Nov. 16, 1937. A. WEAVER 2,099,089

RELAY

Filed Dec. 4, 1935

FIG. 1

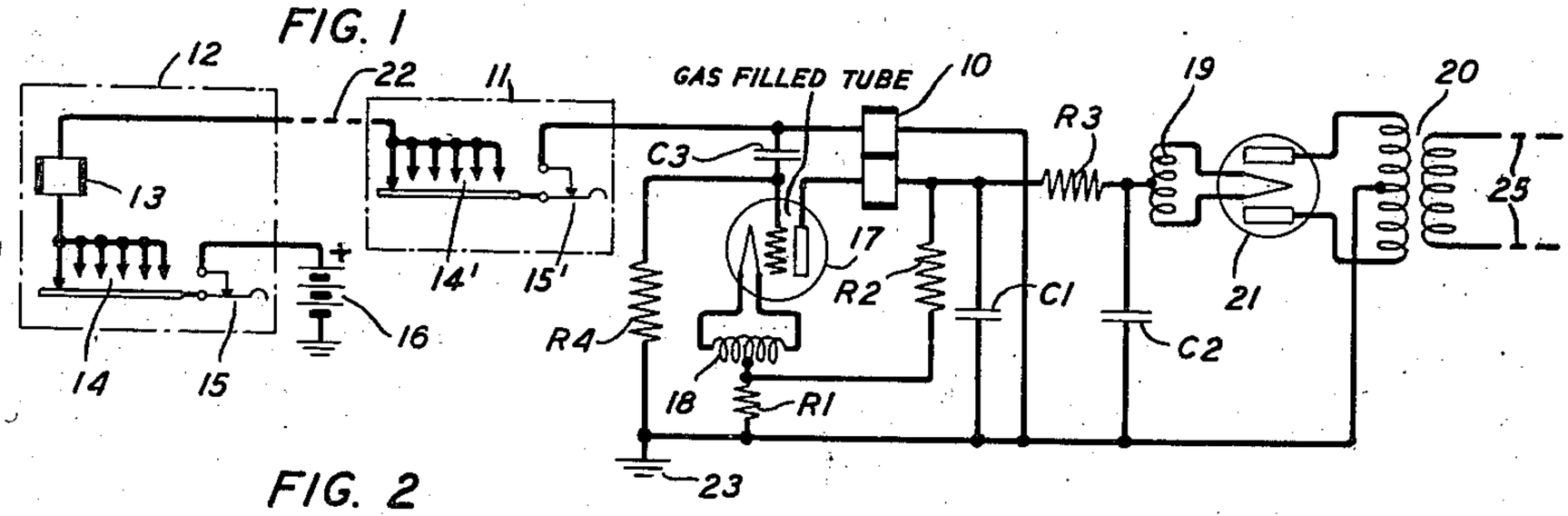


FIG. 2

