Nov. 23, 1926. 1,607,673

A. H. INGLIS

TELEPHONE SUBSTATION CIRCUITS

Filed Oct. 9, 1924 2 Sheets-Sheet 1

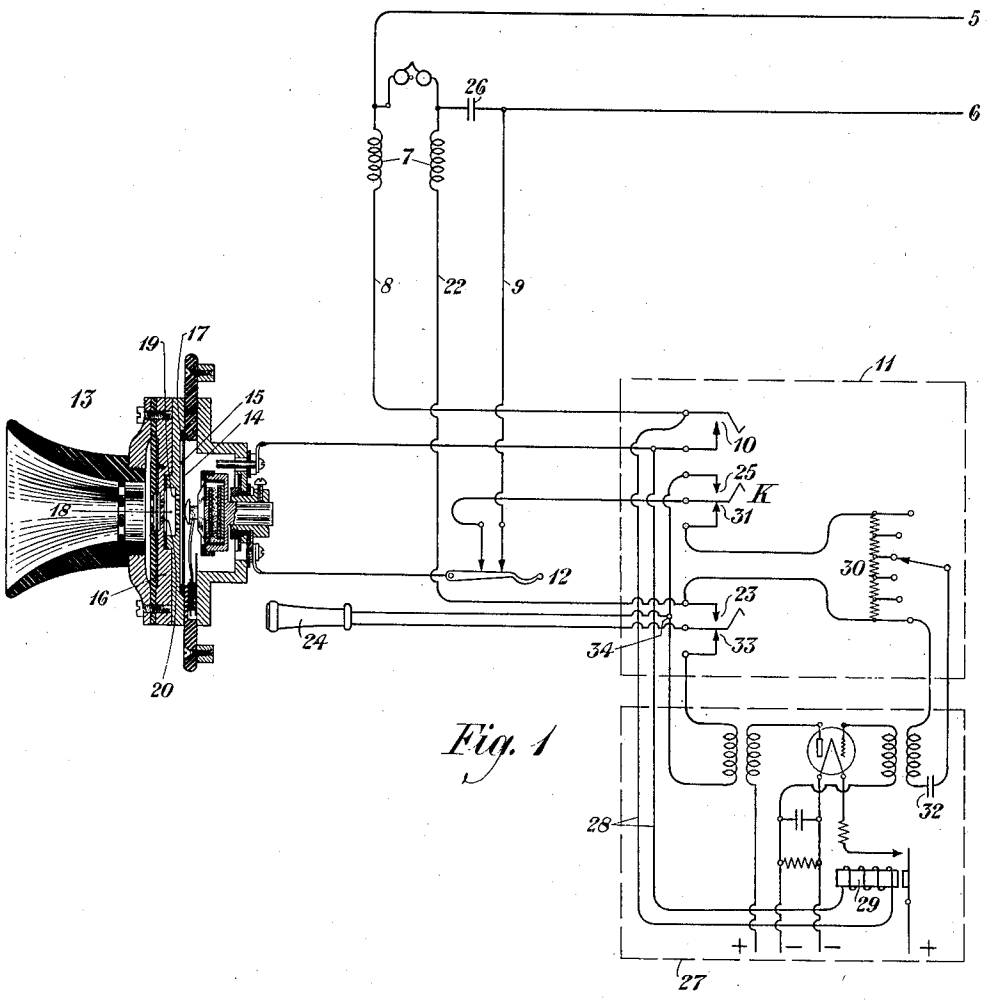

Fig. 1

INVENTOR
A. H. Inglis

BY

ATTORNEY

Nov. 23, 1926. 1,607,673

A. H. INGLIS

TELEPHONE SUBSTATION CIRCUITS

Filed Oct. 9, 1924 2 Sheets-Sheet 2

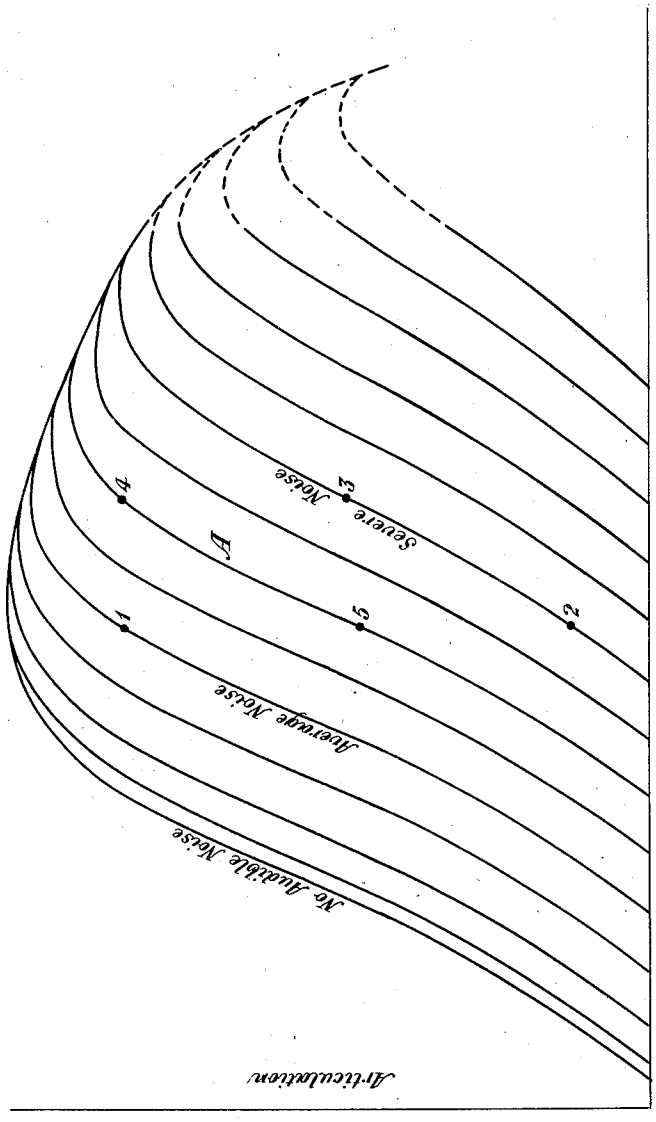

Fig. 2

INVENTOR
A. H. Inglis
BY
ATTORNEY

Patented Nov. 23, 1926. 1,607,673

UNITED STATES PATENT OFFICE.

ALFRED H. INGLIS, OF ORANGE, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

TELEPHONE-SUBSTATION CIRCUITS.

Application filed October 9, 1924. Serial No. 742,581.

This invention relates to telephone circuits, and more particularly to telephone substation circuits having associated amplifying apparatus.

An object of the invention consists in the provision of apparatus at a telephone substation which will permit a maximum of intelligibility of a telephone conversation.

A further object consists in the adaptation of this apparatus for noisy locations and also for aiding persons having defective hearing.

These and further objects will be apparent from the following description, when considered in connection with the accompanying drawings, which illustrate one embodiment of the invention.

In the drawing, Figure 1 illustrates diagrammatically one form of the invention, and Fig. 2 indicates curves showing the principles underlying the invention.

The intelligibility of a telephone conversation is dependent on a number of causes, the frequency-response characteristic of the system, the volume level of the speech, which is dependent on the efficiency of the telephone instruments and circuit, on the amount of side-tone, and on the effective noise, both induced line noise and room noise which is picked up by the