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Harris

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[54] **MOTION PICTURE SOUND PROCESSING APPARATUS**

[76] Inventor: **Hilary Harris,** 49-A Eighth Avenue, New York, N.Y. 10014

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[52] **U.S. Cl.** **352/17,** 352/129

[51] **Int. Cl.** **G03b 31/04**

[58] **Field of Search** 352/12, 15, 16, 17, 352/129

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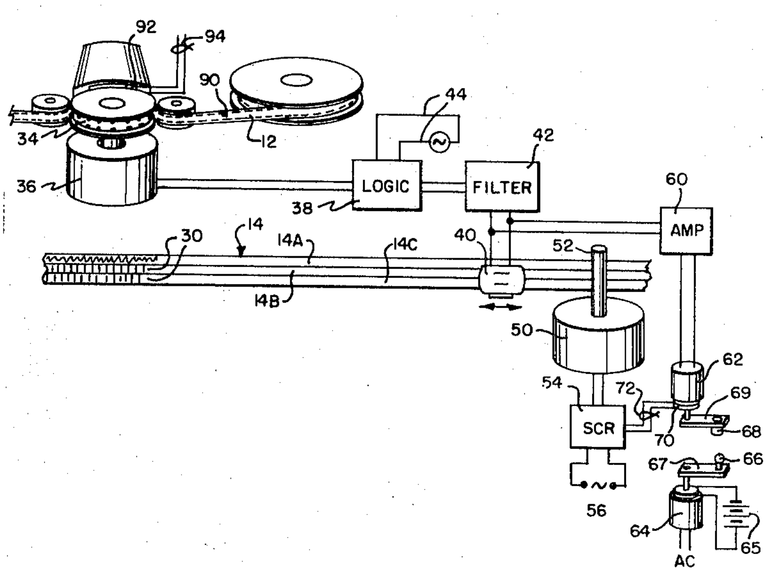
Primary Examiner—Samuel S. Matthews
Assistant Examiner—Michael L. Gellner
Attorney—Darby & Darby

[57] **ABSTRACT**

Apparatus is described for processing motion picture film and audio sound data recorded on standard sprocketless magnetic tape. A tape synchronizing system is used in which the film is driven by a stepper motor which, in turn, is controlled by synchronizing pulses recorded on tracks of the audio tape. The film can be driven in forward and reverse directions at various speeds, with exact synchronization being maintained between the film and tape during editing.

After the sound tracks have been recorded and assembled on their respective tapes, they can be mixed under the control of conductive strips placed on the film which, through a special programming unit, control the starting and stopping of the various tapes.