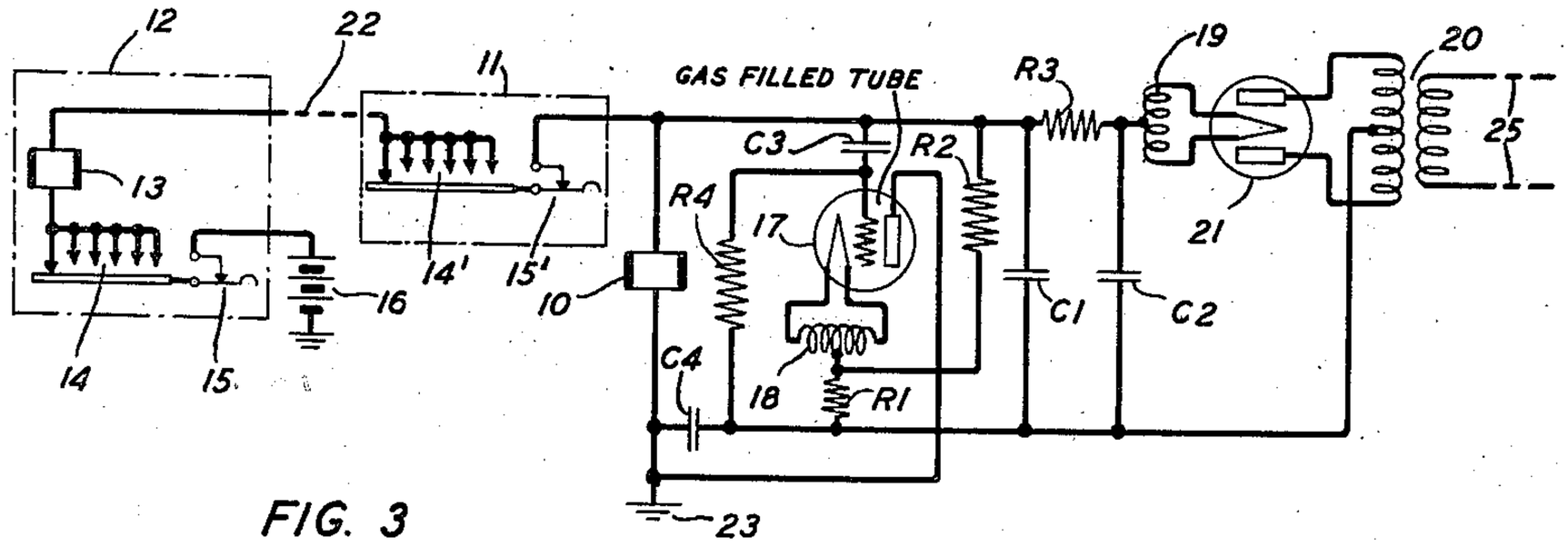


FIG. 3

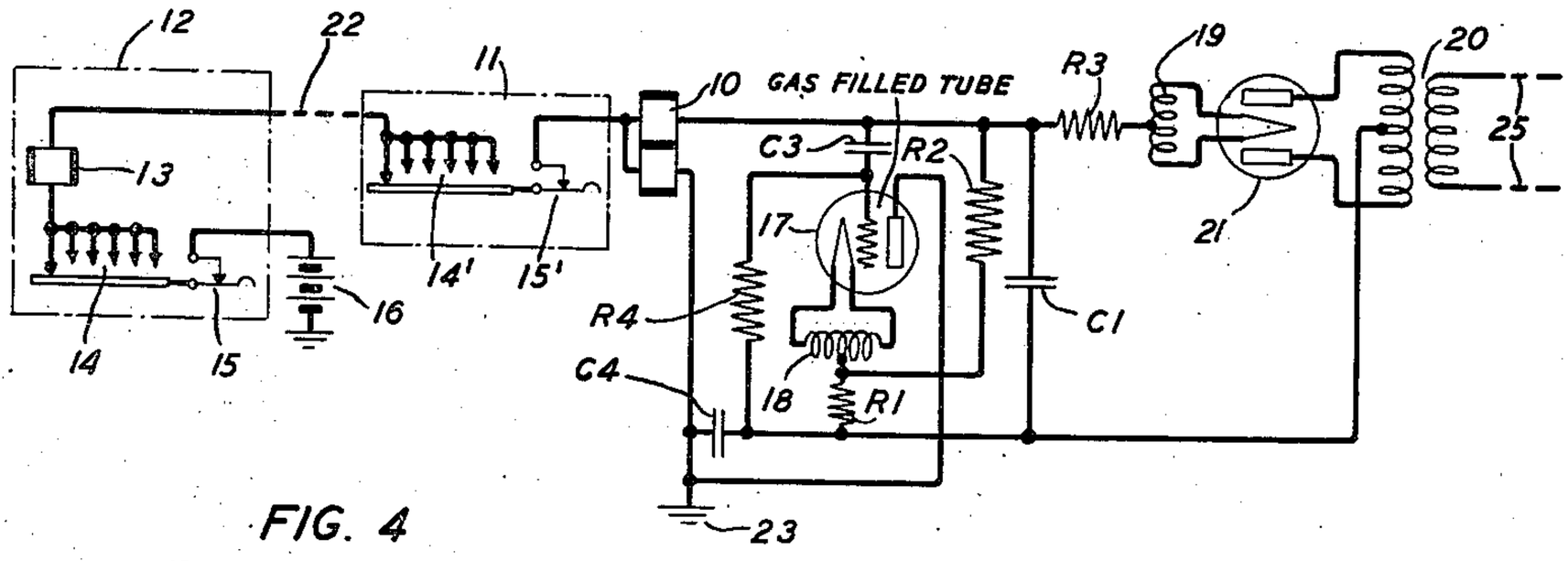
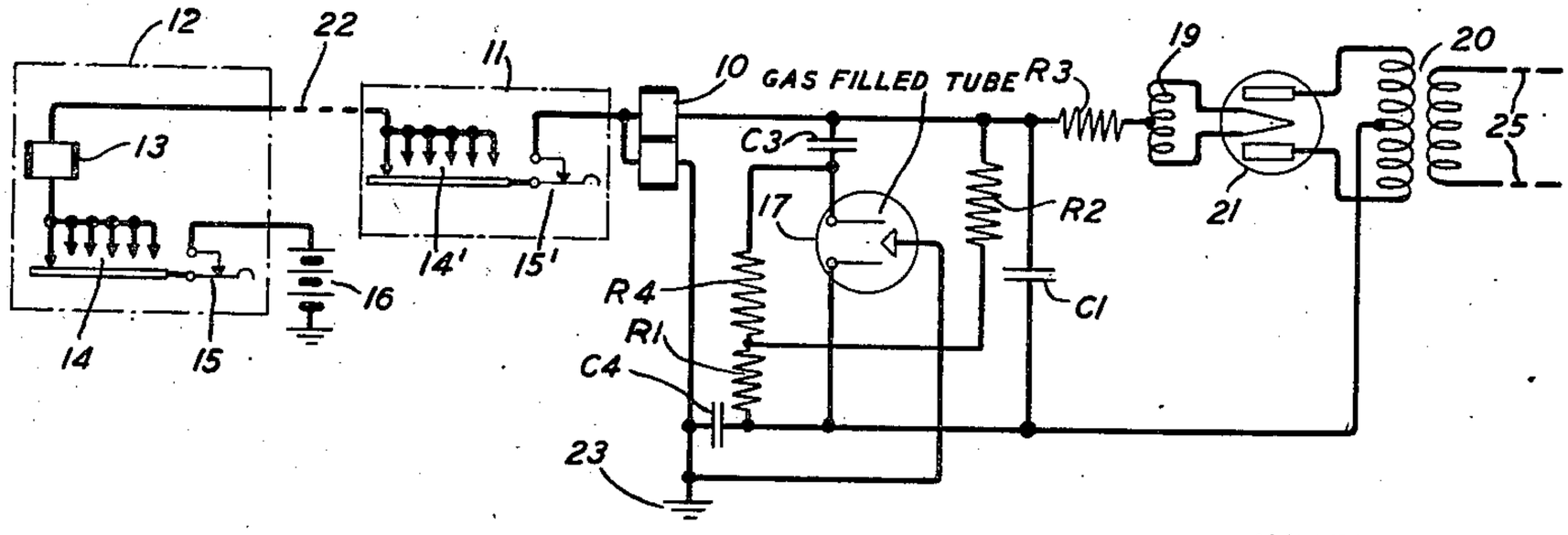


