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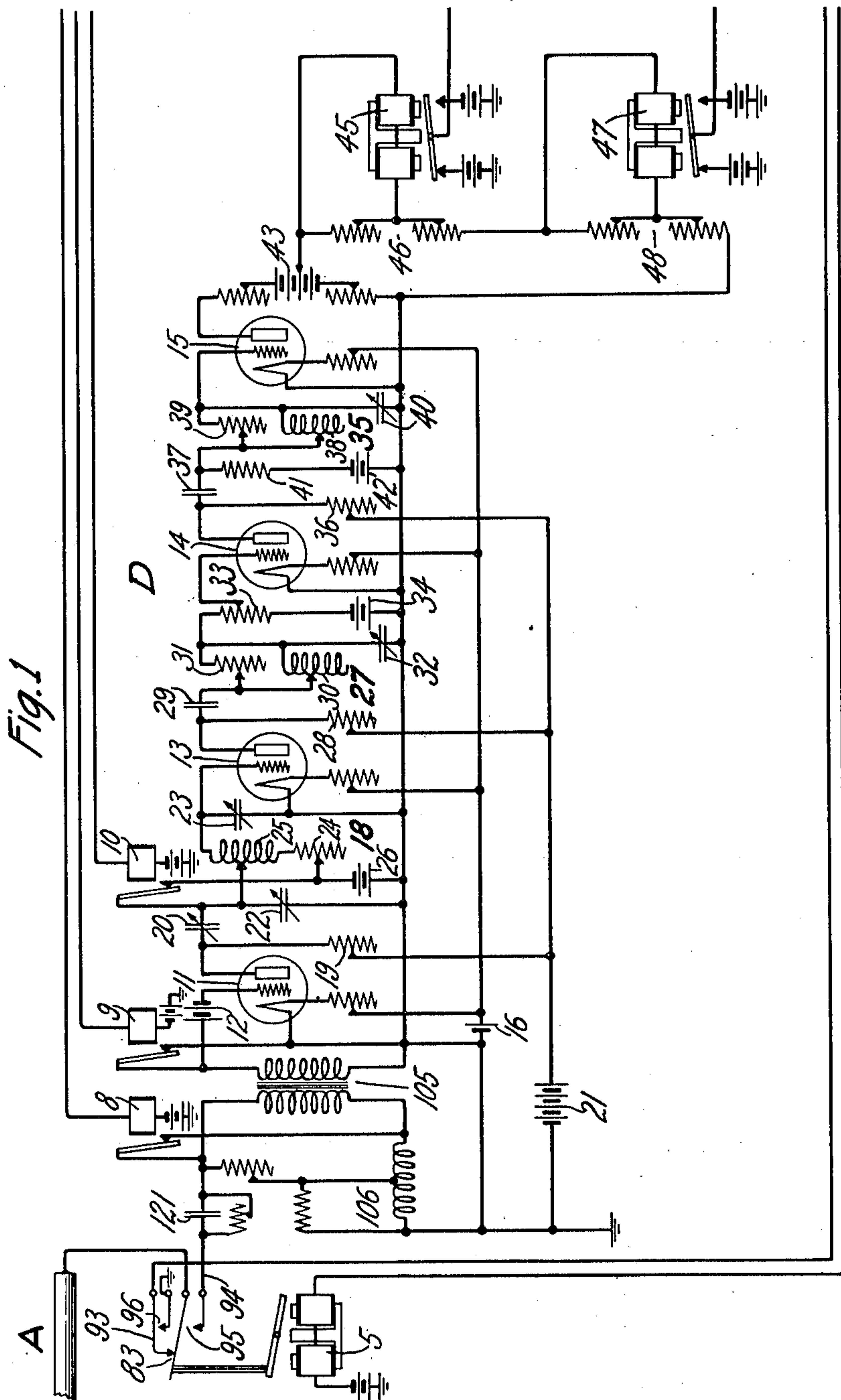
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A. M. CURTIS

