ABSTRACT: Howling in simultaneous communicating system can be eliminated by the provision, in each of the pair of transmitting-receiving instruments, of two microphones disposed in geometrically and electrically symmetrical relation relative to a loud speaker, and two input transformers connected, for differential action, to said microphones so as to follow said microphones so that the input signals of the portions of the voice emitted from the loud speaker picked up by said microphones are inverted and cancelled relative to each other before being applied to a succeeding amplifier.
The present invention relates to means for eliminating howling (which should be understood to bear the same meaning as "feedback" or "screech" as are used by some people) in simultaneous two-way communicating device and to a howlingless simultaneous two-way communicating device. Conventional simultaneous two-way communicating devices of the type as are represented by the simultaneous interphone system have an arrangement wherein a microphone for transmitting the voice of the caller (hereinafter to be also referred to as "addresser" as required) which is amplified and emitted from the loud speaker located at the other end of the line is picked up by the microphone disposed close to said loud speaker and is again amplified and returned to the caller's instrument so as to be emitted from the loud speaker which the caller is using. This recycling of voice is repeated indefinitely so that the initial input signal is amplified in endless repetition to develop the so-called howling phenomenon, with the result that, inconveniently, simultaneous conversation is seriously impaired.

As a means to avoid the jamming of conversation due to the occurrence of such howling, there has been proposed the so-called one-way communicating device which is of the arrangement that a switch is provided in either of the pair of communicating instruments so that the caller manipulates this switch to keep the incoming voice-transmitting circuit in cutoff state during the period of time in which the caller is talking into his microphone to the person using the other one of said pair of instruments located at the other end of the line.

Also proposed is a system wherein the loud speakers of the calling-receiving instruments installed at both ends of the line are designed so as to produce voice in a volume which is small enough as would not be picked up by the microphone encased together with said microphone and would not cause any substantial amount of howling.

Still another attempt has been made to install the microphone as far apart from the loud speaker as possible within the casing of an instrument.

Also known is the system which is designed so that the microphone is shielded by a partition wall from the loud speaker within a casing.

However, said first counter-measure of the prior art is accompanied by the complexity that the caller is required to manipulate the switch of the instrument several times or even more frequently during one conversation to transmit his voice to his listener or recipient and also to receive the voice of said recipient (hereinafter to be also referred to as "addressee" as required). Moreover, the user may require some period of time before he acquires a good command of or the skill to properly operate the instrument.

Said second prior device has the disadvantage that the receiving person has to bring one of his ears quite close to the speaker of the instrument when he is receiving a message of the person talking into the microphone of the other one of the pair of instruments at the other end of the line, since the voice emitted from the loud speaker is very small.

The device referred to thirdly bears the inconvenience arising from the substantial distance provided between the location of the microphone and the location of the loud speaker, so that the user is required to move quickly from the position at which he has been receiving the message delivered from the person talking at the other end of the line over to the position at which the microphone is located so as to start talking into it at the end of the message transmitted from the person using the other one of the pair of instruments, and the user is again required to quickly return to his loud speaker at the end of his talking, covering a substantial distance between the microphone and the loud speaker.

The other conventional system has the shortcoming that the voice emitted from the loud speaker is not necessarily perfectly shielded from the microphone by the partition wall provided therewith.

In short, all of these prior devices have been worked out to cope with the phenomenon of howling only in an indirect and slowest way.

It is, therefore, the primary object of the present invention to provide a method for perfectly eliminating the occurrence of howling in simultaneous two-way communicating systems.

Another object of the present invention is to provide a method for eliminating howling that can be applied to both the system wherein a pair of transmitting-receiving instruments are connected by two wires and the system wherein they are connected by three wires.

Still another object of the present invention is to provide a howlingless simultaneous two-way communicating device wherein a pair of transmitting-receiving instruments can be connected by three wires.

A further object of the present invention is to provide a howlingless simultaneous two-way communicating device wherein a pair of transmitting-receiving instruments can be connected by two wires.

