Feb. 13, 1940. A. F. BENNETT 2,190,466

TELEPHONE SUBSTATION APPARATUS

Filed Oct. 8, 1937

FIG. 1

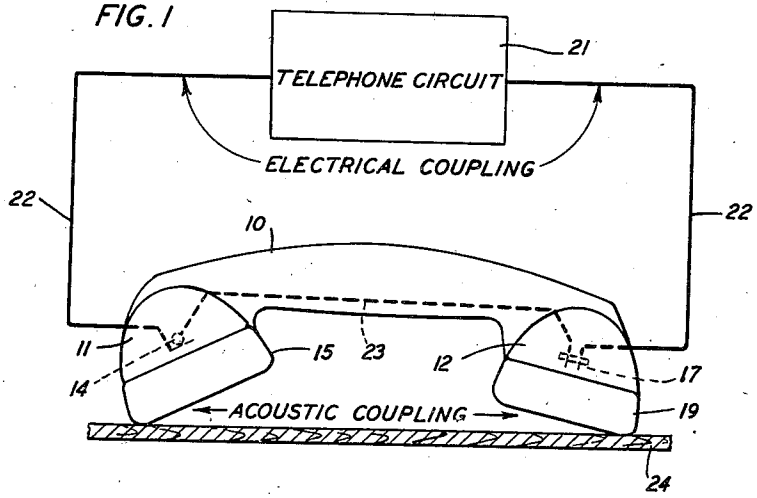


FIG. 2

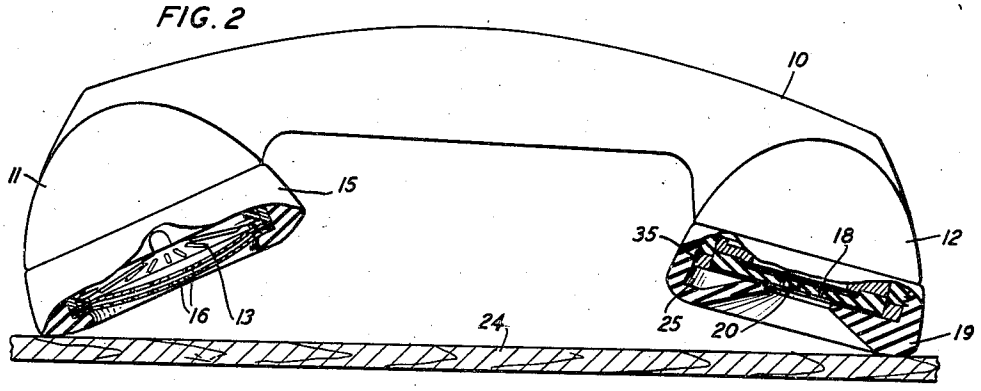


FIG. 3

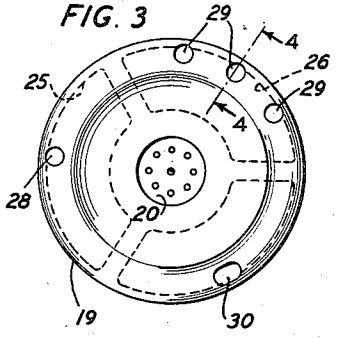


FIG. 4

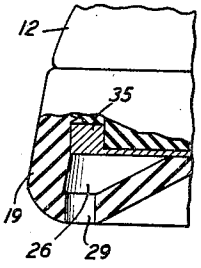


FIG. 5

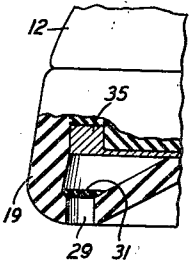
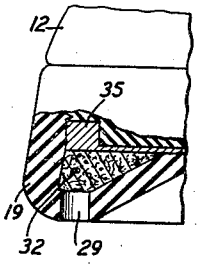


FIG. 6



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2,190,466

TELEPHONE SUBSTATION APPARATUS

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Application October 8, 1937, Serial No. 167,894

12 Claims. (Cl. 179—103)

This invention relates to telephone substation apparatus and more particularly to telephone handsets.

