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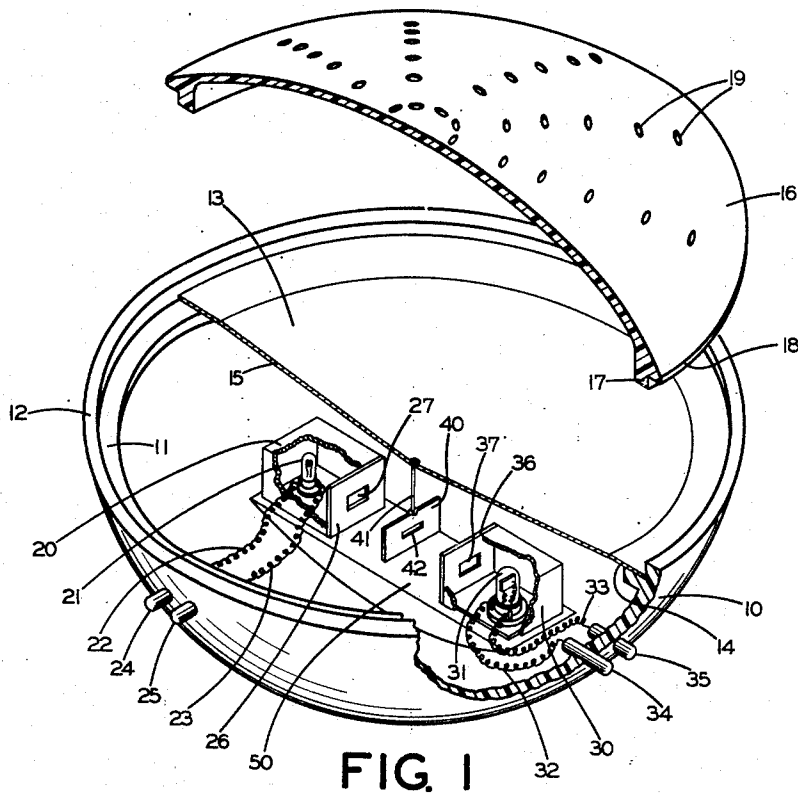


FIG. 1

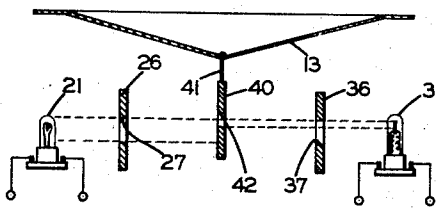


FIG. 2

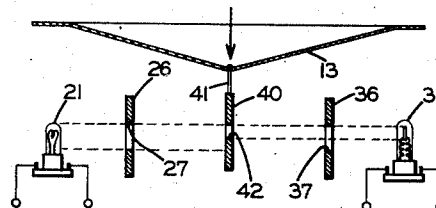


FIG. 3

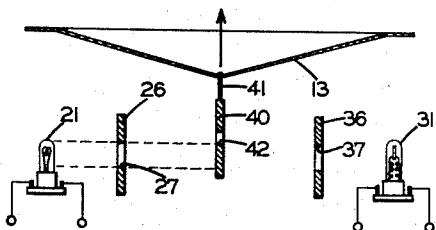


FIG. 4

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This invention relates to a voice peak-clipping microphone.

While not true of music and other sound signals generally, voice signals have the peculiar characteristic that they contain relatively high amplitude peaks of small sound energy content which for any particular voice predominate in either the positive or negative half cycles. These voice peaks may be eliminated without any apparent distortion in the speech signal. The desirability of eliminating such voice peaks is recognized, particularly in radio communication equipment intended substantially solely for voice communication, such as military communication equipment, radio dispatching systems for taxicabs and the like. In all such voice communication systems, it is desirable to bring the voice volume up to the highest practicable level, without distorting the voice signals excessively, by maintaining as high as possible an average percentage modulation of the carrier by the voice signal. This, of course, requires the elimination of voice signal peaks. For the accomplishment of this end, it is currently the general practice to incorporate signal peak limiting devices in the speech amplifier equipment associated with the microphone. This adds to the complexity and expense of such amplifier equipment. It is the purpose of the present invention to avoid such complications by the provision of a microphone which has an inherent voice signal peak limiting characteristic, thereby obviating the need for providing a special peak limiting arrangement in the amplifier.