SIGNALING SYSTEM

Filed June 30, 1926

2 Sheets-Sheet 1



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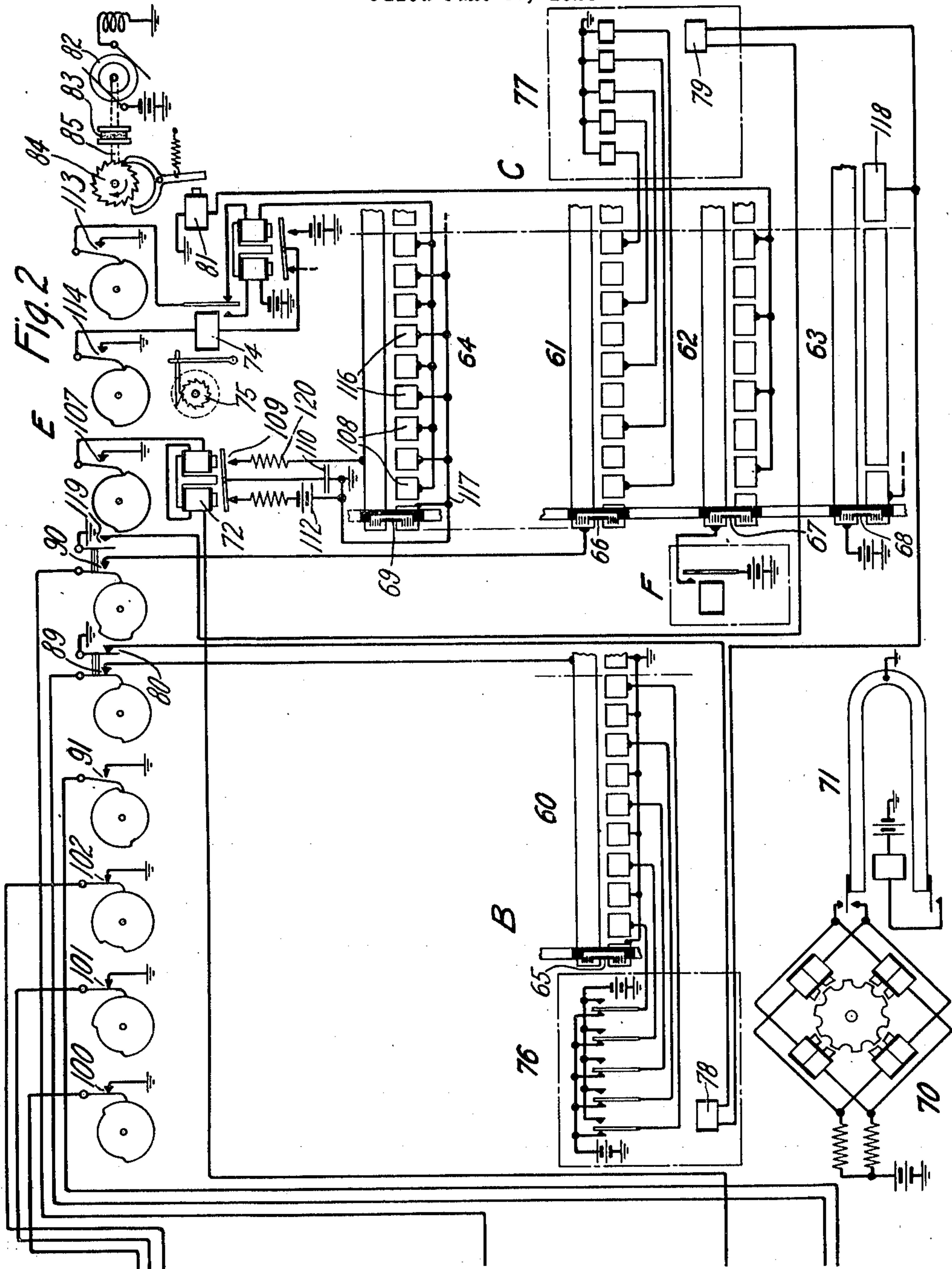
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UNITED STATES PATENT OFFICE.

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SIGNALING SYSTEM.

Application filed June 30, 1926. Serial No. 119,536.

This invention relates to signaling systems and more particularly to systems for use in submarine signaling.

Its principal object is to protect such systems from excessive or injurious currents or potentials occurring during switching operations.

In Patent No. 1,586,970 of the present applicant, issued June 1, 1926, there is described in detail a submarine signaling system in which the received signaling current waves are shaped and amplified before passing into the receiving equipment. In the use of such and similar systems, if employed in connection with an arrangement whereby the receiving and sending equipments are alternately connected to the cable for alternate reception and transmission, it is essential that some means be provided whereby the amplifier will be protected from the flow of excessive currents or potentials occurring when the cable is disconnected from the sending equipment and connected with the amplifier.