FIG. 4



INVENTOR
A. WEAVER
BY
ATTORNEY

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2,099,089

RELAY

Allan Weaver, Port Washington, N. Y., assignor to American Telephone and Telegraph Company, a corporation of New York

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7 Claims. (Cl. 178—88)

This invention relates to electromagnetic relays or devices and more particularly to increasing the speed of operation and at the same time the work the relay can perform in operating.

In many electromagnetic relay circuits such as line circuits the energy available to operate the relays is not much in excess of that required to operate the relay. In other electromagnetic relay circuits the ratio of inductance of the windings of the relays to the resistance of the circuit is large. In both cases, the time required for the current to build up to the operating value of the electromagnets and the operating time of the armature is quite long. This is especially true in cases where the armature performs a considerable amount of mechanical work in operating. Consequently, the electromagnet is either unable to follow short impulses, such as signaling impulses, or else it distorts and mutilates these impulses.

It is an object of this invention to supply an additional short energy impulse to the electromagnet when its circuit is closed to increase the speed at which it will operate and at the same time increase the work that it may perform. In the preferred embodiment, the impulse lasts only long enough for the current in the main circuit of the electromagnet to reach a value sufficient to hold the relay operated.

In brief, the input circuit of an electric discharge device is connected to the main circuit of the electromagnet and the output circuit of the discharge device supplies additional energy to increase the speed of operation of the electromagnet. The output circuit is arranged to cease supplying energy to the electromagnet after a short interval of time during which the current in the main winding has time to build up to the magnitude of the holding current required to maintain the magnet actuated. This arrangement has the further advantage that the current in the main winding need only build up to the holding current magnitude instead of the operating current magnitude. Thus, for the relay to accomplish a given amount of work, the required current in the main winding is reduced from the initial operating magnitude to the magnitude required for maintaining the relay or electromagnet in operated condition.

