

Aug. 5, 1924.

W. T. POWELL

1,503,916

METERING ARRANGEMENT FOR AUTOMATIC TELEPHONE SYSTEMS

Filed Dec. 28, 1920

2 Sheets-Sheet 1

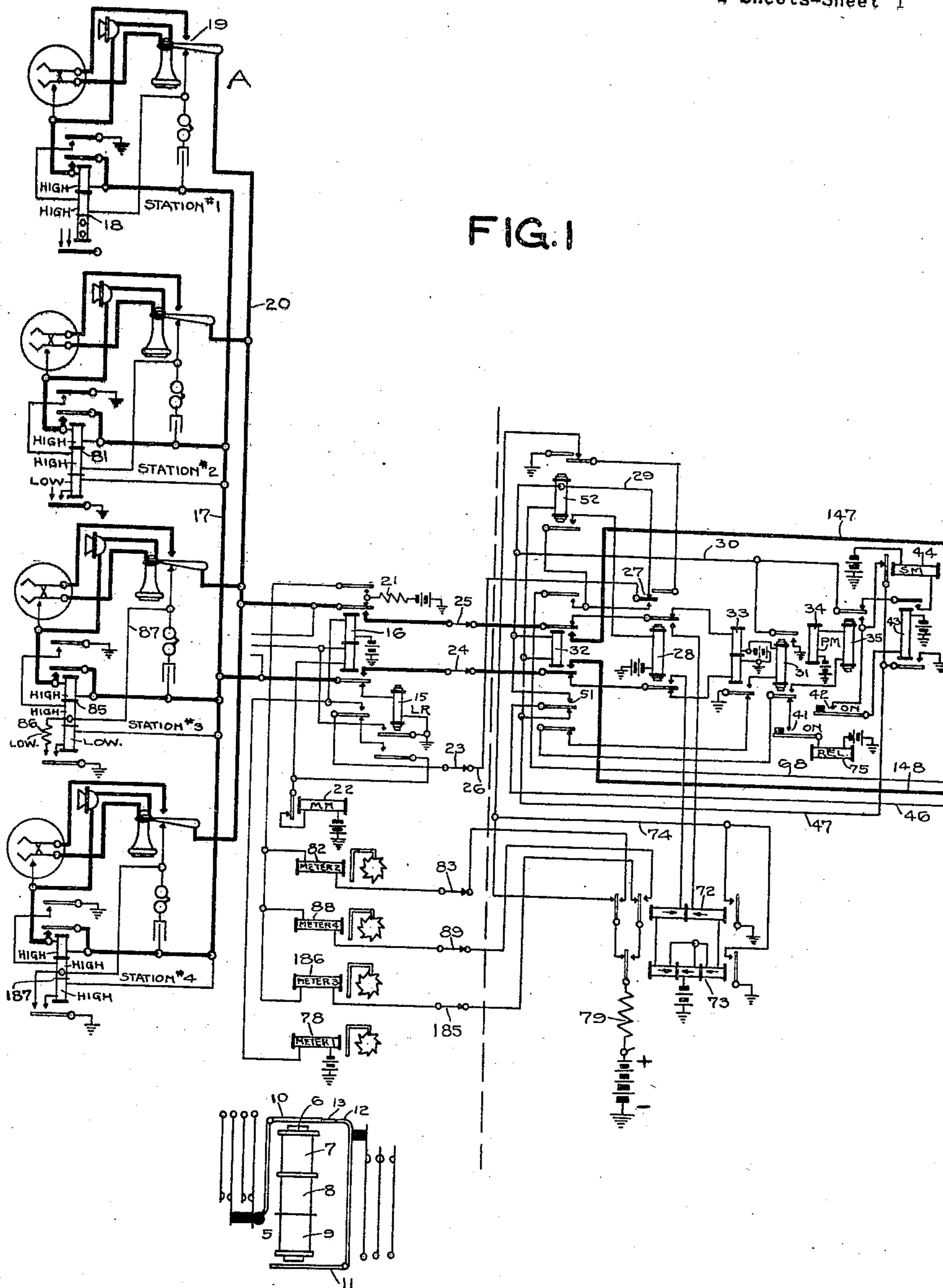


FIG. 3

INVENTOR
WINFRED T. POWELL.
BY *D. Clyde Jones.*
ATTORNEY

Aug. 5, 1924.

