No. 824,376. PATENTED JUNE 26, 1906.

W. OHNESORGE.

TELEPHONE SYSTEM.

APPLICATION FILED FEB. 9, 1906.

2 SHEETS—SHEET 1.

Fig. 1.

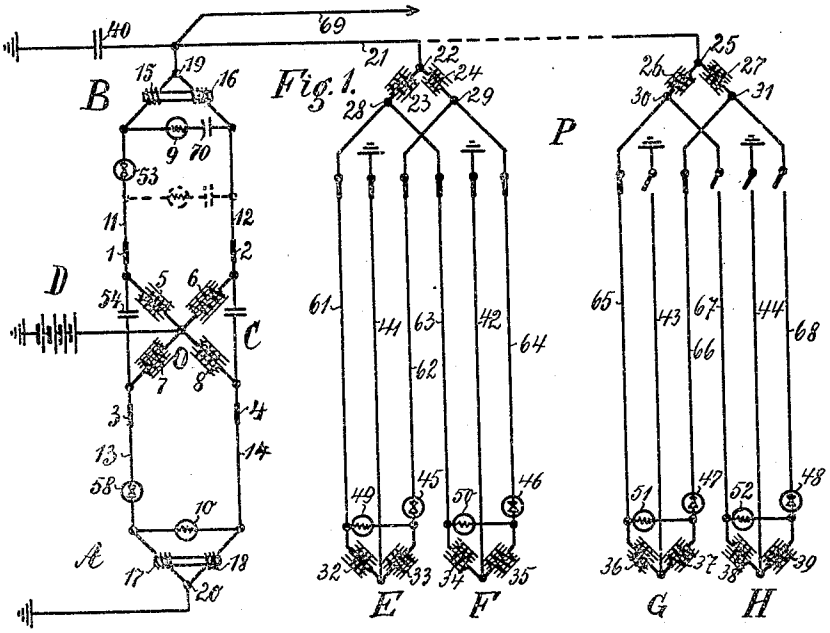
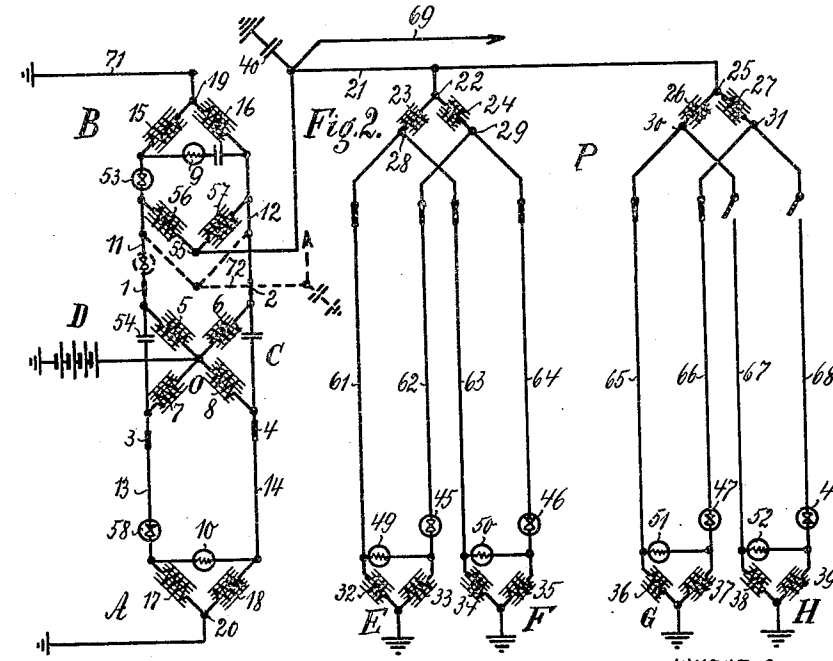



Fig. 2.




WITNESSES:

W. P. Burke

INVENTOR.

Wilhelm Ohnesorge

By Richards & Co.

ATTYS.

No. 824,376. PATENTED JUNE 26, 1906.

# W. OHNESORGE.

## TELEPHONE SYSTEM.

APPLICATION FILED FEB. 9, 1906.