transmitter and transmitted through side-tone to the local receiver, and also over the line to the distant end. This noise masks the conversation. It should be noted that the effect of room noise on the free ear is of relative unimportance compared to that reaching the ear used in telephoning either indirectly through the receiver or directly by leakage around the receiver cap.

Assuming that the present commercial telephone system only is under discussion, where the frequency-response characteristic is roughly of the same nature at all times, the articulation and consequently the intelligibility, is a function of volume and of interfering noise. This relation is shown in Fig. 2.

It will be noted that for any given noise condition there is a volume level at which maximum articulation occurs, although it is never possible to reach as high a maximum with any noise present as with no noise.

In Fig. 2 the numeral 1 on the curve bearing the legend "Average noise" is typical of an average telephone conversation. If this same volume level (20 units below reference) occurred under severe noise conditions, it can be seen that the articulation would be very low, as indicated at point 2. If, however, the volume level is increased without increasing the noise it will be seen that at point 3, a certain small amount of the conversation becomes intelligible. If at this louder level the noise is decreased to curve A, the articulation is gradually increased again to point 4. If the noise is decreased to curve A without increasing the original volume, articulation is increased only to point 5. It is evident therefore, that to get maximum intelligibility under practical conditions it is necessary both to reduce the effective noise as much as possible and to control the volume level.