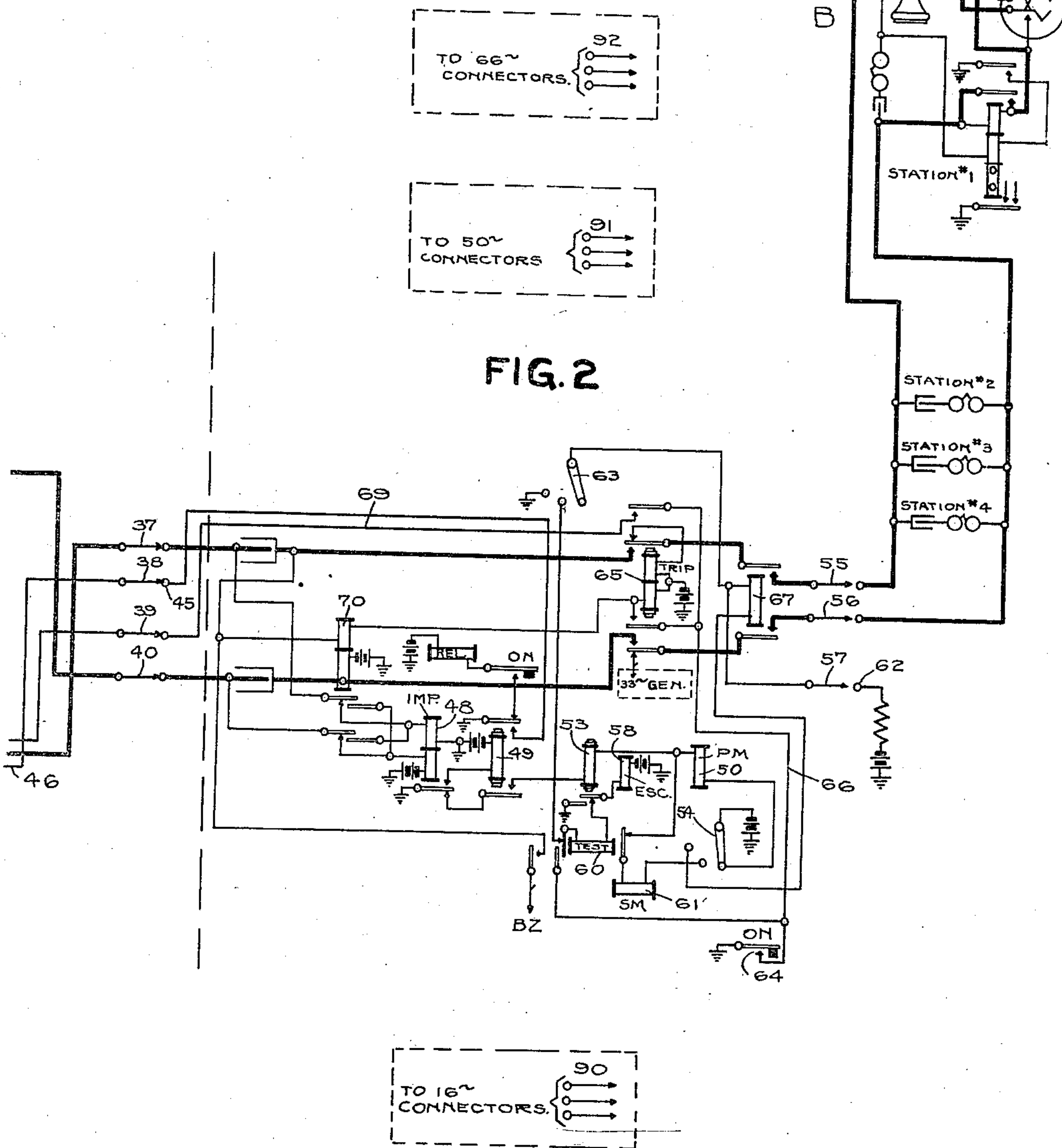
W. T. POWELL

1,503,916

METERING ARRANGEMENT FOR AUTOMATIC TELEPHONE SYSTEMS

Filed Dec. 28, 1920

2 Sheets-Sheet 2



INVENTOR
WINFRED T. POWELL.

BY *S. Clyde Jones*
ATTORNEY

UNITED STATES PATENT OFFICE.

WINFRED T. POWELL, OF ROCHESTER, NEW YORK, ASSIGNOR TO THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, OF ROCHESTER, NEW YORK, A CORPORATION OF NEW YORK.

