

(No Model.)

2 Sheets—Sheet 1

C. R. J. WILLOT.
RELAY.

No. 536,559.

Patented Mar. 26, 1895.

FIG. 1

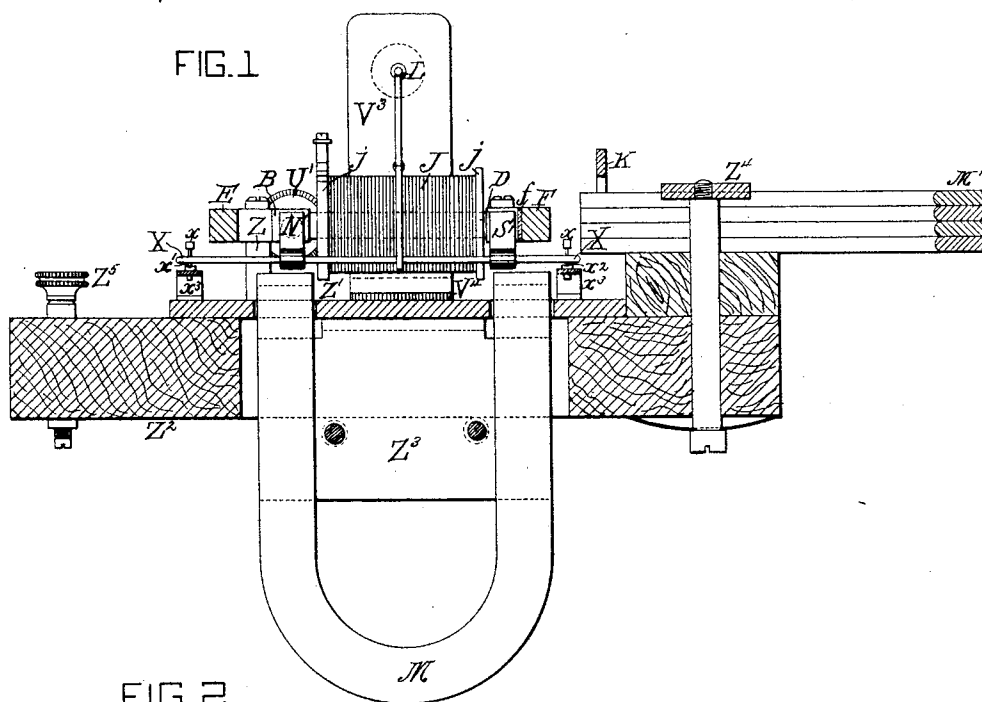
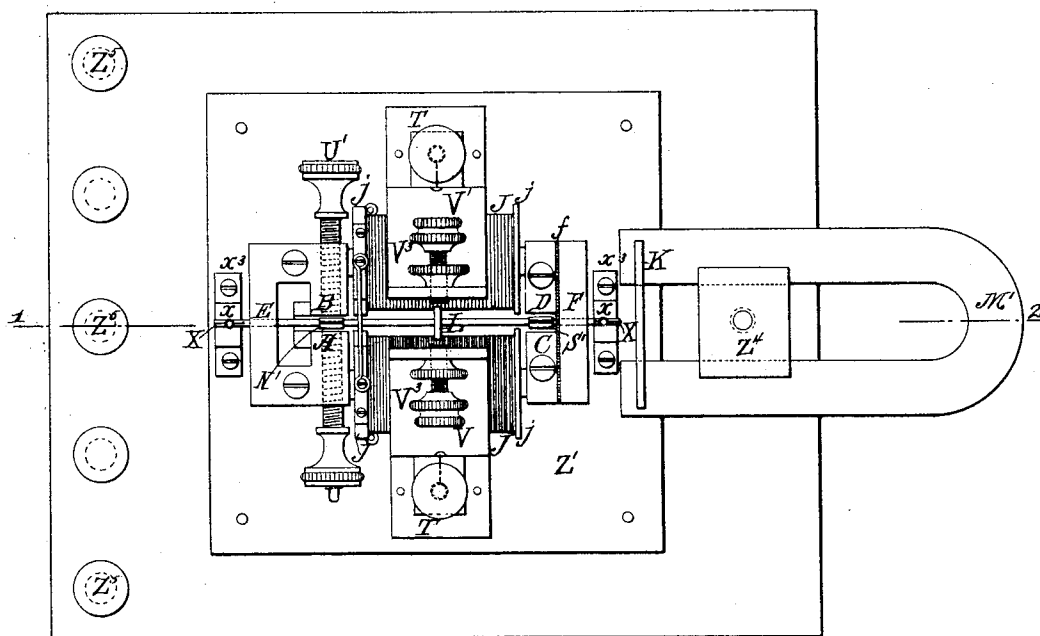


FIG. 2



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(No Model.)

