July 8, 1941. H. R. SHAW 2,248,589

INTEROFFICE TELEPHONE

Filed May 23, 1940

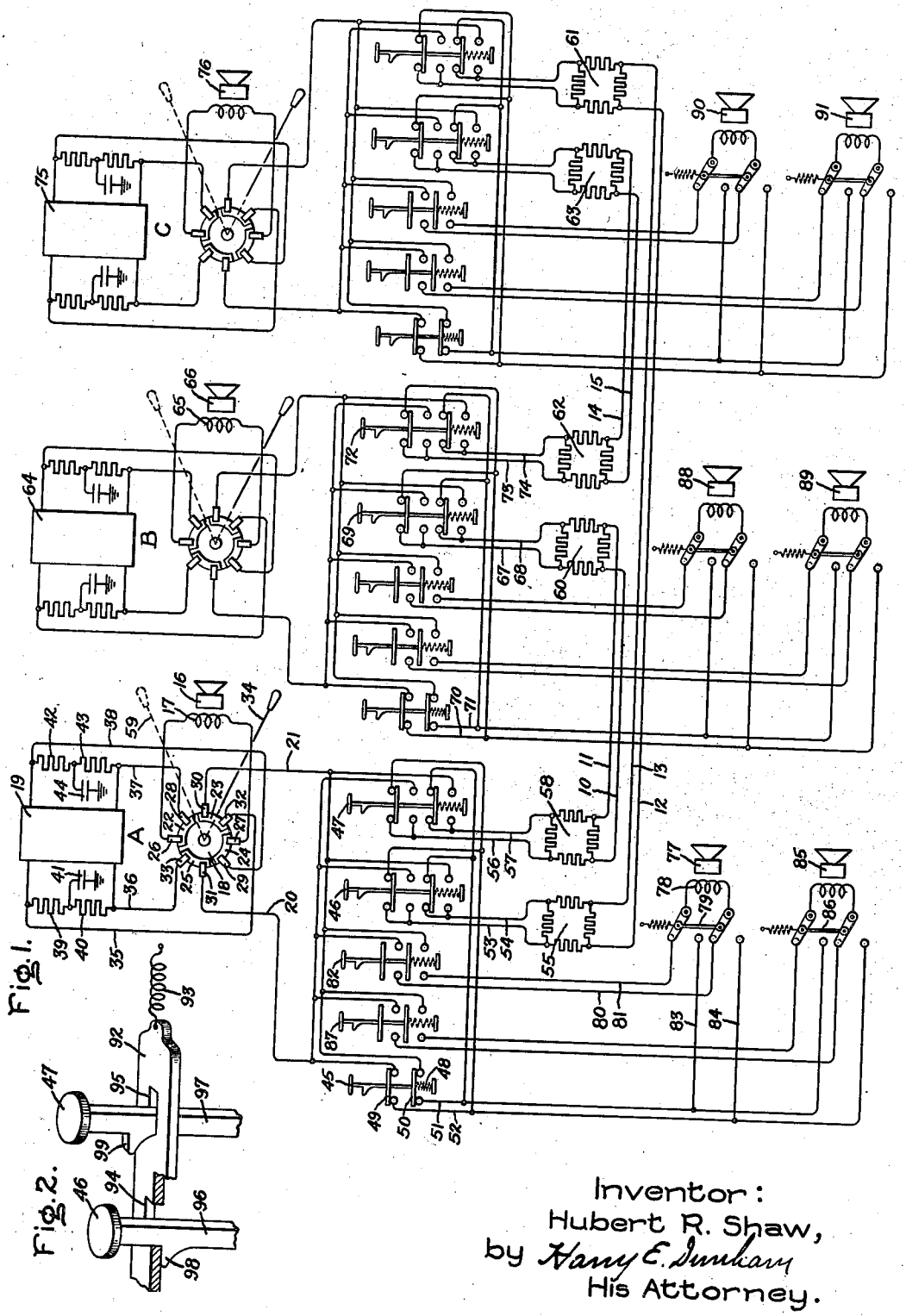


Fig. 1.