Telephone handsets, as is known, usually comprise a handle, a transmitter mounted at one end of the handle and a receiver mounted at the other end of the handle, the cap or ear-piece of the receiver and the cap or mouthpiece of the transmitter being inclined toward each other. During the use of the telephone handset in the course of a telephone call, it frequently occurs that the user places the handset upon a surface, such as the top of a table or desk, so that the transmitter and receiver are in proximity to such surface and a relatively close acoustic coupling between the diaphragms thereof occurs. As a result of such coupling, an electro-acoustic circuit is completed including the receiver, the transmitter, the telephone line, and the confined air path between the transmitter and receiver diaphragms. This circuit inherently has a resonance frequency which may be within the audio-frequency range. Consequently, when the telephone handset is placed upon a surface as above described, highly objectionable howling or singing may occur and a sharp tone may be produced in the receiver.

One object of this invention is to prevent or substantially reduce howling or singing in telephone apparatus when the handset is placed upon a surface such as the top of a table or desk.

In accordance with one feature of this invention, means are provided in the telephone handset for reducing the sound field pressure adjacent the transmitter or receiver diaphragms or both so that when the handset is placed on a desk or the like, the acoustic coupling between the transmitter and receiver is reduced and the tendency for the apparatus to howl or sing is minimized.

In one illustrative embodiment of this invention, the receiver ear-piece or cap or the transmitter mouthpiece or cap, or both, is provided with one or more cavities each communicating with the atmosphere through a restricted aperture. The cavities and the associated apertures are so designed that they constitute resonators resonant, preferably somewhat broadly, at definite frequencies of the order of the howling frequency which normally would be produced. The resonators absorb energy from the sound field between the diaphragms of the transmitter and receiver and thereby reduce the sound field pressures at the diaphragms so that the acoustic coupling between the transmitter and receiver is greatly reduced.

The invention and the foregoing and other features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawing in which:

Fig. 1 is a view, partly diagrammatic and partly schematic, illustrating the couplings between the transmitter and receiver of a telephone handset;

Fig. 2 is a side view, partly in section, of a telephone handset constructed in accordance with this invention;

Fig. 3 is a front view of the receiver portion of the handset shown in Fig. 2;

Fig. 4 is an enlarged view in section along line 4—4 of Fig. 3 illustrating the configuration of one of the cavities and the aperture associated therewith in the cap or ear-piece of the receiver; and

Figs. 5 and 6 are enlarged detail views similar to Fig. 4 illustrating modifications of the embodiment of the invention shown in Figs. 2 to 4.

Referring now to the drawing, the telephone handset comprises a support including a handle 10, a transmitter portion 11 at one end of the handle and a receiver portion 12 at the other end of the handle, each of the portions having a cavity therein for receiving a telephone instrument, such as a transmitter and receiver respectively. The transmitter and receiver may be of any of known types and are disposed at angles to the handle 10. For example, the transmitter may include a transmitter unit of the general construction disclosed in Patent 2,042,822 granted June 2, 1936 to me and William L. Tuffnell and comprising a diaphragm 13 and a carbon granule element 14, the unit being held in place by a centrally apertured clamping member, mouthpiece or cap 15, inclined toward the receiver 12. The diaphragm 13 may have in front thereof a pair of protective grills or screens 16.

The receiver may include a unit of the general construction disclosed in the application of Louis A. Morrison and Edward E. Mott, Serial No. 93,792, filed August 1, 1936, and comprising an electromagnetic element 17 and a magnetic diaphragm 18 associated with the electromagnetic element. The receiver unit may be mounted in position by a clamping member, cap or ear-piece having a relatively thick outer portion 19 and a central grid portion 20 opposite the diaphragm 18.

