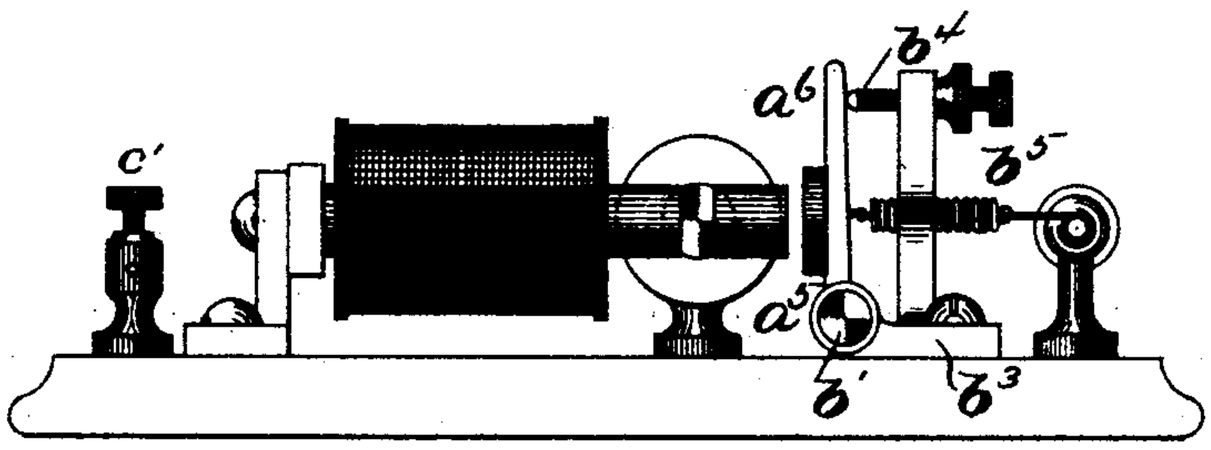


Fig. 3

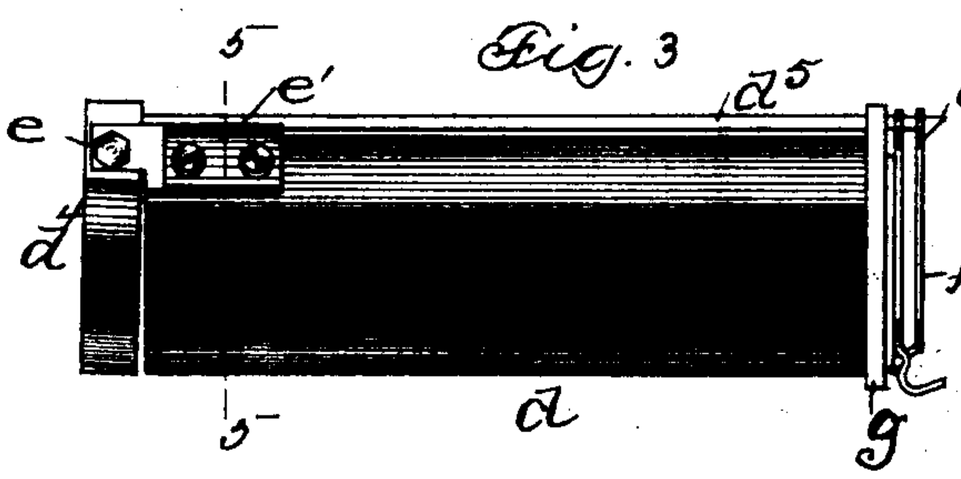


Fig. 5

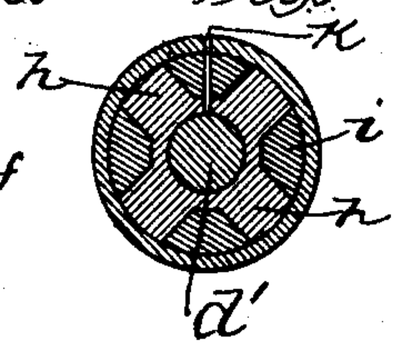
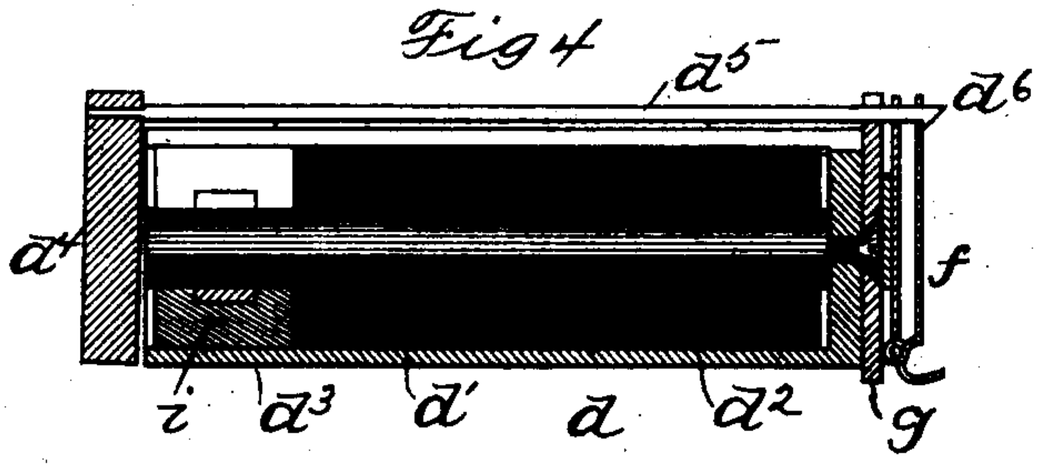


Fig 4



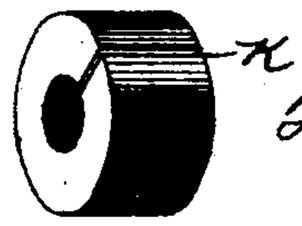


Fig. 6.

WITNESSES

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(No Model.) 2 Sheets—Sheet 2.

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ELECTRO MAGNET.