According to the present invention an arrangement is provided whereby the cable may be quickly drained of injurious currents or potentials and whereby earth currents that are practically always present in the cable are permitted to quickly assume normal values before the amplifier and the receiver equipments are completely connected to the cable.

Currents likely to flow from a cable, for example, after the transmission has ceased may be due to the combined action of the direct currents flowing in the cable caused by different potentials of the earth at the respective terminals of the cable and the flow to earth, if a ground is connected to the cable, of electric charges stored in the cable dielectric during the sending period. This energy may be slow in draining off the cable and may produce potentials far in excess of the normal voltages of the signals to be transmitted and received over the cable if the cable is connected too abruptly with a circuit containing high impedance such as the above mentioned amplifier. If the input circuit of the amplifier were connected directly to the cable the amplifier would receive a momentary current impulse of many times the voltage of the normal receiving

currents. This impulse may contain abnormally high frequency components and since this amplifier may be so designed that up to a certain frequency amplification increases in proportion to frequencies, this impulse when reaching the receiving equipment may be of such amplitude as to severely damage this equipment. Also if these high voltages are impressed upon the latter stages of the amplifier they may override the usual "C" battery associated with the grids and thus produce a disturbance of the normal plate currents in the various stages of the amplifier. Thus it will be seen that absorbed charges and earth currents may, if not properly drained off from the cable, or properly reduced to a normal value cause considerable damage to the amplifier and receiving equipment.

To overcome these difficulties this invention contemplates the use of a plurality of relays for applying various grounds and short-circuits for the cable, and the amplifier before the amplifier is finally completely connected and a switching mechanism for controlling the operation of said relays. One relay is provided for switching the cable connection from the transmitter equipment to the receiving equipment and to momentarily establish a connection to ground for the cable before the transmitting equipment is disconnected. This short grounded period is sufficient to remove from the cable a considerable portion of the above mentioned absorbed charges.

Another relay is provided to short-circuit the primary winding of a transformer in the input circuit of the amplifier. This relay releases to remove the short-circuit a short period after the cable has been connected to the input network. During this period the remainder of the absorbed charge on the cable is allowed to discharge through a portion of the receiving network, so that a stable condition may be rapidly approached.

A third relay is provided for short-circuiting the secondary winding of said transformer. The release of this relay removes the short-circuit a short period after the removal of the short circuit about the primary winding of the transformer. This second short-circuit therefore reduces the reactance of the transformer to the high frequency

current components represented by the steep wave front of the suddenly applied earth currents that are practically always present in the cable and which are impressed upon the primary winding of the transformer when the second mentioned short-circuit is removed. This reduction of the transformer inductance assists in allowing the earth currents to quickly assume a normal value through the primary winding of the transformer.

A fourth relay is provided for short-circuiting the primary winding, including a series resistance, of an auto-transformer usually located in amplifier circuits of this general type between the first and second tubes. The provision of this short-circuiting relay is for the purpose of preventing the overloading of the succeeding tubes in the amplifier, which might occur due to the presence of a considerable voltage across the terminals of the secondary winding of the transformer when the third relay operates to remove the short circuit from the amplifier input terminals. This short-circuit removes the high impedance of the primary winding of the auto-transformer from the circuit of the usual high capacity coupling condenser employed in circuits of this type, and the time constant of the output circuit of the first vacuum tube is thereby reduced so that the surge which occurs when the relay removes the short circuit from the amplifier input circuit is allowed to produce only a momentary effect on the charge in the coupling condenser. The short-circuit provided by the fourth relay remains for a short period after the release of the preceding relay. When it releases to remove the short-circuit, the amplifier is in a condition where it will respond to the incoming signals without appreciable disturbance from earth currents or accumulated charges on the cable.

The cam switching mechanism is provided for the actuation of the above mentioned four relays to control their operation and release in proper sequence and the cam mechanism itself is controlled by the receiving and transmitting equipments to function at the proper time in accordance with predetermined settings of a timing device. Systems utilizing amplifier circuits of the above general character for the reception of signals have been disclosed in applicant's Patent No. 1,586,971 issued June 1, 1926 and patent to G. A. Locke, No. 1,618,416, issued Feb. 22, 1927.

