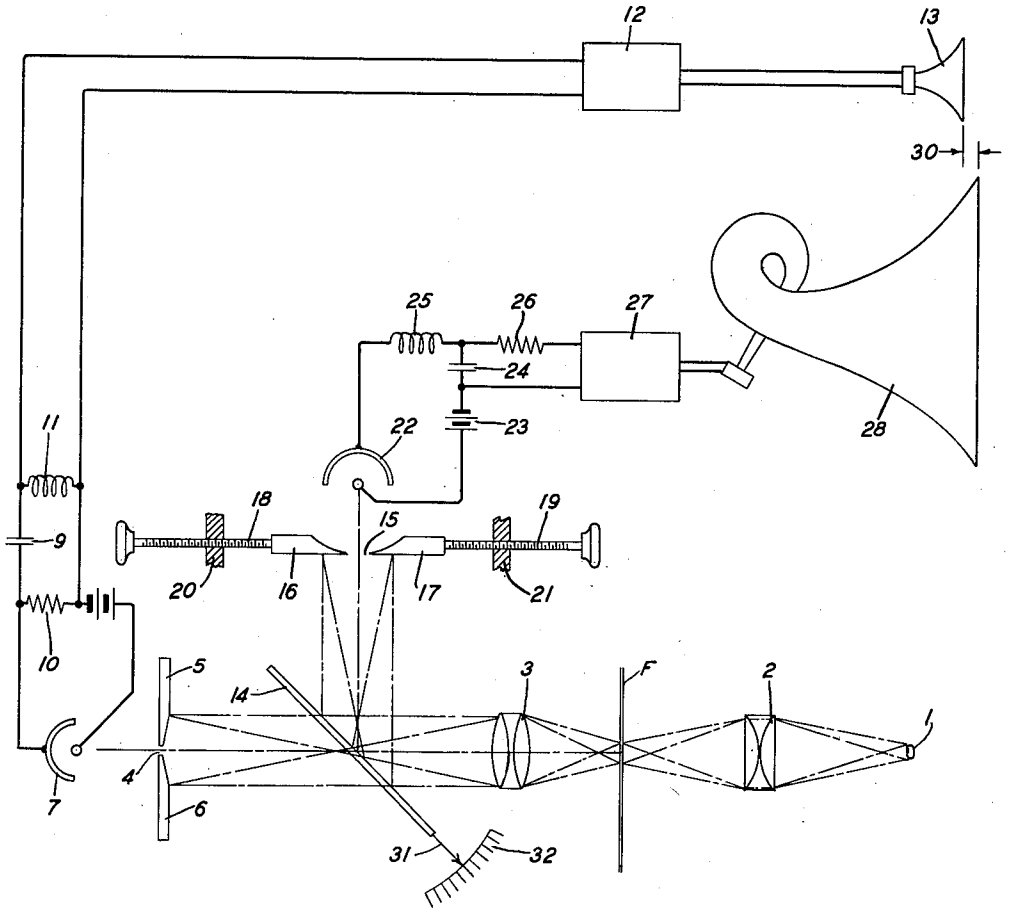
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WIDE RANGE SOUND FILM REPRODUCING SYSTEM

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WIDE RANGE SOUND FILM REPRODUCING SYSTEM

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This invention relates to sound film reproducing systems and particularly to an improved wide frequency range reproducing system employing a plurality of loudspeakers each of which is predominantly effective in a particular frequency range of the entire range to be reproduced.

It is the object of this invention to provide a wide range sound film reproducing system in which the division of the frequency range between the separate loudspeakers and relative phase shift between the separate frequency components may be accomplished simply and accurately by elements included in the optical system of the sound film reproducing system.

A feature of the invention resides in the provision of a separate photoelectric cell for each loudspeaker, each photoelectric cell receiving the sound modulated light through optical slits of a size determined by the upper limit of the frequency range to be reproduced by its associated loudspeaker.

A further feature of the invention resides in the provision of means for deflecting a portion of the modulated light beam to one of the photoelectric cells, which deflecting means is adjustable to advance or retard the image projected to its associated photoelectric cell with respect to the same image projected to the other photoelectric cell in order to adjust the phasing and timing of the sound reproduced by the two loudspeakers.

In wide frequency range sound film reproducing systems used heretofore it is necessary to use an electrical dividing network between the single photoelectric cell and the separate loudspeakers. In addition to a power loss introduced by such a dividing network, one of the loudspeaker units requires attenuation, as these two units are rarely of equal efficiency. Consequently, the power amplifier must carry a combined signal load which is higher than that furnished to the loudspeakers. The amplifier system including the transformers must be capable of passing the entire frequency range of approximately 7.3 octaves. This reduces the load carrying capacity of the transformers and coils thus increasing the number of amplifier stages with a consequent increase in low frequency phase distortion.

