April 16, 1929. H. W. ULRICH 1,708,960

TELEPHONE SYSTEM

Filed July 28, 1927 2 Sheets-Sheet 1

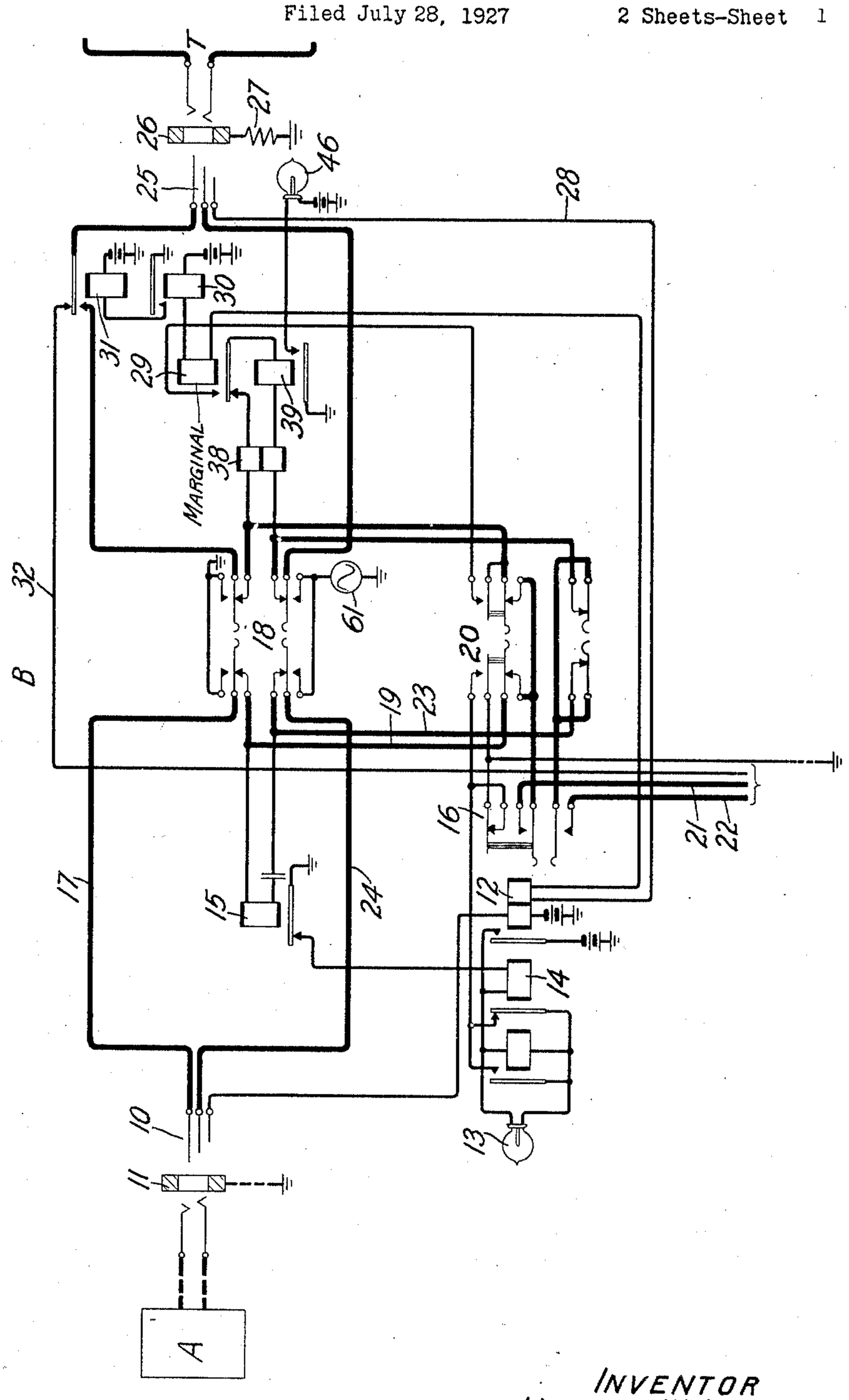

FIG. 1.