2 SHEETS—SHEET 2.

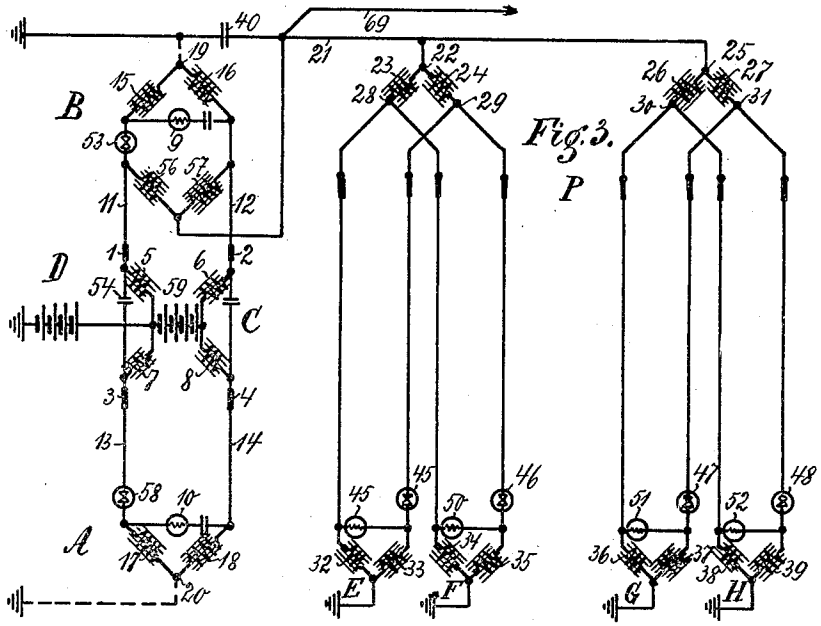



Fig. 3.

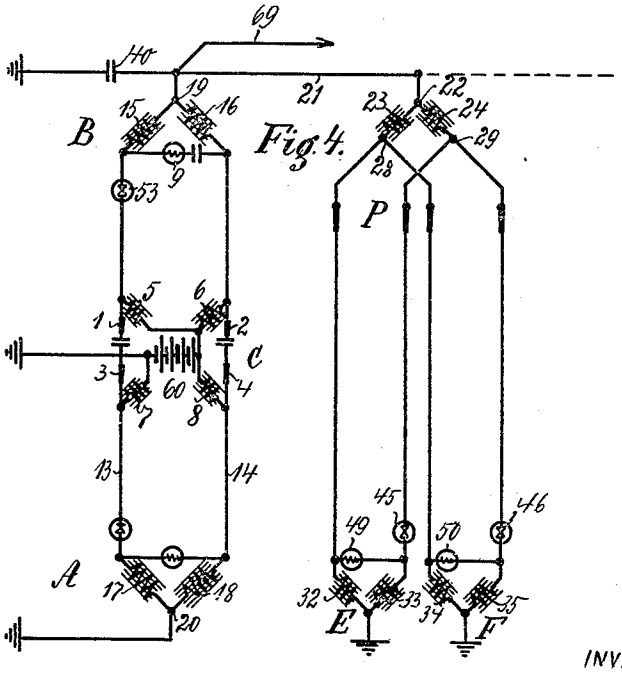



Fig. 4.

WITNESSES:

W. P. Burke

W. J. Donovan

INVENTOR.

Wilhelm Ohnesorge

By Richards & G

ATTYS.

# UNITED STATES PATENT OFFICE.

WILHELM OHNESORGE, OF WILMERSDORF, NEAR BERLIN, GERMANY.

## TELEPHONE SYSTEM.

No. 824,376. Specification of Letters Patent. Patented June 26, 1906.

Application filed February 9, 1906. Serial No. 300,313.

*To all whom it may concern:*

Be it known that I, WILHELM OHNESORGE, a citizen of the Empire of Germany, residing at Wilmersdorf, near Berlin, in the Empire of Germany, have invented a new and useful Telephone System, of which the following is a specification.

My invention relates to a telephone system with a central station, a number of stations connected in multiple with the central station by double telephone-lines, and a number of substations connected severally by lines with either or some of the stations, all the various subscribers' microphones being supplied with current from a central battery at the central station, the current for the microphones at the substations being conducted from the central battery over the double lines, the respective stations, and the lines.

