(No Model.)

# S. D. FIELD.

## ELECTRIC SIGNAL RECEIVING INSTRUMENT.

No. 409,675. Patented Aug. 27, 1889.

*Fig. 1.*

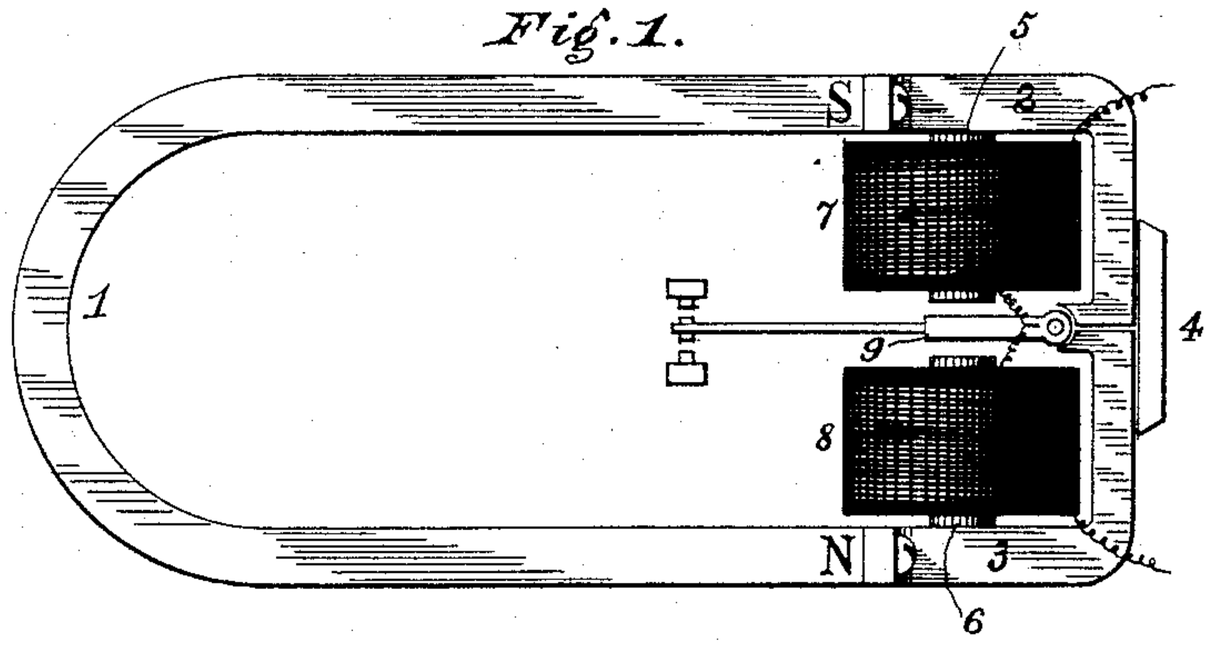



*Fig. 2.*

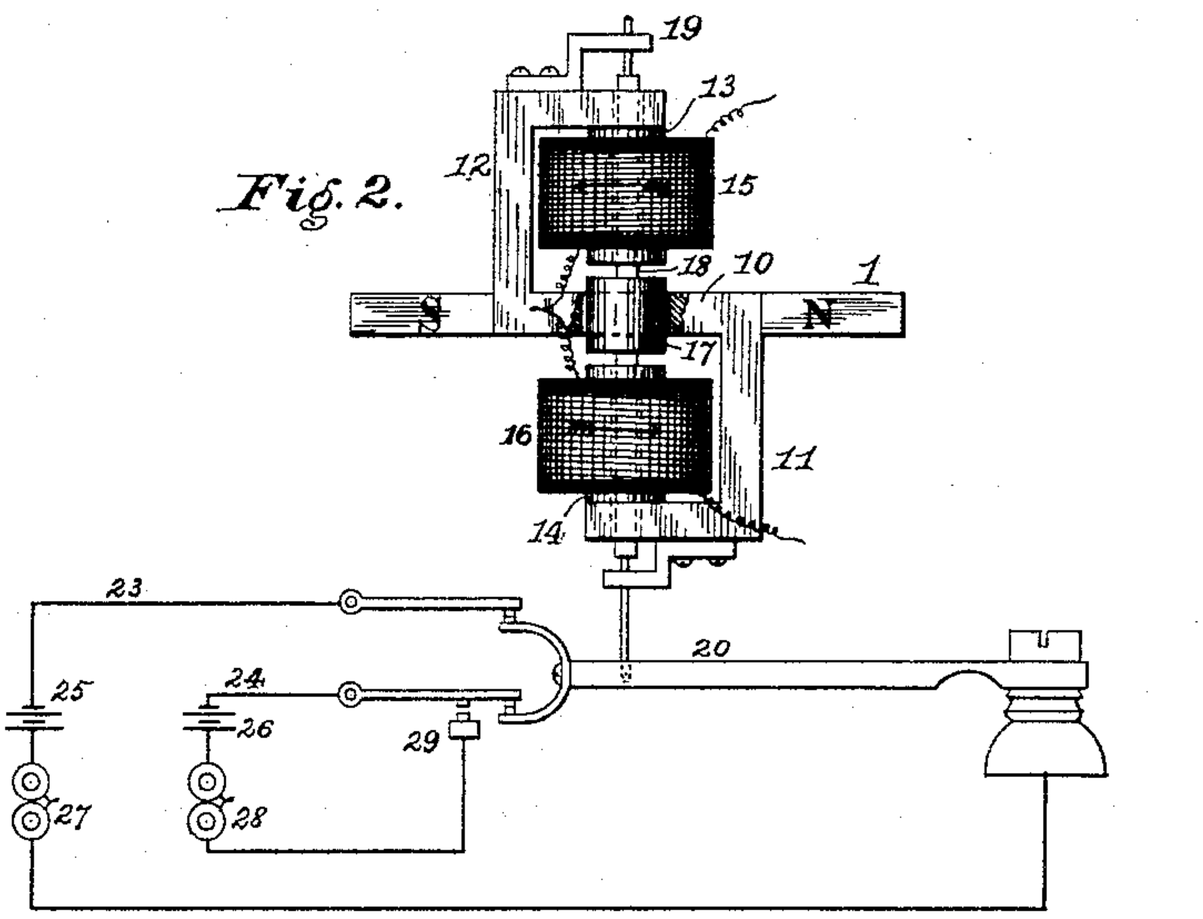
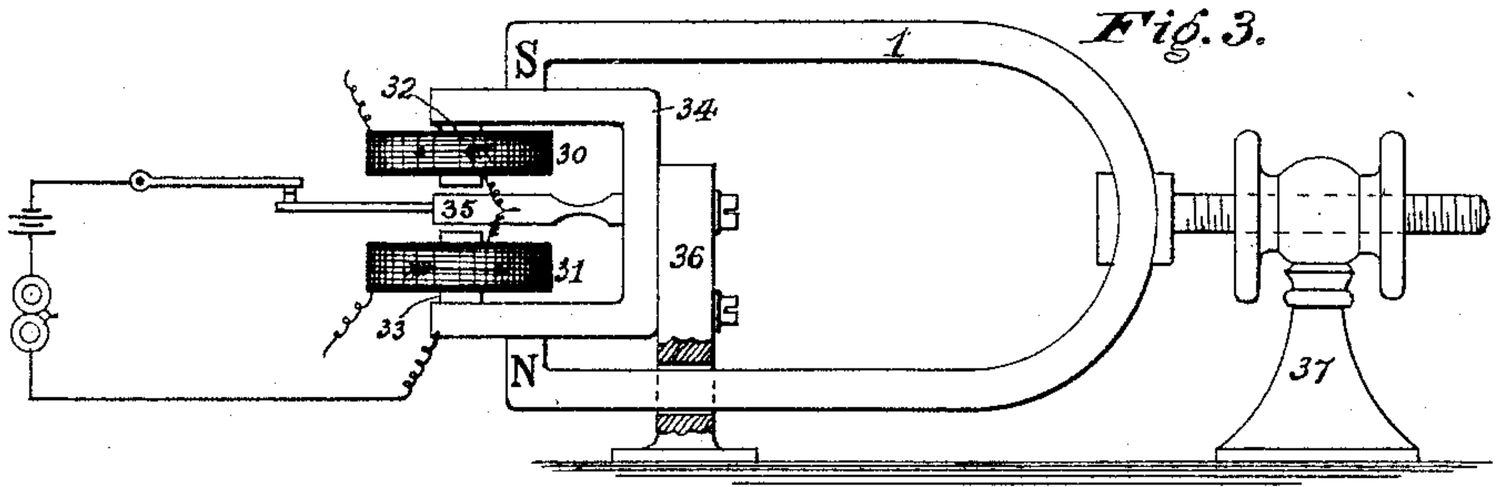



