Sept. 29, 1931. A. J. CAWLEY 1,825,439

SOUND RECORDING OR REPRODUCING APPARATUS

Original Filed Jan. 8, 1921 3 Sheets-Sheet 1

Fig. 1

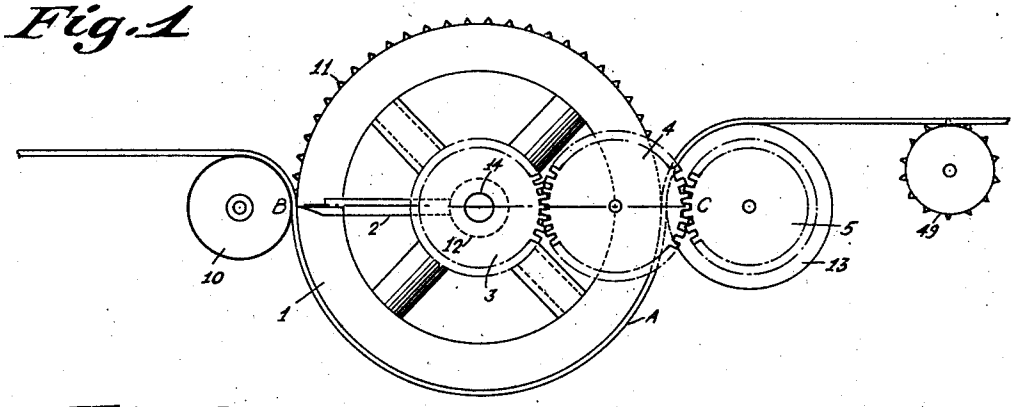


Fig. 2

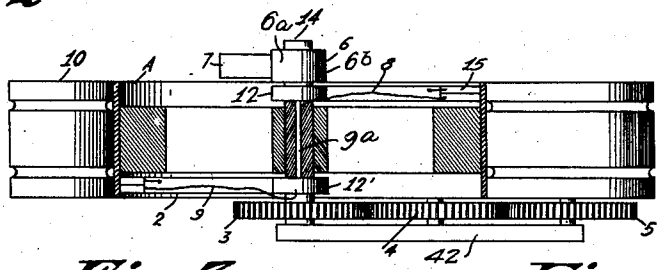


Fig. 3

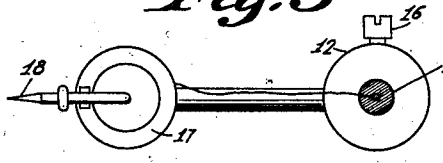


Fig. 4

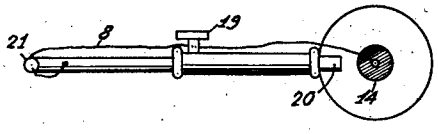


Fig. 5

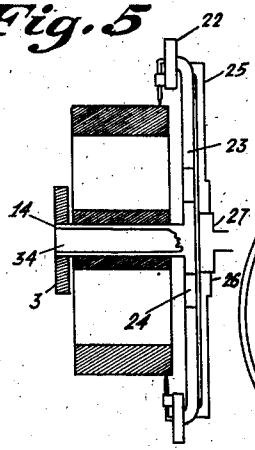


Fig. 6

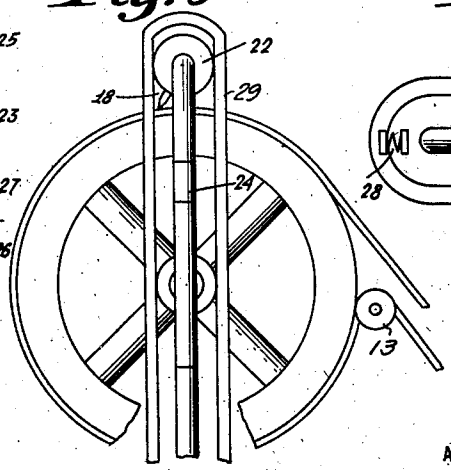
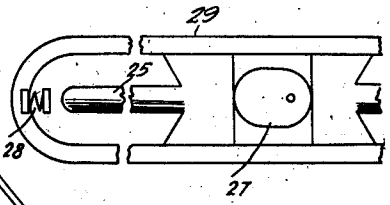


