

March 2, 1937.

S. B. WRIGHT

2,072,287

TELEPHONE TRANSMISSION CIRCUIT

Filed Oct. 17, 1934

2 Sheets-Sheet 1

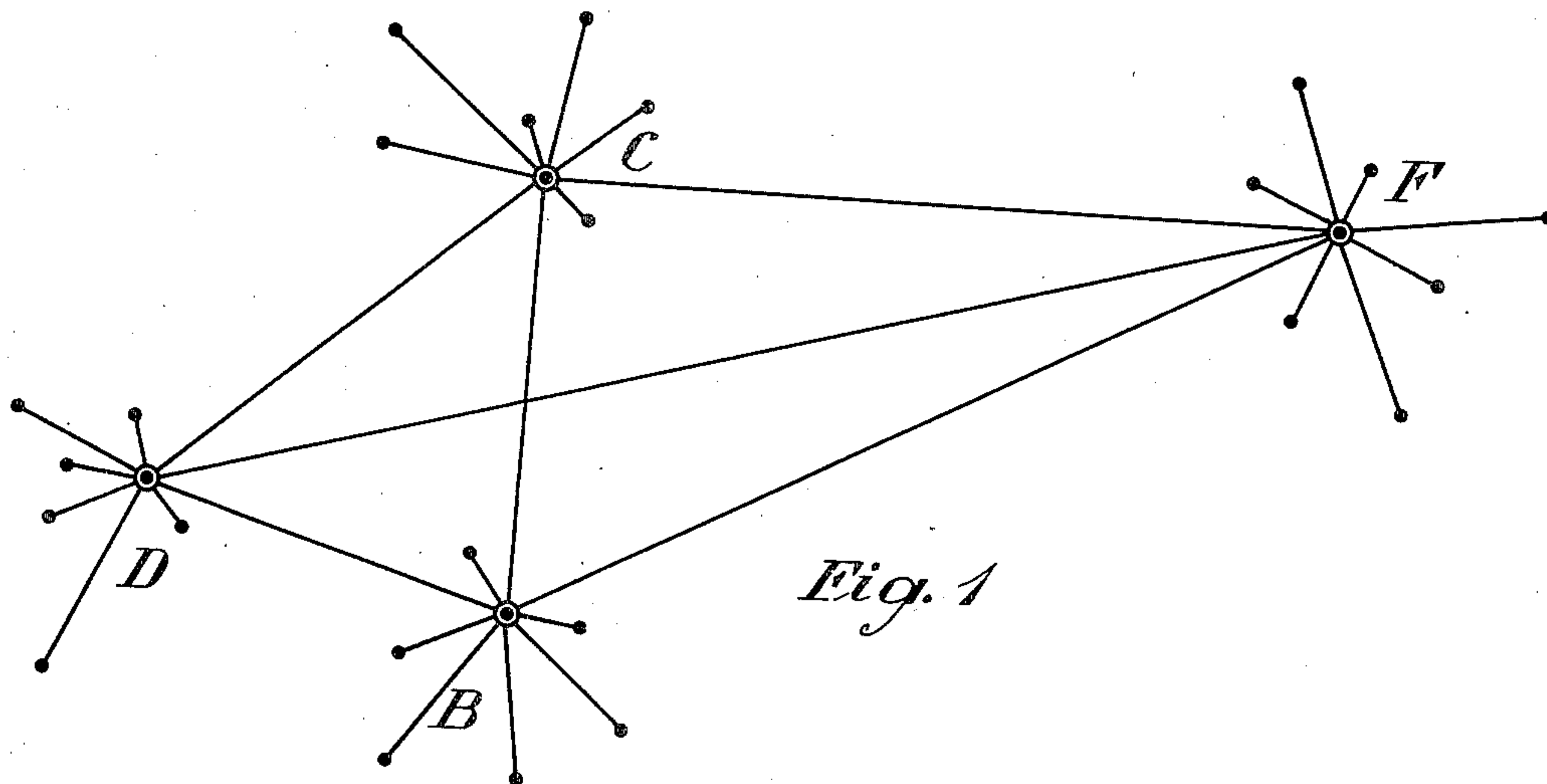


Fig. 1

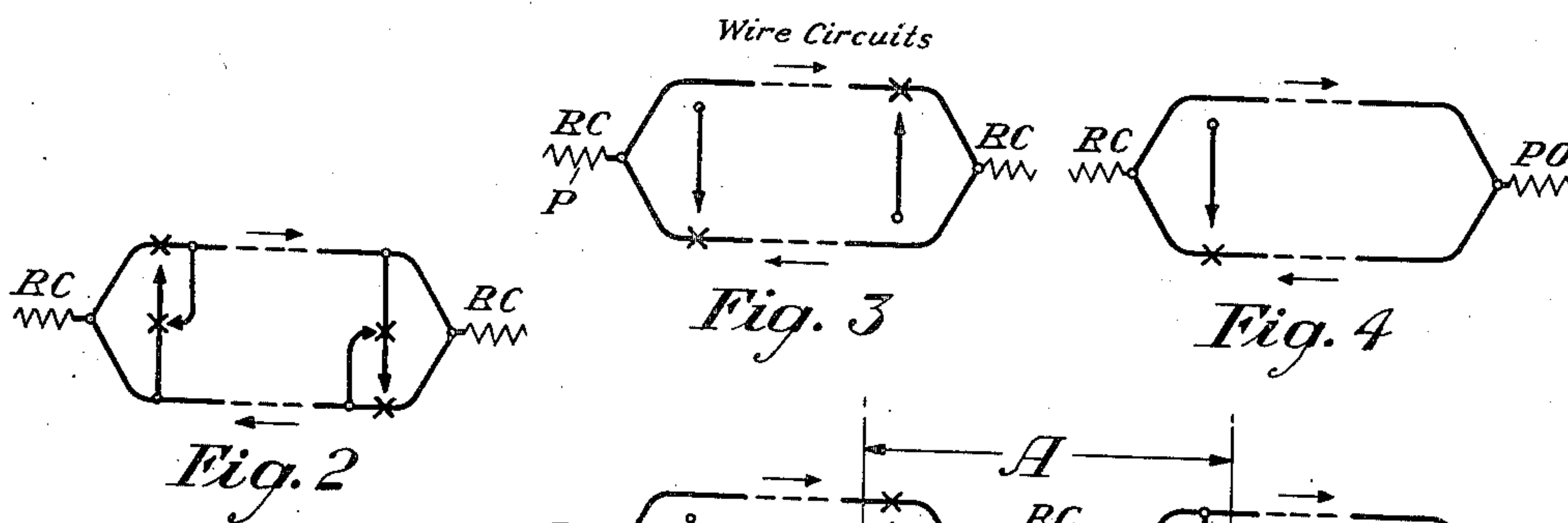