METERING ARRANGEMENT FOR AUTOMATIC TELEPHONE SYSTEMS.

Application filed December 23, 1920. Serial No. 433,678.

To all whom it may concern:

Be it known that I, WINFRED T. POWELL, a citizen of the United States, residing at Rochester, in the county of Monroe and State of New York, have invented certain new and useful Improvements in Metering Arrangements for Automatic Telephone Systems, of which the following is a full, clear, concise, and exact description.

This invention relates to telephone systems and more particularly to automatic telephone systems.

In automatic telephone systems where a plurality of subscribers' stations are arranged on each telephone line it is desirable to provide individual meters at the exchange which will distinguish between the calls originating at the various stations and will charge each call to the sub-station from which it originates. Means are known whereby calls from an individual line or calls from a party line having a plurality of sub-stations thereon are charged on meters located at the exchange, applicant, however, has devised a novel means for accomplishing this result.

The present invention has for its purpose the arrangement of circuits whereby three or more sub-stations on a party line of an automatic telephone system may selectively operate registers located at the exchange so that the calls from each station will be charged on its individual register.

Other features will appear from the detailed description and claims.

The drawings, with Fig. 1 placed at the left of Fig. 2, diagrammatically represent a portion of a telephone system employing the present invention. The circuits shown at the left of the dotted line in Fig. 1 represent the sub-stations and line conductors of a 4-party telephone line, referred to as the calling line, which terminates in an individual trunk selecting switch. Also there are shown four meters, one for each of the sub-stations on the party line. The circuits shown between the dotted lines in Figs. 1 and 2 diagrammatically represent a selector switch circuit, while at the right of the dotted line of Fig. 2 there appears the circuits of a connector switch as well as a second telephone line, herein referred to as the called line. This last line is also a party line similar to the first mentioned

line but only the circuits of one sub-station have been shown in detail, the remaining three sub-stations being indicated merely by their condensers and ringers. In Fig. 3 there is shown a relay, one of which is located at each sub-station for the individual use of each subscriber's sub-station.

The line switch employed in this system may be substantially similar to that disclosed in the patent to Clement 1,107,153, August 11, 1914, while the selectors and connector switches may be of the type disclosed in the patents to Keith, Erickson and Erickson, Nos. 815,321 and 815,176 both issued March 13, 1906, when modified to operate in a so-called two-wire telephone system.

The relay 5 of Fig. 3 is provided with a core 6 on which there are wound three coils—7, 8 and 9. The coil 7 and its core are separated from the coils 8 and 9 and their cores by insulating material, so that it is effective to operate only the armature 10 whereas the windings 8 or 9 are capable of attracting the armature 11. The armature 11 is normally under tension and is provided with a hook 12 which is arranged to abut a projection 13 of the armature 10 under normal conditions. When the armature 10 is attracted, the tension on the armature 11 will cause the hook 12 to engage projection 13 and thus mechanically lock the armature 10 in operated position. When it is desired to release the armature 10, the armature 11 is attracted to cause hook 12 to disengage projection 13.

It is believed that the invention will best be understood by describing the method of establishing and registering a telephone connection from the sub-station 1, herein designated A to the sub-station designated B. When the subscriber at sub-station A removes his receiver from its switch hook, a circuit is closed from ground, winding of the line relay 15, back contact and armature of the cut-off relay 16, over the lower side 17 of the calling line, upper winding of the sub-station relay 18, through the transmitter and receiver in series, through the normally closed contacts of the dial, switch hook contacts 19, over the upper side of the subscriber's line 20, inner upper armature and back contact of cut-off relay 16, through resistance 21, to grounded