These and other objects and features of the invention may be more readily understood from the following description when read with reference to the attached drawing in which:

Figure 1 illustrates one embodiment of the invention as applied to a telegraph line relay;

Fig. 2 shows a similar arrangement applied to a single winding relay or device;

Fig. 3 shows a more sensitive arrangement in which the electromagnetic device or relay also serves as an input transformer for the electric discharge device; and,

Fig. 4 illustrates a circuit arrangement employing a cold cathode electric discharge device.

One embodiment of the invention will now be described with reference to Fig. 1. Here, 12 represents a telegraph station which may be any suitable type of station having a receiving device 13 and a telegraph transmitting device having impulse transmitting contacts 14 and signaling contacts 15. Station 12 may also include switching and interconnecting apparatus and circuit arrangements. While all the details of these devices and circuit arrangements have not been shown, it is to be understood that this invention as hereinafter described may be adapted for use with all these arrangements.

Station 12 is connected by line 22 to other telegraph apparatus. Line 22 is shown as a grounded telegraph line but it is to be understood that it could equally well be a full metallic line. One obvious arrangement may be had by locating battery 16 adjacent the other telegraph apparatus and connecting it to station 12 over the second line wire. Another obvious metallic line may be arranged by supplying ground 23 over the other line wire from station 12.

A transmitting device 11 may be provided in series with line 22 at the second station. Device 11 may be any suitable transmitting device which may have contacts 14′ similar to 14 at station 12 and also includes other signaling apparatus such as switch 15′, for example.

A receiving magnet is represented by 10. This magnet may be a relay magnet or winding, a receiving printer magnet, an electromagnet solenoid, a switch magnet, or other suitable device.

In accordance with this invention an electric discharge device 17 is provided in combination with receiving magnet 10 for supplying additional energy impulses to magnet 10 to increase its speed of operation so that it may readily follow telegraph signal impulses and at the same time have sufficient power to operate a printing mechanism when operated directly over the line circuit without any repeating relay.

Any suitable electric discharge device may be used. However, gaseous conduction tubes in which discharges may be initiated by a potential applied to a control element and in which the discharge continues independently of the potential

of the control element until interrupted in some other manner are preferred. The type illustrated in Fig. 1 is an electrostatically controlled hot cathode arc discharge tube. Tubes of this type are sometimes called "Thyraton" tubes. When the potential applied between the control element or grid and the cathode by the input circuit exceeds a certain value and is of the correct polarity a discharge is initiated between the anode and cathode which continues independently of the potential of the control element until interrupted by some change in the output or anode cathode circuit.

The arrangement shown in Fig. 1 is supplied with energy from a source of alternating current (not shown) connected to transformer 20 by leads 25. Transformer 20 is provided with windings 18 and 19 to supply cathode current for the electric discharge device 17 and rectifying device 21, respectively. Rectifying device 21 supplies both the plate potential and the steady grid bias for the electric discharge tube 17.

Assume now that the transmitting device 14 at station 12 has opened the line and the impulse responsive devices 13 and 10 have returned to their unactuated positions. Then, when the circuit is again completed by this transmitting device 14, current will start to flow in the line circuit from battery 16, through contacts 15 and 14, responsive device 13, line 22, contacts of transmitting device 11, upper winding of electromagnetic responsive device 10 to ground 23. Closure of this circuit will also apply a momentary potential to the grid of tube 17 through condenser C_3 which tends to make the grid potential of this tube more positive. Normally the potential of the grid of tube 17 is maintained negative with respect to the cathode by means of the leak resistance R_4 and the potential drop across the bias resistance R_1 due to current flowing through the bias resistors R_1, R_2 and R_3 from rectifying device 21. The normal potentials applied between the grid and cathode and also between the anode and cathode are such as to normally prevent a discharge of current through tube 17. However, the momentary potential applied to the grid of tube 17 through condenser C_3 when the loop or circuit of line 22 is closed causes the potential of the grid of tube 17 to become sufficiently positive with respect to the cathode to initiate a discharge through the tube. This discharge also flows through the lower winding of the electromagnet 10 in such a direction as to aid the operation of this magnet. The values of resistance R_3 and condenser C_1 are so chosen that the potential of C_1 will fall to such a low value a short time after the discharge through tube 17 is initiated that this discharge will cease. By this time electromagnet 10 has operated and the line current has substantially reached its steady state value which is sufficient to maintain this magnet in its operated position.

Thus, the discharge device 17 supplies an impulse of current or energy to the responsive device 10 every time its circuit is closed. This tends to increase the operating speed as well as increase the work the magnet can perform in operating.