Fig. 7



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Fig. 13

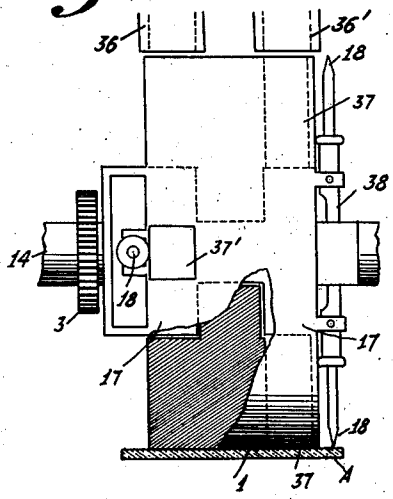


Fig. 14

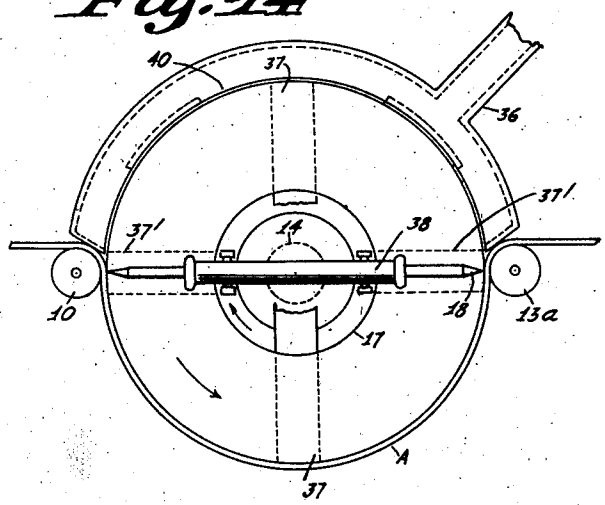


Fig. 8

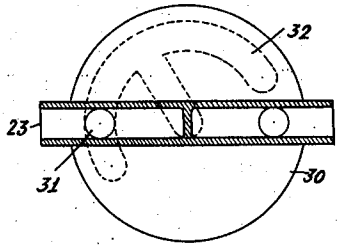


Fig. 9

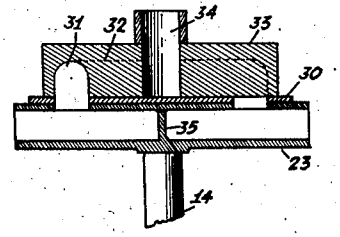


Fig. 10a

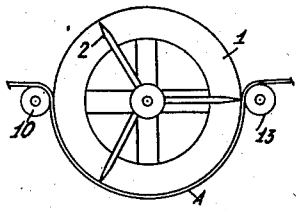


Fig. 10b

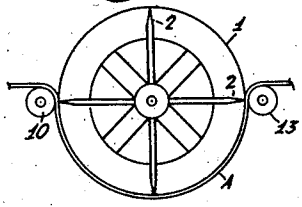


Fig. 11

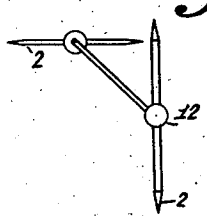
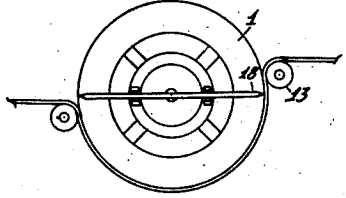