This may be done by a telephone system having the following characteristics:

A transmitter which responds to the voice speaking directly into it but not to other sounds, thus preventing the introduction and transmission over the circuit of such undesirable sounds or noises.

A circuit of a type where relatively little of the power generated by the transmitter is dissipated in the local receiver, thus reducing to a minimum the effect on the ear of such undesirable sound or noise, as may be picked up by the transmitter.

A means of controlling or amplifying the volume of the received speech which it is desired to hear.

Fig. 1 shows diagrammatically a system having these characteristics, employing a combination which is substantially of standard equipment.

This system employs a subscriber's set connected for side-tone reduction, a special transmitter which discriminates against noise, and a receiver circuit including an amplifier and a potentiometer for controlling such amplification. The special transmitter is of a type which will operate efficiently in picking up feeble voice waves, and yet will not respond appreciably to extraneous sounds or to violent disturbances of the air.

With the key of the potentiometer in the normal position, the amplifier is cut out. With the key in the operated position, the amplifier is connected to the receiver leads, permitting the regulation of the vol-

ume of the incoming speech. In transmitting, the circuit is electrically the same as the ordinary telephone substation set.

In the operation of the system, direct current flows from the central office, upon the removal of the receiver from its switchhook, over the talking conductors 5 and 6, left-hand winding of induction coil 7, conductors 8 and 9, closed contact 10 of the potentiometer key K, and closed contact of the receiver hook 12 through the transmitter 13.

The transmitter 13 is provided with the usual cup-shaped casing, mouthpiece, and transmitter button comprising the electrodes and associated elements. The transmitter button bears against the rear side of a diaphragm 14 which is suitably mounted within the casing. A resonating chamber 15 is provided in a recess formed in the plate 16, and an interposed insulating ring 17 separates said plate and the diaphragm 14. An outer auxiliary resonant chamber 18 is formed centrally of the plate 16, and perforations 19 on one side connect this chamber with chamber 15, and perforations 20 on the other side permit the admission of voice waves from openings provided in the mouthpiece. The outer side of the plate 16 is provided with a recessed portion adapted to receive a disc 21 of coarse linen or similar material which is used to prevent dust or moisture from entering and clogging the perforations 20. This disc may be held in place by means of a plate of hard rubber which in turn is clamped by an outer metallic plate to which the mouthpiece is attached. The auxiliary chamber 18 with its restricted openings on either side acts as a resonator for a band of frequencies within the limits of useful speech frequencies and amplifies, or rather intensifies by sympathetic vibrations of the air within the chamber the effect on the transmitter diaphragm of the voice sounds which are important. A large percentage of the disturbing noise is of high frequency nature and the holes 20 due to their small diameter and appreciable length, act as a filter or shield to prevent such vibrations from entering the resonating chamber 18. The natural frequency of this chamber is much lower than the frequency of the vibrations to be eliminated, hence the chamber serves to further impede such vibrations since its impedance to sound transmission increases with the frequency of the vibrations to be transmitted. Such vibrations are further filtered out by means of the small holes 19 in the plate, and are further impeded by the thin resonating chamber 15 between the plate 16 and the diaphragm 14. Vibrations of useful voice frequencies are somewhat impeded by the small perforations 20, but are amplified by means of resonating chamber 18 which is so dimensioned as to be resonant at vibrations of voice frequencies. The chamber 15 between the plate 16 and the diaphragm 14 also acts as a resonating chamber, and, in addition, provides a certain amount of air damping for the diaphragm.

It will therefore be seen that the combination of the small holes and the auxiliary chamber causes an increase in volume of the voice waves which it is desired to transmit, and eliminates to a large extent the undesirable extraneous noises.