INVENTOR
HORACE W. ULRICH
BY John A. Hall
ATTORNEY

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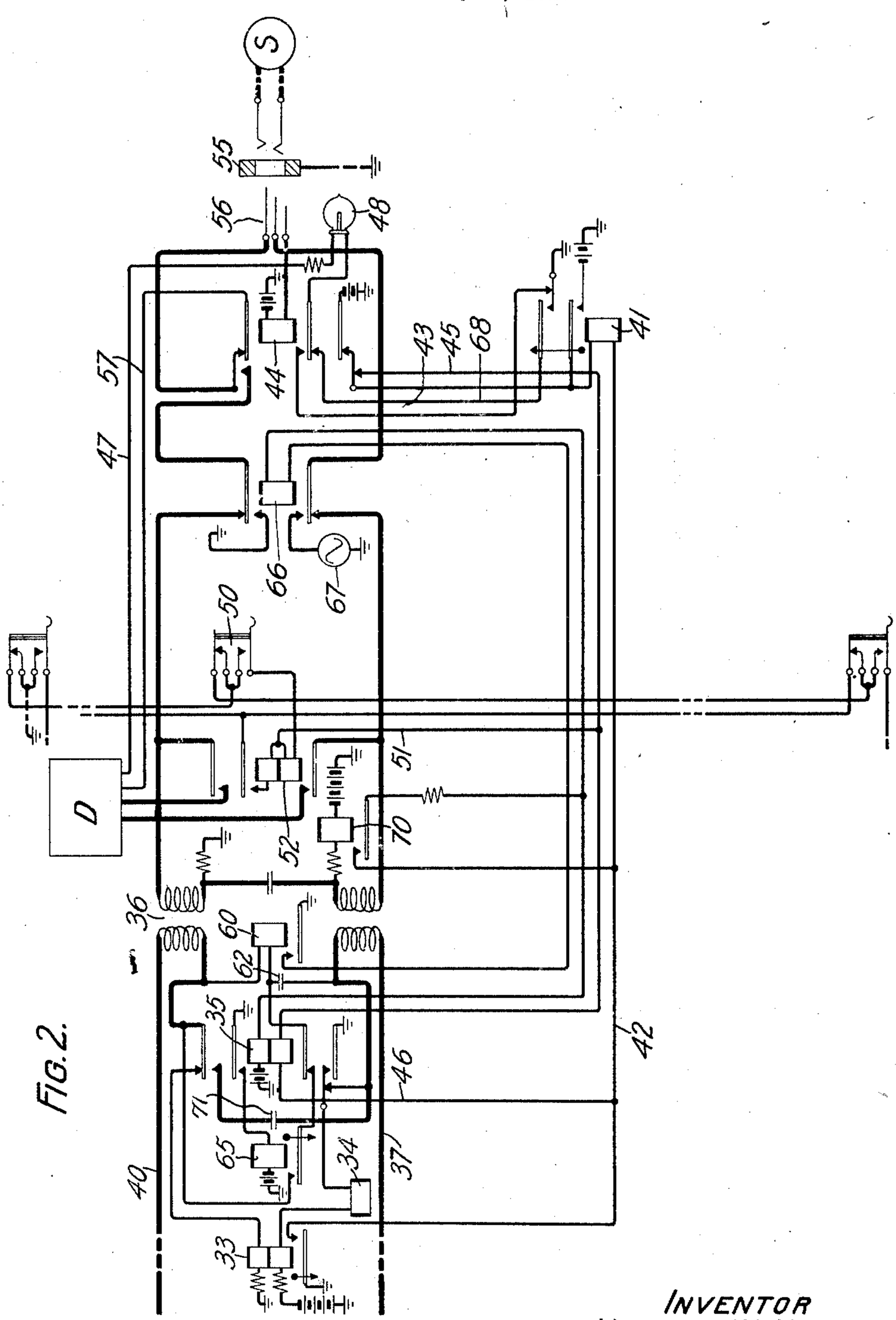

FIG. 2.