Another desirable performance characteristic of voice communication equipment is the elimination of low-level background noise. Accordingly, it would be advantageous to incorporate such a low-level noise elimination function in the microphone itself.

The present invention is directed to a microphone capable of eliminating voice signal peaks and also capable of eliminating low-level background noise.

Accordingly, it is an object of the present invention to provide a novel and improved voice microphone.

It is also an object of this invention to provide a novel voice microphone capable of eliminating voice signal amplitude peaks.

Another object of this invention is to provide a novel voice microphone capable of eliminating low-level background noise.

A further object of this invention is to provide a novel microphone which operates on the principle of modulating a light beam in response to the sound signals to control the impingement of the light beam on a photoelectrically responsive device which determines the output signal from the microphone.

The foregoing objects, as well as such other and further objects of the present invention as may become apparent hereinafter, may be accomplished in an effective manner by the specific presently-preferred embodiment of this invention illustrated in the accompanying drawing and described in the following detailed description.

In the drawing:

Fig. 1 is an exploded perspective view, with parts broken away for clarity, showing the microphone of the present invention.

Fig. 2 is a fragmentary schematic section taken longitudinally through the microphone and illustrating the position of the parts when the microphone diaphragm is in its normal static position, unactuated by sound waves;

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Fig. 3 is a view similar to Fig. 2 and showing the position of the parts as the diaphragm moves inwardly under the influence of speech sound waves; and

Fig. 4 is a view similar to Fig. 2 and shows the position of the parts upon the return movement of the diaphragm as it vibrates under the influence of speech sound waves.

Referring first to Fig. 1, the present microphone may be incorporated in a housing which includes a bowl-shaped base 10 formed with an annular internally protruding flange or shoulder 11 disposed a short distance below the top edge 12 of the base. This flange 11 provides a seat for the circular periphery of a resilient flexible diaphragm 13 of conventional design which may be of aluminum, fiber, or any other material suitable for this purpose. Preferably the diaphragm 13 has a marginal, annular, coplanar mounting segment 14 entirely around its periphery which seats on the flange 11 and extends a slight distance inward therefrom. This peripheral annular mounting portion 14 on the diaphragm provides a rigid support for the conical middle segment 15 of the diaphragm which is preformed to extend at its middle down below the annular mounting portion 14. The diaphragm is clamped on the housing base 10 by means of a top cover 16 of shallow bowl-shaped configuration.

The top cover 16 is formed with a depending annular flange 17 spaced a short distance inward from the peripheral edge 18 of the top cover so as to overlie the base flange 11 when the parts are assembled to clamp the diaphragm 13 securely in place. The top cover 16 is formed with a plurality of perforations 19 for passing the voice signals to impinge on the diaphragm. The housing base 10 and the top cover 16 may be of any suitable material, such as Bakelite, and may be secured together in assembled relation, as described, in any suitable manner.

Below the diaphragm 13 the base 10 rigidly supports an enclosure 20 of opaque material in which is mounted a suitable light source, such as a lamp 21 which is energized from a suitable electrical power source through conductors 22, 23 connected to terminals 24 and 25, respectively, which project through the side wall of the housing base 10. The light source is positioned at one side of the center of the diaphragm. The enclosure 20 for the light source is formed with an opaque front wall 26 formed with a rectangular slot 27 in alignment with the light source 21 to pass a beam of light below the diaphragm 13 in a direction diametrically thereacross. Obviously, the depth and width of this beam of light is determined by the size of the slot 27.