battery. The upper high resistance winding of relay 18 is energized and it attracts its armature, but the line relay 15 is not energized, until the operation of this armature at which time the previously described circuit, with the exception of the upper winding of relay 18, is closed. The line relay is thus energized and attracts its armatures. At the inner armature and front contact of the line relay, ground potential is applied to the multiple test terminals of the calling line at its group of connectors, so that this line cannot be seized as a called line. At the lowermost armature of the line relay a circuit is closed for the motor magnet 22 of the line switch for advancing the line switch until an idle trunk is located. This operating circuit is traceable from grounded battery, winding, back contact and armature of the motor magnet 22, lowermost armature and front contact of line relay 15, lowermost back contact and armature of cut-off relay 16, test brush 23 of the line switch, conductor 26, continuity spring and contact 27 of slow releasing relay 28, conductor 29, conductor 30, to ground at the upper armature and front contact of slow releasing relay 31 individual to an engaged trunk circuit. Under the control of circuits similar to that described the motor magnet advances its brushes 83, 89, 185, 23, 24, and 25 until an idle trunk is located. Let it be assumed that the first idle trunk tested is that shown in Figs. 1 and 2. Under this assumption, when test brush 23 engages test terminal of test conductor 26, there will be an absence of potential on this terminal so that the motor magnet 22 will not be actuated, but a circuit is closed from ground at the inner armature and front contact of line relay 15, lower winding of the cut-off relay 16, armature, back contact and winding of the motor magnet 22, to grounded battery. The cut-off relay is energized in this last described circuit but the motor magnet 22 remains inert. The cut-off relay on operation disconnects the battery bridge including the line relay 15 and extends the calling line to the wipers 24 and 25 of the line switch. As soon as the calling line has been thus connected to its brushes 24 and 25, a circuit is closed through the inner back contacts and armatures of relays 32 and 28, through both windings of the impulse relay 33, to grounded battery. The relay 33 is operated in this circuit and at its armature and front contact closes an operating circuit for the slow releasing relay 31. This operation of the relays 31 and 33 occupies only a small interval of time during which the slow releasing relay 15 maintains the initial energizing circuit of the cut-off relay 16 until this relay completes a locking circuit for itself from grounded battery, through

its upper winding, lower front contact and armature, test brush 23, conductor 26, continuity spring and contact 27, conductors 29 and 30 to ground at the upper armature and front contact of relay 31.

The selector switch of the seized trunk is now in condition to receive directive impulses by which it is adjusted to seize an idle connector switch through which the called line may be reached. The subscriber at sub-station A now operates his dial sender to interrupt the circuit including both windings of the impulse relay 33 causing this relay to vibrate its armatures. In response to the first retraction of the armature of impulse relay 33 a circuit is closed from ground, its armature and back contact, lowermost back contact and armature of relay 32, lower armature and front contact of relay 31, winding of the slow releasing change over relay 35 and the primary motor magnet 34 in series to grounded battery.

In response to this first impulse the selector switch advances its brushes 37, 38, 39 and 40 one step in its primary movement and thereby closes the off-normal contacts 41 and 42 at this switch.

With relay 35 operated and the off-normal contact 42 closed, a circuit is completed for relay 43 from grounded battery, its winding, off-normal contacts 42, front contact and armature of relay 35, upper armature and front contact of relay 31, to ground. The relay 43 is energized in this circuit and closes a locking circuit for itself from grounded battery, its winding, off-normal contacts 42, back contact and armature of the secondary motor magnet 44, armature and front contact of relay 43, to ground. In response to the remaining impulses of this series, the impulse relay retracts its armature intermittently to repeatedly close the circuit for primary motor magnet 34, as previously described, and this magnet advances the selector switch brushes 37 to 40 inclusive to select a group of trunks leading to a group of wanted connector switches. At the termination of this series of impulses the relay 33 will hold its armature attracted for a relatively long period causing the slow releasing change-over relay 35 to retract its armature and thereby complete an operating circuit for the secondary motor magnet 44 of the selector switch. This circuit extends from grounded battery, winding of the secondary motor magnet, upper front contact and armature of relay 43, back contact and armature of relay 35, upper armature and front contact of relay 31, to ground. The secondary motor magnet is energized in this circuit to advance the selector switch brushes one step and at its armature and back contact opens the circuit which has been holding the relay 43 oper-

ated. Relay 43 now deenergizes but, if the first trunk of the selected group is busy, this condition will be indicated by the presence of ground potential on its test terminal 45 and, as a result of this, a circuit is closed through test brush 38, conductor 46, middle lower armature and back contact of relay 32, conductor 47, armature and back contact of secondary motor magnet 44, off-normal contacts 42, winding of relay 43, to grounded battery. The operating circuit of the secondary motor magnet 44 is thereby again closed to advance the selector switch brushes an additional step and also attracts its armature to open the energizing circuit of the relay 43. Thus the relay 43 and the secondary motor magnet 44 are alternately energized and deenergized until an idle trunk leading to a connector switch of the wanted group is reached. Let it be assumed that the first idle trunk tested is that shown in Fig. 2. This idle condition is indicated by the absence of ground potential on its test terminal 45 so that the energizing circuit for the relay 43 will not be again completed with the result that the secondary motor magnet 44 ceases to operate.

