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J. P. RADCLIFF

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SIGNALING SYSTEM

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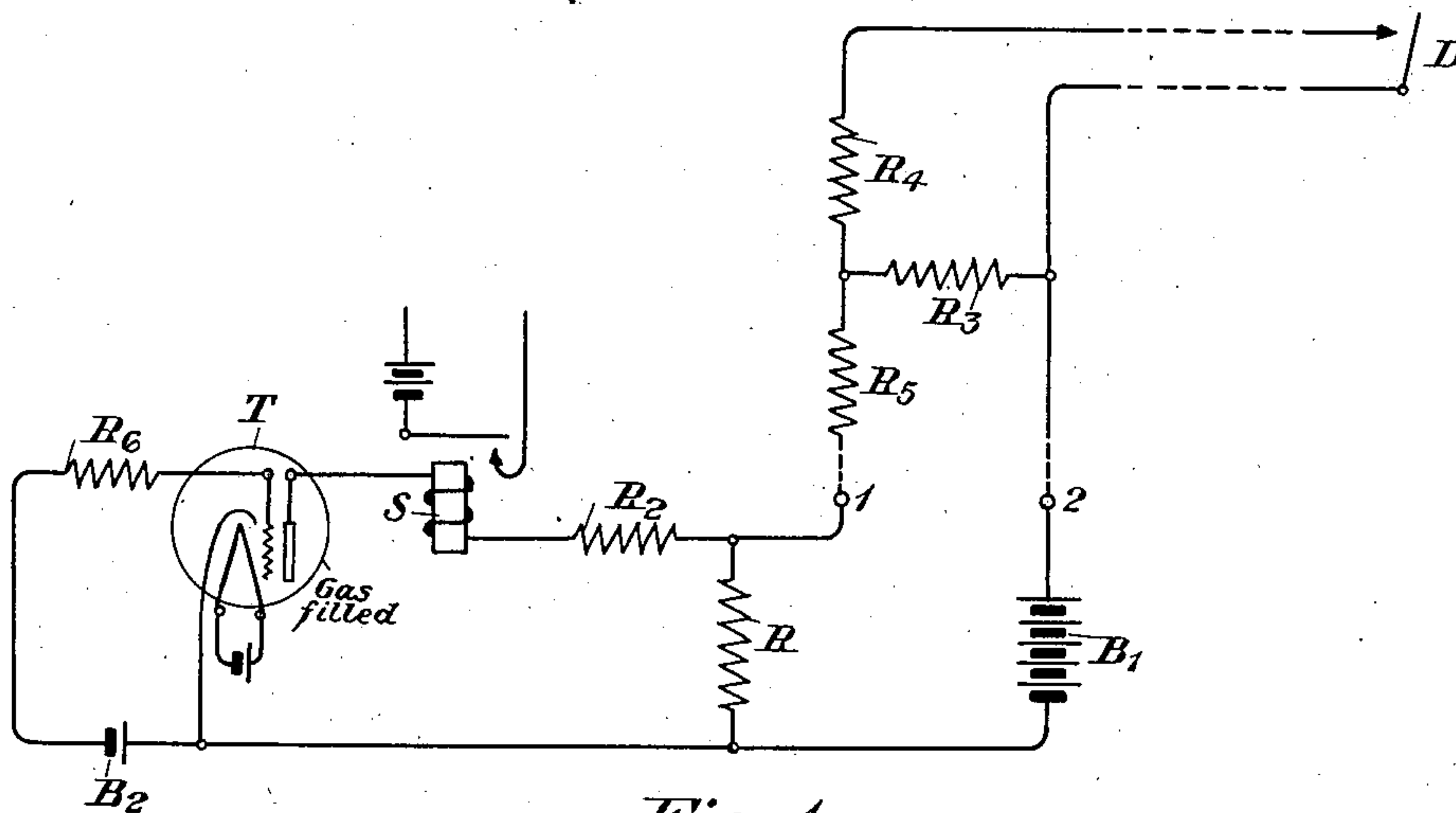
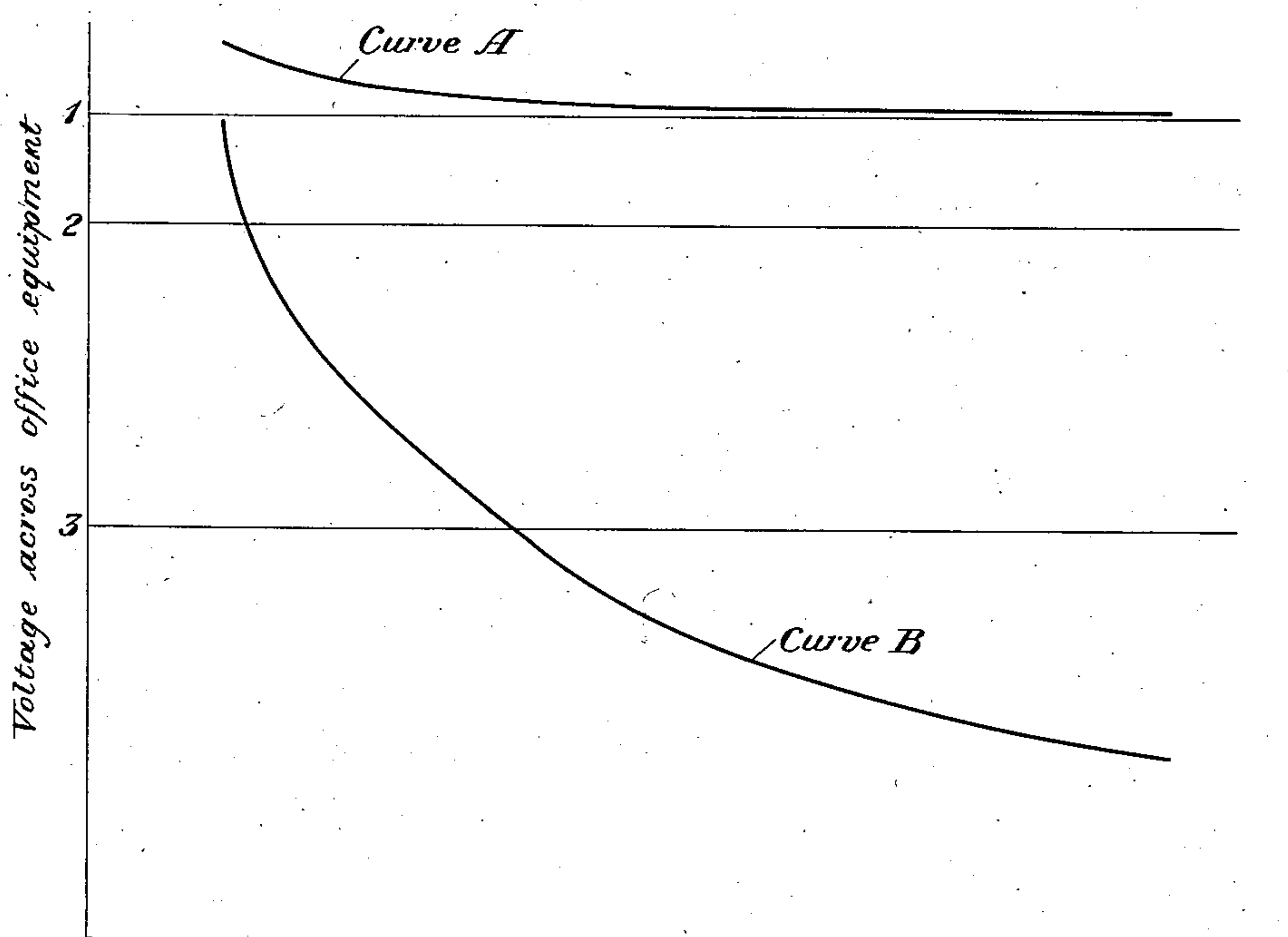


