

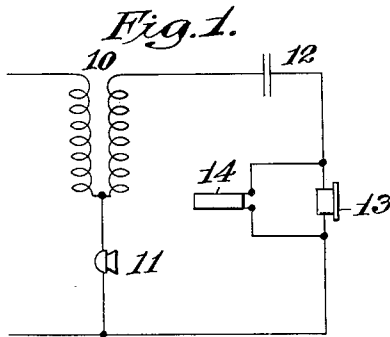
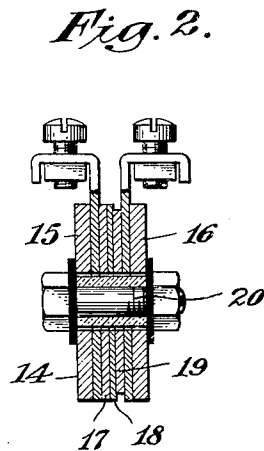
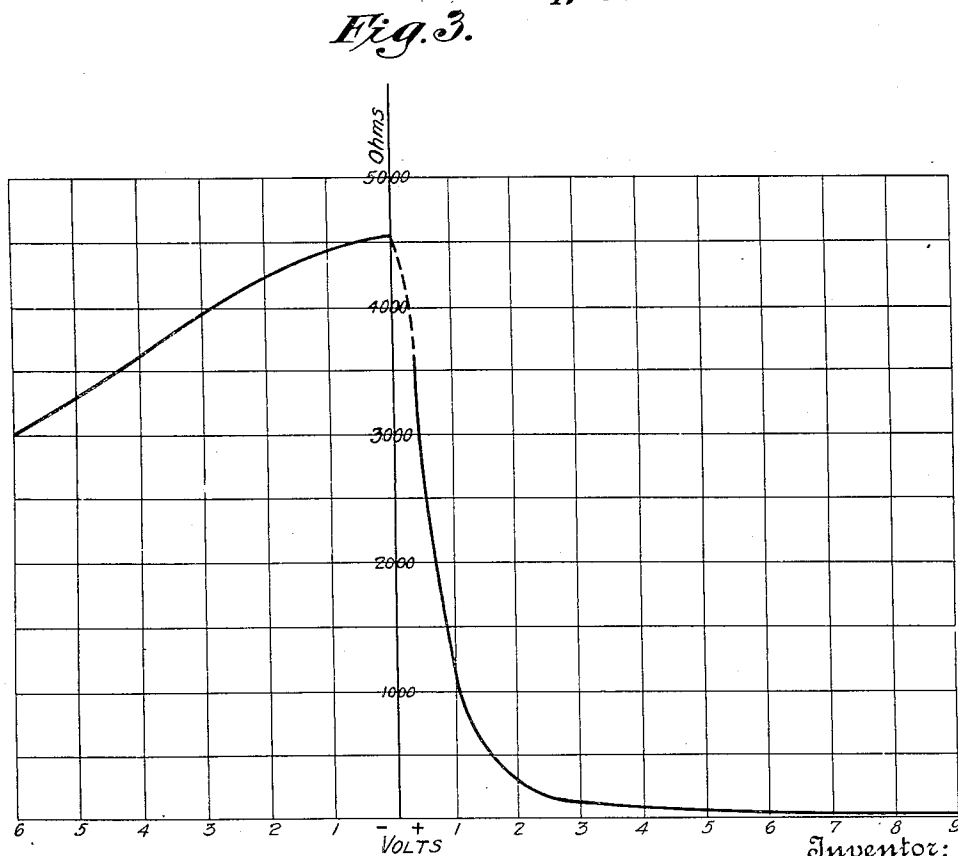
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MEANS FOR PREVENTING ACOUSTIC SHOCK FROM A TELEPHONE RECEIVER

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MEANS FOR PREVENTING ACOUSTIC SHOCK FROM A TELEPHONE RECEIVER

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This invention relates to safeguards for telephone receivers and has for its object to provide a simple and inexpensive means to eliminate the hazard of acoustic shock.