Other objects and attendant features of the present invention will become more apparent as the description of the invention proceeds in conjunction with the accompanying drawings, in which:

FIG. 1 is a schematic explanatory diagram illustrating the principle of the occurrence of howling in a conventional simultaneous two-way communicating device such as interphone unit;

FIG. 2 is a schematic explanatory diagram illustrating the basic principle on how the sound waves of the caller's voice emitted from the loud speaker of the recipient is prevented from entering into the amplifier located behind the microphone of the recipient after said sound waves have been picked up by said microphone in a howlingless simultaneous two-way communicating device;

FIG. 3 is a schematic diagram illustrating the features of the system of the present invention wherein each one of the pair of transmitting-receiving instruments comprises two microphones having the same or closely resembling characteristics and disposed in symmetrical relation to a microphone, and means are provided so as to be operative that the output signals deriving from the two microphones are supplied to their mating amplification circuits with the phase of the output signal from one of the microphones being shifted by 180° from the phase of the output signal from the other of the microphones so that both output signals are cancelled, whereby eliminating the occurrence of howling due to the entry into the microphones of the sound emitted from the loud speaker;

FIG. 4 shows an example of arrangement of microphones and a loud speaker, wherein two microphones having identical characteristics are disposed diametrically centering around a loud speaker, each of said microphones being installed at an angle of 45° relative to the loud speaker;

FIG. 5 is a schematic illustration, showing the manner in which one of a pair of transmitting-receiving instruments shown in FIG. 3 is used in effecting communication;

FIG. 6 is a schematic diagram showing a wiring plan used in the system of the present invention wherein a pair of transmitting-receiving instruments are connected by three wires; and

FIG. 7 is a schematic diagram showing a wiring plan used in the system of the present invention wherein a pair of transmitting-receiving instruments are connected by two wires and wherein there is provided the arrangement in FIG. 3 of two microphones, a loud speaker and input transformer, but said loud speaker is of double voice coils and two mating output transformers, so as to be operative that signal currents with inverted polarities relative to each other are passed from said output transformers to said double voice coils, respectively.

The present invention will hereinafter be described in detail by referring to the drawings.
In FIG. 1, A and B represent a pair of transmitting-receiving instruments, respectively, and they are connected by wires. In each of said transmitting-receiving instruments A and B, 1a and 1b represent microphones, respectively, while 2a and 2b represent loud speakers, respectively, and the reference marks 3a and 3b represent amplifiers, respectively.

Let us now assume that a person has initiated a call by talking into the microphone 1a of the transmitting-receiving instrument A. His voice, as an electric signal, will travel through the entire system in the following manner.

Initial signal—the microphone 1a on the A side—the amplifier 3a on the A side—the loud speaker 2b on the B (addresser) side—the microphone 1b on the B side—the amplifier 3b on the B side—the speaker 2a on the A (addresser) side

In this manner, the caller will hear his own voice returning after travelling through the entire system. This returning voice will again enter the microphone 1a on the A caller's side to be picked up thereby and, as a result, the aforesaid circulation of voice will be repeated. Thus, an indefinite signal amplification system is formed. Therefore, the moment the user has manipulated the power switch to "on," there will occur a screeching sound or the howling phenomenon.

Each obstruction of such obstructions of communication in a simultaneous communicating device will materialize only if, as shown in principle in FIG. 2, means are provided at either P or Q to insure the following action of the transmitting-receiving instruments at both A and B, namely, the signal transmitted through the microphone of one of the instruments will be amplified to actuate the loud speaker of the other of the instruments to transmit the voice, without a part of the voice being picked up by the microphone of said other of the instruments to be amplified by the amplifier of said other of the instruments.

The howling elimination system used in the simultaneous two-way communicating device according to the present invention is characterized by the arrangement that in each of a pair of transmitting-receiving instruments, two microphones are disposed in both electrically and geometrically symmetric relation relative to a loud speaker and that the input signals corresponding to the portions of the voice emitted from the loud speaker and picked up by these two microphones are inverted of their phases by the input transformers of these microphones.