*Fig. 3.*

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## ELECTRIC SIGNAL-RECEIVING INSTRUMENT.

SPECIFICATION forming part of Letters Patent No. 409,675, dated August 27, 1889.

Application filed May 16, 1889. Serial No. 311,016. (No model.)

*To all whom it may concern:*

Be it known that I, STEPHEN DUDLEY FIELD, a citizen of the United States, residing at Stockbridge, in the county of Berkshire and State of Massachusetts, have invented certain new and useful Improvements in Electric Signal-Receiving Instruments; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to a novel form and construction of that class of electric signal-receiving instruments known variously as "receivers," "relays," "alarms," according to the particular character of work for which the instrument is used. Among other objects I have designed this instrument with a view to a very great elimination of self-induction or coil-inertia and magnetic hysteresis, and also to the provision of what I term a "self-adjusting polarization," which automatically follows the variations of current-strength passing through the coils of the instrument.

In the organization of the apparatus to which my present invention relates I have taken advantage of the discovery of Henry—namely, that a coil of wire, when brought into proximity with another coil located in a parallel plane, will, when currents of a given direction are passed through it, induce in such other coil currents which flow in an opposite direction. If, accordingly, I so organize the instrument with two bobbins, so that the exciting-currents circulate in opposite directions in the bobbins, respectively, and locate the bobbins in parallel planes, the inductive effect of the currents in one bobbin upon those in the other will largely overcome the magnetic drag which would be felt were the bobbins so connected that the exciting-currents flowed in the same direction in both, as is the case with this class of apparatus now in use.

It is a well-recognized fact that in ordinary polarized relays having fixed iron cores, since the polarization is a fixed quantity and certain strength, the vibrating tongue is apt to become either too sensitive or too sluggish. When the polarization is weak, the tongue is very readily responsive to light currents, but apathetic toward heavy currents, and vice versa. In accordance with my invention, I superpose upon a practically-closed magnetic circuit an open electro-magnet circuit, in which the vibrating tongue is located. I so arrange these two magnetic circuits relatively that the currents flowing around the poles of the open electro-magnetic circuit will cause more or less lines of force to be deflected from the closed or practically-closed magnetic circuit, and I have found that the number of lines so deflected bears a very close relation to the electrical energy employed to produce such deflection, and that I thus obtain a polarized instrument having what I term a "self-adjusting or automatic polarization."

With the foregoing principles of action my invention consists in the arrangement and organization of devices, substantially as hereinafter fully described, and particularly pointed out in the claims.

In the drawings which form part of this specification, Figure 1 is a plan view of a polarized relay constructed after my invention. Fig. 2 is an elevation of another form having an iron plug instead of a tongue, and designed for a use in a multiple relay apparatus which is diagrammatically appended to the figure. Fig. 3 shows another modification.

Referring to Fig. 1, 1 is a strong magnet having the permanent poles N and S, respectively, on which are mounted the soft-iron pole-pieces 2 and 3, similar in shape and approaching each other so closely as to exhibit little or no polarity at their adjacent ends, because in a practical sense the magnetic break is so short that the circuit may be substantially considered as closed. An armature 4, however, may be used to bridge the break, but can be dispensed with without materially detracting from the efficiency of the apparatus.