As indicated schematically in Fig. 1, when the handset is in use, the transmitter and receiver are connected to a telephone circuit 21 and to one another by conductors 22 and 23. When the handset is being used, it often occurs during the course of the telephone conversation that the user places the handset upon a support 24, such as a shelf or the top of a table or desk. Fre-

quently, the handset is placed upon such a support with the receiver and transmitter face down as shown in Fig. 1. When the handset is placed upon the support **24**, as will be apparent, relatively close acoustic coupling is established between the transmitter and receiver so that an electro-acoustic circuit is completed between the transmitter and receiver through the telephone circuit and the air space between the diaphragms **13** and **18**. This circuit will be resonant at a particular frequency so that upon placement of the handset upon the support **24** a sustained and highly objectionable howling tone may be produced in the electro-acoustic circuit and an acoustic shock will be produced in the receiver at the subscriber's or other station to which the telephone line is connected.

Under the conditions set forth above, the receiver unit acts as a small loud-speaker generating pressure waves which are propagated to the diaphragm **13** of the transmitter through the sound field between the diaphragms **13** and **18**. The magnitude of the pressure waves impinging upon the diaphragm **13** of the transmitter will determine to a large measure the intensity of the howling tone produced. The intensity or magnitude of these waves in turn is dependent largely upon the efficiency with which waves emanating from the receiver diaphragm **18** are transmitted to the transmitter diaphragm **13**.

In accordance with a feature of this invention, means are provided for introducing relatively large losses in the portion of the electro-acoustic system acoustically coupling the receiver and transmitter diaphragms so that a very poor acoustic coupling between the receiver and transmitter results. These losses may be sufficiently great, with respect to the gains in the circuit produced by the transmitter and the amplifiers in the transmission line, to prevent the generation of objectionable oscillations in the electro-acoustic circuit or may be of sufficient magnitude to minimize the production of objectionable pressure waves adjacent the transmitter diaphragm **13**.

In one illustrative embodiment of this invention, the outer portion **19** of the receiver cap or ear-piece is provided with a plurality of generally sectoral or arcuate chambers or cavities **25**, **26** and **27**, which communicate with the sound field between the receiver and transmitter through apertures **28**, **29** and **30** respectively extending through the face of the outer portion **19** adjacent the periphery thereof. The cavities may be formed in part by a metallic or other disc **35**. Each of the chambers and its associated aperture or orifice constitutes a resonator, the resonant or natural frequency of which is dependent upon the dimensions of the chamber and aperture or orifice and may be ascertained by the formula

$$F_0=\frac{C}{2\pi}\sqrt{\frac{K}{V_0}}$$

where

F_0 is the natural frequency,

C is the velocity of sound in air,

K is the ratio $\frac{(A)}{(L)}$ of the area (A) of the aperture or orifice to the effective length (L) thereof, and

V_0 is the volume of the chamber or cavity.

It has been found that the several cavities have the greatest effect in reducing the howling tendency when the orifices thereof are removed or angularly displaced from the points of the cap or ear-piece **19** nearest to and farthest away from the transmitter. Preferably, as indicated in Fig. 3, the aperture or orifice **28** is displaced somewhat from the diameter of the ear-piece or cap **19** in alignment with the longitudinal axis of the handle **10**, and the aperture **30** and the center one of the apertures **29** are at approximately 120 degrees from the aperture **28**.

It will be appreciated that the frequency of the howling tone is dependent upon the constants of the electro-acoustic circuit coupling the receiver and transmitter and that the constants of the acoustic portion of this circuit may vary over fairly wire ranges depending, for example, upon the character of the support **24** and the position of the handset thereon. Hence, to reduce or suppress the howling tendency for substantially all conditions, the several resonators preferably are designed to have different natural frequencies. For example, in a specific instance it was found that when a handset was placed in the face down position upon a hard surface support, which position represents that at which the howling tendency is the greatest, the three cavities **25**, **26** and **27** and the openings **28**, **29** and **30** associated therewith were particularly effective when designed to have natural frequencies of 2200, 2500 and 2800 cycles per second, respectively. The several cavities may be of equal volumes and the orifices of equal lengths but different areas to provide the different natural periods.

Each of the resonators, it will be appreciated, absorbs energy from the sound field adjacent the receiver so that a poor acoustic coupling between the transmitter results with a consequent reduction in the sound field pressure in the vicinity of the diaphragm **13** of the transmitter. If desired, as shown in Figs. 5 and 6, the energy absorption by the resonators may be increased by placing a resistance element **31** (Fig. 5) such as a silk sheet across the openings **28**, **29** and **30** or providing a resistance element **32** (Fig. 6), such as loose fibrous material, in the cavities or chambers **25**, **26** and **27**.