Fig. 3

Fig. 4

Fig. 2

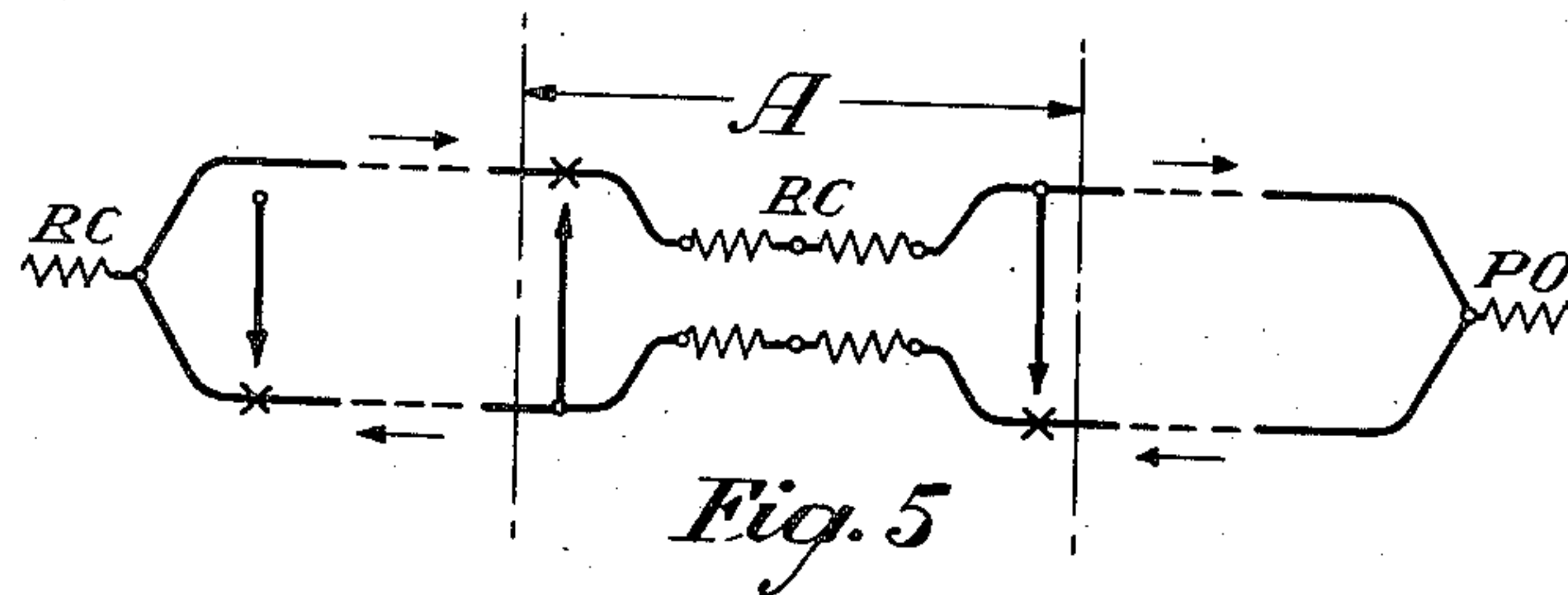


Fig. 5

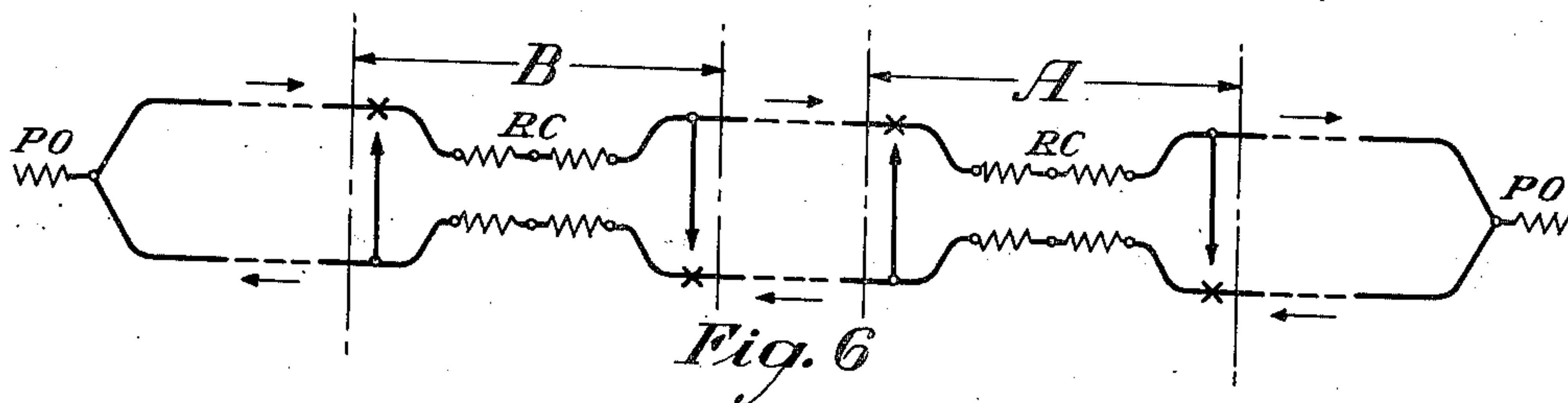


Fig. 6

INVENTOR
S. B. Wright
BY *g. f. c.*
ATTORNEY

March 2, 1937.