Fig 12



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Fig. 15

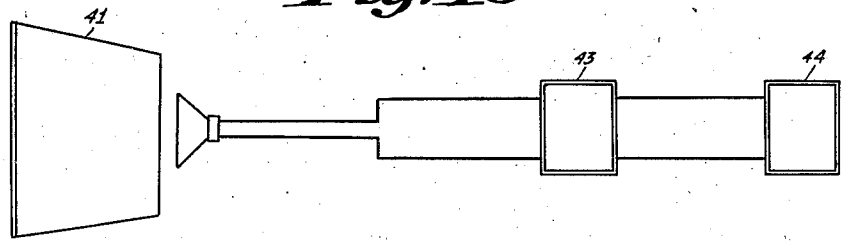


Fig. 16

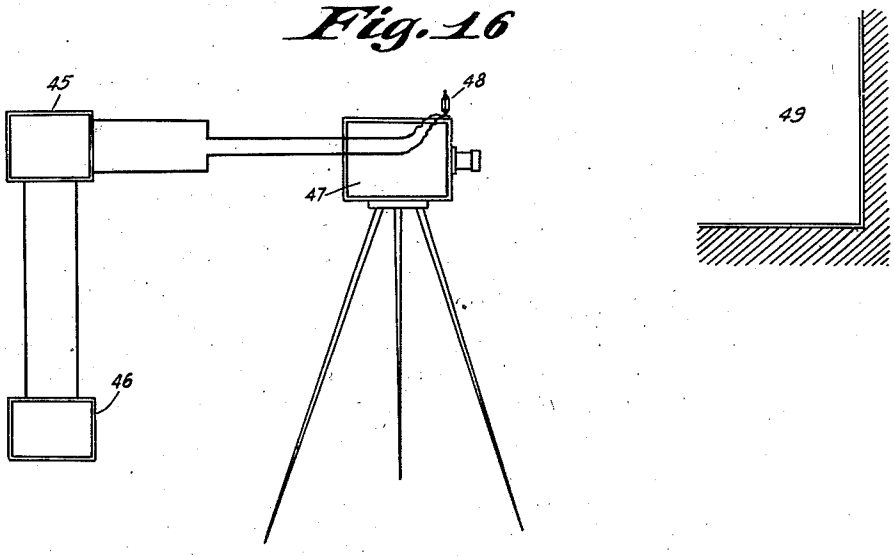
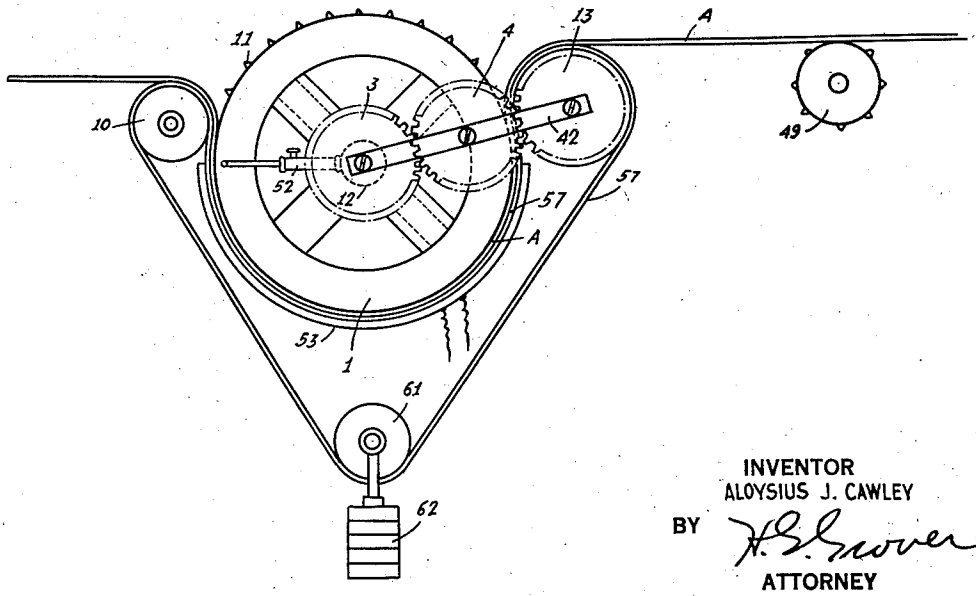


Fig. 17



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UNITED STATES PATENT OFFICE

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SOUND RECORDING OR REPRODUCING APPARATUS

Original application filed January 8, 1921, Serial No. 435,984. Divided and this application filed September 16, 1929. Serial No. 393,072.

This application is a division of my application Serial No. 435,984 filed January 8, 1921.

The invention relates generally to the method of producing sound records on motion picture films, so that sound and picture records may be synchronously reproduced, although the invention is not necessarily limited to this field.

More particularly, the invention is concerned with the recording of sound on a motion picture film at a recording speed that is much in excess of the speed of the film. An arrangement is provided whereby a recorder contacts with a film, while moving in the opposite direction thereto. The recording speed is thus equal to the sum of the speeds of the recorder and film.