INVENTOR
HORACE W. ULRICH
BY John A. Hall.
ATTORNEY

Patented Apr. 16, 1929. 1,708,960

UNITED STATES PATENT OFFICE.

HORACE W. ULRICH, OF NEWARK, NEW JERSEY, ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

TELEPHONE SYSTEM.

Application filed July 28, 1927. Serial No. 208,902.

This invention relates to telephone systems and more particularly to such system wherein low frequency signaling current is employed for signaling over long range toll lines.

In long range signaling with alternating current, it has been found that aside from the impedance offered to signaling currents by the long transmission lines themselves, there are also present other sources of impedance which tend to dissipate the actuating currents intended to operate the regular ringing relays. Such sources are, the direct current bridge usually employed in such systems for the transmission of supervisory signals, and a shunt including a condenser in the voice frequency path which heretofore has been permanently connected in bridge of the regular ringing relay and in series with two of the windings of the repeating coil.

It is the object of this invention to improve the transmission of signaling currents over long transmission lines.

This object is attained in accordance with a feature of the invention, by the provision of a circuit arrangement whereby the usually continuous voice frequency path of a long range toll switching trunk is maintained normally discontinuous, and rendered continuous for conversation purposes only.

Another feature of the invention resides in a circuit arrangement whereby the direct current bridge employed for supervisory purposes is disconnected from the toll switching trunk during the passage of ringing current thereover.

A further feature of the invention is embodied in a circuit arrangement wherein the ringing relay is short-circuited momentarily, to cover the time of charging a condenser associated therewith, thereby preventing surges through the ringing relay and the false operation thereof.

The circuit arrangement embodying the first and second mentioned features provides for the alternate connection of the direct current bridge and the voice frequency condenser to the toll trunk so that during periods of ringing there is present across the trunk only one of these bridge, thereby materially reducing the impedance offered to the ringing current and increasing the efficiency of the ringing arrangement.

The invention will be readily understood from the following detailed description made with reference to the accompanying drawings in which

Fig. 1 shows a toll cord circuit B adapted to interconnect the toll line indicated at A and the toll switching trunk T; and

Fig. 2 shows the toll switching trunk T in full, its associated operator's telephone equipment indicated at D and the subscriber's telephone set indicated at S.

Assuming a call to have come in over the toll line A and the toll operator having been signaled in the usual manner, she will proceed to answer the call by inserting plug 10 of her toll cord circuit B into jack 11 of the calling toll line A. Relay 12 thereupon operates over an obvious sleeve circuit, causing relay 14 to operate in a circuit extending from grounded battery, armature and front contact of relay 12, winding of relay 14, to ground over the back contact and armature of relay 15. The operation of relay 14 prevents the actuation of supervisory lamp 13 at this time.

The toll operator then actuates the talk key 16 to bridge her telephone set (not shown) across the back end of the cord circuit in order to converse with the distant toll operator to learn the details of the call. The circuit for the toll operator's telephone set extends from the tip contacts of jack 11 and plug 10, tip conductor 17 of the cord circuit B, normally closed contacts of ringing key 18, conductor 19, normally closed contacts of splitting key 20, closed tip contacts of talk key 16, conductor 21, through the operator's telephone set, conductor 22, closed contacts of talk key 16, normally closed contacts of key 20, conductor 23, normally closed contacts of ringing key 18, ring conductor 24, ring contacts of plug 10 and jack 11.

Upon learning the nature of the call, the toll operator proceeds to extend the connection by testing for an idle toll switching trunk in the usual manner. Upon finding an idle trunk T, the operator inserts plug 25 of the front end of her cord circuit into jack 26 of the idle trunk T.

