May 30, 1939. O. K. KOLB 2,160,506

REPRODUCTION OF SOUND FROM RECORD FILM

Filed Aug. 3, 1936 2 Sheets-Sheet 1

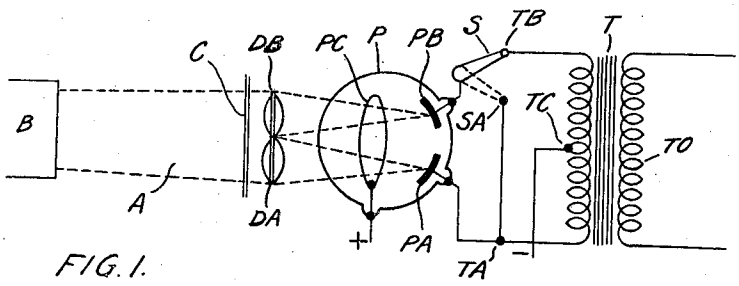


FIG. 1.

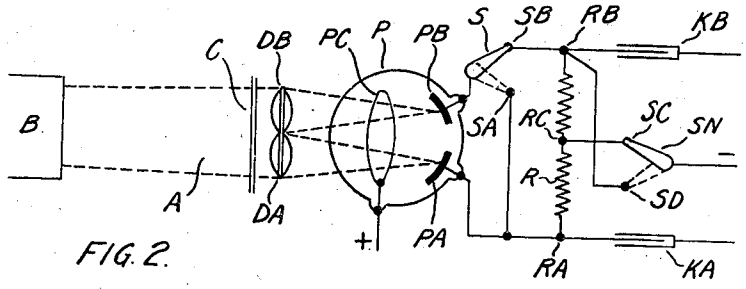


FIG. 2.

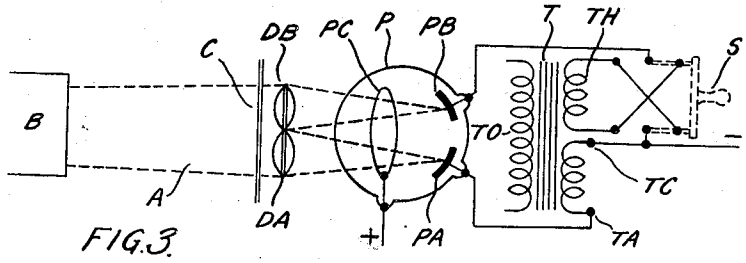


FIG. 3.

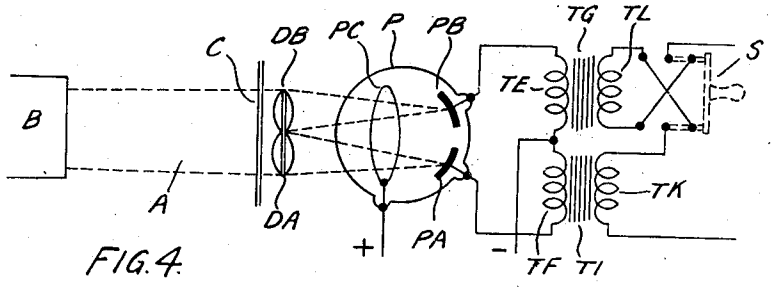


FIG. 4.

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REPRODUCTION OF SOUND FROM RECORD FILM

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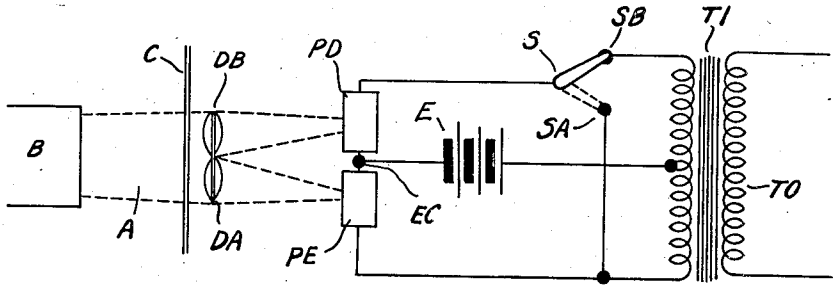


FIG. 5.