Fig. 2.

Inventor:
Hubert R. Shaw,
by Harry E. Dunham
His Attorney.

Patented July 8, 1941 2,248,589

UNITED STATES PATENT OFFICE

2,248,589

INTEROFFICE TELEPHONE

Hubert R. Shaw, Drexel Hill, Pa., assignor to General Electric Company, a corporation of New York

Application May 23, 1940, Serial No. 336,757

4 Claims. (Cl. 179—38)

My invention relates to communication systems and, while not limited thereto, it is particularly useful in interoffice telephone systems.

In certain systems having no central switching station and providing for private communication between any pair of a number of stations, an individual circuit is provided between each station and each of the other stations. When the system is not in use, the telephone apparatus at each station is normally connected to every circuit leading thereto. To assure private conversation between two stations, it is necessary first for a calling station to disconnect its telephone apparatus from all circuits except that leading to the desired station, and second, after a call from the calling station, for the operator at the desired station to disconnect its telephone apparatus from all circuits but that leading to the station at which the call originated. It is an object of my invention to provide a communication system having no central switching station and having a minimum number of interconnecting circuits when the system includes a small number of stations, whereby a private communication may be made to a desired station without any action on the part of an operator at the desired station.

It is a further object of my invention to enable one to make a private communication to a desired station on a system having an individual circuit between each station and each of a number of other stations without the necessity of any action by an operator at the desired station. It is also an object of my invention to provide in such a system means whereby a communication may be transmitted to a desired station and may be prevented from being transmitted elsewhere at the option of the operator at the transmitting station.

The features of my invention which I believe to be novel are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof may best be understood by reference to the following description taken in connection with the accompanying drawing, in which Fig. 1 is a circuit diagram illustrating an interoffice communication system embodying my invention, and Fig. 2 is a detailed view in perspective of a portion of the apparatus indicated in Fig. 1.

Referring to Fig. 1, there is shown a communication system including three stations A, B, and C. Each of these stations includes identical apparatus comprising a telephone and amplifier device, and switching apparatus. Between each station and each of the other stations there is a communicating circuit. These circuits comprise wires 10 and 11 connecting stations A and B, wires 12 and 13 connecting stations A and C, and wires 14 and 15 connecting stations B and C. It is understood, of course, that, if there are more than three stations in the system, there must be provided additional circuits.

Since the apparatus in each station is identical with that in every other station, only the apparatus in station A will be completely described. The telephone and amplifying apparatus at station A comprises a dynamic speaker 16 having a voice coil 17, a reversing switch 18, and an amplifier 19. These devices are arranged for translation of sound into electric energy which is amplified and transmitted through wires 20 and 21 to the switching apparatus corresponding to station A and for translation of electric energy into sound, the energy being received from the switching apparatus through wires 20 and 21 by the amplifier 19 and translated into sound by the speaker 16.

A dynamic speaker whose voice coil moves in a fixed magnetic field produced by either a permanent magnet or an electromagnet is a sound translating device which requires substantially more electric energy to produce a given amount of sound than it can generate when excited by the same amount of sound. That is, if an electric signal of high intensity excites the voice coil 17, the speaker 16 produces a sound of a certain intensity. Now if a sound of equal intensity, produced by some outside means, impinges on the speaker 16, signal energy is generated in the voice coil 17, which energy is relatively of low intensity.

The amplifier 19 is arranged to cooperate with the switch 18 so as to amplify weak signals coming through the wires 20 and 21 to energize the voice coil 17, or so as to amplify weak signals generated by the voice coil 17 for transmission through the wires 20 and 21. In order to accomplish this result the switch 18 is provided with a rotary member having four equally spaced circumferential contacts 22, 23, 24 and 25, and with eight radial, equally spaced, stationary contacts arranged in pairs 26, 27; 28, 29; 30, 31; 32, 33. An operating handle 34 is shown in dotted lines in a position corresponding to the switch position shown. The voice coil 17 is connected between the fixed contacts 26 and 27. The wires 20 and 21 are connected respectively to the fixed contacts 31 and 30. A pair of wires

35 and 36, which are connected to the input terminals of the amplifier 19, are connected respectively to the fixed contacts 32 and 33. A second pair of wires 37 and 38, which are connected to the output terminals of the amplifier 19, are connected respectively to the fixed contacts 28 and 29.