In a sound film reproducing system of the type discussed, the low frequency as well as the high frequency speakers must be placed close to the projection screen. In order to obtain smooth interaction between the outputs of the two loudspeaker horns it is sometimes necessary to shift one speaker edge relative to the other speaker edge by a small amount. Natural reproduction of

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the high and low frequency components of composite sound requires that the sounds of common origin reach the ears simultaneously. Deviation from this requirement by more than one four-hundredths of a second, or about three feet in speaker length, produces unnatural tone quality in impact sounds, such as percussion instruments. In order to meet this requirement, low frequency loudspeakers in present-day wide range reproducing systems have been shortened to the approximate length of the high frequency horn. This precludes the desired use of the long folded horns for low frequency reproduction which have a higher efficiency and quality.

In accordance with this invention the electrical and acoustical disadvantages of the present system of wide range reproduction are eliminated by the provision of such a reproducing system in which each of the loudspeakers is electrically connected to a separate photoelectric cell. Each of the photoelectric cells receives the light modulated by the sound track, one being positioned in the direct beam from the film and the other positioned in the path of a portion of this beam which is deflected by a mirror. The upper frequency of the frequency range being reproduced by the predominantly low frequency loudspeaker is determined by the width of an optical slit disposed in front of the photoelectric cell associated therewith. Means are provided for adjusting the width of this slit so that the associated loudspeaker receives for reproduction only currents of a frequency within the range of frequencies to be reproduced by this loudspeaker.

To obtain phasing and timing adjustments of one frequency component of the composite sounds with respect to the other frequency component, the angular position of the deflecting mirror, which deflects a portion of the modulated light beam to one of the photoelectric cells, is adjustable to advance or retard the image deflected to its associated photoelectric cell with respect to the same image projected to the other photoelectric cell.

It will be seen that by the use of separate scanning slits in accordance with this invention, the power consuming dividing network of the present system is eliminated. Each channel is provided with a separate amplifier which has only to pass a frequency range of three or four octaves, thus permitting higher gain per stage and a more economical transformer design. No intermodulation is likely where the high and low frequencies are separately amplified and gain balance and filtering can be done in each

channel at the low level amplifier stages. Also, the phasing and timing of high and low frequencies can be accomplished by a simple adjustment of one scanning beam, thus permitting the use of a low frequency loudspeaker of the long folded type giving higher quality sound reproduction while maintaining the speaker edges in alignment at the projection screen or shifted relative to each other by the small amount necessary to obtain smooth interaction between outputs.

In the drawing accompanying this specification, numeral 1 indicates a constant intensity light source. A condenser lens 2 forms an image of the light source at or near the plane of the film F which bears the sound track to be reproduced. An objective lens 3 forms an image of the sound track on film F at a slit 4 which is formed by opaque plates 5 and 6. The photoelectric cell 7 receives the modulated light passing aperture 4 and translates this light into electrical current. Numeral 8 indicates a polarizing battery for the photoelectric cell 7. A condenser 9, resistance 10 and inductance 11 constitute a high-pass filter in the circuit from photoelectric cell 7 to an amplifier and gain control unit 12. A predominately high frequency loudspeaker 13 is electrically connected in the output of amplifier 12.

A portion of the modulated light beam is deflected by a mirror 14 disposed between the objective lens 3 and slit 4. At the plane of the image formed by the deflecting beam there is provided a slit 15 which is formed by opaque members 16 and 17. The width of a slit 15 may be varied by the slit-forming members 16 and 17. These members are adjustable toward and away from each other by means of threaded rods 18 and 19 extending through internally threaded holes in a fixed housing indicated at 20 and 21. The end of each rod 18 and 19 is rotatably mounted in its associated slit-forming member to prevent rotation of these members during movement thereof toward and away from each other.

A photoelectric cell 22 receives the modulated light beam passing aperture 15 and converts this light into varying electrical current in a circuit including a polarizing battery 23, a low-pass filter including condenser 24, inductance 25 and resistance 26 and an amplifier and gain control unit 27. In this system, a high quality folded horn 28 is connected in the output from amplifier 27.