The object of my invention is to render possible the simultaneous establishment of direct communication between either station and the central station or any other station, on the one hand, and between the several substations, on the other hand. The said object is attained in the following manner: At the station a single line connects the double line with a switchboard, from which lines lead to the several substations, (the earth serving as a return for known reasons.) The said single line is connected with the two branches of the double line at the station by means of two resistances, the telephone at the station being disposed in a bridge between the two branches. Further, the ends of the two branches of the said double line at the central station are connected with the one pole of the central battery by means of two resistances, and the other pole of this battery is earthed. Thus the two branches of the double line connecting the central station with the station and the four resistances form the four arms of a Wheatstone's bridge and can be so adjusted that the bridge containing the telephone at the station is not influenced by the variations of the current passing over the branches during the conversation between the substations, since the potentials at the two ends of the telephone-bridge vary in the same proportion and in the same sense if under the action of the microphones at the substations the current in their circuits varies, so that no fall of potential in the said telephone-bridge and no sound in the telephone will be produced by the conversation between the substations.

The microphone at the station is disposed in one of the four bridge-arms. To protect the substations from disturbances which may be occasioned by the variations of the current produced by the microphone at the station, the branch lines connecting the station with the substations are preferably disposed in a similar manner as the branch lines between the central station and the station. For every pair of substations the current conducted through the single line at the station is divided at the switchboard and passes through two resistances, four lines connecting the station with the two substations, and is collected behind the apparatuses at these substations by means of two pairs of resistances, after which it returns through the earth to the central battery. The said four resistances at the station and at either substation form, with the two branch lines, the four arms of a Wheatstone's bridge, the bridge of which contains the telephone at the substation. The two telephones at the two substations are connected by a looped circuit, which, owing to the parallelism of the lines between the substations and the switchboard at the station, can be easily protected from foreign induction and do not themselves influence any neighboring lines. By constructing as reaction-coils the said resistances at the two ends of the single line between the double line and the switchboard at the station it is possible to shut off this single line from the looped circuit, so that the variations of the current due to the conversation between the two substations cannot pass over to the single line.

The bridge system at the station further presents the advantage that the telephone-bridge at the station can be in a known manner shut off from the direct current of the central battery by means of a condenser or polarization-cells, so that it is possible to conduct the entire current from the central battery to the substations, which in the hitherto known systems of substations was not the case.

I will now proceed to describe my invention with reference to the accompanying drawings, in which—

Figure 1 shows diagrammatically a tele-

phone system. Fig. 2 shows a modified telephone system. Fig. 3 shows another modification of the telephone system, and Fig. 4 shows a further modification of the telephone system.

Similar characters of reference refer to similar parts throughout the several views.

The system shown at Fig. 1 comprises a central station C with the central battery D, two stations A and B, and four substations E, F, G, and H, which latter are severally connected by lines with the switchboard P at the station B. The two stations A and B are shown as connected at the central station C by means of a jack-cord 1 2 3 4. At the same time two substations E and F are shown as connected at the station B by means of the single line 21, so that they may converse with each other. Then a current passing from the central battery D will be divided at O and pass through the two reaction-coils 5 6, the two branches 11 and 12 of the double line, and the two resistances 15 and 16, whereupon the two currents are again collected at the point 19, from which the current passes through the single line 21. At the point 22 the current is again divided between the two reaction-coils 23 and 24. At the two points 28 and 29 behind the two resistances the currents are each further divided. From the point 28 two currents pass to the substations E and F through the two lines 61 and 63 and the two reaction-coils 32 and 34, respectively. In a similar manner two currents pass from the point 29 to the two substations E and F through the two lines 62 and 64 and the two reaction-coils 33 and 35, respectively. At the substation E the two currents are collected and pass through the line 41 back to the switchboard P at the station B, and thence through the earth to the other pole of the central battery D. The same is the case with the two currents which are collected at the other substation F and pass through the line 42. Thus a current is supplied from the central battery D through the same lines to the microphone 53 at the station B and to the two microphones 45 and 46 at the substations E and F, and yet the several microphones do not disturb each other. The variations of the current caused by the microphone 53 at the station B will operate upon the telephone 9 at the station B and of course also (according to the known principle) upon the telephone 10 at the other station A; but they cannot act upon the telephones 49 and 50 at the two substations E and F, since these telephones are inserted in indifferent bridges between the several branches. The bridge containing the telephone 9 is closed to the battery-current by means of a condenser 70. The variations of the current caused by the microphones 45 and 46 at the substations E and F in turn will operate upon the telephones 49 and 50 at these substations, but are prevented from acting upon the telephone 9 at the station B, owing to the position of this telephone in a bridge.