The present invention is an improvement over the prior art in that the accurate timing of the switching operations incident to the use of cam actuated switches is obtained at the same time that relatively vibrationless control of the amplifier short-circuits is accomplished. In the arrangement of the present invention the cam switches may be

mounted on the distributor table, which is physically separated from the amplifier. Consequently, vibration due to the operation of the cams is not communicated to the amplifier. The location of the cam switch controlled short-circuiting relays within the amplifier cabinet makes possible the use of short short-circuiting leads which are essential to the proper functioning of the amplifier.

It should be understood that when the cable is switched from the receiver to the transmitter, the short-circuits are re-established. This invention, as outlined above, therefore provides an efficient means for effecting the connection of an amplifier to the cable with the least possible delay and without undue excitations of the devices employed therein.

This invention has been illustrated in connection with a submarine signaling system in which the transmitting and receiving apparatus may be alternately connected to the cable for signal transmission thereover, but it should be understood that any similar system may be employed without departing from the spirit of this invention.

In the drawings Fig. 1 shows an amplifier circuit similar to one disclosed in applicant's previously mentioned patents, and a short section of a cable to which the amplifier and receiving equipment or transmitting equipment may be connected. The relays for applying the short-circuits to the amplifier have also been shown in this figure. Fig. 2 shows a transmitting and receiving equipment that may be used in connection with an arrangement of this kind, and also the cam switching mechanism whereby the short-circuiting relays are operated.

In general the arrangement shown consists of a cable A, a transmitter equipment B, a receiving equipment C and an amplifier equipment D for connection between the cable and the receiving equipment for the purpose of shaping and amplifying the incoming signals. The cable A may be connected, through the manipulation of a relay 5, either to the input circuit of the amplifier D or to the transmitting equipment B. A control equipment E is provided comprising a series of cam switches controlled by the operations of the receiving and transmitting equipments in conjunction with a timing device F. This cam mechanism controls the operations of relays 8, 9 and 10 to gradually connect the amplifier D between the cable and receiving equipments, and the operation of relay 5 to alternately connect the amplifier D and the transmitter B to the cable.

Reference will now be made to the general characteristics of the circuits of amplifier D. Four stages of electron discharge amplifiers are provided with suitable coupling circuits and signal shaping networks.

The filaments of all the amplifiers or vacuum tubes 11, 13, 14 and 15 are heated by current from six volt battery 16, under control of rheostats. The first stage amplifier or vacuum tube 11 is provided with a negative grid battery 12. The grid of tube 11 is connected through an input transformer 105 and an input shaping network 106 to the contact 94 of relay 5. The output of tube 11 is coupled to the shaping network 18, by means of a variable resistance 19, and condenser 20. In series with the resistance 19, is a space current battery 21. The shaping network 18 consists of a primary variable condenser 22, a secondary variable condenser 23, and an adjustable resistance 24 and an adjustable auto transformer 25 in series. The upper terminal of auto transformer 25 is connected to the grid of tube 13. The grid of this tube is maintained negative with respect to the filament by means of a battery 26. The output of tube 13 is connected to a shaping network 27 by means of variable resistance 28 and condenser 29. In series with resistance 28 is the space current battery 21. The shaping network 27 consists of an inductance coil 30 shunted by a resistance 31 connected in series with the condenser 32. The input circuit of tube 14 is connected across the variable portion of potentiometer 33, the fixed portion of which is in series with the grid polarizing battery 34. The output of tube 14 is connected to shaping network 35 by means of a variable resistance 36 and a condenser 37. In series with resistance 36 is the space current battery 21. The shaping network 35 consists of inductance coil 38, shunted by resistance 39 and condenser 40 connected in series across resistance 41 and grid potential battery 42. The space current of amplifier 15 is supplied by battery 43. This amplifier is shown as a single vacuum tube but may consist of several vacuum tubes connected in parallel, one only having been shown for simplicity. The output circuit of this tube 15 including the battery 43 extends through a recording relay 45 and variable resistance 46. This relay 45 will cause the impulses to be transmitted to the receiving face 61 of a multiplex printing telegraph distributor and recorded on the printer 77. Another relay 47 is connected in series with relay 45 and is also provided with a variable resistance 48. This relay operates every time the polarity of the signal received from the amplifier D reverses and the impulses produced by its operation are retransmitted to relay 72 for correcting purposes as will hereinafter be described. The networks used in this amplifier circuit D may be adjusted and arranged in accordance with the system disclosed in Patent No. 1,586,970 supra, to receive and amplify signals and cooperate with

the other portions of the amplifier to shape these signals in a particular manner, although it should be understood that the present invention relating to the protection of the amplifier is not confined exclusively to use with the type of amplifier shown in Fig. 1, but is applicable to any other similar amplifying circuit requiring protection from injurious shock such as described above.