A plurality of recorders are employed, which contact alternately with separate portions of the film. These recorders are placed radially at fixed intervals, and one contacts with a record surface of a given length, while the film has actually passed through but a fraction of this length. The other recorder is then in a position to contact with an equivalent length juxtaposed to, or opposite to that traversed by the first.

An electrical or mechanical arrangement is provided whereby the recorders are thrown out of operation when not recording their own specific record groove.

Arrangements are described whereby any desired sound recording speed may be obtained without any increase in the speed of the film, by simply increasing the number and speed of the recording units.

The invention is perfectly adaptable to the standard motion picture film as it exists in practice at present, and is concerned with placing sound records on the margin, or margins of such a film. This is particularly feasible if mechanical sound grooves are used, as there is room for a very large number of such records. The latter may be placed on one margin only, or be distributed on both margins, as hereinafter described.

As the sound records are intended to be placed on the margins of the film, there is no interference of picture and sound record as would be the case, if for instance, the latter were placed across the reverse face of the film, as in such case, they would be projected upon the picture screen.

The invention, further, is not limited to mere mechanical methods of recording, but is adapted to any means, such as photographic, magnetic, or the electrical reproduction described in another application that I am about to file. Although the invention is not limited to any of those methods, great emphasis is placed on the method employing electrically operated sound recorders and reproducers; the recording speed that it is most desired to use with this is approximately double the film speed.

It will be noted that there are no abrupt changes in the direction of moving parts. All parts move in a uniform manner, and the apparatus as a whole is very simple. It is to be especially noted that, although the recording speed is rather high, neither the film carrier nor the recorders move at this speed, the high speed mentioned being due to the relative motion of recorder and film. This means that considerable wear is saved in the apparatus.

One can readily see that by employing a suitable number of recorders moving at a proper speed, that photographic sound recording processes requiring a speed of six feet per second may be utilized so that they may be placed on a film that is moving at the standard motion picture speed of one foot per second.

For a more complete understanding of the invention, reference is to be had to the following description and claims taken in connection with the accompanying drawings, in which like characters of reference denote corresponding parts in all the views, and in which,

Figure 1 is an elevational view showing an electrical reproducing device.

Figure 2 is a cross sectional view on line BC of the rotating film carrier.

Figure 3 is an elevational view of an electrically operated, mechanical sound recorder placed on a radial arm.

Figure 4 is a plan view of a photographic

sound recorder placed on a radial arm, also illustrating the detachable nature of the latter.

Figure 5 is a plan view of a device employing mechanical recording, whereby the non-functioning recorder is raised from the film surface at the proper time.

Figure 6 is a side view of a mechanical recording arrangement.

Figure 7 is a view showing the radial arms, stationary cam and contacts for raising recorder from film surface.

Figure 8 is a plan view of the disk attached to the hollow tubes, showing the passage in the valve body above.

Figure 9 is a cross sectional view of the valve body, showing the communicating passages made with the tubes below.

Figure 10, *a* and *b*, are diagrammatic views showing the arrangements of two and three recorders, respectively.

Figure 11 is a diagrammatic view showing two recorders adapted to play on each margin of the film.

Figure 12 is an elevational view showing the recorder diaphragm placed at the center of the revolving element, with styli extending as radial arms.

Figures 13 and 14 show another type of valve arrangement.

Figure 15 is a diagrammatic illustration of a reproducing apparatus provided with an amplifier and in cooperative relation to a projector screen.

Figure 16 is a diagrammatic illustration of the arrangement of apparatus for recording.

Figure 17 corresponds to Figure 1 but includes the photo-electric reproducer of Figure 4 and additional means for supporting the film.