During the period that the selector switch was testing busy trunks, the switching relay 32 was short-circuited in the following manner. At the armature and front contact of relay 31 ground is applied over conductor 30 to one side of the winding of relay 32, while ground potential at the test terminals of busy trunks is extended through test brush 38, conductor 46, middle armature and back contact of relay 32 to the other winding of this relay. In this manner the switching relay 32 is short-circuited so that it will not operate. However, when the idle trunk is tested in the manner just described, the switching relay 32 is energized and extends the two sides of the talking conductors through leads 147 and 148, through both windings in series of the impulse relay 48, to grounded battery. The impulse relay is energized in this circuit and operates the slow releasing relay 49 which relay on operation at its upper armature and front contact applies guarding potential to the test terminal 45 of the selected trunk. At the lower armature and front contact of relay 49, a break point is closed in the operating circuit of the primary motor magnet 50. As soon as the relay 32 was operated, it closed a locking circuit for itself from grounded battery, winding of relay 43, off-normal contacts 42, back contact and armature of secondary motor magnet 44, conductor 47, winding of relay 32, its contact 51 and armature, conductor 46, test brush 38, test terminal 45, upper front contact and armature of slow releasing relay 49 to ground. Also when relay 32 is operated it disconnects the impulse relay

33 of the selector switch from the calling line permitting this relay to retract its armature and thereby subsequently cause the deenergization of relay 31. The relay 52, the purpose of which will be pointed out, is energized and locked operated in a circuit in multiple of those just described for the switching relay 32.

The connector switch is now in condition to receive the impulses corresponding to the tens digit of the wanted number. The calling subscriber thereupon operates his dial sender to transmit this series of impulses to cause the impulse relay 48 to vibrate its armature. In response to the retraction of the armature of this relay, a circuit is closed from ground, through the lower armature and front contact of slow releasing relay 49, winding of the slow releasing change-over relay 53, winding of the primary motor magnet 50 of the connector switch, side switch wiper 54 in its first position, to grounded battery. In response to each closure of this circuit the primary motor magnet advances its brushes 55, 56 and 57 in its primary movement to select the group of lines in which the calling line terminates. On the first energization of the slow releasing relay 53, it closes a circuit from ground, its armature and continuity spring, winding of the escape magnet 58, to grounded battery.

The escape magnet is energized in this circuit and, since the slow releasing relay 53 does not retract its armature during the momentary interruptions of its operating circuit, the escape magnet will remain energized until the close of the tens series of impulses, at which time the impulse relay holds its armature attracted to open the energizing circuit of change-over relay 53 which in turn opens the energizing circuit of the escape magnet 58. This magnet on deenergization advances the side switch wipers into their second position.

The connector switch is now in condition to receive the series of impulses corresponding to the units digit of the wanted number. In response to the units series of impulses, the impulse relay 48 again vibrates its armatures but this time it closes an operating circuit from ground, its armature and back contact, armature and front contact of relay 49, winding of change-over relay 53, right-hand contact and armature of test relay 60, winding of the secondary motor magnet 61, side switch wiper 54 in its second position, to grounded battery. In response to the opening and closing of this last described circuit by the operation of the impulse relay, the secondary motor magnet advances the brushes of the connector switch over the terminals of the selected group of lines. It will be understood that during this operation of the sec-

ondary motor magnet that the change-over relay 53 is also energized to hold the escape magnet 58 operated.

Let it first be assumed that the wanted line is busy. Under this assumption when the slow-releasing change-over relay 53 de-energizes at the close of the units series of impulses, the escape magnet 58 will be held operated in a circuit closed from grounded battery, its winding, continuity spring and contact of relay 53, winding of test relay 60, its continuity spring and contact, side switch wiper 63 in its second position, test brush 57, multiple test terminal 62 and through a test brush similar to 57 and a side switch wiper similar to 63 in its third position to ground at the connector switch which has previously seized the wanted line. The escape magnet is thus held operated to hold its side switch wipers in their second position so that signalling current will not be applied to the busy wanted line. Also the test relay 60 will be energized in the circuit last described and will close a locking circuit for itself from grounded battery, winding of the escape magnet 58, continuity spring and contact of relay 53, winding of test relay 60, continuity spring and armature of this relay, off-normal contacts 64, to ground. With relay 60 operated, a source of busy tone current is connected to the calling line from BZ, outer armature and front contact of relay 60 to the calling sub-station.