Upon the insertion of plug 25 in jack 26, a circuit is established extending from ground, high resistance element 27, sleeve contacts of jack 26 and plug 25, conductor 28, right-hand winding of relay 12, winding of marginal relay 29, winding of relay 30 to battery and ground. Owing to the high resistance of this sleeve circuit, marginal relay 29 does not

operate, but relay 30 does operate, effecting an obvious circuit to relay 31. Relay 31, in operating, disconnects the busy test lead 32 from the tip of the cord circuit and cuts the tip conductor thereof through to the ringing key 18.

Relay 33 now operates in a circuit extending from grounded battery, lower winding of relay 33, winding of retard coil 34, normally closed contacts of relay 35, lower left-hand winding of repeating coil 36, ring conductor 37 of trunk T, ring contacts of jack 26 and plug 25, lower normal contacts of ringing key 18, lower winding of retard coil 38, winding of relay 39, armature and back contact of relay 29, upper winding of retard coil 38, upper normal contacts of ringing key 18, front contact and armature of relay 31, tip contacts of plug 25 and jack 26, tip conductor 40 of trunk T, upper left-hand winding of repeating coil 36, uppermost armature and back contact of relay 35 to ground through the upper winding of relay 33.

As a consequence of the operation of relay 33, relays 35 and 41 operate. The operating circuit for relay 41 extends from grounded battery, lowermost armature and back contact of relay 44, conductor 43, winding of relay 41, conductor 42, front contact and armature of relay 33, to ground. The circuit for relay 35 extends from grounded battery, lowermost armature and normally closed contacts of relay 44, conductor 45, lower winding of relay 35, conductor 46, to ground over the front contact and armature of relay 33. The operation of relay 35 causes battery and ground to be disconnected from the tip and ring conductors of the trunk T, by way of its uppermost and lowermost armatures. The removal of battery and ground from the trunk T prevents relay 39 from operating, whereby the supervisory lamp 46 is not lighted at this time. Relay 35 also causes relay 65 to operate in an obvious circuit whereupon a short circuit about relay 60 is prepared at the armature and contacts of relay 65, for a purpose to presently appear. Relay 33 is held operated by way of the retard coil 34 and the make-before-break contacts and lowermost armature of relay 35, to ground.

Relay 41, in operating, establishes a circuit extending from the interrupted battery source (not shown), conductor 47, filament of the guard and disconnect lamp 48, inner lower armature and back contact of relay 44, conductor 68, upper armature and front contact of relay 41, to ground. The guard and disconnect lamp 48 associated with the plug end of the trunk T thereupon flashes. At its lowermost armature, relay 41 establishes a locking circuit for itself to ground on the armature of relay 33.

Upon noting the flashing of lamp 48, the operator actuates a non-locking talk key 50 associated with the plug end of trunk T whereupon a circuit is established extending from grounded battery lowermost armature and back contact of relay 44, conductors 45 and 51, lower winding of relay 52, alternate contacts of key 50, to ground by way of the other talk keys in the group of trunks. In attracting its inner upper armature, relay 52 locks to ground over the non-locking talk keys. At its other armatures, relay 52 connects the toll operator's telephone set at D to the tip and ring of the trunk T whereupon the toll operator is informed that the subscriber at station S is desired.

The toll switching operator, in extending the connection tests jack 55 of the line S in the usual manner and, finding it idle, inserts the plug 56 into jack 55. An obvious sleeve circuit is thereupon established in which relay 44 operates. Relay 44, in attracting its lowermost armature, causes relay 52 to restore and disconnect the toll operator's telephone set from the trunk; at its inner lower armature relay 44 opens the circuit for lamp 48 whereupon this lamp is extinguished; at its uppermost armature relay 44 disconnects the busy test lead 57 from the tip of the trunk T and renders the tip conductor thereof continuous; at its lowermost armature relay 44 also opens the circuit for relay 35 whereupon this relay is restored to normal, connecting the direct current bridge to the trunk and removing the condenser 71. The release of relay 35 completes the short circuit about relay 60, hereinbefore mentioned, and due to the slow releasing characteristic of relay 65 this short circuit is momentarily maintained, to cover the period of charging of condenser 62. When relay 35 releases, battery and ground are connected to the ring and tip conductors respectively of trunk T by way of the windings of relay 33, winding of relay 34, normal make-before-break contacts and uppermost armature and back contact of relay 35. It will be noted that relay 60 in series with condenser 62 is also bridged across the conductors of trunk T, but its winding is now short-circuited as just described. The charging of condenser 62, caused by the reassociation of battery and ground with the trunk conductors is effected therefore over a circuit exclusive of the winding of relay 60 and including the armature and front contact of relay 65 and the inner lower armature and back contact of relay 35, thereby preventing relay 60 from experiencing a "kick" and effecting a false signal.