There are many ways of carrying out the invention, and although certain structures will be described in detail, the invention is not limited to them. The film A is passed around the large sprocket wheel 1, contact roll 10 holding it in engagement with sprocket teeth 11, as shown in Figure 1. The film then passes over a smaller sprocket 13, to which is rigidly attached the gear wheel 5. It is obvious that sprocket 13 may pull the film forward. Wheel 5 communicates motion through wheel 4 to wheel 3, which is rigidly attached to shaft 14, which carries the radial arms 2, also rigidly attached to it, and bearing recording or reproducing means at their extremities. Toothed gear wheels 3, 4 and 5 are so proportioned that the devices at the extremities of the radial arms move, while in contact with the film surfaces, at a speed which is equal to (when two arms are employed) that of the film, but in the opposite direction. Obviously, the relative speeds of film and recorder passing over it, will be equal to the sum of their individual speeds. Consequently, if the speed of the film is one foot per second, the recording speed is twice this, or two feet per second. One can readily see that if the gearing is so arranged that the recorders move at a speed double that of the film, and three recorders are used, three records will be impressed, and the recording speed will be three feet per second. Four recorders with a speed of three feet per second would mean a recording speed of four feet per second, and so on.

It is obviously necessary to employ some means whereby only that recorder that is actually impressing its own specific record is in actual operation at any given time, all others being temporarily eliminated from activity. A very satisfactory method of accomplishing this is by the use of electricity, and this will now be described. Other methods will be described later. For this purpose, the commutator 6, Figure 2, is adjustably attached to the shaft, by means of set screws, or the like in such a position that brush 7 cuts out of circuit the recorder or recorders not functioning, and connecting only the recorder that is functioning. The commutator is shown in this case provided with two segments, 6*a* and 6*b* one being attached by wire 9 to the device at the extremity of one radial arm, and the other attached by wire 8 to the other recording device. The wire 9 passes through shaft 14 which may be provided with suitable conducting passages, 9*a*. In the drawing, the radial arms, shaft, etc., form part of the circuit, in which case only one brush 7 is necessary.

In Figures 1 and 2, the radial arms 2 are provided with simple electrical contacting brushes, for the purpose of electrically reproducing a photographic sound record described in my Patent Number 1,698,536. The two contact brushes are shown at 15. Figure 3, however, shows a radial arm provided with an electrically operated, mechanical sound reproducer 17, provided with the stylus 18. The wire 8 and the metal body of the apparatus connects this device with the external reproducing circuit.

However, wires may be used throughout for the circuit connections, and also more than one brush may be used in connection with the commutator. Besides the adjustment of the position of the commutator on the shaft, obviously the brush 7 may be attached to a movable support, as is usual in electrical machinery, whereby it also may be moved to the most favorable position to obtain the best results.

The operation of the apparatus is perfectly simple. A device similar to that shown in Figure 1 may be attached to a camera or projector, and so connected that sprocket 13 is driven at standard motion picture feed, whereupon the recorder or re-

producer will move in the opposite direction at the same speed (if but two recorders are used), with the result that the recording or reproducing speed is double that of the film, or about two feet per second.

The large sprocket wheel 1 is not fixed to the shaft 14, but is permitted to revolve freely upon it, and is held in position by the disks 12 and 12′, which are fixed firmly to the shaft, and which allow just sufficient play to let wheel 1 revolve freely without vibration. In the drawings, this wheel is shown as being operated by the film as it is drawn through the picture machine. However, a special gearing could be provided to move it directly, if desired.

Strong emphasis is placed on the recording or reproducing apparatus, of which Figure 3 is an illustration of the reproducer. This consists of a stylus operated by a telephone receiver to produce the sound record, and a stylus operating a microphone to reproduce it. This arrangement permits of electrical connections throughout, permitting the use of a commutator, as well as the actual reproduction of the sound record at a distance from the reproducer 44, Fig. 15, such as for instance at a projection screen 41. Moreover, the use of microphones 48 or the like in the camera 47 permits the use of special electrical apparatus 45, not otherwise available, whereby amplification of the sound record may be attained. Such amplifying means 43 are also available in the reproduction of the sound record by the reproducing apparatus indicated at 44, Fig. 15. The alternate connecting and disconnecting of the recorders is also more effectively accomplished by the employment of an electrical commutator. The set screw 16 rigidly fastens the disk 12 to shaft 14. Recorder 17 is detachable from the radial arm.