It will now be assumed that the called line was idle at the time when it was tested by the test brush 57 of the connector switch. This idle condition is indicated by the presence of full battery potential on multiple test contact 62 of the wanted line. The test relay 60 will therefore not be operated and the escape magnet will deenergize to move the side switch wipers into their third or talking position. This is effective to complete a circuit from grounded battery, through side switch wiper 54, winding of the cut-in relay 67, side switch wiper 63, to ground. Relay 67 attracts its armatures and completes a signalling circuit from the 33 cycle source of ringing current, lower armature and back contact of trip relay 65, lower armature and front contact of relay 67, connector brush 56, over the lower side of the line and through the ringer of sub-station #1, over the upper side of the line, connector brush 55, upper armature and front contact of relay 67, upper armature and back contact of the slow operating trip relay 65, its upper winding, to grounded battery. When the called party responds, the trip relay 65 attracts its armatures and thereby closes a locking circuit for itself from grounded battery, its lower winding,

front contact and armature, conductor 66, off-normal contact 64, to ground, which circuit insures that the ringing current will not be reapplied to the called line until the connector switch has been released and re-adjusted on a succeeding call. The attraction of the armature of trip relay 65 also serves to close break points in the talking conductor and also completes a circuit for operating the meter relay 28 appearing at the center of Fig. 1. This circuit is traceable from grounded battery, winding of meter relay 28, lower front contact and armature of relay 52, uppermost front contact and armature of relay 32, conductor 68, selector brush 39, conductor 69, uppermost front contact and armature of trip relay 65, conductor 66, off-normal contact 64, to ground.

It should here be pointed out that if the called party does not respond, under which condition the calling party should not be charged with a call, then the trip relay 65 will not be operated and in consequence no circuit will be completed for the metering relay 28. The response of the called party energizes the battery feed relay 70 in bridge of the called line. This relay attracts its armatures to provide reverse battery supervision on toll calls to this connector.

At the termination of the conversation, when the calling party replaces his receiver on its switch hook, the impulse relay 48 of Fig. 2 deenergizes and shortly afterward the slow releasing relay 49 retracts its armature and at its upper armature and front contact breaks the circuit that has been holding the selector switch operated. It will also be remembered that the relays 32 and 52 have been held operated in this circuit, and, when it is opened, the relay 32 deenergizes and shortly afterward the slow releasing relay 52 retracts its armatures. The deenergization of relay 32 connects the calling line conductors through its back contacts and through the front contacts of relay 28 to the relays 72 and 73. At this time the relay 28 and the calling line switch are held operated over conductor 26, continuity spring and uppermost armature of relay 28, continuity spring and upper armature of relay 52, to ground. When shortly afterward relay 52 retracts its armatures, the locking circuit of relay 28 is opened and the conductor 26 extending to the line switch now leads to the continuity spring and uppermost armature of relay 28, continuity spring and contact of relay 52, conductor 74, through the contacts of relays 72 and 73, which relays are at that time operated, as will be described. The relay 28 now deenergizes and disconnects the lead 26 from relays 72 and 73 and opens the holding circuit of the line switch. Also when relay 32 deenergized, a circuit was closed for the re-

lease magnet 75 of the selector from grounded battery, winding of this magnet, off-normal contacts 41, back contacts and armatures of relays 31, 32 and 33, to ground.

The switches of this connection are now in their normal position.

Referring back to the point where relay 32 has retracted its armatures and when the armatures of relay 28 are still in operated position, the registration of the call is then effected in the following manner.

Since it has been assumed that station #1 was calling, when the receiver of this sub-station is placed on its switch hook, a circuit is closed from ground, through the uppermost armature and front contact (mechanically locked closed) and middle winding of relay 18, normal contacts of the switch hook, conductor 20 of the calling line, inner upper armature and front contact of relay 16, line switch brush 25, inner upper armature and back contact of relay 32, inner armature and front contact of relay 28, right-hand winding of relay 72, right-hand winding and middle winding of relay 73, to grounded battery. The current in this circuit has no effect on relays 72 and 73 since the middle winding of the relay 18 is of such high resistance. Since neither the relay 72 nor relay 73 has been operated, the meter magnet 78 of the meter assigned to substation #1 is operated in a circuit extending from grounded battery, winding of this magnet, lowermost front contact and armature of the cut-off relay 16, line switch brush 23, conductor 26, continuity spring and uppermost armature of relay 28, continuity spring and armature of relay 52, back contacts and armatures of relays 72 and 73, through resistance 79 and "booster" battery, to ground. The meter magnet 78 is operated and, when the slow releasing relay 28 shortly afterwards deenergizes, the operating circuit of the meter magnet is opened and it deenergizes.