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Fig. 7

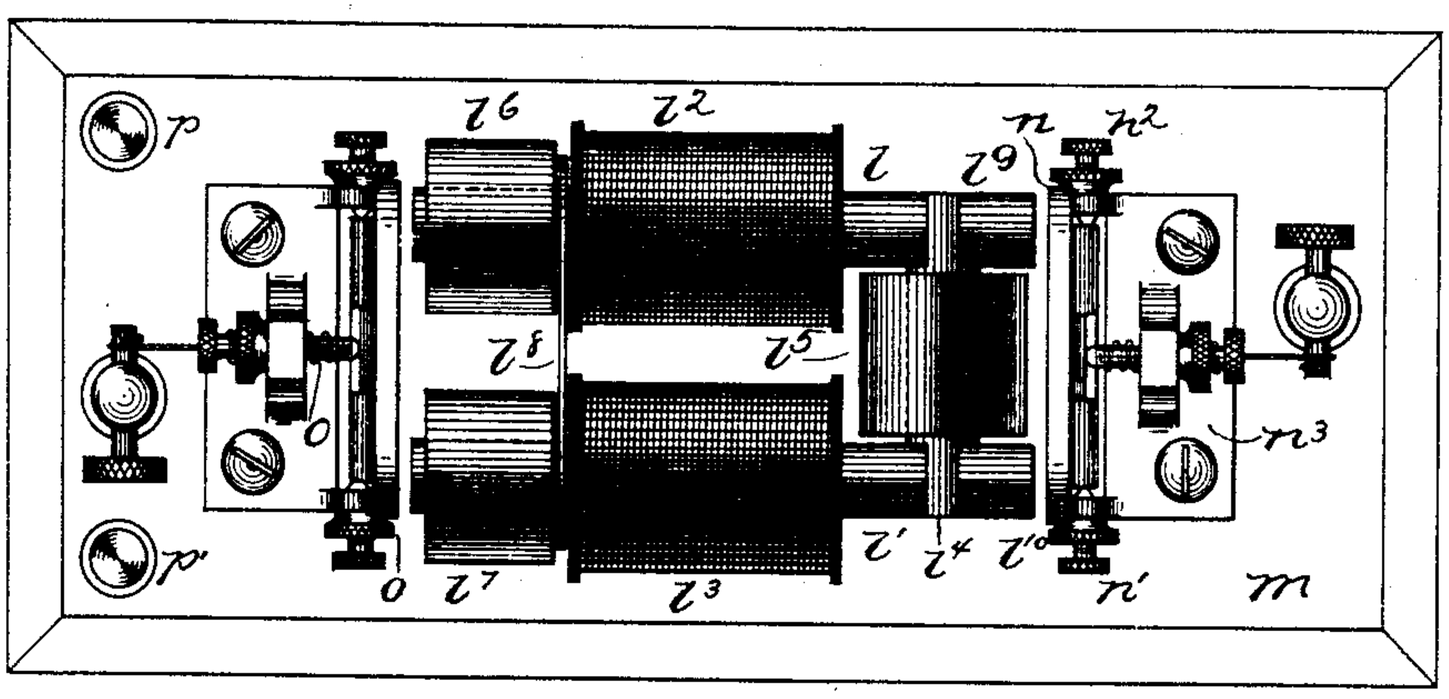


Fig. 8

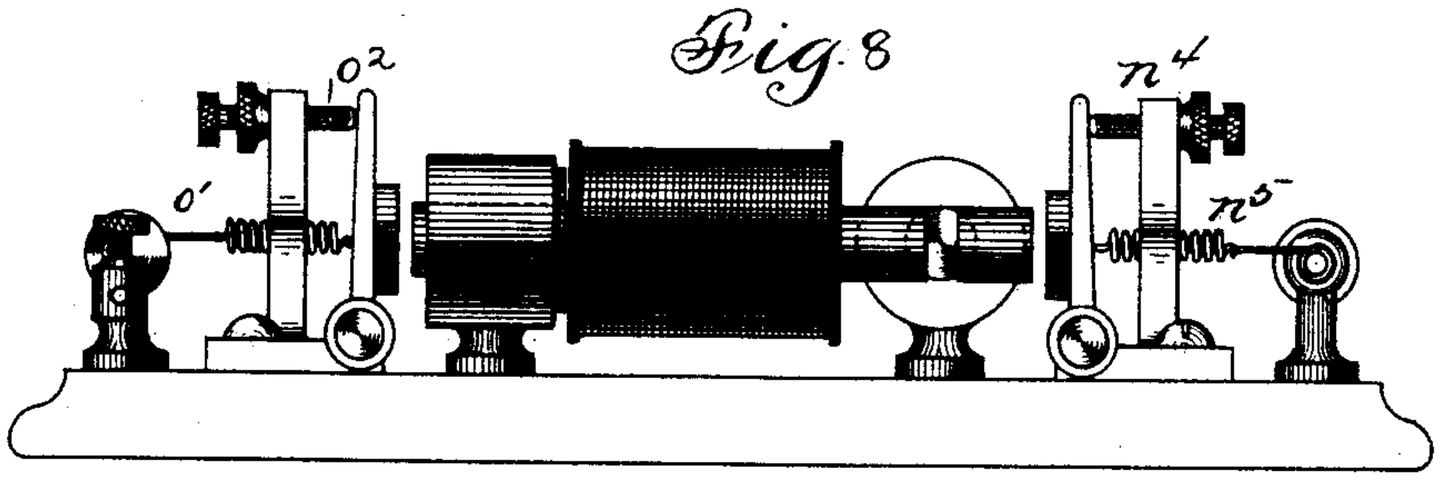


Fig 9

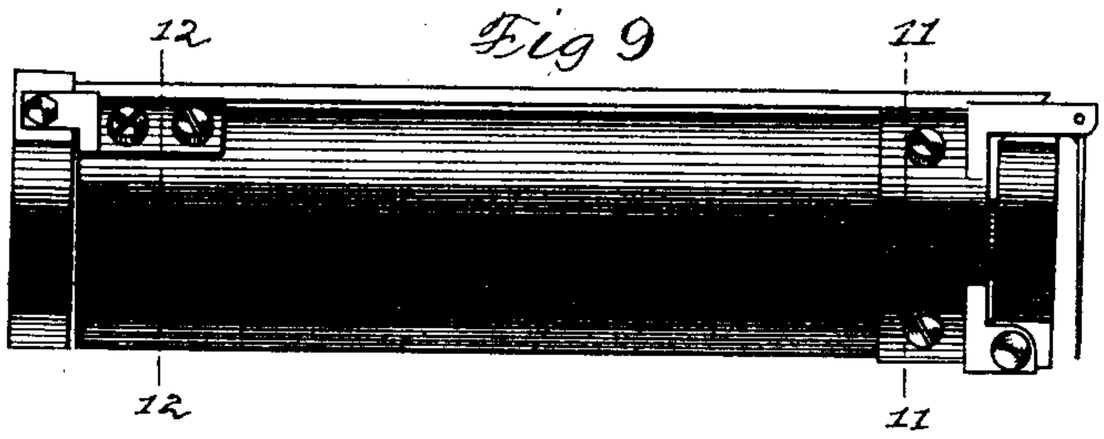


Fig. 10

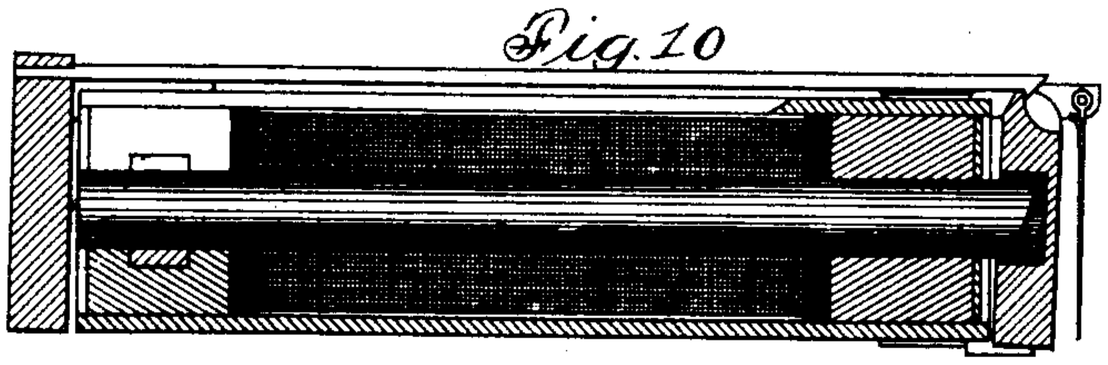


Fig. 11

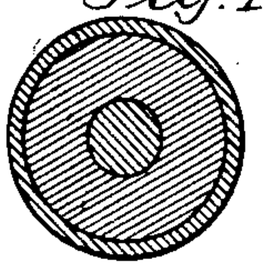


Fig. 12

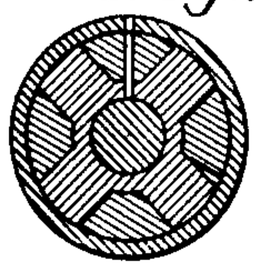
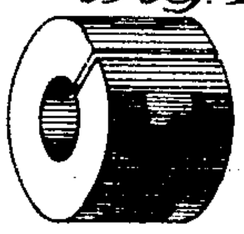


Fig. 13.



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ELECTRO-MAGNET.

SPECIFICATION forming part of Letters Patent No. 512,386, dated January 9, 1894.

Application filed May 16, 1893. Serial No. 474,429. (No model.)

To all whom it may concern:

Be it known that I, FRANK R. McBERTY, a citizen of the United States, residing at Downer's Grove, in the county of Du Page and State of Illinois, have invented a certain new and useful Improvement in Electro-Magnets, (Case No. 7) of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to electromagnetic appliances for use with currents of varying character; its object is to produce an electromagnetic device which shall be responsive to alternating currents, but not to approximately continuous currents of constant direction.

