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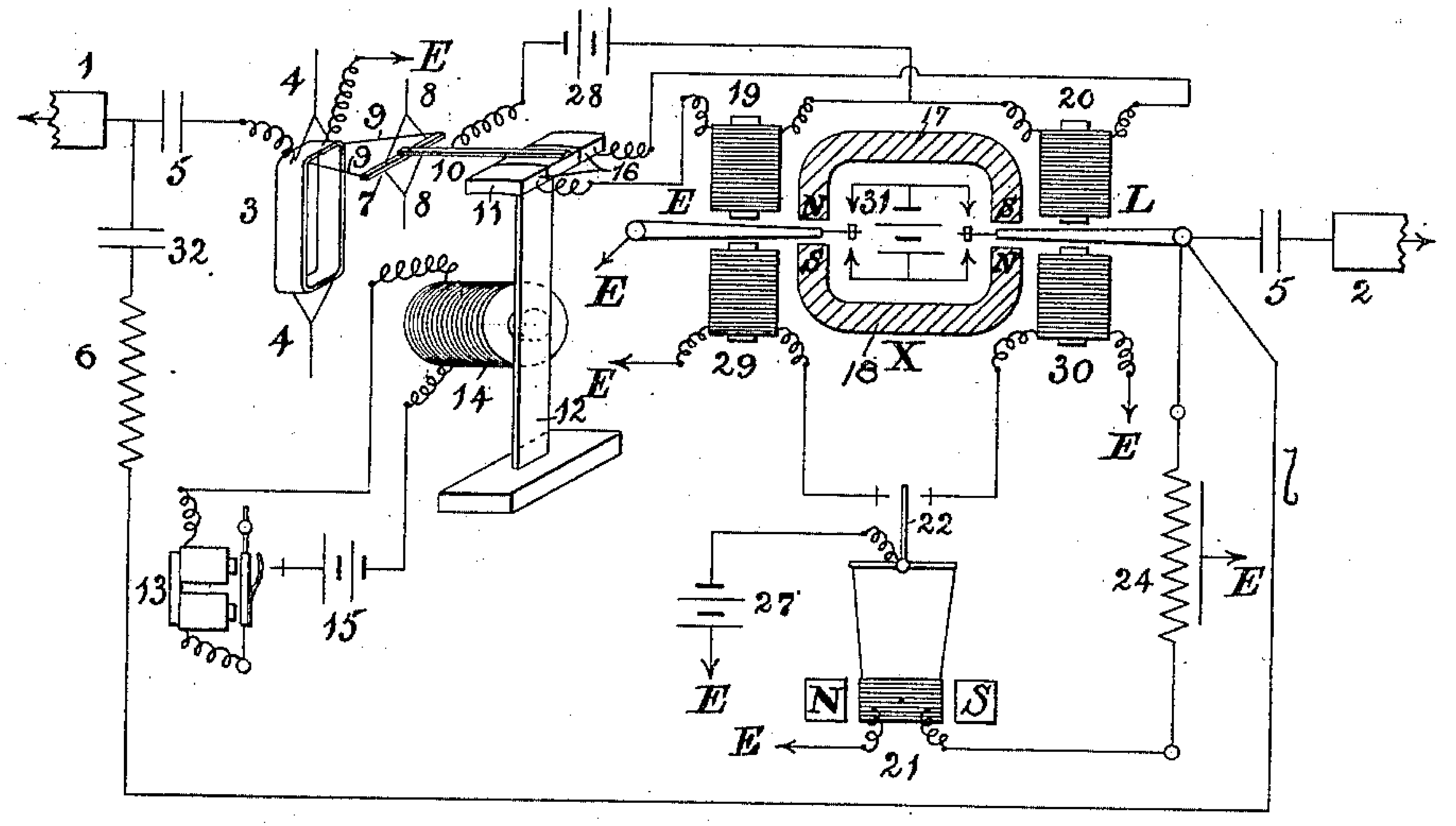
A. MUIRHEAD.

RECEPTION AND TRANSLATION OR RETRANSMISSION OF TELEGRAPHIC SIGNALS.

(Application filed Mar. 15, 1900.)

(No Model.)



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UNITED STATES PATENT OFFICE.

ALEXANDER MUIRHEAD, OF LONDON, ENGLAND.

RECEPTION AND TRANSLATION OR RETRANSMISSION OF TELEGRAPHIC SIGNALS.

SPECIFICATION forming part of Letters Patent No. 652,229, dated June 19, 1900.

Application filed March 15, 1900. Serial No. 8,803. (No model.)

To all whom it may concern:

Be it known that I, ALEXANDER MUIRHEAD, a subject of Her Majesty the Queen of Great Britain, residing at Shortlands, London, in the county of Kent, England, have invented new and useful Improvements in and Relating to the Reception and Translation or Retransmission of Telegraphic Signals, of which the following is a specification.