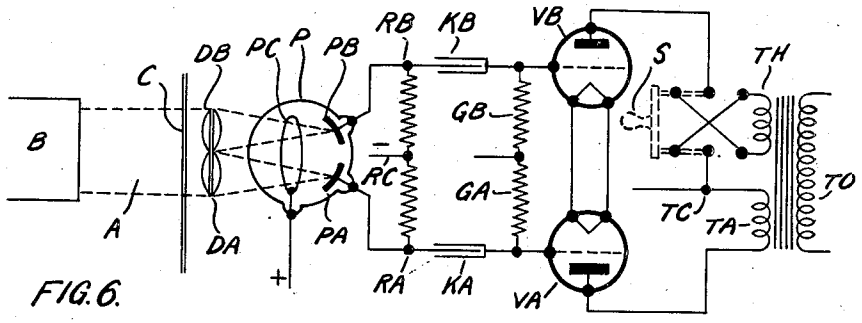


FIG. 6.

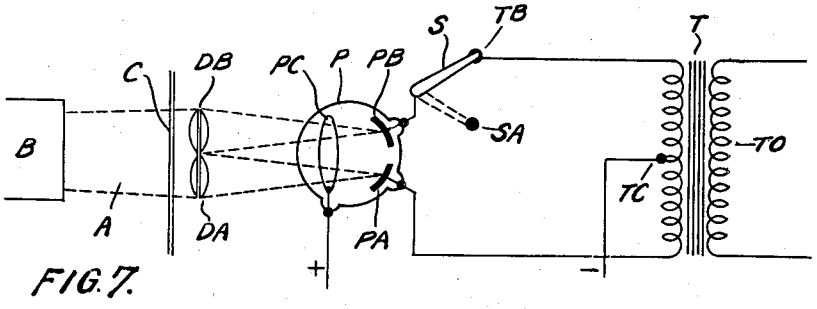


FIG. 7.

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UNITED STATES PATENT OFFICE

2,160,506

REPRODUCTION OF SOUND FROM RECORD FILM

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Application August 3, 1936, Serial No. 94,014
In Great Britain November 14, 1935

2 Claims. (Cl. 179—100.3)

This invention relates to new and useful improvements in the reproduction of sound from record films.

Photographic sound film records are known which bear forms of record trace wherein the sound vibrations are recorded by variations in the opacity of the developed film, such films being known as "variable density" films. There are also sound film records of the kind in which the sound vibrations are recorded by variations in the opaque area as contrasted with the transparent area of the sound track. Such records are known as "variable area" records. Films of both these kinds, using a plurality of sound tracks, are also known. In the class of record in which variable area is used, tracks of the kind in which the sound record is represented by two or more wave traces symmetrical about common axes are also known, these being known as "double-hump" records.

All records of these known types which can be reproduced by the aid of a single photo-sensitive device operating with a scanning system of known kind and possibly projecting sound by the aid of amplifiers and sound projectors of known type, will be hereinafter referred to as "normal" films.

A second type of photographic sound film record has been proposed, which bears form of record trace wherein the positive and negative half waves of each sound undulation are individually recorded on separate and opposed zones of the sound track. Such records will be hereinafter referred to as "bilateral" records.

There has also been proposed a type of film having somewhat similar characteristics, which on the positive film used for reproduction, has presented a central transparent zone, bounded by traces of similar waveform, of which the individual amplitudes about a central and common axis have decreased on one side when increasing upon the other. These wave traces have been bounded by opaque areas, the edges of which have thus represented phase-displaced wave form traces. Such records will be hereinafter referred to as "push-pull" records.

All the second and third types of asymmetric record films referred to have required for their reproduction the use of two light sensitive elements, on which it has been proposed to project by means of a double optical system, utilizing, for instance, lenses or prisms, separate light pencils which have passed through and/or from the two opposed half-wave sound trace areas lying on each side of the center line of such a film sound track.