In the position shown the telephone apparatus is arranged for listening to signals coming over wires 20 and 21. A circuit may be traced from wire 20 through switch contacts 31, 25 and 33, through wire 36 to one input terminal of the amplifier 19 and from wire 21 through switch contacts 30, 23, and 32, through wire 35 to the other input terminal. The output terminals of the amplifier 19 are connected through a circuit which may be traced through wire 37, switch contacts 28, 22, and 26, through the voice coil 17 of the speaker 16, through switch contacts 27, 24 and 29, and through wire 38 to the other output terminal of the amplifier 19.

In order to minimize cross talk between circuits, all circuits are arranged in balanced relation with respect to ground. A pair of equal resistors 39 and 40 are connected in series between wires 35 and 36 and their center point is by-passed to ground by a condenser 41. In like manner, a pair of equal resistors 42 and 43 are connected in series between wires 37 and 38 and their center point is by-passed to ground by a condenser 44. This arrangement maintains the circuits in the telephone apparatus of station A balanced with respect to ground.

The switching apparatus at station A; which provides controllable connections between the wires 10, 11; 12, 13; and 20, 21; comprises three switch buttons 45, 46, and 47, which cooperate with a latching arrangement, to be described later, which provides that upon depression of any one of the switch buttons the other two are released to an undepressed position. Each of these switch buttons is biased into an undepressed position by a spring, such as spring 48 in button 45. Each of these buttons is also provided with a pair of contact bridges, such, for example, as the contact bridges 49 and 50 of the button 45. In its depressed position the button 45 is arranged to make contact, by the contact bridges 49 and 50, from the wires 20 and 21 to a pair of wires 51 and 52. The switch buttons 46 and 47 are provided with similar contact bridges, which, however, are arranged to make contact between circuits both when the switch buttons are depressed and undepressed.

When the switch button 46 is depressed, a circuit exists from the wires 20 and 21 to a pair of wires 53 and 54, which are connected through an attenuation network 55 to the pair of wires 12 and 13 leading to station C. When the switch button 46 is undepressed, it is arranged to complete a circuit between the wires 51 and 52 and the wires 53 and 54, respectively. It is therefore clear that, when switch button 45 is depressed, a circuit exists from the wires 20 and 21 through contact bridges 49 and 50, through the wires 51 and 52, and the wires 53 and 54, through the attenuation network 55, and through the wires 12 and 13 to station C.

Similarly, circuits are arranged to be completed by the switch button 47 which in its undepressed position is arranged to complete a circuit between the wires 51 and 52 and wires 56 and 57 respectively. In the depressed position of the button 47 it is arranged to connect the wires 20 and 21 to the wires 56 and 57, which are connected through an attenuation network 58 to the wires 10 and 11 leading to station B. Thus, when the switch button 45 is depressed, the wires 20 and 21, from which a circuit has been traced to the wires 12 and 13, which lead to station C, are also connected to the wires 56 and 57, and through the attenuation network 58 to the wires 10 and 11 which lead to station B. It is, of course, to be understood that if more than three stations are provided in such a system, additional switch buttons similar to buttons 46 and 47 can be provided for connecting additional circuits at will to wires 51 and 52, or to wires 20 and 21.

The operation of the telephone apparatus and switching arrangement, which form one of the stations of the system, may now be made apparent. With the parts in the positions shown, signals coming either through wires 10 and 11, or wires 12 and 13, are transmitted through wires 51 and 52, and wires 20 and 21, through certain contacts of the switch 18, through the amplifier 19, through other contacts of the switch 18, and to the voice coil 17 of the speaker 16 which reproduces the signals. Thus, with the switch button 45 depressed, station A is conditioned to reproduce signals coming from any other station.