At two corresponding portions of the pole-pieces 2 3, I attach the respective iron cores 5 6, which have a common axis and project inwardly toward each other, as shown. On these I mount the respective helices 7 8, which I connect into the exciting-circuit in such manner that the currents will flow in the helices in relatively opposite directions, as indicated by the arrows.

Since the pole-pieces 2 3 form a practically

closed circuit for the magnet-poles N S, but very little polarity will normally or in a state of rest be found in the adjacent ends of the cores 5 6. A soft-iron tongue 9 is pivoted so that its heel is in close inductive relation to the two pole-pieces 2 3 and its extension stands between the cores 5 6. This tongue will lie indifferently on either side when no current is flowing through the helices 7 8.

We will assume that a current flows in helix 7 in such direction that it tends to induce N polarity at the projecting end of the core 5, attached to the pole-pieces 2 of permanent magnet 1. This current, acting on the pole-piece 2 directly through the rear end of the core 5 and externally by the outer convolutions, will induce stronger S polarity in pole-piece 2 at the heel of tongue 9. At the same time, for similar but converse reasons, the current in helix 8 will weaken the polarity of the end of pole-piece 3. Hence the pole-piece 2 is strengthened and pole-piece 3 weakened in magnetism, while a precisely opposite effect is produced in the cores 5 6. The amount of this respective strengthening and weakening depends upon the current flowing. The result is a movement of the tongue 9 to one side or the other with a force proportional to or dependent on the strength of current used; and as the currents in the respective parallel helices 7 8 are in opposite directions their inductive effects, obedient to the Henry law, largely serve to neutralize their magnetic lag, so that the latter is quite unaffected by the strength of current flowing. In all cases the movement of the tongue 9 is exceedingly sharp and prompt, whether the current used be very heavy or almost infinitely small.

A modification of the foregoing construction and arrangement is shown at Fig. 2, which may be considered as an elevation of the apparatus. The permanent magnet 1 lies in a horizontal plane, having its poles N and S toward the front, as shown, and between these poles is placed an **S**-shaped armature, having its central bar 10 directly in contact at both ends with the poles N S respectively and having next the N pole the downwardly-extended pole-piece 11 and next the S pole the upwardly-extended pole-piece 12. The two pole-pieces 11 and 12 are returned inwardly, so as to have their ends standing in the same axis with the center of the cross-bar 10, as shown.

On the pole-pieces 11 and 12 respectively are mounted tubular iron cores 13 and 14, and on these are mounted the respective helices 15 and 16, which are so connected that the arriving currents pass through the respective helices in opposite directions. The center of the bar-armature 10 is perforated for the location of an iron plug 17, which is fixed to a very light aluminium rod 18, which extends through the tubular cores of the two helices. The upper end of this rod is connected conveniently in the jewel-bearing 19 and the lower end is fixed to a vibrating reed 20, for purposes to be hereinafter described.

If desired, a slight gap may be left in the magnetic circuit of the bar 1 at the faces of the poles N and S; but these will not materially affect the operation of the apparatus in an efficient manner.

The flow of currents through the respective helices 15 and 16 bring about exactly the same inductive influences as those described in connection with the operation of the apparatus illustrated by Fig. 1, and the result is a motion of the iron plug 17 upwardly and downwardly in the same manner as the tongue 9 does in that apparatus. The purpose of the movement of the plug 17 is to cause a corresponding movement of the reed 20, which brings the relay functions into effective operation. For this purpose the tongue 20 is fitted with a fork having the respective local circuits 23 24, which respectively include the batteries 25 26 and sounders 27 28, the contact 29, forming the other terminal of circuit 24, and the reed 20, forming the terminal of the circuit 23, as shown. It will be readily understood that the local circuit 24 is opened and closed by changes of polarity in the line which excites the helices 15 and 16, and that the local circuit 23 is opened and closed only by sharp pulsations or vibrations in the main circuit, in a manner well known in the art, which needs no further description.