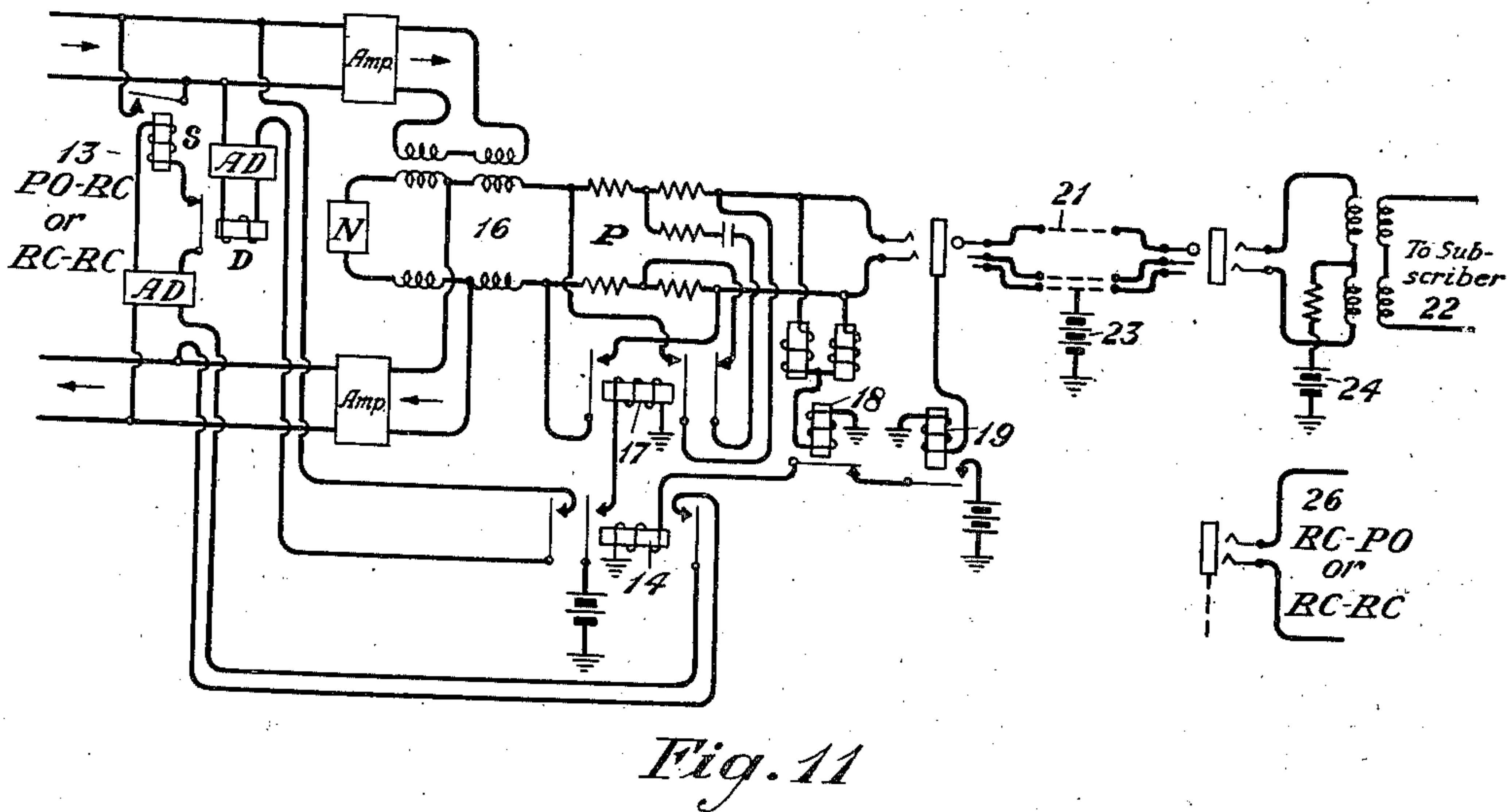
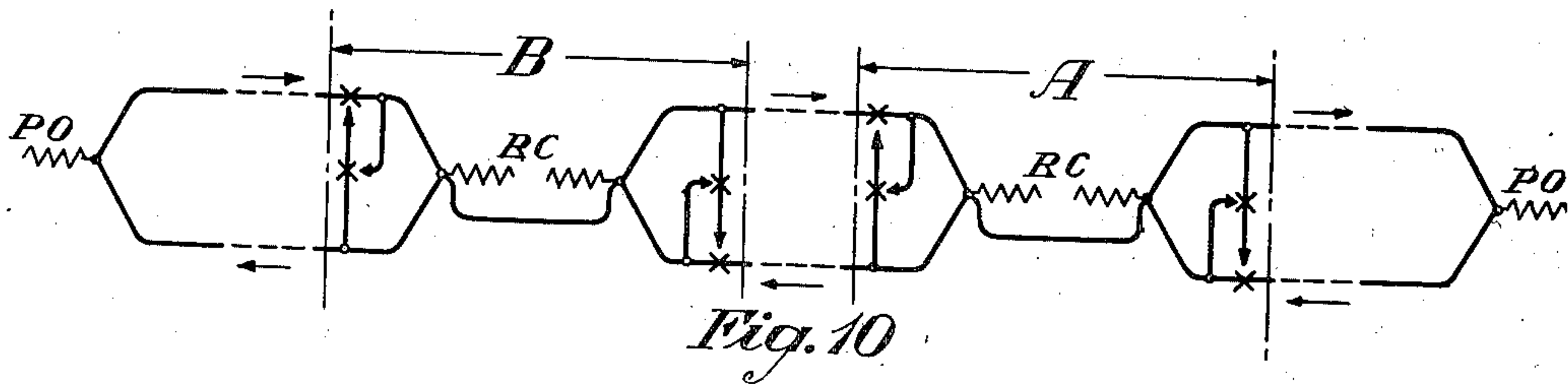