It may be noted that during use of the telephone handset, the several resonators are not in communication with the sound path between the receiver diaphragm **18** and the ear of the user and, therefore, do not affect the reception or transmission of speech.

Although in the specific embodiment shown and described, energy absorbing resonators have been provided in the receiver cap or ear-piece **19**, such resonators may be provided in the mouthpiece or cap **15** for the transmitter. Also such resonators may be provided in both the ear-piece **19** and mouthpiece **15**. Furthermore, it will be understood that various modifications may be made in the embodiment herein shown and described without departing from the scope and spirit of this invention as defined in the appended claims.

What is claimed is:

1. A telephone handset comprising a support, a transmitter and a receiver mounted in spaced relation on said support and having diaphragms facing in substantially the same direction, and resonant means for absorbing energy from the sound field between said transmitter and said receiver, said resonant means having a natural frequency within the range of frequencies to be translated by said transmitter and receiver.

2. A telephone handset comprising a support, and a transmitter and a receiver mounted on said support and facing in the same general di-

rection whereby a close acoustic coupling obtains between said transmitter and receiver when said handset is placed upon a support with said transmitter and receiver in proximity thereto, said handset containing an air chamber having a restricted opening facing in said direction whereby said chamber is coupled to the sound field between said transmitter and receiver, the air chamber and opening being of predetermined dimensions to constitute a resonator resonating at a preassigned frequency within the range of frequencies to be translated by said transmitter and receiver.

3. A telephone handset as claimed in claim 2 in which said handset contains a plurality of resonators each having a different natural frequency within said range.

4. A telephone handset as claimed in claim 2 in which said resonator is located at the receiver end of said handset.

5. A telephone handset comprising a transmitter, a receiver, a unitary support for said transmitter and receiver including a hand grip portion separating said transmitter and receiver, said handset having a tendency to howl while in use under certain conditions, and resonator means in said handset to substantially suppress such tendency.

6. A telephone handset comprising a receiver, a transmitter, an elongated unitary support, said support having a cavity at each end to receive said receiver and said transmitter, and centrally apertured clamping members for securing the receiver and the transmitter in their respective cavities, said members overlying the diaphragms of said receiver and transmitter and one of said members containing a plurality of air chambers connecting with the outside air through restricted openings in the outer surface of the clamping member, said chambers and openings being constructed to resonate at frequencies in the range to be translated by the telephone handset.

7. A telephone handset as claimed in claim 6 in which each air chamber and its associated restricted opening resonates at a different frequency.

8. A telephone handset as claimed in claim 6 in which said member is a receiver clamping member and said restricted openings are located at points on said member removed from the portions nearest or farthest from the transmitter.

9. An electro-acoustic system including a telephone handset comprising a handle, a transmitter at one end of said handle, a receiver at the other end of said handle, said transmitter and receiver being inclined toward one another, and an acoustic resonator in communication with the sound field between said transmitter and said receiver and having a natural period approximately equal to the resonant frequency of said system when said handset is placed upon a support with the transmitter and receiver facing and adjacent said support and acoustically coupled through the atmosphere.

10. An electro-acoustic system including a telephone handset comprising a handle, a transmitter at one end of said handle, a receiver at the other end of said handle, said transmitter and said receiver being inclined toward each other, and a plurality of resonators in communication with the sound field between said transmitter and said receiver, said resonators having different natural periods each of which is approximately equal to the resonant frequency of said system when said handset is placed upon a surface with the transmitter and receiver in face to face relation therewith.

11. A telephone handset comprising a handle, a transmitter at one end of said handle, a receiver at the other end of said handle, an ear-piece for said receiver, and a plurality of resonators having natural periods within the audio frequency range, defined by arcuate cavities in said ear-piece having restricted orifices extending therefrom.

12. A telephone handset in accordance with claim 11 wherein said cavities are of substantially equal volume and said orifices are of substantially the same length and of different areas.

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