In my joint application with C. E. Scribner, Serial No. 469,263, filed April 6, 1893, for electromagnets and annunciators, is described an electromagnet which is responsive to continuous, or approximately continuous currents, but not to alternating currents. This characteristic is produced by closed conductors threaded by lines of force of the electromagnet, the conductors being preferably placed near the poles of the magnet, the effect of the closed conductors being a tendency to demagnetize the poles of the magnet and to prevent their attraction of the armature when the magnetism of the magnet is rapidly varied or alternated.

My present invention is an extension of the idea embodied in the joint invention, the reverse result being obtained; that is, the device is made responsive to alternating currents, but not to continuous currents.

In my present invention I provide a magnetic short circuit for the electromagnet, shunting the armature, and I encircle the bar of iron or other magnetic material constituting the shunt or short circuit by a closed conductor. The magnetic shunt thus becomes operative only when the magnetism of the magnet remains practically constant; a varying or alternating magnetization of the magnetic shunt is prevented or opposed by the induced currents in the conductor encircling the shunt and the lines of force of the electromagnet are compelled to traverse the armature and thus to cause its attraction. Thus in practice I may connect the poles of an ordinary electromagnet by a bar of iron of sufficient cross section to prevent any appreciable attraction of its armature by the electromagnet, and I surround this shunting bar by a mass of copper, as a copper cylinder. The armature will then be found to remain unattracted when the coils of the magnet are traversed by a continuous current, but will be attracted when the coils are traversed by alternating currents, almost as strongly as if the magnetic shunt were absent.