Inductive disturbances in telephone lines are sometimes so serious as to produce what is called "acoustic shock." This is a loud noise comparable to a gun being shot off close to the ear and is thought to be caused by the receiver diaphragm hitting the pole pieces. Telephone operators have been rendered unconscious from such a shock. The most frequent cause of such serious inductive disturbance is a powerful surge such as may be caused by a short circuit in a power transmission line located close to a telephone line or by lightning.

There has been considerable investigation of means for eliminating this difficulty but nothing has previously been discovered which is both effective and sufficiently inexpensive to be practicable. One suggestion was the bridging of a carborundum crystal across the telephone line but this was not successful because the characteristics of such crystals were not permanent nor reliable nor were they adapted to carry the currents to which they would have to be subjected without breaking down. Another disadvantage was that the subjection of such crystal to the telephone line pressure of about twenty odd volts caused continuous current flow through them which soon resulted in evidence of instability of the crystals. A more efficient and reliable suggestion involved the use of a vacuum tube in the receiver circuit connected for use as an ordinary amplifier in series with the receiver. The trouble with such an expedient is the expense and the necessity for inspection and renewal due to current consumption in the filament.

According to this invention a contact rectifier of the copper oxide-lead type is shunted across a telephone receiver and preferably connected so that the rectifier offers minimum resistance to that half cycle of current whose magnetomotive force adds to the permanent magnet magnetomotive force to attract the diaphragm toward the receiver pole pieces, if only one unit is used.

Referring to the drawings, Fig. 1 is a wiring diagram of this invention;

Fig. 2 is a longitudinal section through the copper oxide rectifier;

Fig. 3 is a typical ohmic resistance-voltage characteristic for a copper oxide rectifier.

An ordinary telephone circuit is shown in Fig. 1 comprising the usual transformer 10, transmitter 11, condenser 12 connected in series with the receiver 13. Unlike the usual telephone circuit this invention includes a copper oxide rectifier 14 connected in shunt with the receiver 13. In practice the rectifier 14 would preferably be located in the usual coil box adjacent the receiver or wherever convenient. The copper oxide rectifier is of the general type described by L. O. Grondahl and P. H. Geiger in the Journal of the American Institute of Electrical Engineers for March, 1927, except that those rectifiers having voltage-resistance characteristics given in that article are not as suitable as those having such characteristics similar to Fig. 3 of the drawing herein.

Fig. 2 shows a typical construction for such a rectifier and comprises clamping washers 15 and 16 pressing the oxide filament 18 on a copper plate 17 against a sheet of lead 19, the washers and plates being clamped together by a bolt 20 and suitably insulated so that the voltage across the terminals of the rectifier is placed across the oxide layer.

Fig. 3 shows a typical resistance-voltage characteristic for the copper oxide rectifier. As the condenser 12 in the usual telephone circuit prevents the passage of direct currents through the receiver the only normal voltage across the receiver is the very small pressure of generally less than .01 volts due to the audio frequencies passing the condenser 12. From Fig. 3 it will be seen that the resistance of the copper oxide rectifier at these small voltages is enormously high compared with the resistance of the ordinary telephone receiver, such receiver generally being about 70 ohms. The exact amount of pressure across a telephone receiver at the time of acoustic shock is not known but authorities believe it to be between about 10 or 20 volts or possibly less. Fig. 3 shows how with increased voltage the

resistance of the copper oxide rectifier rapidly decreases to an amount below the resistance of the receiver. The specimen tested and used for plotting the curve shown in Fig. 3 had a resistance of about 20 ohms with direct current at 10 volts. At such pressures therefore the major portion of current would pass through the rectifier and not through the receiver. The rectifier is preferably connected so that it offers minimum resistance to that half cycle of current whose magneto motive force adds to the permanent magnet magneto motive force to attract the diaphragm toward the pole pieces. In other words, it is desirable to connect the rectifier so that its minimum resistance allows most of the current to pass through the rectifier and reduce the likelihood of the diaphragm hitting the pole pieces in the receiver. To ascertain the proper way for connecting the rectifier, either the direction of the windings on the pole pieces are traced out or a test may be used to ascertain which manner of connection for the rectifier gives least shock in the receiver on the application of much higher than normal operating voltage.