If station #2 is calling instead of station #1, at the time when its switch hook is replaced, an energizing circuit is closed through the middle winding of relay 81, causing it to attract its lower armature and effect the release of its upper armature in the manner previously described. The operation of the lower armature closes a circuit traceable from ground, armature, front contact and lower winding of relay 81, conductor 17 of the calling line, inner lower armature and front contact of cut-off relay 16, line switch brush 24, inner lower armature and back contact of relay 32, lower armature and front contact of relay 28, left-hand winding of relay 72, left-hand winding and middle winding of relay 73, to grounded battery.

These two windings of relay 73 are differentially arranged so that it is not oper-

ated but since an operating circuit extends through only the left-hand winding of differentially wound relay 72, this relay attracts its armatures. When relay 52 deenergizes, the meter magnet individual to sub-station #2 is operated in a circuit extending from grounded battery, resistance 21, uppermost front contact and armature of cut-off relay 16, winding of meter magnet 82, line switch brush 83, outermost front contact and armature of relay 72, back contact and armature of relay 73, resistance 79 and "booster" battery, to ground. Similarly when the relay 72 deenergizes due to the opening of its operating circuit, the meter magnet 82 deenergizes.

In the event that sub-station #3 had initiated a call, the replacing of the receiver of this sub-station on its switch hook causes the operation of the lower armature and the release of the upper armature of relay 85 of the sub-station. In this case the operation of the lower armature closes a circuit through the low resistance 86, conductor 87, normal contacts of the switch hook, inner upper armature and front contact of cut-off relay 16, line switch brush 25, inner upper armature and back contact of relay 32, inner upper armature and front contact of relay 28, right-hand winding of relay 72, right-hand winding and middle winding of relay 73, to grounded battery. Also a circuit is closed from ground at the lowermost armature and front contact of relay 86, through the lower winding of this relay, line conductor 17, inner lower armature and front contact of cut-off relay 16, line switch brush 24, innermost lower armature and back contact of relay 32, lower armature and front contact of relay 28, left-hand winding of relay 72, left-hand winding and middle winding of relay 73, to grounded battery. It will thus be seen that the differentially wound relay 72 will not operate but, since all three of the windings of the relay 73 are energized, the differential effect of this relay is overbalanced and attracts its armatures to operate the #3 meter. This circuit extends from grounded "booster" battery, resistance 79, armature and front contact of relay 73, inner armature and back contact of relay 72, line switch brush 185, meter magnet 186, uppermost armature and front contact of cut-off relay 16, resistance 21, to grounded battery.

If station #4 had originated the call, circuits similar to those closed from sub-station #3 will be completed, except in this instance the lower winding is of high resistance. This permits the lower armature of relay 187 to be operated but prevents the differential effect in relay 72 so that it attracts its armatures. This is effective to actuate the meter magnet 88 in a circuit traceable from grounded "booster" battery,

resistance 79, armature and front contact of relay 73, inner armature and front contact of relay 72, line switch brush 89, winding of the meter magnet 88, uppermost armature and front contact of cut-off relay 16, resistance 21, to grounded battery.

It should be noted that the low resistance circuit through the receiver and transmitter of a station using the line will prevent the operation of a sub-station relay at another station, thus acting as a lock-out system.

It will be understood that the three rectangles generally designated 90, 91 and 92 each represent a group of connector switches which is provided with signalling current of proper frequency to signal one of the stations on a party line accessible to this group of connectors.

What is claimed is:

1. In a telephone system, a telephone exchange, a plurality of telephone lines terminating thereat, a plurality of substations on each telephone line, a meter at the exchange for the individual use of each substation, a plurality of relays for operating the meter of a calling substation, means operated on the completion of a call to a wanted substation, and other means co-operating with said last mentioned means and responsive to the concluding of a call for variably operating said relays.

2. In a telephone system, a telephone exchange, a plurality of telephone lines terminating thereat, a plurality of substations on each telephone line, a relay located at each substation, a meter at the exchange individual to each substation, means including automatic progressively movable switches for interconnecting said substations and means including the relay of the calling telephone line for operating the individual meter of said line.