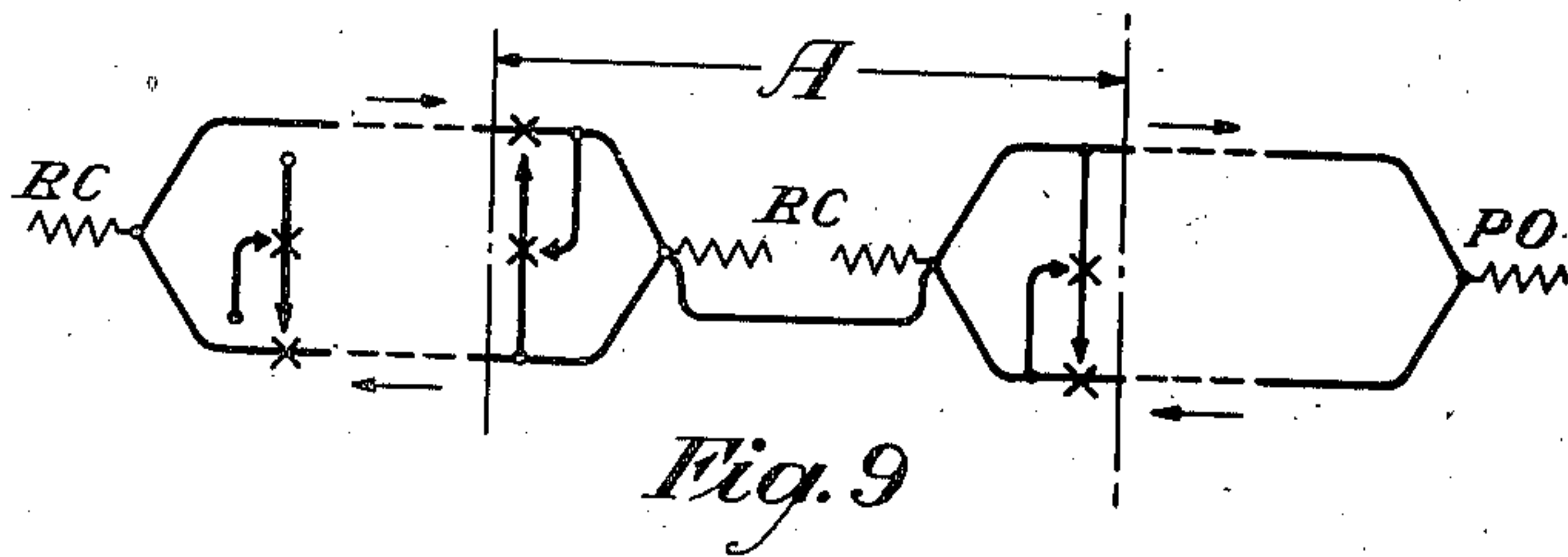
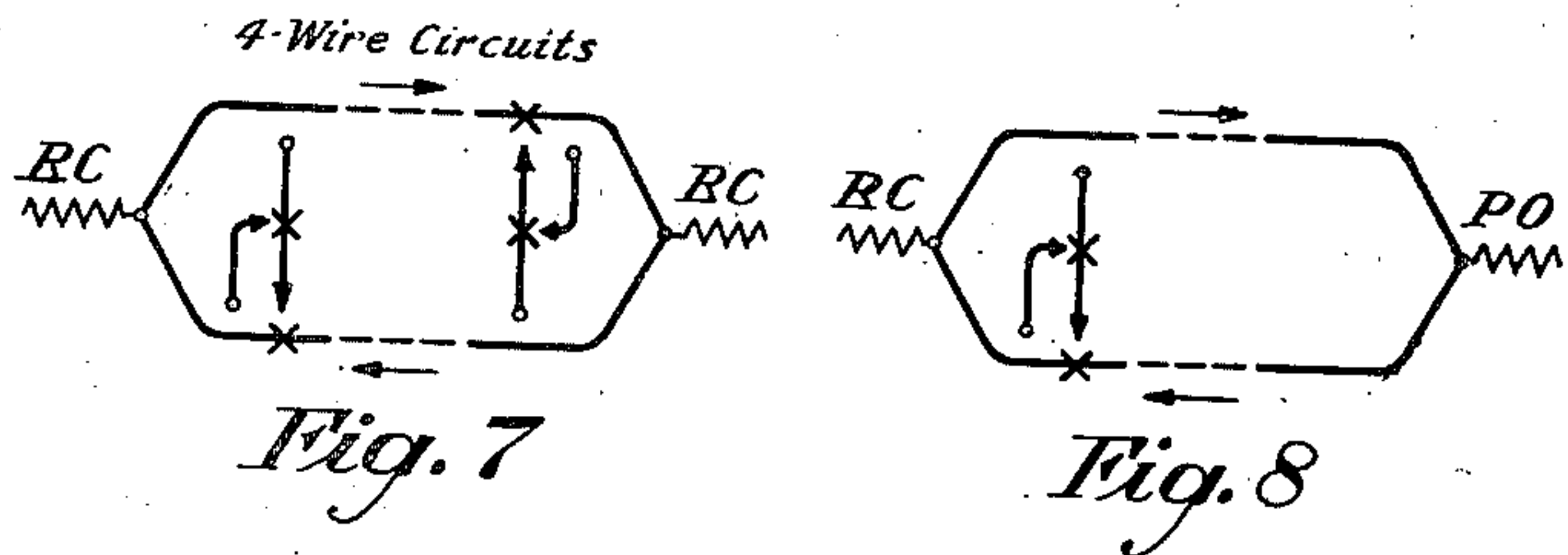
S. B. WRIGHT