In a modification of my invention I combine the present device with that of the joint application mentioned. The electromagnet may be provided with an armature at each end, the cores being united at one end by a yoke of magnetic material surrounded by a copper cylinder, while the other ends of the cores may be each surrounded by a copper cylinder; when an alternating current is sent through the coils of this device one of the armatures is attracted, while with a continuous current through the magnet the other armature is attracted.

My invention is obviously capable of numerous applications, but it is of especial utility in connection with telephone apparatus, particularly in the annunciators of telephone lines. The annunciators in common use are designed to be operated by the alternating signaling currents commonly employed in telephone exchange systems, but they are also equally sensitive to "stray" currents of approximately continuous character which frequently find circuit upon the telephone lines from extraneous sources. An annunciator may be constructed in accordance with my invention which shall be operated by alternating currents only, or, an annunciator of the self-restoring type may be constructed which shall be operated by an alternating current, but which shall be restored or replaced to its normal position by a continuous current.

I have illustrated my invention in the accompanying drawings and will describe it with reference thereto.

Figure 1 of the drawings represent in plan my invention in a simple form as applied to a telegraph relay. Fig. 2 is a side elevation of the same device. Fig. 3 is a side elevation

of an annunciator embodying my invention. Fig. 4 is a longitudinal central section of the annunciator. Fig. 5 is a transverse section of the annunciator on line 5—5 of Fig. 3 through the iron shunting bar or disk and the conducting mass. Fig. 6 is a perspective view of the shunting bar or plate and the copper mass removed from the annunciator. Fig. 7 is a plan of a telegraph relay provided with two armatures, as described. Fig. 8 is a side elevation of the same relay. Fig. 9 is a side elevation of a telephone annunciator of the self-restoring type provided with my improvement. Fig. 10 is a longitudinal central section of the annunciator. Fig. 11 is a transverse section thereof upon line 11—11 of Fig. 9. Fig. 12 is a transverse section on line 12—12 of Fig. 9. Fig. 13 is a perspective view of the shunting plate employed in this annunciator.

Figs. 1 and 2 illustrate my invention in its simplest form. The cores a' a^2 of a horseshoe electromagnet a are united near their polar extensions by a bar a^3 of iron which is surrounded or encircled by a heavy tube or cylinder a^4 of copper. The magnet is mounted in a suitable manner upon a base b; before its poles an armature a^5 is placed, supported upon an armature lever a^6 pivoted upon trunnions b' b^2 supported in a frame b^3 mounted upon the base plate b. The armature lever is normally retracted against a stop b^4 by an adjustable spring b^5 in the usual manner. The terminals of the coils a^7 a^8 of the electromagnet are led to binding posts c and c' as usual. When a continuous current finds circuit through the coils a^7 a^8 the cores a' a^2 are magnetized, the lines of force all, or nearly all, finding circuit through the magnetic shunting or short circuiting bar a^3; hence the prolongations of the cores beyond the bar a^3, or the poles of the magnet, are feebly magnetized or entirely inert, and the armature a^6 remains unattracted. When, however, an alternating current traverses the coils a^7 a^8 the lines of force set up in the cores a' a^2 by the coils are prevented from traversing the shunting bar a^3 by the reaction upon the bar of the closed circuit a^4. Each slight pulsation of magnetism through the bar a^3 induces a current in the cylinder a^4 in a direction to oppose the further magnetization of the bar a^3, and by making the mass of the cylinder a^4 considerable, such magnetism is, as stated, almost entirely prevented. The lines of force of the cores a' a^2 being thus, so to speak, prevented from traversing the shunting path, find circuit onward through the poles of the magnet to the armature a^5, causing the latter to be powerfully attracted.