It should be noted that the output circuit of tube 17 remains in a fixed state of continuity and is not interrupted by device 10 and also after the discharge stops it will not be again initiated until the circuit of magnet 10 has been opened and again closed. During the time the circuit remains closed after the steady state conditions have become established in the line circuit the line current does not change appreciably. There can, therefore, be no potential applied to the grid of tube 17 to initiate a discharge through the tube during this time.

When the line circuit is opened the line current will decrease and apply a momentary potential to the grid of tube 17 which tends to make it more negative with respect to the cathode. This prevents any discharge through tube 17 at this time.

Care must be taken in the design of the windings of magnet 10 so that the ratio between them is not greater than the control ratio of the tube 17 and associated circuit. If this ratio is exceeded by the ratio of the two windings then the plate potential may decrease so much faster than the grid potential increases when the line circuit is closed that no discharge may occur but when the line circuit is opened the plate potential may increase so much faster than the grid potential decreases that a discharge may occur which would tend to hold magnet 10 operated during the discharge time. This improper operation can be prevented by a proper choice of the responsive device 10 and electric discharge device 17.

Fig. 2 shows a modification of the circuit shown in Fig. 1 suitable for use with a single winding electric device 10. The operation of this circuit is quite similar to the operation of the circuit shown in Fig. 1.

When the circuit of responsive device 10 is closed, the grid potential of discharge device 17 with respect to the cathode is increased positively sufficiently to initiate a discharge through device 17. The circuit of this discharge may be traced from rectifier tube 21, resistance R_3, winding of device 10, plate or anode of discharge device 17, cathode of said device, back to rectifier transformer 20 through resistance R_1. Current flowing through this circuit flows through device 10 in the same direction as the current from line 22 flows through device 10. Thus, as before, the discharge current tends to increase the speed of operation of device 10.

In this arrangement, care must be taken that the voltage drop across device 10 due to the discharge current does not reduce the line current sufficiently to interfere with the operation of responsive device 13 at station 12.

As in Fig. 1, the resistance of R_3 and the capacity of condenser C_1 in Fig. 2 are so chosen that the discharge through discharge device 17 ceases a short time after it is initiated. During this time the current from line 22 has reached such a value as to hold device 10 actuated after the discharge from tube 17 ceases.

In the arrangement shown in Fig. 3, device 10 acts as an input transformer for device 17. When the circuit of line 22 is closed current starts to flow through the lower winding. This will induce a potential in the upper winding of device 10. The upper winding of device 10 is connected to the lower winding in such a direction that the voltage across the combination of these windings is the arithmetical sum of the voltages across the individual windings. This total voltage is applied between the grid and cathode of tube or discharge device 17 through condensers C_3 and C_4 and resistance R_1 in such a direction as to cause a discharge through tube 17. The current of this discharge flows through both of the windings of device 10 in a direction to aid the operation of device 10.

It should be noted that with this arrangement it is essential that the ratio between the windings of device 10, the control ratio of device 17 and the voltage drop across the lower winding of device 10 be chosen to insure the correct operation of this circuit.

The embodiment of the invention shown in Fig. 4 employs a cold cathode gas conduction tube 17. This tube may be of any suitable type but is preferably of the type in which the main discharge is controlled by an auxiliary discharge. The right-hand electrode of discharge device 17 as shown in Fig. 4 is the anode, while the upper left-hand electrode is a controlling electrode which initiates a controlling discharge, when the potential applied between this electrode and the cathode exceeds a certain definite voltage. The lower left-hand electrode provides a circuit for the main discharge in the device to the anode. A characteristic of cold cathode gas conduction tubes of this type is that the discharge between the main or lower left-hand electrode and anode after being started by discharge between the anode and the control electrode will continue independently of the potential applied to the control electrode. Consequently, additional means must be provided to interrupt this discharge. In Fig. 4 a condenser C_1 and resistance R_3 are provided to interrupt this discharge and operate in a manner quite similar to the condenser C_1 and resistance R_1 in Figs. 1, 2 and 3. The remainder of this circuit also operates similar to the circuit arrangement shown in Fig. 3. When the line circuit is closed the potential applied to the control electrode and through the windings of relay 10 and capacities C_3 and C_4 is sufficient to initiate a controlling discharge. This controlling discharge initiates the main discharge between the lower left-hand element and the right-hand element of the tube. Current of this latter discharge then flows through both windings of relay 10 and supplies additional energy to operate this relay. It should be noted that relay 10 acts as an input transformer to step up the voltage applied through condensers C_3 and C_4 to the control electrode. After the discharge has been initiated condenser C_1 starts to discharge through the circuit of the main discharge. When condenser C_1 has discharged a certain quantity of the charge stored in it, its voltage will fall to such a value that the discharge through tube 17 can no longer be maintained. The discharge will then cease and tube 17 will be restored to its non-conducting condition. By this time the line current through the lower winding of relay 10 has had time to reach a sufficiently high value to hold relay 10 operated. When the line circuit is then opened a voltage will be applied through condensers C_3 and C_4 to the control element of tube 17. This voltage, however, will be of an opposite polarity to that applied when the line circuit is closed, so that no discharge will be initiated through tube 17. Then when the line circuit is again closed a discharge will be initiated through tube 17 and relay 10 again operated as described above. With the arrangement shown in this figure, care must be taken to select the proper ratio between the windings of the device 10 as well as the control ratio of tube 17 as pointed out above with respect to Fig. 3.