2,072,287

TELEPHONE TRANSMISSION CIRCUIT

Filed Oct. 17, 1934

2 Sheets-Sheet 2



INVENTOR
S. B. Wright
BY *g. H. H. H.*
ATTORNEY

UNITED STATES PATENT OFFICE

2,072,287

TELEPHONE TRANSMISSION CIRCUIT

Sumner Bisbee Wright, South Orange, N. J., assignor to American Telephone and Telegraph Company, a corporation of New York

Application October 17, 1934, Serial No. 748,765

12 Claims. (Cl. 179—170)

This invention relates to telephone transmission circuits, and more particularly to circuits where a number of sections or links of signaling circuits, each normally to be provided with echo suppressors, are connected in tandem. Its purpose is to limit lockout when such series connections of signaling links are made. A further purpose is to concentrate the suppressors at certain important switching centers. Still a further purpose is to reduce the number of echo suppressors in use at any time to a minimum. And still a further purpose is the design of a new type of echo suppressor, all as described hereinafter.

In the case of rather long telephone circuits in which the time of transmission exceeds a certain amount, the echoes which arise in such a circuit become sufficiently serious to justify the introduction of so-called echo suppressors and these have now become fairly well known in the art of communication. When several such links each equipped with echo suppressors are connected in series, then the very presence of these suppressors leads to lockout over certain lengths of line, that is, each speaker disables the line for the other speaker and neither can get his message through. The frequency and seriousness of these lockouts naturally vary widely under different conditions, but it is the aim of this invention to reduce the lockout zone to as low a value as possible and I have found that by the use of proper types of echo suppressors and by their proper disposition, it is possible to make a substantial reduction in the number of echo suppressors over what would otherwise be required and in the lockout zone.