The receiving and transmitting equipments have been shown in a more or less diagrammatic form since their detailed construction is well known in the art, and since they form no part of this invention. Only a brief description of the construction and function thereof will now be made.

A usual type of multiplex distributor may be employed. It must include a sending face 60, receiving face 61, cam switch escapement operating face 62, transmitting and receiving control face 63, and speed correcting face 64 with the brushes 65, 66, 67, 68 and 69 associated respectively with said faces and is driven by a synchronous motor 70 which is controlled by driving fork 71. This distributor equipment is maintained in synchronism with the corresponding distributor at the opposite end of the cable by means of any well known correcting mechanism whereby current impulses incoming to operate relay 72 cause, through the functioning of the correcting face 64 and a second polar relay 73, the operation of magnet 74. This magnet in turn controls, by mechanisms such as the ratchet mechanism shown at 75, the shifting of the brushes 65 to 69 in one direction to place them in synchronism with the brushes of the distributor at the opposite end of the cable. The shifting of the brushes may, of course, be made in either direction depending on whether the speed of the brushes on the distributor at one end of the cable is faster or slower than the speed of the corresponding brushes on the distributor at the opposite end of the cable. No attempt has been made to show the mechanical details of the connection between the motor 70 and the brushes and the connection between the correcting brush mechanism 75 and the brushes as the construction of distributors of this type are well known in the art. The transmission may be accomplished in the usual manner by a perforated tape controlled transmitter diagrammatically indicated at 76 operating in conjunction with the segmented sending ring of the sending face 60 and brush 65. The incoming impulses are received on the upper segment of the receiving face 61 from the relay 45 and distributed by brush 66 to the proper selecting magnets of a printer mechanism 77 shown diagrammatically, while the transmitting and receiving control face 63 is connected through the seg-

ments thereon and the brush 68 to the control magnets 78 and 79 respectively of the transmitter 76 and printer 77 which as is well known in the art, control the operation 5 of the transmitter and printer.

A timing device of any well known construction diagrammatically indicated at F may be provided for controlling the application of battery to the segments of the cam switch escapement operating face 62, so that 10 the cam switching mechanism E may be operated to switch the connections from transmission to reception or vice versa during the operation of the system. This timing device may be set so that the transmitting 15 time is equal to the receiving time or to establish a division of the time in any proportion demanded by the traffic.

The cam switching mechanism may be of 20 any well known type, but may consist in general of a driving motor 82 connected by means of a friction clutch 83, to a shaft 85 on which the various switching cams are mounted. The contact springs controlled 25 by these cams are mounted in proximity to the cams by means not shown. The switching cams are cut in such forms as to cause the contact springs to establish connections in a certain sequence which will be described 30 more fully hereinafter. An escapement mechanism 84 controlled by the operation of a magnet 81 is provided to permit the cams to rotate a certain distance, for example, half a revolution for each operation of the 35 timing device F to switch in the transmitter or receiver.

A detailed description will now be made of the manner in which this system operates during transmission, reception, and the period 40 during which the apparatus is switched from reception to transmission or vice versa. This will also explain the manner in which, in switching from sending to receiving, the amplifier is connected to the remainder of 45 the apparatus by steps in such a manner as to avoid the application to the entire amplifier of any voltage large enough to prevent its subsequent proper operation. Assume that the timing device has caused the actuation of the magnet 81, through the control 50 face 62 of the receiver, to place the cams in the position shown with certain contacts closed and others opened as indicated to permit transmission to take place from the transmitter B. Assume further that the 55 distributors at the opposite ends of the cable have been started and are rotating in synchronism with the brushes in proper phase relation to each other. The printer 77 is under these circumstances in the inoperative condition, while the transmitter is connected to the cable. Signaling impulses will therefore be applied from transmitter 76 60 to the segments of the sending face 60 in accordance with the tape perforations.

These impulses are transmitted through cam switch contacts 89, closed at this time, to conductor 93 through the closed contacts 83, of relay 5 to the cable A. The transmitter 76 is caused to operate by means of magnet 78, once for each letter to be transmitted, 70 by the operation of magnet 78 over a circuit as follows: battery, brush 68, face 63, segment 118, magnet 78, cam switch contacts 80 to ground. Transmission from transmitter 75 76 is continued until the timing device F operates.