If the switch button 46 is depressed, with corresponding release of the switch button 45, the wires 20 and 21 of station A are connected only to the wires 12 and 13. Therefore only signals coming from the wires 12 and 13 are reproduced in the speaker 16 and signals coming from the wires 10 and 11 have no effect thereon. If, with the switch button 46 depressed, the handle 34 of the reversing switch 18 be moved to its alternate position, as indicated by the dotted line 59, the speaker 16 translates sound into electric energy in the voice coil 17. A circuit is completed from the voice coil 17 through the reversing switch contacts 26, 22, 33, and 27, 24, 32, through wires 35 and 36 to the input terminals of the amplifier 19. A circuit is also completed from the output terminals of the amplifier 19 through the wires 37 and 38, through the switch contacts 28, 23, 30, and contacts 29, 25, 31, to the wires 20 and 21.

Signals generated in the voice coil 17 are therefore transmitted from the wires 20 and 21 through the depressed switch button 46 only to the wires 53 and 54 and through the attenuation network 55 to the wires 12 and 13. Thus, by moving the handle 34 of the reversing switch 18 between its two positions, the operator at station A may talk and listen alternately to the operator at station C. If the switch button 47 be depressed, with corresponding release of switch button 46, a similar private conversation may be carried on through wires 10 and 11 with station B.

The function of the attenuation networks 55 and 58 will now be made clear. The wires 10 and 11 are connected through an attenuation network 60 to the switching apparatus of station B, and the wires 12 and 13 are connected through an attenuation network 61 to the switching apparatus at station C. The wires 14 and 15 are connected to stations B and C respectively by attenuation networks 62 and 63. The attenuation networks are all identical and are arranged so that the amount of attenuation produced in a signal passing through such networks, for example, through networks 58 and 60, is the same in amount as the amplification produced by amplifier 19, or the corresponding amplifier at any other station. The amplifier 19 is arranged to amplify electric signals from a low intensity, such as those generated in the voice coil 17, to a high intensity

such as those required by the voice coil 17 to produce sound.

Therefore, when the operator at station A is speaking, the voice coil 17 generates signal energy at low intensity. The amplifier 19 then amplifies it to high intensity, and the attenuation networks 58 and 60 attenuate the signal energy again to low intensity, assuming that the switch button 47 is depressed. An amplifier 64 at station B, corresponding to amplifier 19 at station A, amplifies the energy again to high intensity, so that a voice coil 65 at station B can translate the energy into sound through the speaker 66.

Now at station B it must be noted that the signal, coming from station A through the attenuation network 60, through a pair of wires 67 and 68, through the contact bridges of a switch button 69 in the switching apparatus of station B and through a pair of wires 70 and 71, also passes through the contact bridges of a switch button 72 and through a pair of wires 73 and 74, through the attenuation networks 62 and 63 to station C. However, signal energy travelling by this path from station A through four attenuation networks in cascade to station C is of such low intensity upon arrival at station C that amplifier 75 can only amplify the signal to a low intensity, such as is generated by the voice coil 17 when translating sound into electric energy. Since this low intensity is not sufficient to produce sound through speaker 76 at station C, there is effectively no signal transmitted to station C when the switch button 47 at station A is depressed.

The attenuation networks in the circuits between the stations therefore act as means to attenuate signals transmitted therethrough sufficiently so that signals, passing from a station at which a call originated to a desired station and therefrom to a third station, are too greatly attenuated to effect the third station undesirably by producing sound. However, the quality of communication between two stations which are properly switched together for conversation is not materially affected.

It should be noted that, by the use of attenuation networks so as to provide private communication, as for example, from station A to station B, it is necessary only to depress one switch button 47 in order that signals from station A be received only in station B. This effect is achieved through the use of the attenuation networks.