At the opposite side of the center of the diaphragm and directly in line with the light source there is provided an opaque enclosure 30 in which is mounted a photoelectric cell, indicated generally at 31. In the illustrated embodiment of this invention, a support block 50 secured rigidly to the inner wall of the housing base 10 directly opposite the diaphragm provides a common mounting for the light source enclosure 20 and the photocell enclosure 30. Preferably, this photocell incorporates a photoelectrically responsive semiconductor device, which is especially advantageous because of small size, although this detail is not essential to the principle of this invention. The photocell is connected electrically by means of conductors 32 and 33 to the output terminals 34 and 35, respectively, which project through the side wall of the housing base 10. The opaque enclosure 30 for the photocell 31 is provided with a front wall 36 formed with a rectangular opening 37, which is of exactly the same size as, and is in direct alignment with, the opening 27 in the enclosure for the light source. Obviously, the light opening 37 is positioned to pass the light beam emitted from the light source 21 to the photocell 31, so as to energize the photocell to produce an electrical output signal at the output terminals 34 and 35 which is repre-

sentative of the light signal impinging on the photocell.

For controlling the passage of the light beam from the source 21 to the photocell 31 there is provided a shutter 40 suspended from the diaphragm 13 by means of a rigid pin 41 secured at its upper end to the middle of the diaphragm and at its lower end to the top of the shutter. The shutter 40 is in the form of a thin flat plate of opaque material having a slot 42 which is precisely as wide as the light emission slot 27 and the light receiving slot 37 in the enclosures for the light source and the photocell, respectively. However, the depth of the shutter slot 42 is substantially less than that of the slots 27 and 37, preferably about one-half the depth of those slots. Thus, the maximum depth of the light beam which can be transmitted to the photocell 31 is determined by the depth of the shutter slot 42.

In the operation of this device, the construction and arrangement of the parts is such that the shutter slot 42 has a predetermined position with respect to the slots 27 and 37 in the normal or static position of diaphragm 13, in which the diaphragm is unactuated by sound waves. For example, in this unactuated position of the diaphragm, the shutter 40 may be positioned as shown in Fig. 2, with the lower half of the shutter slot 42 aligned with the upper portions of the light transmitting slot 27 and the light receiving slot 37, so that the light beam passed to the photocell 31 has a depth of one-half the height of the shutter slot 42. The electrical output circuit controlled by the photocell 31 would be biased to cut off in this position of the shutter 40.

When sound waves impinge on the diaphragm 13, the diaphragm moves inward away from the perforated top cover of the microphone housing (downward in the drawing) to displace the shutter 40 so as to pass a greater portion of the light beam to the photocell. The maximum light which can be passed to the photocell is reached when the shutter 40 has been displaced to the Fig. 3 position, in which the top edge of the shutter slot 42 is directly aligned with the top edges of the light emitting slot 27 and the light receiving slot 37. In this position of the shutter, a light beam having a depth corresponding to the full depth of the shutter slot 42 is passed to the photocell to actuate the latter. Any further movement of the diaphragm in the same inward direction will not result in an increase of light to the photocell since the maximum amount of light which may be transmitted to the photocell is determined by the depth of the shutter slot 42. Therefore, even if the amplitude of the positive half cycle of the sound signal impinging on diaphragm 13 should be such as to displace the shutter 40 inwardly beyond the Fig. 3 position, in such further movement of the shutter slot it will merely continue to pass the same amount of light to the photocell. Thus, the microphone inherently acts as an amplitude limiter to clip undesired positive peaks of the sound signals.

Likewise, on the return movement of the diaphragm 13 as it vibrates, it may carry the shutter 40 outward (upward in the drawing) until the lower edge of the shutter slot 42 is in alignment with, or above, the upper edges of the light emitting slot 27 and light receiving slot 37, respectively. This completely cuts off the light transmitted to the photocell and any further excursion of the shutter 40 in the same outward direction will not change this 100% cut-off condition. Thus, the microphone acts as an amplitude limiter to clip negative half cycle peaks of the sound signals.

Since voice signal peaks always predominate on either the positive or negative half cycles, often it will be desirable to adjust the unactuated position of the shutter so as to favor clipping either the positive or the negative peaks. By adjusting the static or unactuated position of the diaphragm so as to establish the desired position of the shutter slot 42 with respect to the light emitting slot 27 and the light receiving slot 37, any desired peak

clipping performance characteristic may be obtained within the range from full positive to full negative.