In connecting ground and battery through the windings of relay 33 to the tip and ring of the trunk T relay 35 causes the supervisory lamp 46 to be lighted as a ringing signal to the toll operator. The lamp 46 is caused to be lighted when relay 39 operates in circuit extending from grounded battery, lower winding of relay 33, winding of retard coil 34, normally closed contacts of relay 35,

lower left-hand winding of repeating coil 36, ring conductor 37, ring contact of jack 26 and plug 25, lower normally closed contacts of ringing key 18, lower winding of retard coil 38, winding of relay 39, armature and back contact of relay 29, upper winding of retard coil 38, upper normally closed contacts of ringing key 18, front contact and armature of relay 31, tip contacts of plug 25 and jack 26, tip conductor 40 of trunk T, upper left-hand winding of repeating coil 36, uppermost armature and back contact of relay 35, upper winding of relay 33, to ground. Relay 39, in operating, established an obvious circuit for supervisory lamp 46.

Upon noting the illumination of lamp 46 at this time, the toll operator realizes that the toll switching trunk has been connected to the desired subscriber's line and she proceeds to signal the subscriber by actuating the ringing key 18 on the front end of the cord. The ringing relay 60 then operates in a circuit extending from the ringing current source 61 associated with the toll operator's cord, lower alternate contacts of key 18, ring contacts of plug 25 and jack 26, ring conductor 37, lower left-hand winding of repeating coil 36, condenser 62, winding of relay 60, upper right-hand winding of repeating coil 36, conductor 40, tip contacts of jack 26 and plug 25, armature and front contact of relay 31, upper alternate contacts of key 18, to ground.

Relay 60, operating in response to the ringing current from source 61, causes relay 66 to operate in series with the upper winding of relay 35. This circuit is obvious. Relay 35 in operating, disconnects the direct current bridge from the trunk and at its uppermost front contact renders continuous the left-hand side of repeating coil 36 for the transmission of speech. Relay 65 again operates, as a consequence of the operation of relay 35, to again prepare the momentary short circuit for relay 60, as hereinbefore described.

Relay 66, in operating as described, connects the ringing current source 67 to ring side of the trunk and ground to the tip, so that the subscriber at S is signaled in a well-known manner. When the ringing key 18 is restored, relay 60 releases, causing relays 66 and 35 to restore, the former disconnecting the ringing current source 67 from the trunk and the latter completing the momentary short circuit for relay 60 as hereinbefore described and reconnecting the direct current bridge to the trunk to operate relay 39, and relight lamp 46 at the inward toll operator's position.

When the subscriber responds to the signal by removing the receiver from the switch hook, relay 70 operates in a circuit extending from grounded battery, winding of relay 70, lower right-hand winding of repeating coil 36, back contact and lower armature of relay 66, ring contacts of plug 56 and jack 55 through the subscriber's telephone set, tip contacts of jack 55 and plug 56, closed make-before-break contacts of relay 44, upper armature and back contact of relay 66, upper right-hand winding of repeating coil 36, to ground. Relay 70, in attracting its armature, causes relay 35 to be operated again over a circuit extending from grounded battery, upper winding of relay 35 front contact and armature of relay 70, conductor 42, to ground on the front contact and armature of relay 33. Relay 35, in operating at this time, cuts the direct current bridge from the trunk, thereby causing the supervisory lamp 46 to be extinguished as an indication to the operator that the called subscriber has responded. Relay 35 again completes the short circuit about relay 60 to prevent this relay from falsely operating upon the reconnection of the direct current bridge to the trunk.