In addition to the three main stations A, B and C, which have been described, and any one of which is arranged so as to be able to call any other main station privately, there may be provided auxiliary or remote stations which may communicate with the main station to which they are related. Since the auxiliary stations and their connections to their corresponding main stations are all identical, only one auxiliary station and its operation will be described. An auxiliary statio nconnected with the main station A, for example, has a speaker 77 with a voice coil 78 and a double pole, double throw switch 79 which is spring-biased so as normally to connect the voice coil 78 to a pair of wires 80 and 81. A switch button 82 in the switching apparatus at station A is arranged in its depressed position to connect the wires 80 and 81 respectively to the wires 20 and 21. If the switch 79 be moved to its alternate position, it acts to connect the voice coil 78 to a pair of wires 83 and 84, which are respectively connected to the wires 51 and 52.

The operation of this remote station is only possible when the switch buttons 46 and 47 are undepressed. Assuming that station A is in a standby position, in which the switch button 45 is depressed, the operator at the speaker 77 may move the switch 79 against its spring bias to connect the voice coil 78 through the wire 83 and 84, and through the wires 51 and 52, the contact bridges 49 and 50, the wires 20 and 21, through certain contacts of the reversing switch 18, through the amplifier 19 and through other contacts of the switch 18 to the voice coil 17. When the operator at the speaker 77 speaks, signals are transmitted through this circuit and are reproduced by the speaker 16.

The operator at station A, may, if he desires, move the handle 34 to the position 59 and speak, so that the signal transmitted from station A effects the speaker 77, as well as the speakers at stations B and C. If, however, the operator at station A desires to speak privately with the auxiliary station, switch button 82 must be depressed and the handle 34 must be moved to position 59. When this is done, a signal from the voice coil 17 passes through certain contacts of the switch 18 through wires 35 and 36 to the input terminals of the amplifier 19, through wires 37 and 38 and through other contacts of the switch 18 to the wires 20 and 21, through the contact bridges of the switch 82 to the wires 80 and 81 and, if the operator at the speaker 77 has released the switch 79, through the switch 79 to the voice coil 78. A two-way private conversation may then be carried on.

As many other auxiliary stations may be associated with station A, or with any other main station, as may be desired. For example, a second auxiliary station, including a speaker 85, is illustrated, which has a double pole, double throw switch 86 corresponding to switch 79 and a switch button 87 forming a part of the switching apparatus of station A. The operation of this auxiliary station including the speaker 85 is identical with the operation described above for the other auxiliary station. Identical auxiliary stations including speakers 88 and 89 are illustrated in connection with station B and also auxiliary stations including speakers 90 and 91 in connection with station C.

The attenuation networks act to provide private communication from an auxiliary station to its corresponding main station in much the same way as they prevent signals from passing from a desired main station to a third main station. That is, signal energy generated in the voice coil 78, for example, is of low intensity and, although it is transmitted through the wires 83 and 84 to the wires 51 and 52 and therefrom through the attenuation neworks 55 and 58 to stations C and B respectively, the energy reaches stations B and C at such a very low intensity that the amplifiers 64 and 75 can only amplify this energy to the low intensity at which it was generated in the voice coil 78, which is, as explained above, insufficient to produce sound in the speakers 66 and 76. Since this energy from the voice coil 78 is transmitted to the amplifier of station A without having passed through attenuation networks, amplifier 19 can raise it to a high intensity sufficient to produce sound in the speaker 16.

Although I have described my invention particularly as embodied in an interoffice telephone

system comprising main and auxiliary stations, it is to be understood that it is useful in any intercommunicating system having no central switching station in which private communication between two stations of the system may be necessary or desirable. This system has the great advantage that when one station initially calls another station only the called station receives the signal. This result is accomplished merely by a single switching operation at the calling station.