2 Sheets—Sheet 2.

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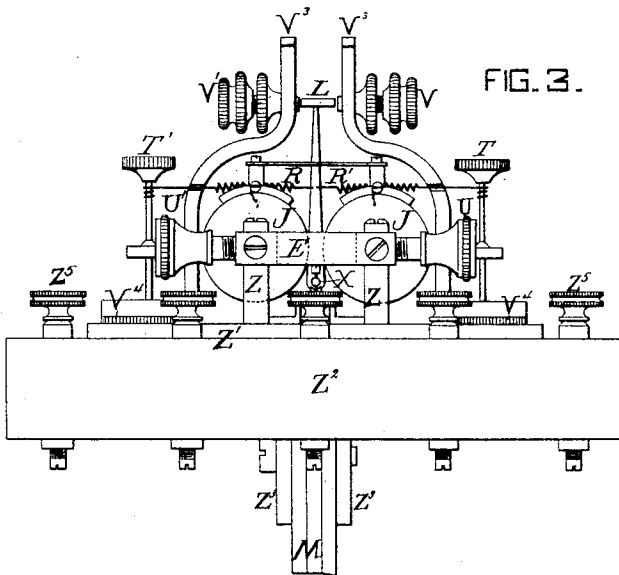


FIG. 3.

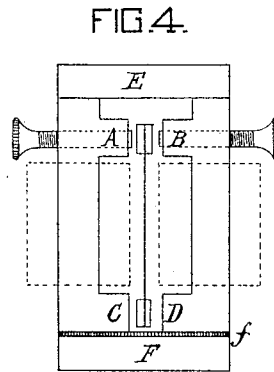


FIG. 4.

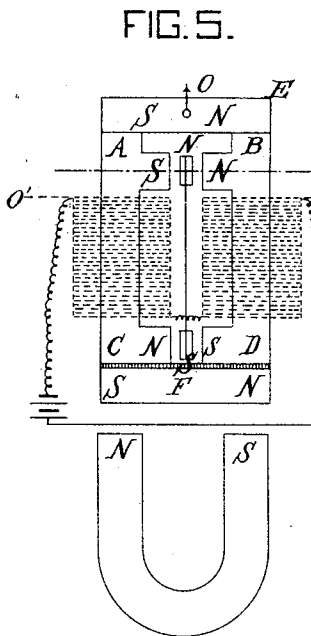


FIG. 5.

FIG. 5. α

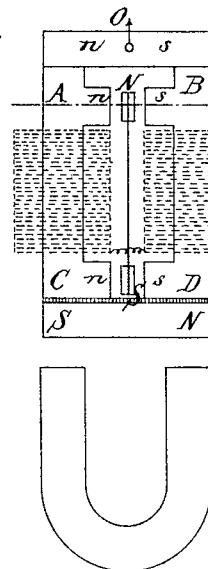


FIG. 6.

FIG. 6. α



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UNITED STATES PATENT OFFICE.

CYPRIEN RENELDE JOSEPH WILLOT, OF PARIS, FRANCE.

RELAY.

SPECIFICATION forming part of Letters Patent No. 536,559, dated March 26, 1895.

Application filed November 24, 1893. Serial No. 491,851. (No model.) Patented in France August 13, 1893, No. 223,657, and in England September 1, 1893, No. 15,689.

To all whom it may concern:

Be it known that I, CYPRIEN RENELDE JOSEPH WILLOT, a citizen of the Republic of France, residing in Paris, France, have invented certain Improvements in and Connected with Relays for Electric Telegraphs, Telephones, or other Analogous Purposes (for which I have obtained a French patent, dated August 13, 1893, No. 223,657, and a British patent, dated September 1, 1893, No. 15,689,) of which the following is a specification.

My invention relates to an improved sensitive polarized relay, suitable for use with Morse, Hughes, Wheatstone and other like telegraphic instruments or apparatus, more particularly in connection with submarine cable work.