All copper oxide rectifiers will not be found alike in their resistance voltage characteristics so that it will be found desirable to test each specimen before being embodied in a telephone circuit. Some copper oxide rectifiers have the peak resistance on the left of and farther away from zero voltage than does the specimen whose characteristic is shown in Fig. 3. Others will be found to have a much less steep resistance gradient. The desirable rectifier should have say 8 or 10 times the resistance of the receiver for normal operating conditions and a sharp decrease in resistance for voltages above normal. If it is desired to use the copper oxide rectifier with telephone receivers of much higher than ordinary resistance, such as are used in radio work for example, it is desirable that the rectifier be of correspondingly higher resistance. To increase the resistance of the rectifier the simplest way is to reduce the effective contact area of the lead plate. Another way to increase the rectifier resistance is to add several rectifiers in series, but for this purpose it is desirable that the resistance-voltage characteristics of each be of similar shape. Referring to Fig. 3 the dotted line portion of the graph was not determined by test. From this figure it will be seen that the resistance of the rectifier element has decreased rapidly with increased voltage.

The rectifier unit shunted around the receiver functions as an instantaneous pressure responsive relief valve to allow the shock creating currents to by-pass the receiver yet offers sufficiently high resistance to the passage of any current under normal operating conditions so as not to affect the successful operation of the receiver. This shunt device has the

additional advantage of being rugged and relatively permanent in its resistance characteristic while at the same time of sufficient current carrying capacity to be reliable. It has under test withstood currents of greater magnitude than would be encountered in an acoustic shock from any 60 cycle inductive disturbance without breaking down. In case of disturbances from higher frequencies it has the advantage of being substantially non-inductive compared with a telephone receiver so that with such higher frequencies it is better in its function as a by-pass valve. A copper oxide rectifier having roughly about two square centimeters effective lead plate contact area did not break down until under 1.7 amperes which exceeds the severe acoustic shock conditions.

While Fig. 2 shows only a single unit for use across the receiver it is desirable for maximum protection to have at least two rectifier units in parallel and both shunted across the receiver and oppositely arranged so as to offer the minimum resistance to surges in either direction. This last gives more protection and while slightly more expensive than a single unit is nevertheless believed to be desirable.

The current carrying capacity depends on the effective contact area and also upon the dissemination of heat losses in the rectifier.

The term "telephone receiver" as used herein signifies in its broader aspect an audio electric converter for any use and not merely one restricted to telephone practice.

I claim:

1. The combination with a telephone receiver, of a copper oxide rectifier in shunt with the receiver.

2. The combination with a telephone receiver having a diaphragm and permanent magnet, of a copper oxide rectifier shunted across the receiver and arranged to offer minimum resistance to the component of currents larger than normal operating currents whose direction is such that its magneto motive force adds to the permanent magnet magneto motive force to attract the diaphragm toward the permanent magnet.

3. The combination with a telephone receiver, of a stable, solid rectifying device in shunt with the receiver adapted to safely carry currents under an applied electromotive force of 20 volts and having a decreasing resistance with an increase in impressed voltage from below one volt, the resistance of said device being proportional to its effective contact area.

4. The combination with a telephone receiver, of means for reducing the hazard of acoustic shock comprising a copper oxide rectifier in shunt with said telephone receiver, said rectifier having its maximum resistance under an impressed electromotive force of less than one volt.

5. The combination with a telephone receiver, of means for reducing the hazard of acoustic shock comprising a copper oxide rectifier in shunt with said telephone receiver, said rectifier having a resistance-voltage characteristic with at least a major portion of its steeper gradient in resistance on the opposite side of the zero voltage line from the major portion of its less steep resistance gradient from its maximum.

6. The combination with a telephone receiver, of means for reducing the hazard of acoustic shock comprising a rectifier in shunt with said telephone receiver, said rectifier being of the static or contact type without moving parts, having a resistance of more than eight times the receiver resistance under normal operating conditions, substantially less than the receiver resistance under ten volts, having a steeper resistance gradient under less than two volts than a carborundum rectifier, and having a resistance which varies substantially directly with the area of contact and which is fixed and reliable.

In witness whereof I have hereunto set my hand this 7th day of April, 1928.

EDWARD C. PRITCHETT.