Broadly, the invention consists in having the echo suppressors which are appropriate for a given transmission channel normally disconnected, this differing markedly from previous practice. In this invention the suppressors are connected only when a telephone circuit is made up and then only those suppressors are introduced which are needful. I accomplish this in part by means of a new type of suppressor which I will call the transmitting echo suppressor to distinguish from previous suppressors which may be spoken of as receiving echo suppressors.

The invention will be better understood by reference to the following specification and the accompanying drawings, in which Figure 1 gives a schematic layout of telephone circuits as used in such countries as the United States; Fig. 2 illustrates a type of connection for echo suppressors used heretofore and shown for illustrative purposes only; Figs. 3 to 10 are various communi-

cation links or combinations thereof which illustrate my invention and Fig. 11 shows some of the details at a switching center to carry out my invention.

Referring more particularly to Fig. 1, there are shown certain important telephone centers B, C, D and F represented by circles and which might correspond to such cities as New York, Chicago, Dallas and San Francisco. Important centers such as these have been classed as regional centers and will be referred to in this specification by the abbreviation "RC". It is the practice, in general, to have each of these regional centers connected to each of the other regional centers and such connections between two regional centers will be referred to hereafter as an RC—RC link. At the same time each regional center is connected to a number of important outlying points commonly spoken of as primary outlets or toll centers and a link between a primary outlet and a regional center will be hereafter referred to as a PO—RC link. It is to be understood, of course, that from these primary outlets there are still further circuits fanning out to outlying communities and on to subscribers' stations, and thus it is possible to connect any two subscribers' stations in the country by passing through a minimum of switching points. These links may be anywhere from a few hundred to two or three thousand miles long. A description of these features is found in an article entitled "General Switching Plan for Telephone Toll Service" by Osborne, Bell System Technical Journal, July 1930.

In the event that the links are quite long or the character of the line is such that the velocity of transmission is rather low, then the echoes set up in these circuits become disturbing, the extent to which they become disturbing being approximately proportional to the delay of the echo behind the direct speech. To overcome these echoes, echo suppressors of various types have been designed and a type which has been used on the RC—RC links is that known as the single terminal echo suppressor such as is described in the patent to Abraham, No. 1,825,196, October 9, 1931. Also, a form of echo suppressor which has been found suitable for use in the PO—RC link is that known as the double terminal echo suppressor shown in the patent to Crisson, No. 1,961,279, June 5, 1934. Such links as described above are operated as four-wire circuits and the connection of two or more links in series at a switching point may be on a four-wire or on a two-wire basis.

An RC—RC link of the kind described above

is shown in conventional form in Fig. 2, in which the transmission is shown as going from terminal to terminal, the speech in one direction as it reaches the end of that section operating an echo suppressor to disable the line in the other direction, this being done through a simple echo suppressor. If, however, speech arrives at that point from the other direction first, then this echo suppressor is disabled by that speech. Such a type of echo suppressor may be called a single terminal receiving echo suppressor for the reason that the suppressors are at the terminals of the links and for the further reason that the suppressor is connected at the terminal to be operated upon by the speech after speech has traveled through the length of the link and is being received at the corresponding regional center. In some cases these echo suppressors are not equipped with the disabling means shown in Fig. 2 but they would still be classed as receiving echo suppressors.

Fig. 3 shows a similar RC—RC link provided with single terminal suppressors at each end but these suppressors are normally disconnected for reasons which will appear below. Also, these suppressors are connected in a manner to form what I will call transmitting suppressors in that a suppressor is operated by speech when the speech first arrives on the link and is about to be transmitted over the link. The link of Fig. 3 as described constitutes one of the elements in a built-up circuit of the kind to be described below. It may be used without connection to other RC—RC links or PO—RC links and in that case, according to my invention, the suppressors will not, in general, be connected. This is feasible either because the RC—RC link may be relatively short or because it is a high speed line, such as an unloaded cable circuit.

Fig. 4 shows the arrangement in the case of a PO—RC link where, in accordance with my invention, a single terminal suppressor is supplied only at the end terminating in a regional center, and again, the suppressor is normally disconnected and is of the transmitting type of suppressor.

Fig. 5 shows the series connection of a PO—RC link and an RC—RC link, the connection at the switching point A being on a four-wire basis. This makes the circuit equivalent to a single link of approximately double length and in this case the suppression of echoes becomes important. To this end I arrange for the introduction or connection of the terminal suppressors at the regional center, this being accomplished in any manner such as that described in detail hereinafter. The arrangement consists of the connection of these suppressors to their lines by relays operated on the introduction of the cord circuit connecting the two links and under these circumstances, the circuit as a whole is equivalent to a fairly long circuit with a central type echo suppressor and it is obvious that there is no opportunity for lockout.