Fig. 1



Leakage Resistance

Fig. 2

INVENTOR
J. P. Radcliff
BY
J. P. Radcliff
ATTORNEY

UNITED STATES PATENT OFFICE

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SIGNALING SYSTEM

John P. Radcliff, New York, N. Y., assignor to
American Telephone and Telegraph Company,
a corporation of New York

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3 Claims. (Cl. 179—16)

This invention relates to electrical circuits and more particularly to electrical signaling circuits intended to operate on direct current impulses such as are received from a subscriber's station by the selecting equipment of a dial central office. More specifically, this invention relates to the application of a gas-filled tube and associated equipment to the circuit which receives, detects and transmits to other equipment in the central office signals received from the subscriber's line circuit.

This invention is peculiarly adapted for use in connection with subscribers' lines in which a relatively low insulation resistance exists between wires. Such lines may be described as "leaky lines". These lines may be either pole lines or cable lines. The relatively low insulation resistance between the wires may be caused by defects in the insulation or by changes in weather conditions, for example, from dry to wet weather. One of the objects of this invention is to provide a relay device controlled by direct current impulses over a line which will operate over a range of leakage resistance values as long as the leakage resistance of the line is not less than a predetermined minimum. Furthermore no adjustment is necessary to maintain the arrangements of this invention in an operating condition when variation in the leakage resistance takes place so long as this quantity remains greater than a predetermined value.

Dial signals are sent over a subscriber's line by the alternate opening and closing of the loop at the subscriber's subset by means of a dial. Whenever the dial is in such a position as to cause a short circuit to be applied to the line, a current flows over the line and the result of this flow of current is a potential drop across a certain portion of the circuit which will hereinafter be referred to as R and which is in series with the subscriber's line and the battery. When the dial is in such a position as to cause an open circuit on the line, no current should flow through the circuit and there should be no potential drop across R. However, if the insulation resistance which exists between wires or between wires and ground has a low value, then current can flow through the circuit made up of R and the subscriber's line and there will be a resulting potential drop across R. This potential drop may result in the failure of the selecting equipment to correctly interpret the dialed pulses.

It is proposed in this invention to apply a gas-filled tube of the proper type and design to perform certain necessary functions when connected to or associated with that portion of the circuit designated as R. This gas-filled tube is of such a type and design that for any given condition of the circuit with which it is associated it will operate when a certain potential is applied

from anode to cathode and will release when this applied potential has fallen to a lower value. A discharge tube suitable for use in the arrangements of the invention might, for example, be one filled with a gas such as argon or helium.

The invention may be more fully understood from the following description, together with the accompanying drawing in the Figures 1 and 2 of which the invention is illustrated. Fig. 1 is a circuit diagram embodying a preferred form of the invention. Fig. 2 shows graphically certain principles of operation of the arrangements.

The circuit shown in the drawing consists essentially of a gas-filled tube T which together with relay S, is associated with resistance R. Resistance R is connected in series with the subscriber's line which for the purpose of this invention description is illustrated as a T network comprising resistances R_3 , R_4 and R_5 . Battery B_1 supplies the potential which is interrupted by the dial D located at the subscriber's subset. The resultant pulses of current flow through resistance R and the potential drop across the resistance is a function of the position of the dial D.

Let R_0 be the effective resistance of the line circuit between points 1 and 2 when the contacts of dial D are opened. R_c is the effective resistance of the line circuit between points 1 and 2 when the contacts of dial D are closed. The T network which is used to represent the line circuit is composed of resistances R_3 , R_4 and R_5 . Reducing the network resistances to R_0 and R_c ,

$$R_0 = R_5 + R_3 \quad (1)$$

$$R_c = R_5 + \frac{R_3 R_4}{R_3 + R_4} \quad (2)$$

Now since

$$\frac{R_3 R_4}{R_3 + R_4}$$

is of lower resistance than R_3 , then R_0 will always be of greater resistance than R_c .

The potential from the anode to the cathode of tube T is the potential drop across the resistance R less any potential drop in R_2 and the winding of relay S if the tube is operated and current flows in the anode circuit. R_2 is a protective resistance necessary to limit the anode current to a safe value. Relay S is a means of transmitting the received and detected pulses to the selecting equipment of the central office. The gas-filled tube circuit is so adjusted that the tube will operate when the potential drop across resistance R is equal to or greater than E_0 and the tube will release when the potential drop across resistance R is less than E_0 . The point of operation and release can be adjusted by varying resistance R and battery B_2 . The potential

of battery B_2 is applied to the grid of the tube through the protective resistance R_s . The purpose of this resistance is to limit the current which the grid may draw when the tube is operated.

E_o is the potential drop across resistance R when the contacts of dial D are opened. E_c is the potential drop across resistance R when the contacts of dial D are closed. Let E represent the voltage of battery B_1 which is assumed to be constant. Then:

$$E_o = E \times \frac{R}{R + R_s} = E \times \frac{R}{R + (R_s + R_3)} \quad (3)$$

$$E_c = E \times \frac{R}{R + R_s} = E \times \frac{R}{R + \left(R_s + \frac{R_3 R_4}{R_3 + R_4} \right)} \quad (4)$$

From these formulas, it is evident that E_o will always be less than E_c , since it was demonstrated above that R_s was always greater than R_c .