As Fig. 1 shows, the telephones 49 and 50 at the substations E and F are connected by a closed circuit, the parts of which are placed parallel to each other between the switchboard P at the station B and the two substations E and F. Thus the circuit for the current used for the conversation between the two substations E and F is protected from foreign induction and is at the same time unable to produce any inductive effects upon neighboring lines—such, for example, the returns 41 and 42. The reaction of the coils 23 24, 32, 33, 34, and 35 prevents the variations of the current from passing over to the single line 21.

Preferably the line 21 is connected with the earth by the intermediacy of a condenser 40, (or polarization-cells,) so that the line 21, the reaction-coils 23 24, the lines 61, 62, 63, and 64, the reaction-coils 32, 33, 34, and 35, the lines 41 and 42, the earth and the condenser 40 will form a circuit closed to alternating currents, in which circuit any current that may happen to be produced by foreign induction can be equalized in the single line 21 without passing over the apparatuses at the station B and over the central battery D to the earth.

As is shown at Fig. 1, further pairs of substations, such as G and H, may be connected with the single line 21 at the station B and be supplied with current from the central battery D in a similar manner as the two substations E and F. Then both stations A and B, both substations E and F, and both substations G and H, and any further pairs of substations may converse with each other, respectively, at the same time without disturbing the other substations or stations. By the by, in Fig. 1 the two substations G and H are shown as switched off from the single line 21 at the station B. Where so preferred, separate single lines, such as 69, may be connected direct with the point of union 19 and be arranged for supplying a series of pairs of substations with current from the central battery D.

The bridge containing the telephone 9 at the station B is shown as disposed behind the microphone 53; but where so preferred it may be disposed before the microphone 53, as is indicated by the dotted lines.

The telephone system shown at Fig. 2 differs from the previous one in that the single line 21 is connected direct with the two branches 11 and 12 of the double line by means of two reaction-coils 56 and 57 before the microphone 53 and the telephone 9 at the station B. The currents passing through the two branches 11 and 12 are each divided and pass, on the one hand, through the apparatuses at the station B, the two reaction-

coils 15 and 16, and the common line 71 to the earth and, on the other hand, through the two reaction-coils 56 and 77, the common line 21, and the several substations E F G H to the earth. The condenser 40 is again disposed for the purpose mentioned above. It will be seen that the telephone system shown at Fig. 2 operates in exactly the same manner as the telephone system in Fig. 1. There is no objection to disposing the microphone 53 at the station B between the two reaction-coils 5 and 56, as is indicated by dotted lines, instead of between the two reaction-coils 56 and 15, as shown by full lines. In general it is immaterial at which points of the two branches 11 and 12 the two reaction-coils 56 and 57 should be joined. The point of union 55 is shown as connected with the single line 21 and the latter in turn as connected with a separate single line 69. In other words, the two reaction-coils 56 and 57 are shown as supplying current to all the various pairs of substations E F G H. Where so preferred, however, several separate pairs of reaction-coils besides those, 56 and 57, may be connected with the two branches 11 and 12 and be arranged for supplying current to other pairs of substations by means of separate single lines, such as 72. (Indicated by dotted lines.) The telephone system shown at Fig. 2 further differs from that shown at Fig. 1 in that the points of union between the pairs of reaction-coils 32 and 33, 34 and 35, 36 and 37, 38 and 39 are directly earthed at the respective substations E F G H instead of at the station B by means of return-lines 41 42 43 44. This means that for every substation a return-line, leading to the switchboard P at the station B, is saved. The lines 61 62 63 64 65 66 67 68 are exactly the same as those in Fig. 1.

The telephone system shown at Fig. 3 is substantially the same as that shown at Fig. 2, only that a battery 59 is disposed at the central station C besides the battery D. The battery 59 is located between the two branches of the jack-cord 1 2 3 4, the same as known central batteries. This telephone system operates in exactly the same manner as that in Fig. 1 or that in Fig. 2. The plan of connections shown presents the advantage that it may be applied to any of the existing known telephone systems with central batteries, in which the central battery is connected in a bridge of the jack-cord, so as to create a bridge system according to my invention for any station. In this case it is only necessary to connect the one pole of the central battery 59 with the earth by the intermediacy of an additional battery D. Then the several pairs of substations E F G H will receive the current from the additional battery D, while the microphone 53 at the station B, connected with the substations and the microphone 58 at the station A without any connection with substations, will receive their current from the central battery 59. This means that the existing stations may be left as they are and need not be altered. This is not the case if they were to be subsequently connected with substations in any of the known manners.