In the annunciator shown in Figs. 3 to 6 the electromagnet d is, for the sake of compactness, constructed in the tubular form. It thus comprises a core d' upon which the helix d^2 is wound, the whole being inclosed in a tubular shell d^3 closed at one extremity. Opposite the open extremity of the tube, before the poles of the magnet, an armature d^4 is suspended at its upper edge upon trunnions e carried in a bracket e' fixed to the shell of the magnet. The armature d^4 carries a light arm d^5 which extends forward and terminates in a catch d^6. A light shutter f is hinged at its lower edge and to one side of its center of gravity to a base plate g upon which the annunciator is mounted; the upper edge of the shutter f is adapted to engage with the catch d^6, the shutter being normally retained thereby in its vertical position. When the catch d^6 is disengaged from the shutter the latter is permitted to fall into a horizontal position, disclosing the face of the plate g upon which any suitable number or indication may be placed. The bar or magnetic bridge or shunt in this form of magnet may best be constructed as a star or radiated disk of magnetic material, whose arms are surrounded by a metallic mass, preferably of low magnetic permeability. Thus, as seen in Fig. 5, a star h of iron is constructed, having a central perforation which fits closely upon the core d' of the magnet, the extremities of the arms of the star being made to fit closely the interior of the shell d^3. The star h is embedded in a mass i of copper, the copper being continued to a considerable depth upon each side of the star and filling the openings between the arms. There thus exists a closed circuit of copper about each of the arms of the star, the circuit being very short and of comparatively large cross section. A slot or saw-cut k is cut radially in the cylinder formed by the star and the mass of copper to prevent the detrimental effect of induced currents circulating about the core d'. The operation of the annunciator is substantially the same as that of the form of electromagnet before described. The magnetic circuit of the magnet, when continuously energized, is through the core d', the bridge h of iron to the shell d^3, thence returning to the core; the armature is thus shunted as before by the iron disk h and remains unattracted; but when the magnet is energized by alternating currents in the coil d^2, induced currents are caused to circulate about each of the arms of the star h in the mass i of copper, thus preventing the shunting effect of the star h and causing the armature d^4 to be attracted. The catch d^6 is thus raised out of engagement with the shutter f, permitting the latter to fall and give its signal.

In the modified form shown in Figs. 7 and 8, a pair of cores l l' are provided, surrounded by helices l^2 l^3. At one end of the magnet the cores l l' are joined by a bar l^4 of iron which is surrounded by a heavy copper cylinder or tube l^5. The other extremities of the cores l l' are encircled by other copper cylinders l^6 l^7 and are connected by a light bridge l^8 of iron, placed between the magnet helices and the cylinders l^6 l^7. The magnet is supported upon a base plate m. Two armatures n and o are provided for the magnet,

one at each end. The armature n is arranged before the polar extensions l^9 l^{10} of the cores l l' beyond the yoke or bar l^4, being supported upon trunnions n' n^2 in a base plate n^3. The armature is provided with the usual adjustable stop n^4 and retractile spring n^5. At the other end of the magnet the armature o is pivotally supported before the poles of the cores l l' which project through the cylinders l^6 l^7, the armature being also provided with the retractile spring o' and stop o^2. The terminals of the helices l^2 l^3 are led to binding posts p p'. When in this modification a continuous current finds circuit through the coils of the magnet, the cores l l' are magnetized, the lines of force developed in them finding circuit through the bar l^4 and the armature o unopposed by induced currents in either cylinder l^5, l^6 or l^7. The armature o is attracted and moves toward its poles, the armature n at the same time remaining unattracted. When, on the other hand, alternating current traverses the magnet, the lines of force produced in the cores l l' are prevented from finding circuit through the bar l^4 and are forced to pass through the tubular extensions l^9 l^{10} and the armature n, attracting this armature and setting it in motion. The magnetization of those portions of the cores l l' which are encircled by the cylinders l^6 l^7 is prevented by the similar opposing effect of the induced currents in the cylinders, the armature o remaining therefore unattracted. The thin bridge l^8 between the cores is provided to serve as a path for the lines of force through the cores when the armature o is unattracted — that is, when alternating currents are traversing the magnet helices.

If desired the stops n^4 and o^2 and the cooperating contact surfaces of the armature levers, properly insulated, may control two local circuits including sounders, the coils l^2 l^3 being in a telegraph line provided with keys for closing either alternating or continuous current to the line circuit in the well known manner. When thus arranged, each closure of the key sending alternating current will cause the armature n to be attracted and to operate its sounder; while each closure of the key sending continuous current will cause the armature o only to be operated. When the keys are simultaneously closed, I find that both armatures are attracted, and hence both sounders are operated. In fact, by the simultaneous manipulation of the two keys, two messages may be simultaneously transmitted and reproduced, one upon each of the sounders, through the medium of the same relay, one of the armatures of the relay responding only to current of one character, and the other only to current of the other character.