3. In a telephone system, a telephone exchange, a plurality of telephone lines terminating thereat, a plurality of substations on each telephone line, each substation being provided with a relay having interlocking armatures, a meter at the exchange for each substation, means including automatic switches for completing telephone connections between said substations and means including circuits controlled at the armatures of the relay of the calling substation for operating the individual meter of said substation.

4. In a telephone system, a telephone exchange, a plurality of telephone lines terminating thereat, a plurality of substations on each telephone line, a relay having a plurality of windings at each substation, a meter at the exchange for each substation, means including automatic switches for completing telephone connections between said substations, means for initially energizing the substation relay of the calling

substation in a circuit including two sides of the calling line in series and means responsive to the operation of said substation relay for operating the individual meter of said substation.

5. In a telephone system, a telephone exchange, a plurality of telephone lines terminating thereat, a plurality of substations on each telephone line, each substation being provided with a relay having a plurality of windings, an individual meter at the exchange for each substation, means including automatic switches for completing telephone connections between said substations, means for initially energizing one winding of said relay in a circuit including two sides of said telephone line in series, means operated thereby for subsequently short-circuiting said winding, and means co-operating with the substation relay of the calling substation for operating the individual meter of this station on the completion of a call.

6. In a telephone system, a telephone exchange, a plurality of telephone lines terminating thereat, a plurality of substations on each of said telephone lines, means including automatic switches for completing telephone connections between said substations, an individual meter at the exchange for each substation and means including a plurality of differentially wound controlling relays operated on the release of a telephone connection for operating the individual meter of the calling substation.

7. In a telephone system, a telephone exchange, a plurality of telephone lines terminating thereat, a plurality of substations on each of said telephone lines, an individual meter at the exchange for each substation, means including automatic switches for completing a telephone connection between substations and a plurality of differentially wound controlling relays arranged to be variably operated on the release of a telephone connection for operating the individual meter of the calling substation.

8. In a telephone system, a telephone exchange, a plurality of telephone lines terminating thereat, a plurality of substations on each telephone line, an individual meter at the exchange for each substation, each meter being provided with a magnet having but one operating winding, means including automatic switches for completing telephone connections between said substations, a plurality of differentially wound controlling relays arranged to be operated on the release of a telephone connection for operating the magnet individual to the meter of the calling substation.

9. In a telephone system, a telephone exchange, a plurality of telephone lines terminating thereat, a plurality of substations on said telephone lines, an individual meter at the exchange for each substation, each

70

75

80

85

90

95

100

105

110

115

120

125

130

meter being provided with an operating magnet having but a single winding, means including automatic switches for interconnecting said substations and means including differentially wound controlling relays arranged to be variably operated on the release of a telephone connection for operating the magnet of the meter individual to the calling substation.

10 10. In a telephone system, a telephone exchange, a plurality of telephone lines terminating thereat, a plurality of substations on each telephone line, a relay located at each sub-station having a winding of relatively low resistance and a winding of high resistance, a meter at the exchange for each substation, means including automatic switches for completing telephone connections between said substations, and means including circuits extending through the windings of the relay of the calling substation for operating the individual meter of said substation.

25 11. In a telephone system, a telephone exchange, a plurality of telephone lines terminating thereat, a plurality of substations on each telephone line, a relay located at each substation having a winding of relatively low resistance and a winding of high resistance connected to the sides of its telephone line, a meter at the exchange for each substation, means including automatic switches for completing telephone connections between said substations, and means including circuits extending through the windings of the relay of the calling substa-

tion for operating the individual meter of said substation.

12. In a telephone system, a telephone exchange, a plurality of telephone lines terminating thereat, a plurality of substations on each telephone line, a relay located at each substation having a winding of relatively low resistance and a winding of high resistance, one winding being connected to one side of said telephone line and the other winding being connected to the other side of said telephone line, a meter at the exchange for each substation, means including automatic switches for completing telephone connections between said substations, and means including circuits extending through the windings of the relay of the calling substation for operating the individual meter of said substation.

13. In a telephone system, a telephone exchange, a plurality of telephone lines terminating thereat, a plurality of substations on each telephone line, a meter at the exchange individual for each substation, a plurality of relays for operating the meter of a calling substation, at least one of said relays being differentially wound, means for interconnecting said telephone lines, and means including certain of said relays actuated responsive to the completion of a call for operating the meter individual to the substation that initiated the call.

In witness whereof, I hereunto subscribe my name this 22nd day of December A. D. 1920.

WINFRED T. POWELL.