Fig. 4 shows diagrammatically a telephone system which bears a resemblance to that shown at Fig. 3. The station B is connected with the central station C by means of a bridge system according to my invention. The central battery 60 is in a known manner permanently connected with the branches 11 12 and 13 14 of the double lines by means of reaction-coils 5, 6, 7, and 8 and not with the jack-cord, as will be obvious from the position of the jacks 1, 2, 3, and 4. Some of the reaction-coils 5, 6, 7, and 8 may be constructed as call-relays, as usual. For connecting a known central-battery system of this kind with a pair of substations E and F in the manner according to my invention it is only necessary to earth the one pole of the central battery 60, which, by the by, is usually done for other reasons, and to connect the two branches 11 and 12 leading to the station B with the other pole of the central battery 60 by means of reaction-coils 5 and 6, respectively. Then the stations without connections with substations, such as A, will receive their current from the central battery 60 by means of the branches of their double lines—*i. e.*, in this case the branches 13 and 14. The microphone 53 at the station B, however, will be actuated by the current destined for the substations E F, the same as explained above with reference to Fig. 1. The manner of operating the station B and the substations E F is the same as explained above with reference to Figs. 1 to 3. Of course separate single lines 69 may be employed, as before, for operating other pairs of substations. It is not necessary that the central battery 60 should be in a bridge between the branches 13 and 14. For instance, the reaction-coil (or the call-relay) 7 may be joined to the same pole of the battery 60 as the reaction-coil (or the call-relay) 8, in which case the station A will require to be connected with the earth, as is indicated by dotted lines, and the current passing to the station A will return by the earth to the central battery 60.

I have shown in the figures only those connections between the central station, the station, and the substations which form my invention and render possible a simultaneous conversation between the station and the central station or any other station and between the two of any or all of the pairs of substations. For this reason only that part P of the switchboard at the station B is shown which forms a part of my invention. The switchboard itself may be of any known

construction and may comprise all the known accessories, and its manner of operation is well known. It is therefore evident that by means of the said switchboard also either of the several substations may be connected direct with the station B for conversing with the central station C or thereby with any other station, or the station B may converse direct with any of the substations—for example, F. The connection of the apparatuses at the station B with the two branches 11 and 12 of the double line for a position of constant current may be effected in a known manner.

The reaction-coils 15 16 and 32 33 34 35 may be constructed as relays for signaling purposes in any of the known manners the same as the reaction-coils 5 6 7 8 and 17 18. Where so preferred, these coils may be made as countercoils on a common iron core in order to avoid any undesirable damping of the variations of the current produced by the microphones.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In a telephone system, the combination with a central station, of a station, two substations, a central battery at the central station and having its one pole earthed, a circuit connecting the other pole of the central battery at the central station with the station and forming the four arms of a Wheatstone's bridge, two pairs of resistances at the central station and at the station in the four bridge-arms, a microphone at the station in the one bridge-arm before the two resistances, a telephone at the station in the bridge of the circuit, two circuits connecting the station with the two substations and forming each the four arms of a Wheatstone's bridge, two resistances at the station in bridge-arms common to the two circuits, a line connecting the four resistances at the station, two pairs of resistances at the two substations in the respective bridge-arms, two microphones at the two substations in the bridge-arms before the resistances, two telephones at the substations in the bridges of the circuits, and two lines connecting the two pairs of resistances at the substations with the earth.

2. In a telephone system, the combination with a central station, of a station, a plurality of pairs of substations, a central battery at the central station and having its one pole earthed, a circuit connecting the other pole of the central battery at the central station with the station and forming the four arms of a Wheatstone's bridge, two pairs of resistances at the central station and at the station in the four bridge-arms, a microphone at the station in the one bridge-arm before the two resistances, a telephone at the station in the bridge of the circuit, a plurality of pairs of circuits connecting the station with the plurality of pairs of substations and forming each the four arms of a Wheatstone's bridge, a plurality of pairs of resistances at the station in bridge-arms common to the pairs of circuits, connections between the resistances at the station, a plurality of pairs of resistances of which each pair is at either substation in the respective bridge-arms, a plurality of microphones of which each is at either substation in the bridge-arms before the resistances, a plurality of telephones of which each is at either substation in the bridge of the circuit, and a plurality of lines connecting the pairs of resistances at the substations with the earth.