In Figs. 9 to 13, the annunciator shown resembles that previously described, but the shutter is arranged to be an armature of the tubular electromagnet so as to be restored by the energization of the magnet. This annunciator comprises a tubular electromagnet q having a core q', a helix q^2 wound thereon, and a tubular shell q^3, the magnet being open at each end; before one end of the magnet an armature r is hung from its upper edge as in the ordinary annunciator; before the other end of the magnet another armature s is placed, pivoted at its lower edge and a little to one side of its center of gravity in order that the armature may fall outward when free. The armature r carries an arm r' terminating in a catch which is adapted to engage with the upper edge of the armature s, and thus to retain the latter armature in its vertical position. In front of the armature s is suspended a light shield t from its upper edge, which normally conceals the face of the armature; when the armature is released it falls against the shield and pushes it into a horizontal position, thus disclosing the face of the armature and the number or other indication which may be painted thereon. The core q' is surrounded at the extremity nearest the armature r by a cylinder u consisting of an iron star h embedded in a mass of copper i, like that described before in connection with the other form of annunciator. The other extremity of the core is surrounded by a solid copper cylinder or tube v. When an alternating current traverses the helix q^2 of this annunciator, the armature s remains unattracted, while the armature r is attracted, releasing armature s and permitting it to fall and give the indication; but when a continuous current, as the current from a battery, is closed through the annunciator magnet the armature s is attracted and drawn back to its normal position, in engagement with the catch, the armature r being now unattracted.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. The combination with an electromagnet provided with an armature, of a bridge or bar of magnetic material shunting the armature, and a closed conducting circuit encircling the said bridge, substantially as described.

2. The combination with an electromagnet, of a bar of iron permanently uniting the poles thereof, and a cylinder or tube of metal surrounding the said bar, substantially as described.

3. The combination with a tubular magnet, of radial arms of magnetic material connecting the core with the shell of the magnet, and a mass of conducting metal surrounding the said arm, substantially as described.

4. The combination in an electric annunciator, of an electromagnet, an armature therefor, an indicator controlled by the said armature, a bridge of magnetic material connecting the poles of the magnet, and a mass of metal of low magnetic permeability surrounding the bridge, substantially as described.

5. The combination in an electromagnet, of the two cores thereof, a bar or yoke of magnetic material joining the two cores near one

end, a closed conducting circuit encircling the said bar, a movable armature before the extremities of the cores at the same end, other closed conducting circuits encircling the other ends of the said cores, and another armature before the latter extremities of the bars, substantially as described.

6. The combination with the core of an electromagnet, of two armatures one opposite each end thereof, a bar or mass of magnetic material arranged in magnetic shunt of the said armature, a closed conducting circuit encircling the said bar, and another closed conducting circuit encircling the core near the other armature, whereby the magnet is caused to attract one armature when energized by a continuous current, and the other armature when energized by an alternating current, substantially as described.

7. In an electric annunciator, the combination with a tubular magnet, of an armature opposite each end thereof, one armature, serving as the indicator of the annunciator, being normally retained undisplayed by mechanism controlled by the other armature engaging with the shutter, radial arms of magnetic material shunting the armature controlling said mechanism, a mass of metal of low magnetic permeability surrounding the said radial arms, and a cylinder of metal of low magnetic permeability surrounding the end of the core which is adapted to attract the shutter-armature, substantially as described.

8. The combination with an electromagnet and the movable armature thereof, of a bar or mass of magnetic material in magnetic shunt of the armature, a closed conducting circuit encircling the said magnetic shunt, and means for closing either alternating or continuous current through the coil of the electromagnet, substantially as described.

9. The combination with an electromagnet, of an armature at each end thereof, a closed conducting circuit encircling the pole of the magnet near one of the armatures, a magnetic shunt about the other armature encircled by a closed conducting circuit, and means for closing either alternating or continuous current through the coil of the magnet, whereby one armature or the other may be operated, substantially as described.

In witness whereof I hereunto subscribe my name this 24th day of April, A. D. 1893.

FRANK R. McBERTY.

Witnesses:
ELLA EDLER,
D. E. WILLETT.