In the accompanying drawings, Figure 1 represents the apparatus in longitudinal vertical section, the section being taken along the line 1—2, Fig. 2. Fig. 2 is a plan. Fig. 3 is an elevation of the apparatus. Figs. 4, 5, 5^a, 6, and 6^a are diagrammatic views of the soft iron cores of the electro-magnet of my polarized relay.

The important features of the improved relay are as follows: first, the peculiar form and arrangement of the soft iron bars of the electro-magnet, and, second, the mode of suspending and connecting the two armatures connected together on the same axis, with which they move and the arrangement of the magnetic field in which they move, consisting, on the one hand, of a polarizing magnet acting on these armatures, and on the other hand, of two breech-pieces E, F (Fig. 1) of soft iron placed at the extremities of the electro-magnet J. One of the breech-pieces F is subjected to the magnetic action of an artificial or permanent magnet M' (Fig. 1) independent of the polarizing magnet of the armature M (Fig. 1).

The shape of the soft iron bars submitted to the action of the magnetizing helix is represented by a horse-shoe closed by means of two soft iron breech-pieces E F (Figs. 1 and 2) of the same section as the bars. Polar enlargements or extensions A, B, C, D (Figs. 2, 4 and 5) are placed between the breech pieces

E, F and the flanges *j, j* of the bobbins J. The breech-piece E (Figs. 1 and 2) is attached direct to the ends of the soft iron bars by means of iron screws, while the breech piece F is attached to the opposite end by means of copper screws and is magnetically separated from the extensions C, D, by a plate *f* (Figs. 1 and 2) equally of copper. Two wooden or ebonite bobbins with fine wire covered with silk are fitted between the polar extensions A B of the horse-shoe and constitute the magnetizing helix of the electro-magnet J. Two soft iron screws U, U' are passed through the extensions A, B on the side of the breech-piece E (Figs. 2, 3, and 4). This electro-magnetic system is supported horizontally upon four copper pillars Z (Fig. 3) attached to a thick metallic plate Z' (Fig. 3) fixed on a wooden base Z².

Two soft iron armatures N' S' are fixed upon a copper axis X, X (Fig. 1) capable of rocking on two steel screws *x, x*, each terminating in a point and passed vertically through the axis near its ends. These two steel screws rest, one in a V-shaped notch in a hardened steel piece *x'*, and the other in a conical hole in a hardened steel piece *x''*. These two bearings, on which the axis X, X rocks, are fixed on copper bridges or supports *x''* attached to the metal plate Z' of the instrument. The two armatures N', S' thus suspended and connected together mechanically on the axis X oscillate between the soft iron polar extensions A, B, C, D (Figs. 1, 2, and 3).

The movement of the axis X, X of the armature is limited by two contact screws V V' (Figs. 2 and 3) carried by supports V³ insulated from the plate Z' by suitable insulating material V⁴ (Fig. 3) and between these contact screws moves a lever arm L (Fig. 3) attached to the middle of the axis X X. Two opposite helical springs R, R' are connected to the lever L and retained at their other ends by silk cords capable of being wound upon two rods provided with buttons T, T'. Owing to this arrangement, the tension of the said springs can be regulated at will, by rotating the buttons T, T' (Fig. 3).

The armatures N', S' are polarized by a very powerful artificial magnet M (Figs. 1 and 3)

which is passed through the base plate and board, and is supported in a vertical position at a slight distance from the armatures by means of clamps Z^3 upon the base board Z^2 (Fig. 3). Another magnet M' is placed horizontally upon the copper plate in front of the breech-piece F (Figs. 1 and 2). The adjustment of this magnet M' which is frictionally held between the base Z^2 and a plate Z^4 connected to the said base in any suitable manner, permits this magnet to be brought nearer to, or withdrawn farther from this breech piece F so as to modify thus the magnetic field produced by the polarizing magnet M (Figs. 1 and 3), in which field are placed the two armatures and the whole mass of soft iron. A soft iron plate K is provided for the purpose of modifying the power and consequently the action of the magnet M' according to the position which the said plate is made to occupy upon the latter. Five terminals or binding screws Z^5 are fixed on the base, for the reception of the electrical connections of the apparatus, such as the wires to and from the bobbins, the base plate and the two contact screws. The differential adjustment of the bobbins for duplex working involves the use of two extra external binding screws.