All films of the kinds requiring for their reproduction such a double light sensitive system, will be hereinafter referred to as "asymmetric" sound films.

The present invention has for object the provision of sound reproducing arrangements of a photoelectric type, by means of which all film of the known "normal" type as well as all film of the known "asymmetric" type are equally well reproduced by the same apparatus which is readily altered in its mode of working by the projectionist or operator and consequently requires a minimum of attention or loss of time in making the changeover.

According to the present invention a sound film record passing through a suitable sound-gate or like device, intercepts at a focal plane and modulates in known manner a beam of light which passes through a secondary optical system by which it is divided, so that pencils of light which have passed through the two opposed and phase-displaced zones of a "asymmetric" sound track are separately directed on to two light sensitive elements, which may be, for example, twin photo-sensitive cathodes arranged in one photoelectric cell. The two light sensitive elements referred to are connected to an electric coupling device, similar to and acting in the same manner as the push-pull intervalve couplings of push-pull amplifiers; the whole arrangement being such that the photoelectric effects set up in the two light-sensitive elements, although opposed in phase or alternated in impulse, are caused to produce currents which act vectorially in an additive sense as regards an output circuit.

When the film to be reproduced is of the ordinary or "normal" type, that is, when a single light-sensitive element can be used for its reproduction, the two photoelectric elements referred to are by the use of means according to the invention now caused to act virtually as one, and in such a sense that they influence a final output circuit in exactly similar phase, in parallel or in an additive manner.

Or, in alternative arrangements, one of the light-sensitive elements alone is connected to the output directly or indirectly when ordinary or "normal" films of the variable density or variable area type are being reproduced. In this case, the variable area type of film used will be of the double or quadruple track kind, and the amplifying system used may, if desired, be adapted for simultaneous adjustment by means linked to those

modifying the light-sensitive element connections, to suit the modified photoelectric or light-sensitive element output conditions.

For the more complete explanation of the nature of the invention and of means for carrying it into effect, reference will be made to the appended drawings in which Figs. 1 to 7 diagrammatically illustrate various embodiments.

In apparatus constructed according to the invention, a switch or commutator is provided by means of which when two light-sensitive elements are used, and these are operated in an in-phase parallel connection referred to, the connection of one of them to the electric coupling system is modified by causing the connection of the one light-sensitive element referred to, to the common point in the coupling system to which the other is connected, whereas, when the two light-sensitive elements are active, each respectively in an opposite and balanced phase opposed sense with push-pull sound films, they are connected to terminals or junctions of the push-pull output coupling system which are disposed symmetrically in an electrical sense about a common polar tapping. Fig. 1 and Fig. 2 of the drawings show schematically arrangements of this kind.

In Fig. 1 a pencil of light A is focused by an optical system B upon the film C which is regarded as being provided with a sound track of the "asymmetric" type. The pencil of light after passing through the film is received by the twin optical systems or lenses DA and DB and thereby focused upon the two photoelectric cathodes PA, PB mounted in the photoelectric cell P. An anode PC is provided in this cell. The cathode PA, for example, is directly connected to a junction or terminal TA of the push-pull transformer T whilst the other cathode PB is connected by means of a switch S to a second and symmetrical terminal TB on the same transformer primary.

The transformer primary has a common polar tapping centrally disposed TC. A secondary output winding TO is provided in this transformer, which is connected to the amplifying system in known manner. The switch S is provided with a contact SA on to which the switch arm can be moved when a film of the "normal" type is to be reproduced. In this case, both the cathodes PA and PB being connected to a common junction TA operate in parallel and therefore additively as regards the output circuit.