This will be described in further detail by referring to the drawings. FIG. 3 is a schematic explanatory illustration of the transmitting-receiving instrument on the A side according to the system of the present invention (the instrument on the B side is identical in construction with that of the A side). In FIG. 3, reference marks 1a-1 and 1a-2 represent microphones having identical or relatively similar characteristics. These microphones are disposed in electrically and geometrically symmetric relation relative to the loud speaker 2a. This relative arrangement of the microphones and the loud speaker insures that the microphones receive the same influence of the voice transmitted from the B side, that is to say, with respect to the loudness of the voice, the phase of the oscillatory waves of the air, and reverberation time, for example.

Reference marks 4a-1 and 4a-2 represent input transformers having nearly identical characteristics and being adapted to supply signals derived from their secondary sides to the amplifier 3a in such manner that the phases of the signals are shifted by 180° relative to each other.

This provision of the input transformers works so that the input signals are cancelled by virtue of the mutual differential actions of said transformers, whereby the voice of the other party which is emitted from the loud speaker 2a and which has been received by the microphones 1a-1 and 1a-2 as their inputs will bear an effect on the amplifier 3a as if no signal has been applied to said amplifier, and thus there is obtained the action at Q as has been discussed in connection with FIG. 2.

According to the experiments conducted by the inventor, it has been found that where the microphones 1a-1 and 1a-2 are disposed at 45° relative to the loud speaker 2a as shown in FIG. 4, each of the two microphones 1a-1 and 1a-2 can be subjected to an exactly identical influence of the sound emitted from the loud speaker 2a within a relatively narrow space.

In order to converse through a device embodying the system of the present invention, the caller talks into either one of the microphones 1a-1 and 1a-2 in a manner as shown in FIG. 5 (in the drawing, the caller is shown talking into the microphone 1a-1). It is needless to say that he microphone 1a-1 receives the signal of the voice of the caller, but the other microphone 1a-2 also receives a signal which is much weaker than that received by the microphone 1a-1.

However, the amplifier 3a is adapted to properly amplify only the amount of difference between these two signals which are derived from the two microphones with different intensities relative to each other. Therefore, by using microphones having an appropriate sensitivity and an amplifier with an appropriate gain, the voice of the addressee emitted from the loud speaker 2a is not applied to the amplifier 3a as an input signal, but instead, the voice of the caller who is talking to either one of the two microphones is applied to the amplifier 3a as a signal. FIG. 6 shows a simultaneous communicating device according to the present invention where a pair of transmitting-receiving instruments are connected by three wires. It is to be noted that, in this drawing, all of the essential constituents of the transmitting-receiving instrument on the B side are mentioned, whereas only a loud speaker 2a and an input transformer 5a are illustrated. By arranging that the voice of the caller transmitted from the A side of the system and emitted from the loud speaker 2b is equally received by the microphones 1b-1 and 1b-2 of an appropriate type such as the crystal-type, that the signals derived from the microphones are inverted of their phases by their mating input transformers 4b-1 and 4b-2 and that the intensity of these signals are adjusted by the variable resistors connected to the secondary sides of the respective input transformers, there is generated, in the first stage transformer of the amplifier, no input due to said voice emitted from the loud speaker 2a. However, when the addressee talks into one of the two microphones 1b-1 and 1b-2, his voice after being amplified by the amplifier 3b, is emitted from the loud speaker 2a on the A side. In this manner, simultaneous two-way communication without the accomplishment of howling is attained. In the drawing, reference mark 6b represents a battery which serves as the power source, and reference mark 7b represents a switch.

FIG. 7 shows another embodiment of the simultaneous two-way communicating device according to the present invention wherein each of the transmitting-receiving instruments comprises a loud speaker, two microphones and their mating two input transformers, but said loud speaker has double voice coils. There are also provided two output transformers. This drawing illustrates the wiring plan which is adapted to work in such manner that the signal currents having inverted polarities are passed from said output transformers to said double voice coils, respectively. More specifically, two input transformers 4b-1 and 4b-2 are connected to the two microphones which may be either the crystal-type or the dynamic-type in such manner that said transformers are disposed in sequential relation so as to follow the microphones 1b-1 and 1b-2. On the other hand, the movable contacts of the variable resistors connected, as a load, to the secondary coils of these two input transformers are connected to the gates of the first stage transistors of the push-pull type amplifier, respectively.
The amplifier 3b comprises several stages of amplification circuits and its final stage circuits are connected to the primary coils of two output transformers 5b-1 and 5b-2 which are identical in both the shape and the size.