Now for any given subscriber's line and battery, the value of resistance R and the potential applied to the grid of tube T by battery B_2 may be so adjusted that the tube will operate when a potential E_c is applied to the anode, but will release when the potential falls to the smaller value E_o . Furthermore since the line resistance which is represented by R_4 and R_5 remains essentially constant and since the leakage resistance which is represented by R_3 may vary, as the leakage resistance increases E_o will decrease in value as can be seen by an inspection of Equation (3). Thus the tube will quench for all values of R_3 above a certain minimum leakage. Let $E_{o(max.)}$ be the value of potential which results across resistance R when the leakage resistance is a minimum.

Considering Equation (4) it is evident that as the leakage resistance R_3 reaches a maximum value, E_c will reach a minimum value given by Equation (5).

$$E_{c(min.)} = E \times \frac{R}{R + (R_s + R_4)} \quad (5)$$

The sum $(R_s + R_4)$ is the resistance value of the subscriber's line circuit.

Hence if for any given line and battery, the value of the resistance R and the potential applied to the grid of the tube T are so adjusted as to cause the tube to operate when a voltage $E_{c(min.)}$ is applied across resistance R and cause the tube to release when a voltage $E_{o(max.)}$ is applied across resistance R , then the tube will continue to function for all values of leakage resistance above the minimum value.

Fig. 2 illustrates graphically the improvement of this invention over the type of relay equipment which it replaces. Curve A gives the voltage available for use by the office equipment when the dial contacts are closed. This voltage is reasonably constant in value since the leakage resistance does not affect the loop resistance to any great extent. Curve B gives the voltage which is present across the office equipment due to the leakage resistance of the line. Voltage 1 is required to operate the office equipment which may be either of the relay type or the gas-filled tube type. Voltage 3 is the voltage below which it is necessary to go before the relay type of equipment will release; whereas voltage 2 is the voltage below which it is necessary to go before the gas-filled tube type of equipment will release. It can be seen from the group of curves that the gas tube equipment can be employed on lines in which the leakage resistance is much

lower than those lines which employ relay equipment.

While the invention has been disclosed as embodied in a specific form, it will be understood that it is capable of embodiment in other and different forms without departing from the spirit and scope of the invention. For example, the use of a gas-filled tube having a greater or smaller number of elements shall not be construed as departing in sense from the embodiment of the invention described herein for the purpose of illustration when read in connection with the accompanying drawing and for which the appended claims are drawn. Furthermore, although the tube used to describe this invention is of the hot cathode type, it is understood that a gas-filled tube of the cold cathode type may be employed in this invention without departing from the spirit and scope of the invention.

What is claimed is:

1. A marginal relay circuit comprising a line having series resistance and shunt leakage resistance, a source of potential in said line, switching means for applying an open or short circuit condition at one end of said line, a terminating resistance bridged across the other end of said line, a gas-filled discharge tube having its discharge path bridged across said terminating resistance, the value of said terminating resistance being so chosen that the voltage across said terminating resistance due to said source of potential will always be less than the breakdown voltage of said tube when the remote end of said line is open circuited and will always be greater than the breakdown voltage of said tube when the remote end of the line is short circuited.

2. A marginal relay circuit comprising a line having series resistance and shunt leakage resistance, a source of potential in said line, switching means for applying an open or short circuit condition at one end of said line, a terminating resistance bridged across the other end of said line, a gas-filled discharge tube having its discharge path bridged across said terminating resistance, the value of said terminating resistance and the constants of said tube circuit being so chosen that the voltage across said terminating resistance due to said source of potential when the remote end of said line is open circuited will be below the breakdown voltage of said tube and will always be less than the voltage across said resistance when the remote end of said line is closed, which latter voltage will be greater than the breakdown voltage of said tube.

3. A marginal relay circuit comprising a line having series resistance and shunt leakage resistance, a source of potential in said line, switching means for applying an open or short circuit condition at one end of said line, a terminating resistance bridged across the other end of said line, a gas-filled discharge tube having its discharge path bridged across said terminating resistance, the value of said terminating resistance and the constants of said tube circuit being so chosen with respect to said line and said source of potential therein that said tube will not be operated by voltages across said terminating resistance resulting from leakage resistance of an arbitrary minimum value across said line but will be operated by voltages across said terminating resistance whenever said line has a short circuited condition at the end thereof.

JOHN P. RADCLIFF.