Fig. 6 shows the combination of a PO—RC link, an RC—RC link and an RC—PO link, all again connected on a four-wire basis and at the regional centers A and B the terminal suppressors are connected for service in the same manner as described in connection with Fig. 5. This circuit, it will be observed, is equivalent to a long circuit with two central type echo suppressors and lockout is limited to the RC—RC link between A and B. The system may obviously be

extended to include additional RC—RC links although it would be on rare occasions only that more than one RC—RC link would be required for any circuit set up within the United States under the present toll switching plan.

In the circuits thus far described, the connection of links has been on a four-wire basis but it would frequently be desirable to connect them on a two-wire basis and the necessary arrangements for this are shown in Figs. 7 to 10. In that case it will be desirable that instead of the simple suppressors of the kind shown in Figs. 3 to 6, these should be replaced by suppressors with a disabler. Figs. 7 and 8 correspond to Figs. 3 and 4 but each suppressor is now supplied with a disabler and as before, each suppressor with its disabler is normally disconnected and at most will be used only on the connection of two or more links. The purpose of this disabler is to avoid false operation of an echo suppressor by echoes of incoming speech which are reflected at the two-wire junction point. If no disabler were used conditions might arise such that echoes of strong waves would operate the suppressors and cut off the direct transmission. The disabler is set to operate on any waves strong enough to cause this, thereby preventing false operation of the suppressor by these echoes.

Such a connection is shown in Fig. 9 and upon the connection of the two links at the switching point A, the echo suppressors and their disablers at the end of the links terminating at A are connected, this connection again being brought about through any suitable means such as relays operated through the sleeve of a cord circuit. In this circuit there is no lockout.

Fig. 10 corresponds to Fig. 6 and it will be noted that suppressors are connected in at the same points as in Fig. 6, namely at the regional centers A and B, and that lockout is limited to the RC—RC links.

In each of the circuits of the drawings there is shown an element P at each link end. This is a conventional showing of an attenuation or switching pad which may be used or not as the circumstances justify. In present practice, whenever two four-wire circuits are connected on a two-wire basis at a switching point, there is a certain loss introduced amounting to approximately 6 decibels, 3 decibels at each hybrid coil, but such loss does not occur in the case of connection on a four-wire basis. It is obvious that the loss in the former case might be made up by increasing the gain of one or more repeaters but it is found to be better practice to operate the repeaters at a constant and higher level sufficient to give the desired overall loss or gain after the introduction of the loss due to a two-wire switching connection. In order, however, that the transmission level shall still remain the same in the event of a four-wire connection, the attenuating pads are provided and are connected in series with the circuit to introduce the same loss on a four-wire connection as occurs on a two-wire connection when the pads are removed. It is to be understood that this feature of the circuit connections does not constitute a part of the invention described in this specification.

The matter of a suitable means of carrying on the switching operations at one of the regional centers will be better understood by reference to Fig. 11, in which at the left hand side there is shown one end of a PO—RC or an RC—RC link 13. A transmitting terminal echo suppressor

with disabler is shown, both of these being normally disconnected through contacts of the relay 14. The amplifier-detector adapted to be connected across the lower path of the four-wire circuit includes in its output circuit the winding of the relay S, designed to render the upper path of the four-wire circuit inoperative. The amplifier-detector adapted to be connected across the upper path controls the operation of relay D, which is designed to open, in response to energy approaching the amplifier input, the circuit including the winding of relay S and thus to prevent the subsequent disabling of the upper path. This link 13 contains also the usual hybrid coil 16 to step down to a two-wire circuit, and following this is shown one of the switching pads P consisting of series resistance and shunt resistance. This pad is normally in the circuit but may be eliminated by the short-circuiting of the series resistances and the opening of the shunt resistance upon the activation of the relay 17. Bridged across the circuit there is also a relay 18, the use of which will appear later, and the circuit then goes to the usual jack, to the sleeve of which there is connected a relay 19. Next there comes a cord circuit 21 and following this is a circuit 22 to a local subscriber. The relay 14 is controlled by the relays 18 and 19 in such a manner that the relay 18 normally leaves the circuit of 14 closed, but the relay 19 normally keeps that circuit open. If now the cord circuit is set up to connect the four-wire circuit to a subscriber circuit, then battery 23 will excite the relay 19, thus closing the circuit for relay 14, but at the same time battery 24 operating on relay 18 will open the circuit. As a result the echo suppressors are left disconnected and at the same time the relay 17 is not operated so that the switching pad remains in the circuit. If now the cord circuit instead of being connected to the subscriber circuit 22 is connected to an RC—PO or an RC—RC link at 26, which is a duplicate of that shown at 13, then the relay 18 is not operated but the relay 19 is, closing battery to relay 14. This immediately connects the echo suppressor and the disabler to their respective lines and at the same time operates relay 17 to eliminate the switching pad. The circuit 26, being an RC—PO or an RC—RC link, would be operated upon in the same manner. Much of the equipment appropriate for such a switching point has been omitted for the purpose of simplicity and only those elements are shown which are necessary to explain this part of my invention. In case the switching is done on a four-wire basis an equivalent arrangement for introducing the suppressors would be used but the switching pads would be left in.