Figure 4 shows a photographic recorder 21, consisting of a small tungsten incandescent tubular lamp attached to the extremity of the radial member. It is firmly held in position by the screw 19, while electrical connection is made by the wire 8 and conducting metallic body of the arm. The radial arm may be detached from the disk by unscrewing the threaded end 20 out of the corresponding socket. Any type of sound recorder may thus be attached to the radial arm. The term radial member may be construed to mean not only the mechanical device but also a device that is partly made up of a light beam, which is directed by proper apparatus toward the moving film to chemically alter it. One readily sees that the invention is not concerned with any specific type of sound recording, but with a means of recording sound at a speed that is greater than that of the moving medium upon which the sound is recorded.

If it is desired to record or reproduce without the use of electricity, recourse may be had to the device illustrated in Figures 5, 6 and 7. Here the film is wound upon the revolving film carrier as before. The shaft 14 is made hollow. The recorders 22 connect with the hollow shaft by means of the hollow radial members 23, having the flexible element 24, which may be either a section of rubber tubing or the like, or a sliding joint; this is designed to permit of the recorders 22 being lifted in turn from the surface of the film, by operation of the connections 25 provided with the shoes 26, which coact with the stationary cam 27. The cam is stationary, while the arms revolve. Gear wheel 3 is attached to the shaft 14, which is provided with the passage 34. External connection is made by means of a swivel or other flexible joint, which permits turning but is sufficiently sound tight. The action of spring 28 holds the shoes 26 in firm contact with the cam 27. Wheel 13 moves the film and toothed gear wheel 3, 4 and 5 move the radial members in the opposite direction as in Figure 1. It is to be understood that actual contact with the film is only made through part of the circumference of film carrier 1, namely the lower part shown in Figure 6. The radial member lifts the recorder completely away from the film surface when it reaches the upper part of the circumference, as shown in Figure 6; no trouble is occasioned by the ravelling and unravelling of the film at the point where they leave or arrive at the rotating member. The exact contour of the cam shown is not implied in the drawings, as it may be made in many forms other than that shown at 27, Figure 7.

Another modification, whereby the film is in contact with both recorders or reproducers at all times, commutation being made by means of a valve arrangement, is shown in Figures 8 and 9. A disk 30 is rigidly attached to the radial arms 23, and communicates therewith by means of the openings 31. Above this disk is placed the stationary valve body 33 having the passage 32 located directly over the disk 30. Passage 32 communicates with sound tube 34. Tubes 23 are isolated from each other by diaphragm, or partition 35. Moreover, those tubes are rigidly attached to shaft 14 as above described. It can be readily seen that as the radial tubes revolve together with disk 30, openings 31 communicate alternately with passage 32, so that at any given time, but one sound device is recording or reproducing. In other words, only the functioning recorder is in action.

Many other mechanical arrangements are possible, but it is not deemed necessary to illustrate them here. Where the radial members are made up of reciprocating parts, it is best to provide guides as shown at 29.

Figure 10, *a*, illustrates diagrammatically the arrangements of the radial members when three are used, the speed being double that of the film by suitable gearing; the recording speed is thus three times the film speed. Figure 10 *b* illustrates the arrangement diagrammatically when four radial members are employed; their speed is three times that of the film, the recording speed being four times that of the film. Figure 11 is also a diagrammatic view showing a method of using four radial members, two being one each side of the film and coacting therewith; the recording speed in such case is also four times film speed. Figure 12 illustrates the fact that the recording diaphragm may be located at the center of the revolving film carrier, while the styli extend as radial arms. All of those figures merely illustrate different ways in which the fundamental principles underlying the invention may be carried out. The invention embraces them and many other modifications.

If the photographic method of reproducing is used, the selenium cell or equivalent 53, Fig. 17, can be made in the form of slit arranged in a semi-circle, corresponding to the form of the curved film. The effective part of the cell will be thus in the form of a long, narrow slit over which the light recorder on the radial arm 52, illustrated in detail in Fig. 4, passes longitudinally. Consequently, as the light is not stationary, a heat-absorbing means will be unnecessary.

By making the rotating film carrier 1 of very large diameter, the styli would remain in contact with the film for a much longer period. Also the possibility of the commutation of the different reproducers being audibly detected by the audience would be minimized.

Each recorder contacts with the precise portion of the film as regards right or left throughout the length of the film. As the latter is held rigidly in position, the proper sound reproducer finds its corresponding groove with absolute precision.