For example, to obtain full negative clipping (eliminating completely the negative half cycles) the diaphragm 13 may have a static or unactuated position such that the lower edge of the shutter slot 42 would be in direct alignment with the lower edges of the light emitting slot 27 and the light receiving slot 37. Thus, in this static position of the diaphragm, the maximum amount of light would be passed to the photocell. The electrical output circuit would be biased to cut-off for this condition of light transmission. With such an arrangement, in the positive half cycle of the sound wave, the shutter slot would move inwardly so as to pass less and less light to the photocell 31, which would actuate the electrical output circuit in response to such modulation of the light beam. In the negative half cycle of the sound wave, after the shutter slot 42 has returned to its static starting position, at which the shutter is positioned to pass a maximum amount of light to the photocell, upon further return movement of the shutter in the same direction (outward), the shutter slot would merely continue to pass the same amount of light, so that the response of the photocell would be exactly the same for the negative half cycle of the sound wave as for the static or unactuated condition, so that the negative half cycle would be completely eliminated in the overall response of the microphone.

Alternatively, full negative clipping might be obtained by positioning the lower edge of the shutter slot 42 in alignment with the top edges of the light emission slot 27 and the light receiving slot 37, respectively, in the static position of the diaphragm. In this static position, the light beam would be completely cut off. On the positive half cycle of the voice signal the shutter slot would move inward to pass a progressively greater amount of light to the photocell to actuate the latter, so that the response of the photocell would correspond to the amplitude of the positive half cycle of the voice signal. On the negative cycle of the voice signal, however, the shutter would move outward beyond its static position and maintain the light cut-off condition which prevails in the static position of the diaphragm.

Conversely, for full positive clipping (eliminating completely the positive half cycles) the diaphragm in its static, unactuated condition would position the shutter 40 to have the upper edge of its light slot 42 aligned with the upper edges of the light emitting slot 27 and the light receiving slot 37, respectively. This would result in maximum light transmission to the photocell in the static position of the diaphragm, and the output circuit from the photocell would be biased to cut-off in this condition of light transmission. When sound waves impinge on the diaphragm, in the positive half cycle the diaphragm moves inward and the shutter continues to pass the maximum amount of light to the photocell, determined by the depth of the shutter slot, and the output circuit remains in its cut-off condition. In the negative half cycle of the sound wave, the diaphragm moves the shutter slot outward beyond its static position, so as to pass a reduced amount of light, determined by the instantaneous position of the shutter slot. Such modulation of the light beam controls the response of the photocell to produce an electrical output signal corresponding to the light beam modulation, so that during the negative half cycle of the sound wave the output from the microphone would be fully responsive to the input sound signals.

Full positive clipping may also be obtained by positioning the upper edge of the shutter slot 42 in alignment with the lower edges of the light emission slot 27 and the light receiving slot 37, respectively, in the static position of the diaphragm. The light beam is fully cut off at this time and the output circuit from the photocell also would be in its cut-off condition then. During the positive half cycle of the speech signal, the diaphragm would move the shutter slot further inward, continuing

the light cut-off condition so that there is no response at the photocell. During the negative half cycle of the speech signal, the diaphragm would move the shutter slot outward to pass an amount of light to the photocell which at any time is proportionate to the instantaneous amplitude of the negative half cycle of the speech signal.

The present microphone may also be operated to eliminate low level background noise which does not exceed a predetermined amplitude. To this end, the arrangement could be such that in the static condition of the diaphragm the shutter slot 42 would be midway between the top and bottom edges of the light beam emitted from the enclosure opening 27, so as to pass maximum light to the photocell, for which condition the output circuit would be adjusted to cut-off. Signals smaller than a predetermined amplitude would merely cause the shutter slot to move up and down without moving out of full registration with the light beam, so that there would continue to be passed to the photocell the same maximum amount of light, determined by the size of the shutter opening.

Similar results may be obtained by arranging the static condition of the diaphragm to position the shutter slot completely above or below the light beam emitted from the opening 27 in the enclosure for the light source. In this condition of complete cut-off of light to the photocell the output circuit from the photocell would be adjusted to cut-off. Sound signals of less than a predetermined amplitude would not move the diaphragm sufficiently to bring the shutter slot into even partial registration with the light beam, so that the light transmission to the photocell would remain cut off.

It will be apparent that in each of these arrangements having provision for eliminating low level noise, the peak clipping characteristic is also retained.