The connection is now prepared for conversation. It will be noted that at its outer upper armature relay 35 connects the condenser 71 between the two left-hand windings of repeating coil 36 for the transmission of voice frequency currents, but that during the ringing period relay 35 operated to remove the direct current bridge including battery and ground through windings of relay 33 and retard coil 34. The removal of this bridge tends to maintain the proper wave form of the ringing current inasmuch as its continued association with the trunk circuit would result in superimposing direct current on the ringing current and the consequent distortion of the A. C. wave. Subjecting the ringing relay 60 to superimposed direct current would result in a less positive operation of the relay.

At the completion of conversation and when the called subscriber at station S replaces the receiver on the switchhook, relay 70 releases, causing relay 35 to restore. The release of relay 35 again connects the direct current bridge across the trunk, causing relay 39 to operate, which in turn causes the supervisory signal 46 to be actuated as a disconnect signal to the distant toll operator. Upon noting the illumination of lamp 46 at this time, the distant toll operator removes plug 25 from jack 26, whereupon relay 33, which operated upon the connection of the direct current bridge to the trunk, releases, causing relay 41 to restore. Relay 41, upon restoring, opens its own locking circuit and causes the guard and disconnect signal 48 to flash as a disconnect signal in a circuit extending from interrupted battery (not shown), conductor 47, lamp 48, inner lower armature and front contact of relay 44, to ground at the normal make-before-break contacts of relay 41. Upon noting the flashing of lamp 48 at this time the operator removes plug 56 from jack 55, whereupon relay 44 restores, open-

ing the circuit for lamp 48 which is then extinguished. The circuit is now in normal condition.

What is claimed is:

1. In a telephone system, a trunk circuit, a direct current bridge normally connected across said trunk, a condenser, a ringing current source, and means responsive to current from said source for disconnecting said direct current bridge from said trunk and substituting therefor said condenser.

2. In a telephone system, a trunk circuit, a direct current bridge normally connected across said trunk, a normally open voice frequency path associated with said trunk circuit, an alternating current relay, and means responsive to the actuation of said relay for disconnecting said bridge from said trunk and closing said voice frequency path.

3. In a telephone system, a trunk circuit, a direct current bridge normally connected across said trunk, a normally open voice frequency path associated with said trunk circuit, an alternating current relay, and a second relay controlled by said alternating current relay for disconnecting said direct current bridge from said trunk and closing said voice frequency path.

4. In a telephone system, a trunk circuit, a direct current bridge normally connected across said trunk, a normally open voice frequency path associated with said trunk circuit, an alternating current source, and a relay associated with said trunk circuit, said relay being effective subsequent to the application of current from said source to said trunk for disassociating said bridge from said trunk and closing said voice frequency path.

5. In a telephone system, a trunk circuit having outgoing and incoming ends terminating in a repeating coil for the transmission of voice frequency currents, the voice frequency path of the outgoing end being normally open, a direct current bridge normally connected to said trunk, a ringing relay responsive to alternating current over said trunk, and means responsive to the operation of said ringing relay for closing the normally open voice frequency path of said trunk and disconnecting said direct current bridge from said trunk.

6. In a telephone system, a trunk circuit having outgoing and incoming ends terminating in a repeating coil for the transmission of voice frequency currents, the voice frequency path of one end being normally open, a direct current bridge normally connected to said normally open voice frequency path, a relay associated with said trunk, and a second relay responsive to the actuation of said first relay for closing said normally open voice frequency path and disconnecting said direct current bridge therefrom.

7. In a telephone system, a trunk circuit, a direct current bridge normally connected thereto, a relay in bridge of said trunk, and means responsive to the actuation of said relay for disconnecting said direct current bridge from said trunk and preparing a short-circuit for said relay, said direct current bridge being connected to said trunk and said short-circuit completed upon the restoration of said means.