By making shaft 14 sufficiently long and adding one or more extra arms similar to 2 and 2′ and spacing them equidistantly on the shaft, and changing the gearing to rotate them at the proper speed, which is a multiple of the film speed, the sound recording speed is thus increased. The electrical connections and commutator must be also adjusted to correspond. The flexibility of the mechanism is obvious.

In order to offer a firm support to the film while the recorder or reproducer is passing over its surface, an endless belt 57, Fig. 17 made of a substance approximating the density of ordinary phonograph record backing material, such as waxed paper, may be arranged so as to pass around the contact roll 10 and sprocket 13. This belt may be provided with a slack adjuster or idler consisting, for instance of a weighted pulley 61, the weight being indicated at 62.

Wheels 3, 4 and 5 are supported on any suitable frame work 42. Power is preferably applied to 5 or 13, so as to move the film at standard motion picture speed. The film, however, may be simply pulled through the apparatus by other sprocket wheels, such as indicated at 49 in Figure 1.

Laterally undulating sound recording has been very successful commercially, and as there is room for many such record grooves on the margin of a moving picture film, the invention offers a means of placing several such records there utilizing them to reproduce sounds. Moreover, by this means a recording speed is available that is in excess of that used in commercial sound recording.

An advantage of electrical commutation is that a record can come into contact with the film for a time before it is actually brought into electrical connection.

Having thus described my invention, I claim as new and desire to secure by Letters Patent:

1. Phonographic apparatus adapted for sound records on film, comprising a means including a large wheel directly supporting that portion of the film laterally adjacent to that portion of the sound record from which sound is reproduced, whereby said apparatus operates in a uniform manner, the sound record portion being unsupported thereby.

2. A phonographic apparatus adapted for operation with motion picture film having a sound record thereon comprising a large wheel in cooperative relation with the film adjacent the recording or reproducing point whereby said apparatus operates in a uniform manner and means independent of said wheel for pulling the film through the said apparatus.

3. Phonographic apparatus adapted to operate with film having a photographic sound record thereon comprising a large wheel in cooperative relation with the film laterally adjacent the operational point, whereby said apparatus operates in a uniform manner, the sound record portion being unsupported thereby and means independent of said wheel for pulling the film through the said apparatus.

4. Phonographic apparatus adapted for operation with film having a photographic sound record thereon comprising a sound recording or reproducing means and a large wheel in cooperative relation with said film adjacent the said means for recording or reproducing, whereby said apparatus operates in a uniform manner and additional means for feeding the film through said apparatus.

5. In an apparatus of the class described a wheel adapted to support a motion pic-

ture film having a sound record thereon, said wheel being relatively large, whereby said apparatus operates in a uniform manner, sound reproducing means in cooperative relation to said record adjacent to said wheel, and means independent of said wheel for drawing said film through said apparatus.

6. A phonographic apparatus adapted to operate with film having a photographic sound record thereon comprising a large wheel in cooperative relation with the film adjacent the recording or reproducing point and means uniformly contacting with the portion of the film upon said wheel for maintaining the same in uniform cooperative relation with said wheel.

7. In a sound reproducer for motion picture film having a sound record adjacent the edge thereof, in combination, a large wheel adapted to support the film adjacent the reproduction point, whereby said apparatus operates in a uniform manner means for maintaining the film on the wheel with the sound record over-hanging the edge thereof, sound reproducing means adapted to cooperate with the sound record on the over-hanging edge of said film, and means independent of said wheel for drawing said film through said apparatus.

8. Phonographic apparatus adapted to operate with photographic sound records on film comprising a large wheel in cooperative relation with the film adjacent the operational point whereby said apparatus operates in a uniform manner, means comprising a yieldable idler for maintaining said film in cooperative relation with said wheel, whereby said film is firmly supported upon said wheel, and means independent of said wheel for pulling the film through the said apparatus.

9. In a sound reproducer for motion picture film having a sound record adjacent the edge thereof, in combination, a large wheel adapted to support the film at the reproduction point, whereby said apparatus operates in a uniform manner and yieldable means including a belt passing over the film upon said wheel and a yieldable idler maintaining said belt under tension for maintaining the film on the wheel with the sound record overhanging the edge thereof.

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