From the foregoing, it will be apparent that the microphone illustrated in the accompanying drawing and the detailed description above is particularly suitable for the accomplishment of the objectives of the present invention in an advantageous manner. However, while there has been disclosed herein a specific preferred embodiment of this invention, it is to be understood that various modifications, omissions and refinements which depart from the disclosed embodiment may be adopted without departing from the spirit and scope of this invention.

I claim:

1. A microphone comprising a housing, a light source in said housing, an opaque enclosure for the light source formed with an opening for passing a light beam from the light source, a photoelectric cell in said housing, an opaque enclosure for the photoelectric cell formed with an opening in alignment with said opening in the enclosure for the light source to pass the light beam from the light source to the photoelectric cell, a reciprocating opaque shutter interposed between said enclosure openings to control the transmission of light from the light source to the photoelectric cell, said shutter being formed with an opening which is smaller in the direction in which the shutter reciprocates than either of said enclosure openings, whereby the size of said shutter opening determines the maximum amount of light which may be transmitted from the light source to the photoelectric cell, and a sound responsive diaphragm connected to the shutter to move the shutter in response to sound impinging on the diaphragm.

2. The microphone of claim 1, wherein said diaphragm in its static condition positions the shutter to have its opening in partial registration only with the enclosure openings to pass less than said maximum amount of light to the photoelectric cell.

3. The microphone of claim 1, wherein said diaphragm in its static condition positions the shutter to have its opening in full registration with the enclosure openings

to pass the maximum amount of light to the photoelectric cell.

4. The microphone of claim 1, wherein said diaphragm when static positions the shutter to have its opening completely out of registration with the enclosure openings to cut off the passage of light to the photoelectric cell.

5. A microphone comprising a housing, a diaphragm, means in said housing for transmitting at one side of the diaphragm a light beam of predetermined cross section, a photoelectric cell positioned at said one side of the diaphragm to have the light beam impinge thereon, and an opaque shutter attached to said diaphragm for reciprocation thereby transversely across said light beam between said light transmitting means and the photoelectric cell and formed with an opening for passing light to the photoelectric cell, said shutter opening being smaller than the cross sectional dimension of the light beam in the direction in which the shutter reciprocates so that the size of the shutter opening determines the maximum amount of light transmitted to the photoelectric cell.

6. In a voice peak limiting microphone, the combination of light source means providing a light beam, a photoelectric cell positioned to be impinged upon by the light beam to produce an output signal in response thereto, an opaque shutter interposed between said light source means and said photoelectric cell and formed with an opening for passing light to said photoelectric cell, and a movable sound responsive diaphragm connected to the shutter to move the shutter opening across the light beam to register partially therewith and thereby modulate the light transmission to said photoelectric cell in accordance with the amplitudes of the voice signals impinging on the diaphragm between extreme conditions of light transmission to said photoelectric cell in which the shutter opening registers fully with the light beam and in which the shutter opening is completely out of registration with the light beam, respectively.

7. In a voice peak limiting microphone, the combination of a light source providing a light beam, a photoelectric cell positioned to be impinged upon by the light beam to produce an electrical output signal responsive thereto, a reciprocating opaque shutter interposed between the light source and the photoelectric cell to control the impingement of the light beam on the photoelectric cell, said shutter being formed with an opening which establishes an extreme condition of light transmission to the photoelectric cell when it registers fully with the light beam to pass maximum light to said photoelectric cell and which establishes the opposite extreme condition of light transmission to the photoelectric cell when it is completely out of registration with the light beam to completely cut off the passage of light to the photoelectric cell, and a movable sound responsive diaphragm connected to the shutter to reciprocate the shutter transverse to the light beam to thereby control the registration of the shutter opening with the light beam as the diaphragm moves in response to voice signals to modulate the light transmission to the photoelectric cell in accordance with the amplitudes of the voice signals and to establish one of said extreme conditions of light transmission to the photoelectric cell in response to voice signal amplitude peaks above a predetermined maximum value.

8. The microphone of claim 7, wherein said shutter opening has an extent in the direction in which the shutter reciprocates which is less than the extent of the light beam in said direction.

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