8. In a telephone system, a trunk circuit, a direct current bridge normally connected thereto, a relay in bridge of said trunk, and means responsive to the actuation of said relay for disconnecting said direct current bridge from said trunk and preparing a short-circuit for said relay, said direct current bridge being connected to said trunk and said short-circuit completed and momentarily maintained upon the restoration of said means.

9. In a telephone system, a trunk circuit, a relay in bridge thereof, a condenser in the circuit of said relay, means for charging said condenser, and means responsive to the actuation of said relay for preparing a short-circuit for said relay, the restoration of said means completing said short-circuit whereupon the charge on said condenser is dissipated therethrough.

10. In a telephone system, a trunk circuit, a relay in bridge thereof, a condenser in the circuit of said relay, means for charging said condenser, and means responsive to the actuation of said relay for preparing a short-circuit for said relay, the restoration of said means completing and momentarily maintaining said short-circuit whereby the charge on said condenser is dissipated therethrough.

11. In a telephone system, a trunk circuit, a relay in bridge thereof, a condenser in the circuit of said relay, means for charging said condenser, and means including a slow-releasing relay responsive to the actuation of said first relay for preparing a short-circuit for said first relay, the restoration of said means completing said short-circuit whereupon the charge on said condenser is dissipated therethrough.

12. In a telephone system, a trunk circuit, a relay in bridge thereof, a condenser in the circuit of said relay, means for charging said condenser, and means including a slow-releasing relay responsive to the actuation of said first relay for preparing a short-circuit for said first relay, the restoration of said means completing and momentarily maintaining said short-circuit whereby the charge on said condenser is dissipated therethrough.

13. In a telephone system, a trunk circuit, a relay in bridge thereof, a direct current bridge, means for disconnecting said direct current bridge from said trunk and reconnecting it thereto, and means controlled by said first mentioned means for momentarily

shunting said relay when said direct current bridge is connected to said trunk, thereby preventing surges through said relay.

14. In a telephone system, a trunk circuit, a relay in bridge thereof, a direct current bridge, a second relay for disconnecting said direct current bridge from said trunk and reconnecting it thereto, and means controlled by said second relay for momentarily shunting said first relay when said direct current bridge is connected to said trunk.

15. In a telephone system, a trunk circuit, a relay in bridge thereof, a direct current bridge, a second relay for disconnecting said direct current bridge from said trunk and reconnecting it thereto, and a slow-releasing relay controlled by said second relay for momentarily shunting said first relay when said direct current bridge is connected to said trunk.

16. In a telephone system, a trunk circuit, a relay in bridge thereof, and a second relay controlled by said first relay and adapted upon its actuation to prepare a short-circuit for said first relay and upon its restoration to complete said short-circuit.

17. In a telephone system, a trunk circuit, a direct current bridge normally connected across said trunk, a condenser, a relay in bridge of said trunk, means responsive to the actuation of said relay for disconnecting said direct current bridge from said trunk and substituting therefor said condenser, and means controlled by said first mentioned means for preparing a short-circuit for said relay, said short-circuit being completed when said first mentioned means is restored to connect said direct current bridge to said trunk.

18. In a telephone system, a trunk circuit, a direct current bridge normally connected across said trunk, a condenser, a relay in bridge of said trunk, means responsive to the actuation of said relay for disconnecting said direct current bridge from said trunk and substituting therefor said condenser and means controlled by said first mentioned means for preparing a short-circuit for said relay, said short-circuit being completed and momentarily maintained when said first mentioned means is restored to connect said direct current bridge to said trunk.

19. In a telephone system, a trunk circuit, a direct current bridge normally connected across said trunk, a condenser, a relay in bridge of said trunk, means responsive to the actuation of said relay for disconnecting said direct current bridge from said trunk and substituting therefor said condenser, and a slow-releasing relay controlled by said first mentioned means for preparing a short-circuit for said relay, said short-circuit being completed and momentarily maintained when said first mentioned means is restored to connect said direct current bridge to said trunk.

In witness whereof I hereunto subscribe my name this 27 day of July A. D. 1927.

HORACE W. ULRICH.