My invention, which relates to the "relaying"—*i. e.*, the reception and translation or retransmission—of telegraphic signals at intermediate stations on submarine telegraphic-cable systems, has for its objects, first, to provide improved means whereby the local electrical contacts made by the relay are strengthened and the sensitiveness of the receiver-coil and its attachments improved, and, secondly, to improve the character of both the received and the retransmitted signals.

I attain the objects in view, first, by providing an improved relay contact-making device, which, in spite of the fact that the contact-tongue of the receiver is constantly in sufficiently-firm contact with it to insure good electrical contact has not the effect of reducing the sensitiveness of the attached receiver-coil; secondly, by the introduction of means at the relaying-station whereby the movements of the recorder-coil or other receiving instrument employed, which is actuated by the feeble impulses received from the cable, are strengthened or improved, and, further, by the introduction of a local device that is controlled by the received cable-current, whereby the movements of the recorder-coil are "curbed" or whereby those of the local transmitter, which is actuated by the latter, are regulated.

The accompanying drawing is a diagram showing an organization of apparatus required to carry out my invention when a local transmitter is employed to send on or retransmit signals from one section of cable into another.

The details of the construction of the recorder-coil instrument and certain other apparatus herein specified as forming part of a complete organization according to my invention being well known need not be particularly described, especially as in themselves they form no part of the subject-matter herein claimed.

In the diagram, 1 and 2 represent the two cables, between which retransmission takes place. The connections, as shown, are for receiving from cable 1 and retransmitting into cable 2; but it will be understood that in practice either there will be a switch for changing over the connections or the apparatus will be duplicated. It must be so duplicated when the cables are "duplexed."

The numeral 3 represents the coil of a recorder-coil receiving instrument (which is the form of receiving instrument now almost universally adopted on all important cables) as modified to serve as a relay for retransmission purposes suspended in the well-known manner by fibers 4 4 in the field of a magnet. (Not shown in the diagram.)

5 5 represent the condensers, which are usually placed between the cable and the receiving or sending apparatus, and 6 represents a resistance inserted for the purpose of regulating the strength of the current flowing in the circuit wherein it is located.

E E represent the earth connections.

Fixed either directly upon the coil 3 or upon a light cross-bar 7, that may be delicately suspended by fibers 8 8 similar in manner to the coil 3, and which cross-bar is tied by fibers 9 9 to the coil 3, as shown in the figure, is a contact-tongue 10. This tongue rests upon a surface or body that is kept in constant motion or vibration in the plane of its contact-faces and to and from the center of motion of the coil. The tongue is continually touching the said moving body, and the imparting of movement to such body has the effect of reducing or obviating cohesion between the surfaces of contact of the tongue 10 and the battery-terminals or contact-plate, thereby increasing the sensitiveness of the coil 3 and its attachments—that is to say, the coil has more freedom of movement and can be actuated by much feebler impulses when the contact-plate upon which the attached tongue bears is moving or vibrating than when stationary.

The diagram shows the tongue 10 resting upon a moving body that comprises a curved plate 11, supported on a spring 12, which is kept vibrating by any suitable means for the

purpose of this invention. This may be effected by an intermittent current generated by the vibrator 13, in the circuit of which are the electromagnet 14 and battery 15. The plate 11 is shown divided into three sections insulated from each other by thin sheets of mica 16, the middle plate being left free and the two outer ones being connected, respectively, to the bobbins of the two upper electromagnets 19 20 of the local transmitter X.

It is essential to the efficient working of my present invention that there should be as little resistance as possible to the movement of the coil 3, introduced in the making of contact between its attached contact-tongue 10 and the battery contact-plate 11, on which it oscillates. Whenever an impulse is received through the coil 3 from the cable 1, the attached tongue 10 moves to the one side or the other from its "zero" position on the vibrating battery contact-plate 11, thus sending into the second cable 2 a corresponding current from retransmitting line-battery 31 through the intermediary of the local transmitter X.

It is well known that whenever the rate of transmission on a submarine telegraph-cable exceeds a certain rate, depending upon the K R—*i. e.*, the product of the capacity (K) and the conductor resistance (R) of the cable—the signals received at the distant end of the cable run into each other—that is to say, the index of the receiving instrument (the siphon in the case of the siphon-recorder or the contact-tongue 10 of the recorder-coil in the diagram) does not return to the zero position between each signal, but remains over onto the one side or the other throughout the duration of a succession of signals. In order to produce from such prolonged deflections of the index of the receiving instrument the original number of separate impulses for retransmission into the second cable, I introduce, in connection with the local transmitter of the organization, means whereby the movements of the line and earth levers of such transmitter are automatically cut up, so as to make the same number of line-battery contacts as were made at the initial transmitting-station. For this purpose a recorder-coil 21, actuating a contact-tongue 22, (in a manner similar to that in which the coil 3 actuates the tongue 10,) together with an artificial line 24 and local battery 27, is employed.