The foregoing description of several specific embodiments of this invention is to enable one skilled in the art to more readily understand it while the following claims particularly point out the novel features of the invention.

What is claimed is:

1. A signaling line relay, a line circuit including circuit closing means, a line winding wound upon said relay and connected to said line circuit, an auxiliary circuit including a single gaseous discharge device, an operative connection between said auxiliary circuit and said relay for controlling said discharge device and for supplying additional energy to aid in the operation of said relay when said line circuit is closed.

2. An electromagnetic device comprising a single winding, a first circuit connected thereto including a source of potential and means for controlling the current to flow in said circuit, an electrostatically controlled gaseous conduction device having a control circuit and an output circuit therefor, an operative connection between said electromagnet and said electric discharge device whereby a discharge is initiated through said discharge device to supply additional energy to said electromagnetic device when current starts to flow through said first circuit, and means in said output circuit for terminating said discharge after a predetermined interval of time.

3. In combination, an electromagnetic device, a holding circuit therefor including a winding on said device and a source of energy, the current of which is capable of holding said device operated but incapable of operating said device, a gaseous discharge device having an input circuit and an output circuit in a fixed state of continuity, said discharge device being of the type in which the input circuit controls the starting of a discharge in the output circuit which discharge continues independently of said input circuit, means for inductively coupling said input circuit to said holding circuit through said electromagnetic device for initiating a discharge through said discharge device when said holding circuit is closed, an operative connection between said output circuit and said electromagnetic device for operating said electromagnetic device by discharges through said discharge device and means for terminating discharges through said discharge device a short time after the discharges are initiated.

4. In combination, a single gaseous conduction tube having an input circuit and an output circuit in a fixed state of continuity, an operable electromagnetic device, a holding circuit therefor, an inductive connection between said input circuit and said holding circuit for initiating discharges through said device when the holding circuit is closed, an operative connection between said device and said output circuit, and means for terminating discharges through said tube a short time after they are initiated.

5. In a telegraph system, a line magnet and incoming line capable of supplying only sufficient energy to hold said magnet operated, connected to said magnet, an auxiliary circuit also connected to said magnet to supply sufficient energy to said magnet to operate it when said line circuit is closed, said auxiliary circuit comprising a single gaseous conduction tube having input and output circuits in which a discharge is initiated by said input circuit and is thereafter independent of said input circuit, means for terminating said discharge a predetermined interval after it is initiated and an operative connection between said input and output circuits and said magnet for operating said magnet when said line circuit is closed.

6. In combination, an electromagnet, a single winding wound thereupon, an electrical circuit for supplying current to said winding connected thereto, a gaseous conduction device having an input circuit and an output circuit of the type in which discharges are initiated in said output circuit by said input circuit and then continue independently of the condition of said input circuit, an operative connection between said single winding and said input and output circuits for initiating discharges through said gaseous conduction device under control of said current supply circuit and for supplying additional energy to said electromagnet from the output circuit of said gaseous conduction device, and means in a fixed state of continuity connected in said output circuit for extinguishing said device a predetermined interval of time after discharges through it have been initiated.

7. A telegraph relay comprising a first winding, a second winding, an input line connected to said first winding, a gaseous conduction device having input and output circuits, means for connecting said input circuit to said windings of said relay whereby said windings serve as an input transformer for said gaseous conduction device, means connecting the said output circuit to said windings to supply additional energy to said relay, and means connected in said output circuit for extinguishing discharges through said gaseous conduction device a short time after they are initiated therethrough.

ALLAN WEAVER.