As explained above, the switching apparatus at each main station is provided with means for maintaining a switch button in a depressed position, which means, upon depression of any switch button, releases all switch buttons and thereafter locks the last one depressed in its depressed position. Fig. 2 illustrates a detailed view of a portion of such a means in which the switch buttons **46** and **47** are illustrated in cooperating relation with a latch bar **92**. The latch bar **92** is biased to the right by a spring **93** and is provided with slots **94** and **95** through which the shanks **96** and **97** of the switch buttons **46** and **47** respectively extend.

As illustrated, the switch button **46** is depressed and is maintained in depressed position by the latch bar **92** which cooperates with a projecting portion **98** of the shank **96**. A corresponding projecting portion **99** of the shank **97** is so arranged that, when the switch button **47** is depressed the portion **99** moves the latch bar **92** to the left against the force of the spring **93**, so that the projecting portion **98** of the shank **96** is released and the switch button **46** moves under the influence of a spring **48** (Fig. 1) to its undepressed position. Upon slightly greater depression of the switch button **47**, the projecting portion **99** moves completely beneath the latch bar **92**, which thereafter moves to the right under the influence of the spring **93** and in cooperation with the portion **99** locks the switch button **47** in depressed position.

It is to be understood that the latching mechanism for the switching operation which has been described is merely illustrative of one possible type of switching apparatus and its exact form is no part of the present invention. Other types of latching mechanism, such, for example, as are commonly used at the present time in radio receiver station selector switches, may be preferred.

While I have shown a particular embodiment of my invention, it will, of course, be understood that I do not with to be limited thereto, since different modifications may be made both in the circuit arrangement and instrumentalities employed, and I aim by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim is new and desire to secure by Letters Patent of the United States is:

1. In a communicating apparatus, at least three intercommunicating stations, an independent communicating circuit extending from each of said stations to each of the other of said stations, means to connect each of said stations to all of said communication circuits extending thereto, means to disconnect one of said stations from all of said circuits except one circuit extending to a desired station, and means in each of said communicating circuits to attenuate signals transmitted therethrough sufficiently so that signals passing from said one station to said desired station and therefrom to a third station are too greatly attenuated to affect undesirably said third station.

2. In a communicating apparatus, at least three intercommunicating stations, an independent communicating circuit extending from each of said stations to each of the other of said stations, means to connect each of said stations to all of said communicating circuits extending thereto, means to disconnect one of said stations from all of said circuits except one circuit extending to a desired station, means in each of said communicating circuits to attenuate signals transmitted therethrough sufficiently so that signals passing from said one station to said desired station and therefrom to a third station are too greatly attenuated to affect said third station, and means at each of said stations for amplifying said signals to their original value after attenuation in one of said independent communicating circuits.

3. In a communicating apparatus, at least three intercommunicating stations, each of said stations comprising a speaker for translating high level electric energy into sound and sound into low level electric energy and an amplifier for amplifying low level electric energy to high level electric energy, an independent communicating circuit extending from each of said stations to each of the remaining one of said stations, means to connect each of said stations to all of said communicating circuits extending thereto, means to disconnect one of said stations from all of said circuits except the circuit extending to a desired station, and means in each of said communicating circuits to attenuate signals transmitted therethrough from a high level to a low level so that signals passing from said one station to said desired station are transmitted therefrom to a third station at so low a level that the amplifier and speaker at said third station are not affected.

4. In a communicating apparatus, a plurality of intercommunicating main stations and an auxiliary station, each of said stations comprising a speaker for translating high level electric energy into sound and sound into low level elecric energy and an amplifier for amplifying low level electric energy to high level electric energy, an independent communicating circuit extending from each of said main stations to each of the other of said main stations, means to connect each of said main stations to all of said communicating circuits extending thereto, means to disconnect one of said main stations from all of said circuits except the circuit extending to a desired main station, means in each of said independent communicating circuits to attenuate signals from a high level to a low level, and means for disconnecting each of said main stations from all communicating circuits and for connecting said main station to said auxiliary station through said amplifier for private communication therebetween.

HUBERT R. SHAW.