3. In a telephone system, the combination with a central station, of a station, two substations, a central battery at the central station and having its one pole earthed, two resistances joined to the other pole of the central battery, two resistances joined to a point of union at the station, two branch lines connecting the four resistances at the central station and at the station, a microphone in one of the two branch lines at the station, a telephone in a bridge between the two branch lines at the station, a line connecting the point of union at the station with the earth and containing a condenser, another point of union at the station, a single line connecting the two points of union at the station, two branch resistances joined to the other point of union, two points of union at the two substations, two pairs of resistances joined to the two points of union at the two substations, two branch lines connecting the one branch resistance at the station with two resistances at the two substations, two microphones in these two branch lines at the two substations, two other branch lines connecting the other branch resistance at the station with the other two resistances at the two substations, two telephones in bridges between the branch lines at the two substations, and two lines connecting the two points of union at the two substations with the earth.

4. In a telephone system, the combination with a central station, of a station, a plurality of pairs of substations, a central battery at the central station and having its one pole earthed, two resistances joined to the other pole of the central battery, two resistances joined to a first point of union at the station, two branch lines connecting the four resistances at the central station and at the station, a microphone in one of the two branch lines at the station, a telephone in a bridge between the two branch lines at the station, a line connecting the first point of union at the station with the earth and containing a condenser, a plurality of points of union at the station, connections between the first point of union and the plurality of points of union, a plurality of pairs of resistances joined to the plurality of points of union, a plurality of points of union each at either substation, a

plurality of pairs of resistances joined to the plurality of points of union at the substations, a plurality of branch lines between the plurality of pairs of resistances at the station and the plurality of pairs of resistances at the substations and so disposed, that for every pair of substations two branch lines connect the one resistance of the respective pair at the station with two resistances at the two substations and two other branch lines connect the other resistance at the station with the other two resistances at the two substations, a plurality of microphones at the substations and each inserted in one of the two branch lines thereat, a plurality of telephones at the substations and each inserted in a bridge between the two branch lines, and a plurality of lines connecting the plurality of points of union at the substations with the earth.

5. In a telephone system, the combination with a central station, of a station, two substations, a central battery at the central station and having its one pole earthed, two resistances joined to the other pole of the central battery, two resistances joined to a point of union at the station, two branch lines connecting the four resistances at the central station and at the station, a microphone in one of the two branch lines at the station, a telephone in a bridge between the two branch lines at the station, a line connecting the point of union at the station with the earth, two additional resistances connected with the two branch lines before the telephone at the station and with a common point, another point of union at the station, a single line connecting the common point with the other point of union, a line connecting the single line with the earth and containing a condenser, two branch resistances joined to the other point of union, two points of union at the two substations, two pairs of resistances joined to the two points of union at the two substations, two branch lines connecting the one branch resistance at the station with two resistances at the two substations, two microphones in these two branch lines at the two substations, two other branch lines connecting the other branch resistance at the station with the other two resistances at the two substations, two telephones in bridges between the branch lines at the two substations, and two lines connecting the two points of union at the two substations with the earth.

6. In a telephone system, the combination with a central station, of a station, a plurality of pairs of substations, a central battery at the central station and having its one pole earthed, two resistances joined to the other pole of the central battery, two resistances joined to a first point of union at the station, two branch lines connecting the four resistances at the central station and at the station, a microphone in one of the two branch lines at the station, a telephone in a bridge between the two branch lines at the station, a line connecting the first point of union at the station with the earth, two additional resistances connected with the two branch lines before the telephone at the station and with a common point, a plurality of points of union at the station, connections between the common point and the plurality of points of union, a line connecting the connections with the earth and containing a condenser, a plurality of pairs of resistances joined to the plurality of points of union, a plurality of points of union each at either substation, a plurality of pairs of resistances joined to the plurality of points of union at the substations, a plurality of branch lines connecting the plurality of pairs of resistances at the station with the plurality of pairs of resistances at the substations and so disposed, that for every pair of substations two branch lines connect the one resistance of the respective pair at the station with two resistances at the two substations and two other branch lines connect the other resistance at the station with the other two resistances at the two substations, a plurality of microphones at the substations and each inserted in one of the two branch lines thereat, a plurality of telephones at the substations and each inserted in a bridge between the two branch lines, and a plurality of lines connecting the plurality of points of union at the substations with the earth.

In testimony whereof I have singed my name to this specification in the presence of two subscribing witnesses.

WILHELM OHNESORGE.

Witnesses:

WOLDEMAR HAUPT,

HENRY HASPER.