From the above description it will be seen that according to my invention it is possible to concentrate all echo suppressors at regional centers, these suppressors being normally out of action, but that on any call involving two toll lines the equivalent of a central type echo suppressor is placed in operation automatically by the act of putting up a cord. This applies where the connection is from RC to PO or from PO to PO through the regional center. On a connection involving three or more links the equivalent of two central type echo suppressors would be applied automatically, the lockout being limited to the circuit between the regional centers. So far as economy of suppressors is concerned it will be observed that this arrangement saves one-half of the apparatus on the RC—PO circuits which,

it is to be borne in mind, are much more numerous than the RC—RC circuits.

Many variations in the circuit connections may be made without departing from the spirit of my invention. Thus, while the suppressor disablers of Figs. 7 to 11 are shown as disconnected when the suppressors are disconnected, it is apparent that they may be left on all the time since they do not in themselves affect transmission substantially.

In the specification and in the claims the term "single transmitting terminal echo suppressor" is used, and this term is to be understood as meaning a single echo suppressor at one terminal of a link, and so connected that speech coming into that terminal from an adjoining circuit and passing out over the transmitting channel operates to disable the receiving channel at that terminal over which messages come from the link, either with or without a disabling device for such suppressor. This term is used to distinguish such a suppressor from a single receiving terminal echo suppressor, which is known in the art, and is connected at the other end of the link, and also to distinguish from so-called double echo suppressors in which both a transmitting and a receiving terminal suppressor are associated at one end of a link.

What is claimed is:

1. In a communication system consisting of a PO—RC and an RC—RC link adapted for switching in series, a single terminal transmitting echo suppressor present in each link at the adjacent ends, said suppressors being normally disconnected, and means associated with the links for connecting and disconnecting the suppressors as the two links are switched together and switched apart.
2. In a communication system consisting of a PO—RC link and an RC—RC link adapted for four-wire switching in series, an echo suppressor present in each link at the adjacent ends, said suppressors being normally disconnected, and means associated with the links for connecting or disconnecting the suppressors as the two links are switched together or switched apart.
3. The combination of claim 2 characterized by the fact that the echo suppressors are each of the single terminal transmitting echo suppressor type.
4. In a communication system consisting of a PO—RC and an RC—RC link adapted for two-wire switching in series, a single terminal transmitting echo suppressor present in each link at the adjacent ends, said suppressors being normally disconnected, and means associated with the links for connecting and disconnecting the suppressors when the two links are switched together or switched apart.
5. In a communication system consisting of two or more RC—RC four-wire links adapted for connection in series, transmitting echo suppressors present at each terminal of each link where a series connection may be made, the suppressors being normally disconnected, and means associated with the links for connecting and disconnecting the suppressors at a switching point when two links are connected or disconnected at that point, said means being controlled by the operator.
6. In a communication system of several four-wire links adapted to be connected at switching points by two-wire or four-wire cord circuits, each link being equipped with echo suppressors, normally inoperative means associated with the

- links and controlled by the cord circuits whereby the echo suppressors are left inoperative when a single link is used and are rendered operative when the links are switched together.
- 5 7. In a communication system, a plurality of four-wire links adapted for four-wire or two-wire switching, a single terminal transmitting echo suppressor at the adjacent ends of each link, said suppressors being normally disconnect-
 10 ed, a disabler for each suppressor at points where switching is effected on a two-wire basis, and means associated with the links for connecting and disconnecting the suppressors as adjacent links are switched together and switched apart.
- 15 8. In a communication system, a plurality of four-wire links adapted for four-wire or two-wire switching, a single terminal transmitting echo suppressor at the adjacent ends of each link, said suppressors being normally disconnected, a nor-
 20 mally disconnected disabler for each suppressor at points where switching is effected on a two-wire basis, and means associated with the links for connecting and disconnecting the suppressors and for connecting and disconnecting the dis-
 25 ablers at points where switching is effected on a two-wire basis, as adjacent links are switched together and switched apart.
9. In a communication system of several four-wire links adapted to be connected in series at
 30 switching points by two-wire or four-wire cord circuits, each link being equipped with echo suppressors, normally disconnected means associated with the links and controlled by the cord circuits whereby the echo suppressors are left discon-
 35 nected when a single link is used, and whereby

those at the switching points where connections are made are connected for operation when the links are switched together.

10. In a communication system calling for the series connection of two or more four-wire links, 5 each link being of such character as not to require echo suppressors when used alone, terminal suppressors present in each link but normally disconnected and means associated with the links whereby the suppressors are connected for 10 service when two links are connected at that point.

11. In a communication system calling for the series connection of two or more four-wire links, 15 each link being of such character as not to require echo suppressors when used alone, terminal suppressors present at each link end but normally disconnected, means for establishing series connections between said links, and means as- 20 sociated with the links and controlled by the first mentioned means whereby the suppressors at any switching point are connected for service when two links are connected at that point.

12. In a communication system calling for the series connection of two or more four-wire links, 25 each link being of such character as not to require echo suppressors when used alone, single terminal transmitting suppressors present at each link end but normally disconnected, and means associated with the links whereby the echo sup- 30 pressors at any switching point are connected for service when two links are connected at that point.

SUMNER BISBEE WRIGHT.