My relay works as follows: When the apparatus is out of action, that is to say, when no current passes through the bobbins of the electro-magnet, the relay must be adjusted so that the oscillating armatures N' S' (Figs. 1, 4, 5 and 6) may be in indifferent equilibrium in the combined magnetic field of the magnets M M' . I will endeavor to describe that combined magnetic field by stating precisely the nature of the elements which compose it and the function filled by every one of these elements; but it is evidently not possible to describe exactly the distinction of the magnetism into the different elements (magnets and soft iron cores) which co-operate to produce the indifferent equilibrium of the armatures, on account of the extremely complex actions and reactions which are produced by these elements acting upon each other. Therefore, there is no figure in the drawings to show exactly the distribution of the magnetism, when the relay is out of action and the armatures are in indifferent equilibrium in the combined magnetic field.

Figs. 5 and 5^a show the orientation of the magnetism produced in the soft iron cores of the relay, but only when the current is passing through the bobbins, and Figs. 6 and 6^a show only the residual or condensed magnetism, that is to say, the magnetism resulting from the momentary magnetization of the soft iron cores, due to the impurities of the iron.

The magnetic field is produced, first, by the action of the polarizing magnet M (Figs. 1 and 2) which induces the armatures N' , S' and the polar extensions A B , on the one hand, and C D on the other hand, while the magnetisms induced in each armature and in

the polar extensions react equally, the one on the other. This magnet M which contributes to the production of the combined magnetic field serves, more especially in my system, as a polarizer of the armatures N' , S' , in an analogous manner to the ordinary polarized relays; second, by the auxiliary magnet M' , which induces the breech piece F (Figs. 1 and 2). This breech piece F equally submitted to the inductive action of the polarizing magnet N , induces in its turn, the armature S' (Figs. 1, 2, and 5) and the polar extensions C D , which are also, on the other hand, submitted to the direct induction of the corresponding pole of the magnet M . The result of these combined magnetic actions and reactions is a very complex magnetic field in which the two armatures N' , S' connected mechanically on the same axis X X are placed in indifferent equilibrium obtained by adjusting the screws V , V' and consequently by bringing together or separating the armatures N' , S' relatively to the extensions A , C or B , D (Figs. 2 and 3), according to the position given to the magnet M' , which position is adjusted, once for all, according to the capacity and the condensation of the cable to which the relay is applied, as will be explained hereinafter.

The most important function of the auxiliary magnet M' in the working of the relay may be described as follows:

First. To adjust the limit of the insensitiveness of the relay. When a current passes through the electro-magnet J , the inductive force of the magnet M' (the orientation of the magnetizing helix being suitable) is added to the inductive force developed by the passage of the current round the coils of the electro-magnet. This inductive force of the magnet being constant, it is sufficient to develop in the electro-magnet a less inductive force or what amounts to the same thing, to send through the electro-magnet, a current of less intensity, in order to destroy the indifferent equilibrium and displace the armatures. The greater the length and capacity of the cable and consequently its power of condensation, the greater will be its fitness to cause the working of the telegraphic apparatus with very feeble currents, in order to reduce as much as possible, the power of this condensation and residual discharges which result therefrom. It will be necessary then to adjust, once for all, the relay, as to sensitiveness according to the capacity of the cable employed. This adjustment can be very simply effected, as hereinbefore stated, by varying the position of the magnet M' relatively to the position of the breech piece F and the soft iron cores of the electro-magnet, and by establishing by means of the screws V , V' the indifferent equilibrium of the armatures in the combined magnetic field corresponding to the position given to the magnet M' . When the initial adjustment of the relay for a given cable is being made, it is necessary to establish the indifferent equi-

librium, solely with regard to the magnetic actions on the armatures, that is to say, by the single movement of the screws V, V'. The adjustment by the springs R, R', which exert opposite mechanical actions upon the lever L of the armatures ought to be employed only in very rare instances; when, for example, at any moment and for any reason, to vary momentarily the sensitiveness of the relay.