The loud speaker 2b disposed exactly midway between the two microphones 1b-1 and 1b-2 is provided with two voice coils 9b-1 and 9b-2 having inverted polarities relative to each other. Said voice coils are connected to the secondary coils 8b-1 and 8b-2 of the aforesaid output transformer 5b-1 and 5b-2, respectively.

Description has been directed to the structure and the wiring plan of the transmitting-receiving instrument on the B side. It is to be noted that exactly the same is applied to the transmitting-receiving instrument on the A side. One 9a-2 of the voice coils of one 2a of a pair of loud speakers is connected by two transmitting wires to one 9b-2 of the voice coils of the other 2b of the pair of loud speakers.

In the aforesaid structure and wiring plan of the transmitting-receiving instruments, the signals of the voice of the addressee which, after passing through the amplifier 3b, are derived from the secondary coils 8a-1 and 8a-2 of the output transformers 5a-1 and 5a-2 are identical in size relative to each other. However, owing to the fact that the loud speaker 2b on the addressee's side is provided with double voice coils 9b-1 and 9b-2 having inverted polarities relative to each other, said two signals cancel each other so that, as a result, no sound is emitted from the loud speaker on the addressee's side.

The output signal of the secondary coil 8b-2 of the output transformer 5b-2 is passed, through the two transmitting wires, to only the voice coil 9a-2 of the loud speaker 2a on the addressee's or the A side, and as a result, the loud speaker 2a is actuated to transmit the message dispatched by the addressee on the B side to the addressee on the A side.

In the manner as has been described, the message dispatched at the A side is transmitted with a clearly audible sound, after passing through one of the two output transformers on the A side and via the two transmitting wires, to the recipient from the loud speaker 2b on the B side. Likewise, the message delivered at the B side is transmitted with a clearly audible sound, after passing through one of the two output transformers on the B side and via the same two wires, to the recipient on the A side from the loud speaker 2a on the A side. Thus, a simultaneous two-way communication without howling is obtained.

As has been described, the howling elimination system of the present invention is drastically effective since this invention has been developed based on the research of the principle of the development of howling. The simultaneous two-way communicating devices embodying the present invention are simple in structure and substantially free from the occurrence of disorder, and thus they are of great utility values. It is to be noted, however, that the howling elimination system of the present invention can be applied also to a system wherein the pair of transmitting-receiving instruments are connected by four or more wires and also that various modifications of the invention can be made easily by those skilled in the art without departing from the spirit of the present invention.

I claim:

1. A circuit for preventing feedback howling in a two-way communicating system comprising, a pair of transmitting receiving instruments, each instrument having a loudspeaker and two microphones disposed in equal spaced relation to said loudspeaker, each of said loudspeakers having double voice coils and two output transformers, each microphone being connected to input transformer means, one of said input transformers having means adapted to shift an input signal by 180° so that equal signals from each transformer cancel each other out, said input transformers being connected to an amplifier which in turn is connected to the loudspeaker in the other instrument and said pair of instruments being connected by two wires, whereby feedback howling is eliminated in both instruments during two-way communication.

2. A circuit for preventing feedback howling in a two-way communicating system comprising, a pair of transmitting receiving instruments, each instrument having a loudspeaker and two microphones disposed in equal spaced relation to said loudspeaker, each microphone being connected to input transformer means, one of said input transformers having means adapted to shift an input signal by 180° so that equal signals from each transformer cancel each other out, said input transformers being connected to an amplifier which in turn is connected to the loudspeaker in the other instrument, said amplifiers including output transformers with the secondary coils of said output transformers being connected to the loudspeaker in the other instrument by three wires, whereby feedback howling is eliminated in both instruments during two-way communication.