A suitable form of transmitter for the purpose of this invention is one as illustrated diagrammatically in the figure, in which a magnetic bias is given to the line and earth levers L and E by means of permanent magnets, so that whenever one or other lever is deflected it remains over on the limiting-stop. The bobbins 19 20 of the two upper electromagnets of the local transmitter X are shown joined up through the tongue 10 and its battery 28 and through the contact-plate 11 and the bobbins 29 30 of the two lower electromagnets to the stops between which the tongue 22 of the coil 21 oscillates. The coil 21 and the artificial line 24, of the correct amount of retardation, are connected up between the line-lever L of the local transmitter X and earth.

Whenever a current flows through the coil 3 from the cable 1, the tongue 10 is deflected onto one outer section or the other of the vibrating plate 11, thus closing the circuit between the corresponding electromagnet of the transmitter and the local battery 28, whereupon the corresponding lever of the transmitter is deflected and a current from the line-battery 31 sent into the cable 2 and also into the artificial line 24, the tongues L and E of the transmitter being adjusted with reference to the biasing-magnets 17 18, so that they remain over on either limiting-stop until deflected by a current flowing through the bobbin of the opposite electromagnet. The current which flows through the artificial line 24 deflects the coil 21 in the direction and at the right moment to pass a current from the battery 27 through one of the lower electromagnets 29 30 of the transmitter X to restore the lever which was deflected to the back limiting-stop at the end of the period corresponding to the duration of a signal. This operation continues so long as the tongue 10 is deflected. The artificial line 24 must be adjusted in retardation, so that the coil 21 oscillates with the required frequency.

Another connection may beneficially be made between the line-lever L of the transmitter and the cable 1 to "curb" the movements of the signal-coil 3 or counteract what is called the "shifting zero" in submarine-cable telegraphy—*i. e.*, the tendency of the signal-coil to vary its zero during signaling. Impulses of current from battery 31 pass to lever L and to cable 2 and also through conductor *l*, resistance 6, and condenser 32 to cable 1 and coil 3 to earth and are of such polarity as to curb the movements of coil 3 or induce its return to zero position. The effect of a succession of currents through this extra connection between the line-lever of the local transmitter and the signal-coil is to produce a wave through the latter in the contrary direction to the slow wave, which represents the average current flowing from the cable, and thus to keep the ripples or rapid variations of current which constitute the signals at equal distances from the true zero or zero of the instrument. The amount of retardation in this extra circuit must be adjusted to produce the right amount of "curbing" of the receiving instrument to get rid of the shifting zero, so that the tongue 10 of the signal-coil will always return to the zero position on the contact-plate 11 between a succession of deflections on one side and the other during the reception of signals. The accurate transmission of separate impulses into the second cable by the local transmitter depends on the

elimination of the so-called "shifting zero" of the receiving instrument. Hence the value of the above extra connection between the line-lever of the local transmitter and the cable 1.

What I claim, and desire to secure by Letters Patent of the United States, is—

1. The combination, in a relaying arrangement of a submarine telegraphic-cable system, of a receiver-coil, a contact-tongue attached thereto, a body with contact-surfaces thereon in the same plane, over or across which the tongue oscillates, forming part of a retransmitting-circuit, means serving to curb the movements of the receiver-coil and means for moving such body in the plane of its contact-faces and to and from the center of motion of the coil.

2. The combination, in a relaying arrangement of a submarine telegraphic-cable system, of a receiver-coil, a contact-tongue attached thereto, a moving body in constant contact with the tongue the surface of the said moving body being divided into sections the two outer sections forming part of a circuit through the electromagnets on one side of a local transmitter, and means actuated by the retransmitted impulses serving to send a battery-current through one of the electromagnets on the opposite side of the local transmitter whereby the movements of the line and earth levers of the latter are regulated.

3. The combination, in a relaying arrangement of a submarine telegraphic-cable system, of a receiver-coil, a contact-tongue attached thereto, a moving body in constant contact with the tongue the surface of the said moving body being divided into sections the two outer sections forming part of a circuit through the electromagnets on one side of a local transmitter, means actuated by the retransmitted impulses serving to send a battery-current through one of the electromagnets on the opposite side of the local transmitter whereby the movements of the line and earth levers of the latter are regulated and further means serving to curb the movements of the receiver-coil.

In testimony whereof I have hereunto subscribed my name.

ALEXANDER MUIRHEAD.

Witnesses:
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