In the system as shown in the drawing the predominately high frequency loudspeaker 13 and the predominately low frequency loudspeaker 27 are placed immediately behind a projection screen with their edges substantially in the same plane. A slight displacement of the edges as indicated in 30 may be necessary to obtain smooth acoustical interaction between the loudspeakers. This adjustment once made is permanent and the phasing and timing of high and low frequency sound to compensate for the difference in acoustical paths of the separate components of the composite sound is accomplished by adjustment of the scanning beam as will be explained hereinafter.

The mirror 14 is mounted on a pivot mounting (not shown) located substantially in a horizontal plane including the center line of the optical system. The angle of deflection of mirror 14 may be changed to advance or retard the image projected to photoelectric cell 22 with respect to the same image projected to photoelectric cell 7.

Since sound travels approximately 1100 feet per second in air and the film F travels at 18 inches per second, a mutual displacement of .001 inch between the scanning beams would be equivalent to a mutual displacement between the high and low frequency speaker diaphragms of .73 inch. Thus, if the distance from diaphragm to horn edge in the loudspeaker unit 28 is ten feet greater than the distance between diaphragm and horn edge of loudspeaker 13, the center of the image projected to slit 15 may be placed ahead of the same image projected to slit 4 by .164 inch to compensate for the difference in distance between the speaker diaphragms and horn edges. In this manner, a high quality horn of the folded type indicated at 28 may be employed and all sounds, including impact sounds, may be reproduced with natural tone quality.

While the light deflecting means is shown in the form of a mirror 14, it is within the scope of this invention to provide other optical means for splitting the modulated beam and for adjusting the position of the deflected beam relative to the other light beam.

The sound film reproducing system in accordance with this invention includes novel features offering definite advantages in a high quality, wide range sound film reproducing system.

What is claimed is:

1. A sound film reproducing system comprising a predominately high frequency loudspeaker, a predominately low frequency loudspeaker, a pair of photoelectric cells each electrically connected to a separate one of said loudspeakers, means producing a light beam modulated in accordance with sound variations recorded on said film, means disposed in front of each photoelectric cell forming a scanning slit, means to adjust the width of one of said scanning slits in the direction of film motion, and means imaging different elemental areas of said modulated light beam at said scanning slits.

2. A sound reproducing system comprising a photographic film having a single record of sounds recorded thereon, a predominately high frequency loudspeaker, a predominately low frequency loudspeaker, a first photoelectric cell electrically connected to said high frequency loudspeaker, a second photoelectric cell electrically connected to said low frequency loudspeaker, means producing a light beam modulated in accordance with sound variations recorded in the single record on said film, means to project said light beam to said first photoelectric cell, means deflecting a selected elemental area of said light beam to said second photoelectric cell, means forming a scanning slit in front of said first photoelectric cell, and means forming a scanning slit in front of said second photoelectric cell, said last-mentioned means being adjustable to vary the width of said scanning slit formed thereby in the direction of film motion.

3. A sound film reproducing system in accordance with claim 2 in which the position of said means deflecting a portion of said light beam to said second photoelectric cell is adjustable to advance or retard the elemental area of said light beam projected to said second photoelectric cell with respect to the elemental area of said light beam which is being simultaneously projected to said first photoelectric cell.

4. A sound film reproducing system comprising a predominately high frequency loudspeaker, a predominately low frequency loudspeaker, a pair of photoelectric cells, one of said photoelectric

cells being electrically connected to said high frequency loudspeaker and the other of said photoelectric cells being electrically connected to said low frequency loudspeaker, optical means producing a light beam modulated in accordance with the sound variations recorded on said film, means for projecting said modulated light beam simultaneously to both said photoelectric cells, means containing a scanning slit disposed in a path of the light beam to each of said photoelectric cells, one of said scanning slits being wider in the direction of film motion than the other of said scanning slits, and adjustable light beam deflecting means for projecting onto one of said photoelectric cells an elemental area of said light beam which precedes or follows an elemental area of said light beam being simultaneously projected onto the other of said photoelectric cells.

5. A sound film reproducing system comprising a predominately high frequency loudspeaker, a predominately low frequency loudspeaker, a pair of photoelectric cells each electrically connected to a separate one of said loudspeakers, means producing a light beam modulated in accordance with sound variations recorded on said film, means forming a scanning slit in front of each of said photoelectric cells, means for projecting said modulated light beam simultaneously to both said photoelectric cells, and adjustable means in the path of said modulated light beam to one of said photoelectric cells to advance or retard the elemental area of said light beam projected to said photoelectric cell with respect to the elemental area of said light beam which is being simultaneously projected to the other of said photoelectric cells.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,901,033	Karolus	Mar. 14, 1933
1,901,034	Karolus	Mar. 14, 1933
1,950,011	Scheibell	Mar. 6, 1934