When the period for transmission comes to an end the timing device F will cause the operations of the escapement magnet 81 to 80 permit the cam switch to function to open certain contacts and close others for switching the cable from the connection with the transmitter to a connection with the receiver. That is, when a battery connection 85 is closed in the timing device, magnet 81 will alternately operate and release as the circuit therefor is alternately closed and opened through the segments of the face 62. According to the arrangement of the segments 90 of face 62 and the number of teeth in the escapement mechanism 84 the cams will be permitted to rotate one-eighth revolution as the brush 67 passes from one end to the other of the face 62. As the cams have been 95 cut so as to complete all the functions required for each switch-over from the transmitter to the receiver or vice versa during one-half revolution of the cams it is readily seen that the brush 67 must make four revolutions 100 over face 62 before the one-half revolution of the cams is accomplished.

The functions relating to the switch-over are as follows: The first cam controlled 105 contacts opened are the transmitter contacts 89 and 80 and simultaneously therewith the contacts 91 for relay 5 are closed. These operations take place before the cams have rotated one-thirty-second of a revolution and as the windings of relay 5 are now 110 connected through contacts 91 to ground, this relay will operate to switch the cable A from the transmitting lead 93 to the receiving lead 94 by the closure of contacts 95.

It should also be noted that as the armature 115 of relay 5 moves from the position shown to its opposite position to close contacts 95, a momentary contact is made through contacts 83 and 96 to ground from the cable A. The purpose of connecting the 120 cable momentarily to ground is to remove a considerable portion of the charges that have accumulated on the cable during the transmitting period.

It should be noted that the relays 8, 9 125 and 10 are in actuated position as the cams 100, 101 and 102 still maintain the circuits for these relays closed to ground through the respectively closed contacts. Relay 8 applies a short-circuit across the primary 130

winding of the transformer 105 in the input circuit of the amplifier D, so that when the cable becomes connected to the receiving lead 94, the voltage remaining on the cable is permitted to charge the shunted condenser 121 quickly through this short-circuit and a portion of the receiving network 106. The charging surge is thus excluded from the primary winding of transformer 105. However, after condenser 121 is fully charged a current will still continue to flow from cable to earth through the leak resistance, which resistance is of the order of a hundred thousand ohms. As the cams at E continue to rotate and complete the first one-eighth of a revolution the contacts 100 open and relay 8 is released thus removing the short-circuit across the primary of the transformer 105. A potential equal to the product of the steady earth current and the resistance of the primary of the transformer 105 is now abruptly applied to the latter. As the quotient of inductance by resistance of the transformer is rather large, (the "time constant" being of the order of a second) an appreciable time is required for the current in the transformer to arrive at a steady value. During this time a relatively large voltage would be applied to the amplifier input were it not for the fact that the transformer secondary coil is still short circuited by relay 9. When now the cams continue to rotate, another one-eighth of a revolution, contacts 101 are opened to release relay 9 which opens the short-circuit around the secondary winding of transformer 105. The cable will now therefore be associated with the first amplifier tube 11 and through the output circuit of this tube to the shaping network 18. Any voltage that may be present across the terminals of the secondary winding of 105, due to normal value of the earth currents in the primary winding, will now therefore be amplified by the first tube and might be of sufficient magnitude to overload the succeeding tubes were it not for the short-circuit provided through the contacts of relay 10. This short-circuit around the primary winding of the network 18 therefore takes the high impedance of this network out of the circuit of the high capacity coupling condenser 20 and prevents the surge which would otherwise be induced in the entire coil and thus be applied to the input circuit of amplifier 13. The contacts 102 on the cam switch will open the operating circuit of relay 10 when the cams have rotated another one-eighth of a revolution. When they come to rest after having rotated a total of one-half of a revolution the circuits are set for reception of signals.

The signals from the cable will now be transmitted through the amplifier, amplified through the four stages and cause the oper-

ation of relays 45 and 47. In response to these signals relay 45 will actuate its armature to apply negative or positive current impulses through the upper segment of the receiving face 61 and as the brush 66 travels over this face, the impulses will as is well known in the art cause the operation of the printer magnets in proper combinations. It should be noted that before the end of the last one-eighth of a revolution of the cams the contacts 90 and 119 are closed so that the connections for the receiving impulses to the receiving face 61 will be completed in ample time. It should also be observed that after the magnets in printer 77 have been set magnet 79 will operate to complete the function of the printer as is well known in the art. A circuit will at this time be closed for magnet 79 as follows: battery, upper segment of face 63, brush 68, segment 118, magnet 79, contacts 119 to ground.