Another modification is illustrated in Fig. 3, wherein the receiving-helices 30 31 are mounted on cores 32 33, which in turn are connected to a **U**-shaped iron yoke 34, which may either have the ordinary pivoted tongue or in lieu thereof the tuned reed 35, made of iron and at its base rigidly connected to the yoke 34, the whole being connected by suitable fastenings to a standard 36. The permanent magnet 1 in this case is adjustably attached to a separate standard 37, and has its N and S poles substantially in contact with the outer faces of the sides of yoke 34.

The operation of this apparatus, so far as principles are concerned, is substantially the same as already described, but it has the additional advantage of a convenient means of adjusting the polarized magnet 1. When the poles N and S are adjusted to the left, the effect is to cause more lines of force to pass directly through the tongue 35 between the cores 32 and 33, and less lines of force to pass around through the short circuit of the yoke 34. On adjusting the poles N and S to the right the contrary effect is produced.

In the foregoing invention, but specially in its application to instruments ordinarily known under the title of "polarized relays," there is an important advantage compared with the ordinary well-known forms of such apparatus. By my construction in the normal condition of the apparatus the cores of the coils of the instrument are nearly or quite destitute of magnetism, since the magnetic circuit is practically closed around them, and

the cores are therefore in what may be termed a condition of the greatest possible sensibility for inductive influence from an arriving current. This condition is perhaps more emphasized in the form of apparatus shown in Fig. 2, whereof it may be said that the iron plug 17 is floating in a very intense magnetic field, while the cores of the electro-magnets are but feebly magnetic, and are therefore ready to have the inductive effect of the current impressed on them with great vigor. The principles of the invention enable me to produce an intensely polarized relay, having exceedingly small cores for its electro-magnets, even as small as one thirty-second of an inch in diameter, and such small cores will be just as sensitive to arriving currents as in the case of larger cores. In the ordinary construction of polarized relays such small cores would be practically saturated by the permanent magnet, and would be therefore quite insensible to currents tending to strengthen their polarity, while in my case the cores would be quite neutral normally, and therefore fully capable of working up to their maximum capacity. It will thus be understood that in my relay the cores are practically neutral until influenced by a current traversing their helices, while in other forms of polarized relay the cores are normally subjected directly to the influence of the polarizing-magnet, and it has been the growing practice of later years to make this polarizing influence as strong as possible, thereby preventing the possibility of neutral cores.

I claim as my invention—

1. An electrical signal-receiving instrument consisting of a closed magnetic circuit in combination with an open magnetic circuit having a movable body of magnetic material interposed in the opening, and a helix in inductive relation to the open magnetic circuit.

2. An electrical signal-receiving instrument consisting of a single magnet having two magnetic circuits between its poles, in combination with a coil of wire inclosing one of said magnetic circuits and adapted on the passage of current therethrough to vary the lines of force in one or both of said magnetic circuits, and a movable body of magnetic material interposed in one of said circuits.

3. An electrical signal-receiving instrument consisting of a single magnet having two magnetic circuits between its poles, one of them incomplete, in combination with a helix or coil of wire inclosing the incomplete magnetic circuit, and a movable body of magnetic material in the gap of the incomplete magnetic circuit.

4. An electrical signal-receiving instrument consisting of a single magnet having a substantially-closed magnetic circuit and an incomplete magnetic circuit constituted by two approaching iron projections, in combination with two parallel electric circuits in inductive relation respectively to the two iron projections, and a movable body of magnetic material interposed between said projections.

5. An electrical signal-receiving instrument consisting of a single magnet having a substantially-closed magnetic circuit and an incomplete magnetic circuit constituted by two approaching iron cores as pole-pieces, in combination with two helices wound upon said cores, and a movable body of magnetic material interposed between said cores.

6. An electrical signal-receiving instrument consisting of two or more coils wound on iron cores facing each other and so connected that currents pass through the coils in respectively opposite directions, said cores being attached to a substantially-closed magnetic circuit, and an iron tongue or body interposed between the adjacent ends of said cores.

In testimony whereof I affix my signature in presence of two witnesses.

STEPHEN DUDLEY FIELD.

Witnesses:

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C. H. WILLIS.