Second. To hasten the re-establishment of the normal magnetic field in the soft iron cores of the electro-magnet as soon as the passage of an electric current through the coils has ceased. In fact, during its passage, the electric current has modified the magnetic field of the soft iron cores and destroyed thus the equilibrium of the armatures N'S'. The magnet M' also re-establishes instantaneously the normal magnetic field for the equilibrium of the armatures, as soon as the current ceases to flow, so as to cause the instrument to be ready for immediate action, when the current commences to flow again, and thus to increase notably the speed of transmission of the telegraphic signals. For this purpose, at the moment of the rupture of the circuit, the magnet M' repels toward the principal neutral line O (Fig. 6) the magnetism developed in the soft iron cores by the passage of the current, and the re-establishment of the magnetic field is made instantaneously under the impulse of the magnet M', while if this magnet were not present, that re-establishment not being helped by external reactions, would be much slower. The passage of the current through the coils of the electro-magnet J develops, in the soft iron extensions between which oscillate the armatures, opposite poles at the same side of the said electro-magnet (Fig. 5). The axes of the armatures are thus induced by parallel forces $p\ p$ (Fig. 5^a) which cause their displacement to the right or left, according to the direction of the current.

A line O'O² (Fig. 5) shows the change of polarity in the soft iron cores of the electro-magnet, which coincides with the line of the flanges of the bobbins $j\ j$ (Figs. 1 and 2). On breaking the circuit, the magnetic restoration takes place at the principal neutral line O (Figs. 5 and 6) in the middle of the breech piece E. The polarity N, S developed in the polar enlargements A B is reversed by the effect of this restoration. The soft iron cores of the electro-magnet J retain a certain amount of magnetization due to the impurity of the iron; but the residual or condensed magnetism is of the same denomination at the same side of the electro-magnet and, consequently, has no mechanical effect upon the axes of the armatures, the latter being, at this time, under the influence of forces setting in opposite directions $p' p'$ (Fig. 6). In this figure the residual or condensed magnetism is represented by the small letters n, s and in Fig. 5, the magnetism produced by the passage of

the current in the bobbin is represented by large letters N, S. Nevertheless, in order to neutralize this action it is indispensable that the residual magnetic force of the extensions A, B (Fig. 6) be equal to that of the extensions C, D. As the extensions A, B are in proximity to the principal neutral line O, the magnetism developed therein is necessarily weaker and, in order to equalize the mechanical action produced upon the two armatures by unequal magnetic forces, the soft iron extensions A, B are made somewhat longer, and the two soft iron screws U, U' (Fig. 2) are fitted in these extensions. The magnetic forces acting in inverse ratio to the square of the distance, it is thus rendered easy to compensate very exactly for the action of the residual or condensed magnetism, so as to neutralize the mechanical effect produced upon the axis. During the passage of the current, the extensions C, D (Fig. 5) induce the breech piece F submitted to the action of the magnet M'; but as soon as the current ceases the action upon the breech piece F of the magnet M' becomes again predominant, the restoration of the normal magnetic conditions in the mass of soft iron takes place more rapidly and the armatures resume their position of indifferent equilibrium, the contact lever L fixed on the same axis partaking of a corresponding movement. The first current, which has passed through the bobbins having the effect of directing the magnetic molecules of the mass of soft iron, the momentary magnetization of this mass does not disappear entirely at the same time as the current which produced it. I have shown that the residual or condensed magnetism does not produce a mechanical effect upon the axis of the armatures, any more than does the magnetic condensation produced by the residual discharges of a line of great capacity, such as a submarine cable, provided that the intensity of the current of the successive discharges does not exceed a milli-ampère. Owing to the special properties possessed by these relays, their installation at the ends of submarine cables of any length permits of employment for single or duplex working of Morse, Hughes, or Wheatstone instruments, which are usually employed for overhead conductors.

I claim as my invention—

1. A relay for electric telegraphs comprising two movable armatures fixed on the same axis, and an electro-magnetic system in a magnetic circuit closed by means of two breech pieces E F and a combined magnetic field with two magnets acting simultaneously upon the mass of the soft iron of the electro-magnet and upon said armatures, substantially as described.

2. In a relay for electric telegraphs, an electro-magnet having its soft iron cores in a magnetic circuit closed by means of two breech pieces E, F of which one of the said breech pieces F is insulated magnetically from the

soft iron cores by means of a copper plate *f*
in combination with two magnets M M', the
magnet M' being effective in accelerating the
re-establishment of normal magnetic condi-
5 tions after each emission of current, and in
enabling the adjustment of the limit of the
insensitiveness of the relay, as substantially
hereinbefore described.

In testimony whereof I have signed my
name to this specification in the presence of 10
two subscribing witnesses.

CYPRIEN RENELDE JOSEPH WILLOT.

Witnesses:

HUBERT J. A. CHOBOT,
CHARLES DONY.