In Fig. 2 a similar disposition of the parts of the photoelectric cell and optical system is utilized, but in this case the cathode PA connects to one termination RA of a coupling resistance R and the switch S to which the cathode PB is connected contacts with the stud SB, which is connected to the symmetrical terminal RB of the same resistance, during the reproduction of "asymmetric" films. When, however, it is desired to reproduce "normal" films, the switch arm is again shifted to a contact or stud SA which connects the cathode PB to a common junction RA. At the same time, a second switch arm SN may be provided to alter the negative feed serving the two cathodes from a contact SD communicating with a central tapping RC on the resistance on to a contact SE which is connected to the junction RB, thus bringing the whole resistance into series with the two cathodes referred to. The two terminations RA and RB of the resistance may be connected to any further stages of an amplifier of known kind, for example, through coupling condensers KA, KB.

Alternatively, if the said photoelectric elements are connected by means of a push-pull transformer having a center tapped primary winding, one half of this winding may be reversed in sense by a switch referred to, which in this case, is of the changeover or reversing kind. Fig. 3 of the drawings indicates schematically an arrangement of this kind, and herein the two cathodes PA, PB arranged in the photoelectric cell P are connected to the two symmetrically disposed halves of the primary winding in the transformer T. The cathode PA is connected to the junction TA and the cathode PB and central tapping TC are connected to half the primary winding TH through the changeover switch S, the transformer being provided as before, with an output secondary winding TO. In this case, when the film being reproduced is of the "asymmetric" type, the impulses of current passing to the two cathodes are passed through the transformer primary in opposite phase, and the switch is placed in the position in which these impulses act additively as regards the output winding TD. When a "normal" film is being reproduced, a reverse of the switch causes the current impulses reaching the cathodes to act in phase and additively upon the output winding.

Or, in yet another modified arrangement for causing the change of phase operation referred to, each photocell cathode may be connected to a separate transformer, the secondary windings of which may be arranged in series or parallel with a changeover switch in circuit with one of them, permitting of a reversal of direction and of phase of output of the current from one photo-cathode only.

An arrangement of this kind is indicated in Fig. 4. Herein, the two cathodes PA and PB are connected to transformers TG and TI, respectively. The secondary TK is permanently connected in circuit but the secondary TL of the transformer TG is connected in series with the secondary TK by means of the changeover switch S, which can be thrown into either one of two positions, permitting a reversal of phase for the purpose referred to.

When the two photo-sensitive elements are connected in parallel by the switching means referred to for the purpose of reproducing "normal" sound films, auxiliary coupled switch contacts are, or can be, according to the invention, arranged to alter the resistance, inductance, capacity or neutral inductance of the coupling elements employed, or to alter the point of a coupling system to which or at which the negative potential to the cathode is applied. The switch contacts SD and SE referred to in relation to Fig. 2 are examples of such contacts.

Thus switch contacts may be provided by means of which one cathode of a pair may be disconnected from one termination of the primary winding of an output transformer, and may be connected to the common junction of the other cathode and the corresponding termination of the primary winding. At the same time, the central tapping which during push-pull operation is connected to the negative pole of a suitable source of electric supply, may be connected by means of auxiliary switch contacts to a different tapping point connected with the same primary winding. By the use of such an arrangement, the two cathodes under the modified conditions act virtually as one and the system is so adapted to reproduce "normal" films.

Instead of the resistance symmetrically ar-

ranged and centrally tapped as shown in Fig. 2, the two arms of this resistance may be replaced by separate inductances, and the operation of a system of this kind will be followed by those versed in the art without further description.

Separate photocells having their anodes connected together and to a common positive pole of electric supply, may be used instead of the bicathodic type of photoelectric cell herein before referred to; the two cathodes of the separate cells being adapted to receive the separated light pencils passing through the two opposed sound tracks of the film and functioning in a manner strictly equivalent to the combined photoelectric apparatus hereinbefore referred to.

Other photo-sensitive elements of the current modulating type such as selenium cells may be connected to equivalent points on similar push-pull output systems, in series with a suitable source of electric supply, one pole of which is connected to terminations of the said selenium or like cells, and the other to a central tapping of the system. An arrangement of this kind is indicated in Fig. 5 of the drawings. In this figure two selenium cells of any of the known types, diagrammatically indicated at PD and PE, have one extremity each connected to a common junction EC, each of the other extremities being respectively connected to the terminations of the primary winding TA of transformer T, the middle tapping of which TC is connected to the negative pole of the same source of supply E. Each of the two cells functions as and electrically takes the place of one of the photo-electric cathodes previously referred to.