During the receiving period the position of the brushes is corrected from time to time so that they travel in synchronism with the brushes of the distributor at the opposite end of the cable. Relay 47, provided for this purpose, transmits positive and negative impulses for the operation of relay 72 which at this time has a connection to ground through cam contacts 107.

The functions of the correcting mechanism are as follows: At the end of the switch over period from transmitting to receiving, and before the distant transmitter is permitted to commence sending character impulses, corrective signals may be sent through the amplifier, for the operation of relay 47. It is evident that these impulses will also operate relay 45 but may be of such a combination of polarities as to have no effect on the printer, that is, a combination of relays in the printer could be chosen for this purpose that would not produce any printing operations. These impulses may, therefore, only cause shifting effects on the brushes to bring them entirely into phase with the brushes of the distributor at the distant end of the cable. If, for example, the brush 69 has been advanced to a segment such as 108, when an impulse arrives to operate relay 72, indicating that the brushes at the distant end are still in contact with segments corresponding in position to the segment preceding segment 108, a circuit would be completed for the operating of relay 73. Relay 72 in operating would cause the closing of contacts 109 and in this case the condenser 110 would discharge through segment 108. Condenser 110 is normally charged from a battery 112 when the armature of the relay 72 is in the position shown. This discharge impulse would take the following path: condenser 110, up-

per segment of the correcting fact 64, brush 69, segment 108, right hand coil of relay 73, armature and back contact of magnet 74, switch contacts 113 to ground. Relay 73
 5 now operates to shift the armature thereof into a position opposite to that shown to close a circuit as follows: battery, armature of relay 73, winding of magnet 74, switch contact 114 to ground. Magnet 74 will then
 10 operate through the ratchet mechanism 75 in any manner well known in the art to shift the brushes 65 to 69 a short step backwards. If now an impulse of the opposite polarity operates relay 47, relay 72 would
 15 operate to return to the position shown and the condenser 110 would again be charged from the battery 112. When another impulse arrives to operate the armature of relay 72 to a position opposite to that shown
 20 and if the brush 69 is still sufficiently in advance of the brushes at the distant end of the cable so as to be in contact with a segment 108, a second impulse from condenser 110 causes a second shift of the brushes
 25 backwards. If the previous correction was sufficient to bring the brushes into phase, said impulse from relay 47 will not have any effect as the condenser 110 would be connected through a segment 116 with the con-
 30 ductor 117 so that it would be discharged through resistance 120 as the opposite plates of condenser 110 are connected to this conductor. It should be noted that when the magnet 74 operates, a circuit is established
 35 from battery through the left hand winding of relay 73 to restore this relay to the position shown. In this manner the shifting of the brushes may ordinarily be completed within a very short time so that sending
 40 from the distant end of the cable may begin. It will be noted moreover that correcting may be done each time relay 47 is operated to the position opposite to that shown if the brush 69 has at such times ad-
 45 vanced to connect with a segment 108 connected to the right hand winding of relay 73.

By the incorporation of the various features of the invention in the submarine signaling system as described, the transmitting and receiving apparatus may control the inclusion of the amplifier circuit in the receiving path for the incoming signals in such a manner that the absorbed charges on the
 55 cable due to the transmisison of impulses in the opposite direction and earth currents that are almost always present on cables of this type will have any effect on the amplifier circuit.

60 What is claimed is:

1. In a signaling system, a conductor, a receiver, a signal amplifier having its output end associated with the receiver, means for associating the input end of the amplifier
 65 with the conductor, means for short-circuit-

ing the amplifier at a plurality of points therein, and means for removing said short-circuits successively at predetermined intervals after the amplifier has been connected with the conductor. 70

2. In a signaling system, a conductor, a receiver, a signal amplifier having its output end associated with the receiver, means for associating the input end of the amplifier with the conductor, means for short-circuiting the input circuit of the amplifier, means for short-circuiting the amplifier at a plurality of other points, and means for removing said short-circuits successively at predetermined intervals after the amplifier
 75 has been connected with the conductor. 80