The circuit previously described through the transmitter 13 supplies current thereto which is modulated by the transmitter agitated by the voice. The resultant voice currents follow the same path, and in addition introduce a certain amount of side-tone currents in the right-hand winding of induction coil 7. The path followed by these currents extends from the right-hand winding of coil 7, conductor 22, contact 23 of key K, through the receiver 24, contact 25 of said key, through the contacts of switchhook 12, conductor 9 and condenser 26 to the right-hand winding of coil 7. The impedance relations of this circuit are such that the relative amount of "side-tone" induced in the receiver is less than with the well known "booster" connection.

In the receiving circuit the incoming voice currents follow the same path as outlined above, in connection with the transmitting circuit inducing current in the local receiving path through the right-hand winding of induction coil 7, as just described for the path of the side-tone currents.

To connect the amplifier 27 in the circuit, key K is operated, thus extending the path for direct current over conductors 8 and 9 as previously described, over conductors 28, through the winding of relay 29. The closure of the circuit causes the operation of relay 29 which establishes a circuit through the filment of amplifier 27 in an obvious manner. The operation of the amplifier 27 is therefore controlled by the switchhook 12 through the operation of relay 29.

The primary path of the receiving circuit is the same as that described for the transmission circuit. The secondary path extends from the right-hand winding of induction coil 7, conductor 22, resistance 30 of potentiometer 11, contact 31 of key K, contacts of switchhook 12, conductor 9, over conductor 6. The potentiometer 11 is, therefore, in place of the receiver 24 in a non-operated condition, and a potential drop occurs across said potentiometer. One side of the input coil of the amplifier 27 is connected directly to one side of the resistance 30 of the potentiometer 11, and the other side of the input coil is connected through condenser 32 to the movable arm of the resistance element 30 of said potentiometer,

thus making it possible to impress any desired part of the total drop on the input transformer of the amplifier. This potential is then amplified in the usual manner, and the resultant potential impressed on the secondary of the amplifier output transformer. The circuit now established extends from the output primary coil of the amplifier, contact 33 of key K and point 34, through the receiver 24. The closure of this circuit causes the incoming speech over the receiving circuit to be amplified in the receiver 24.

The return of the receiver 24 to its hook 12 and the restoration of key K of the potentiometer 11 cause the release of relay 29 of the amplifier and the disconnection of the potentiometer.

What is claimed is:

1. In a telephone sub-station, a transmission circuit, a transmitter included in the transmission circuit being substantially unresponsive to frequencies other than voice frequencies, a receiving circuit, a potentiometer, switching means associated with the receiving circuit and potentiometer, and an amplifying circuit controlled by said switching means for increasing the volume of speech in the receiving circuit.

2. In a telephone sub-station, a transmission circuit, a receiving circuit, a potentiometer associated with the receiving circuit, switching means associated with the receiving circuit and potentiometer, an amplifying circuit associated with the potentiometer and receiving circuit, and means controlled by the switching means for connecting the receiving circuit and amplifying circuit to increase the volume of speech in the receiving circuit.

3. In a telephone sub-station, a transmission circuit, a transmitting element included in said transmission circuit, said transmitting element being sensitive to voice waves and substantially non-sensitive to extraneous noises, a receiving circuit, a potentiometer associated with the receiving circuit, switching means associated with said receiving circuit and potentiometer, an amplifying circuit associated with the receiving circuit and potentiometer, and means associated with the amplifying circuit and controlled by said switching means for connecting the receiving circuit and amplifying circuit to increase the volume of speech in the receiving circuit.

4. In a telephone sub-station, a transmission circuit, a transmitter included in the transmission circuit having a plurality of chambers in serial relation and resonant only to voice frequencies, a receiving circuit normally in direct connection with the talking circuit, an amplifying circuit, switching means for connecting the receiving circuit and amplifying circuit, and a potentiometer for controlling the adjustment of the amplifying circuit whereby the vloume of incoming speech in the receiving circuit is regulated.

5. In a telephone sub-station, a transmission circuit including a transmitter sensitive to speech and insensitive to noise, a receiving circuit, a circuit of comparatively low side-tone associated therewith, a potentiometer associated with the receiving circuit, switching means associated with the receiving circuit and potentiometer, an amplifying circuit, and means controlled by the switching means for connecting the receiving circuit and amplifying circuit to increase the volume of speech in the receiving circuit sufficiently above the local noise level to make it intelligible.

In testimony whereof, I have signed my name to this specification this 8th day of October 1924.

ALFRED H. INGLIS