Cells capable of generating electric current themselves when light beams impinge upon them; for example, rectifier cells of the cuprous oxide type, may replace the photo-sensitive elements hereinbefore referred to and in this case their central and common junction is connected directly to the central tapping TC of the transformer indicated in Figs. 1 and 5, their two outer extremities being connected directly to the junctions T and the switch S as therein indicated.

In a circuit in which the two light-sensitive elements operating in opposite phase to scan an "asymmetric" film are connected by means of equal separate resistances or inductances to a suitable pole of supply and are each individually and respectively coupled through condensers in known manner to a push-pull amplifying stage, the changeover switch when used to alter the ystem for the reproduction of "normal" films may be arranged so as to connect, under these conditions, the anodes of the two valves utilized in such an amplifying stage, together and to a common output, or, when these anodes feed each into a separate primary winding on an output transformer, the switch may be arranged to reverse only one of these windings, thus causing the two anode outputs to act additively and in phase on a common secondary output circuit.

Alternatively, the switch may be used to reverse one output winding only of a pair, connected in series or parallel, when each valve anode is individually connected to a primary winding of a separate transformer. With such arrangements, it will be followed that the switch controlling the asymmetrical or "normal" use of the device is applied solely to the valve anodes, and the connections of the individual light sensitive elements are not altered in the two cases.

A circuit of this kind is schematically indicated in Fig. 6 of the drawings. In this figure the twin cathodes PA and PB are fed through a centrally tapped resistance R and the extremities of this are connected through coupling condensers KA and KB to the control grids of two valves VA and VB which are connected in push-pull to the split primary winding of a transformer and a switch S is provided to change the anode connection of one of these half windings from the in-phase to the push-pull opposed phase connection for use with asymmetric films.

In alternative arrangements in which one light-sensitive element alone out of the pair is used to reproduce "normal" films, and twin light-sensitive elements are brought into circuit in a push-pull arrangement when asymmetric films are being reproduced, the switching arrangements are similar to those hereinbefore set forth and described, but in this case, where transformers are used as coupling means, one of the light-sensitive elements and the associated winding, or the light-sensitive element alone may be cut out of circuit, leaving the one light-sensitive element alone active, or in those modifications of the apparatus hereinbefore referred to, in which both light-sensitive elements are jointly connected to a common point, only the one will be left so connected. Fig. 7 illustrates a simple circuit of this kind. Herein, the two cathodes PA and PB connect as in Fig. 1 to the input or primary winding of a push-pull transformer T provided with an output winding TO, but in this case the switch S is arranged to break the circuit of the cathode PB to this transformer winding, when "normal" films of the variable density or of variable area multi-hump track type, with an even number of double hump traces are to be reproduced, whilst said switch connects both cathodes in push-pull for the reproduction of asymmetric films. The auxiliary contacts of the switch adapted to alter the resistance, inductances or mutual in the output of the remaining light-sensitive element may still be retained; or this switch may function to alter the connection of the center or supply tapping lead to another point on the resistance, inductance or transformer connected to the said light-sensitive element, in order to adjust the working conditions of the system.

Apparatus according to the invention may be embodied in diverse mechanical, electrical or optical forms of construction without departing from its essential nature as herein set forth and defined in the appended claims.

What I claim is:

1. Apparatus for the reproduction of sound records from films, comprising two photo-sensitive elements each responsive to one lateral zone of a film, a push-pull amplifying stage coupled with said elements and comprising two valves, and a change-over switch in the output circuit of said valves.

2. In a system for reproducing sound records from films, two photo-sensitive elements each responsive to one lateral zone of a film, two valves each having a filament, a grid and an anode, a connection between an element and a grid, a second connection between the other element and grid, a condenser in each connection, a connection between the filaments, a transformer in circuit with the anodes, and a change-over switch in said circuit.

OTTO KURT KOLB.