3. In a signaling system, a conductor, a receiver, a signal amplifier having its output end associated with the receiver, means for short-circuiting the amplifier at a plurality of points therein, and means for momentarily grounding the conductor and for thereafter connecting the conductor to the input end of the amplifier and for thereafter removing said short-circuits from the ampli-
 85 fier at predetermined intervals. 90

4. In a signaling system, a conductor, a receiver, a signal amplifier having its output end associated with the receiver, means for short-circuiting the input circuit of the amplifier, means for short-circuiting the amplifier at a plurality of other points, and means for momentarily grounding the conductor and for thereafter connecting the conductor to the input end of the amplifier and for thereafter removing said short-circuits from the amplifier at predetermined intervals. 95 100

5. In a signaling system, a conductor, a receiver, a signal amplifier, means for short-circuiting the amplifier at a plurality of points therein, and means for momentarily grounding the conductor and for thereafter connecting the conductor to the input end of the amplifier and for thereafter removing said short-circuits from the amplifier at predetermined intervals and for thereafter connecting the output end of the amplifier to the receiver. 105 110

6. In a signaling system, a conductor, a receiver, signal amplifying means comprising successive stages of amplifying devices and a transformer in the input circuit of the first stage said means being associated with the receiver at the output end of the last stage, means for short-circuiting the input circuit of the transformer, the output circuit of the transformer and the input circuit of the second amplifying device, means for connecting the input circuit of the transformer with the conductor, and means for removing the three short-circuits at predetermined intervals in the order in which they appear in the amplifying means beginning with the short-circuit for the input circuit of the transformer, said short-circuits being re-
 115 120 125

moved at predetermined periods after the input circuit of the transformer has been connected to the conductor.

7. In a signaling system, a conductor, a receiver, a signal amplifier, means for short-circuiting the amplifier at a plurality of points therein, and means including a cam switching mechanism for momentarily grounding the conductor and for thereafter connecting the conductor to the input end of the amplifier and for thereafter removing the short-circuits at predetermined intervals from the amplifier, and for thereafter connecting the output end of the amplifier to the receiver.

8. In a signaling system, a conductor, a transmitter, a receiver, a signal amplifier associated at its output end with the receiver, means for alternately connecting the transmitter and the input end of the amplifier with the conductor, means for short-circuiting the amplifier at a plurality of points therein, and means for removing said short-circuits successively at predetermined intervals after the amplifier has been connected with the conductor.

9. In a signaling system, a conductor, a transmitter, a receiver, a signal amplifier associated at its output end with the receiver, means for alternately connecting the transmitter and the input end of the amplifier with the conductor, means for short-circuiting the input circuit of the amplifier, means for short-circuiting the amplifier at a plurality of other points, and means for removing said short-circuits successively at predetermined intervals after the amplifier has been connected with the conductor.

10. In a signaling system, a conductor, a transmitter, a receiver, a signal amplifier, means for short-circuiting the amplifier at a plurality of points therein, means for alternately connecting the transmitter and the in-

put end of the amplifier with the conductor, means for momentarily grounding the conductor, for thereafter causing the disconnection of the transmitter from the conductor for thereafter causing the connection of the input end of the amplifier with the conductor for thereafter removing the short-circuits at predetermined intervals and for thereafter connecting the output end of the amplifier with the receiver.

11. In a signaling system, a conductor, an impulse sending and an impulse receiving mechanism, means for actuating said mechanism, an impulse amplifier, means for short-circuiting the amplifier at a plurality of points therein, means for alternately connecting the transmitting mechanism and the input end of the amplifier with the conductor, means including a cam switching mechanism controlled by the means for actuating the transmitting and receiving mechanisms for momentarily grounding the conductor and for thereafter causing the disconnection of the transmitting mechanism from the conductor and for thereafter causing the connection of the input end of the amplifier to the conductor and for thereafter removing the short-circuits at predetermined intervals, and for thereafter connecting the output end of the amplifier to the receiving mechanism.

12. In a signaling system comprising a cable, a sending mechanism, and a receiving mechanism including an amplifier, an input transformer for said amplifier, and means comprising a short-circuiting connection for the secondary of said transformer for preventing excessive current impulses at the time of completing the circuit between the receiving mechanism and the cable.

In witness whereof, I hereunto subscribe my name this 24th day of June, A. D. 1926.

AUSTEN M. CURTIS.