2 Claims, 3 Drawing Figures



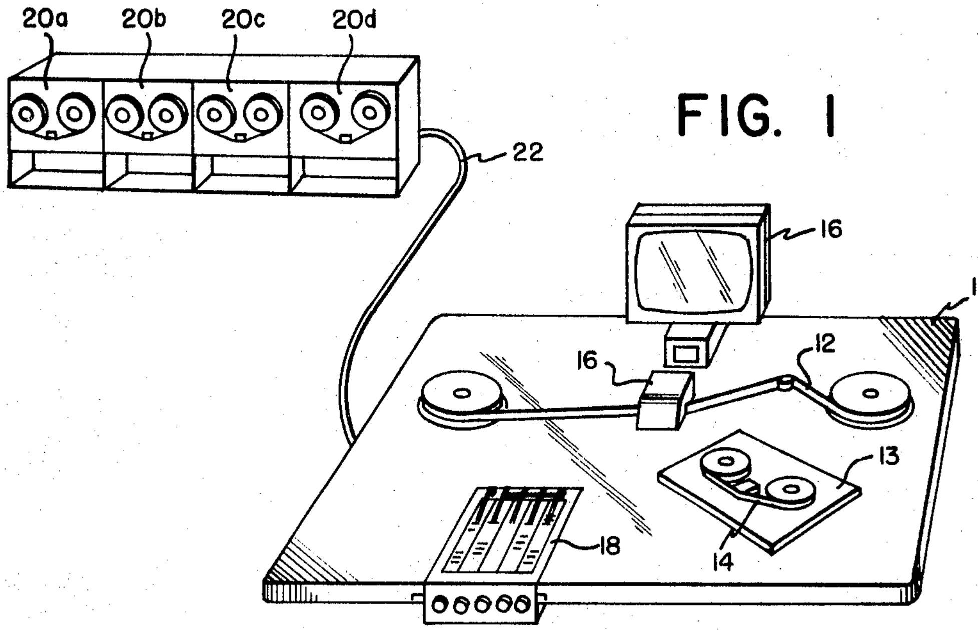


FIG. 1

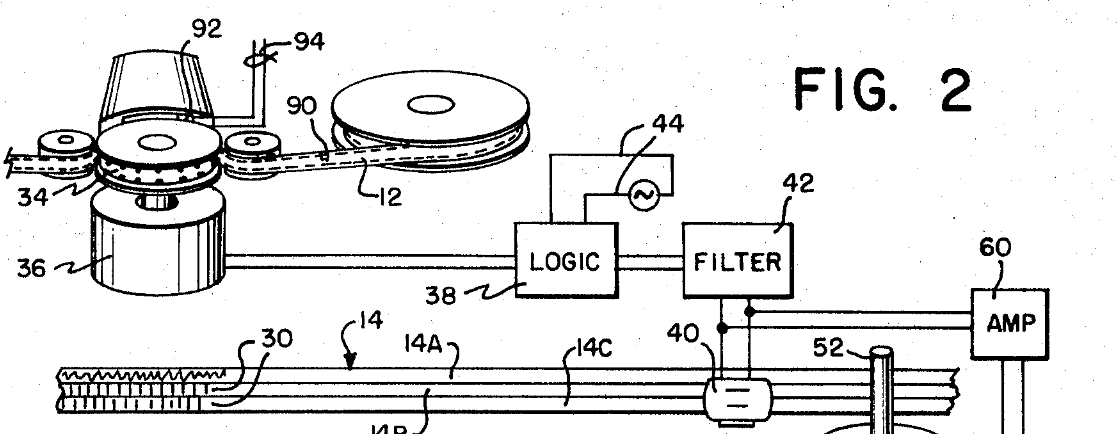
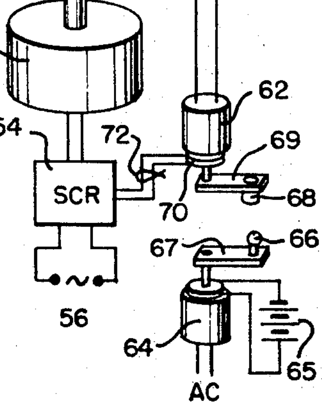



FIG. 2

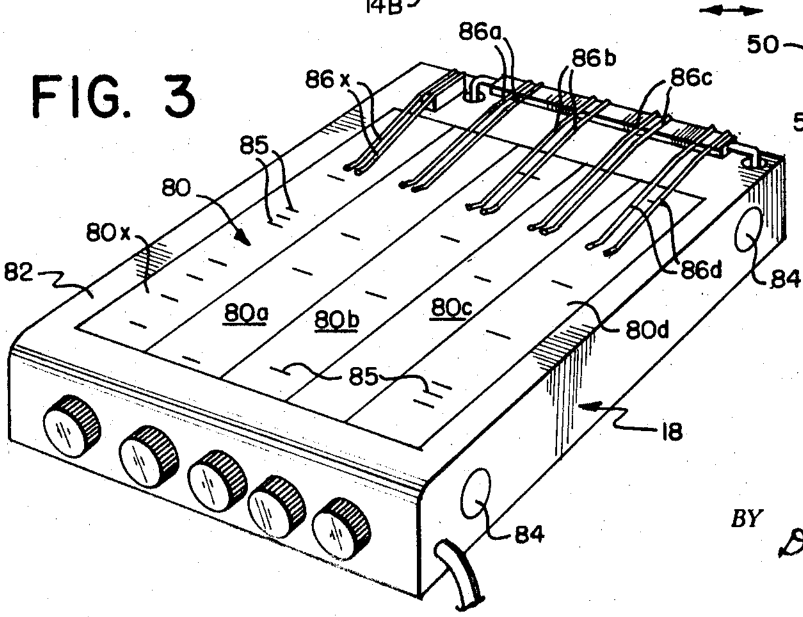


FIG. 3

INVENTOR.
HILARY T. HARRIS

BY Darby & Darby

ATTORNEYS

MOTION PICTURE SOUND PROCESSING APPARATUS

This invention relates to apparatus for processing motion picture film in conjunction with sound. More particularly, the present invention relates to apparatus for editing motion picture film and for mixing a plurality of sound tracks to yield a final mix.

In the production of motion pictures, it is standard practice to use a number of different sprocketed sound tracks. For example, such sound tracks may contain audio corresponding to dialogue, music, sound effects, etc. In producing the final sound track, it is necessary to combine these multiple sources into a single track which, of course, must correlate with corresponding frames of the film. In some cases (for example, the dialogue) the recorded audio must be accurately synchronized with the film images. In other cases (such as background music) precise synchronization is not required.

In practice, the production of a motion picture wherein multiple sound tracks must be mixed in a cumbersome and expensive undertaking. The present invention provides apparatus which is convenient to use and relatively inexpensive, which produces high quality results in a relatively short time, and which, most importantly, gives the film editor greater "feel" for the final effect of the picture. It permits production of sound tracks on convenient sprocketless magnetic tape while maintaining exact synchronization (where required) between the sound track and film during editing for tape movement in forward or reverse directions.

The processing unit, in the preferred embodiment, also includes a means for mixing or combining all of the various sound tracks, including those produced pursuant to the foregoing. According to this feature of the invention. The various sound tracks are recorded on individual magnetic tapes. A special programmer operates each of these tapes only when it is desired to add the sound recorded on that tape to the final mix.

Briefly, the invention comprises an editing table on which a film-viewing mechanism and a magnetic tape deck are supported. The film is driven by a stepper motor either under control of the line voltage or synchronization pulses recorded in special tracks on the magnetic tape. The film includes conductive strips at preselected positions which cause a special programmer unit to actuate one or more of a plurality of additional tape decks to add the sound recorded on their associated tapes to the final mix when desired.

The invention is described in further detail below with reference to the annexed drawings wherein:

FIG. 1 is a diagrammatic illustration of the physical layout of a system embodying the invention;

FIG. 2 is a block diagram of the system used by the invention to synchronize the tapes and film with respect to each other and also to synchronize the tapes and films with the line frequency; and

FIG. 3 is a semidiagrammatic illustration of the programmer used in the preferred embodiment of the invention.

FIG. 1 illustrates the components of a preferred embodiment of the system and is intended to illustrate the manner in which the invention is used for editing and mixing. In FIG. 1, a basic editing table is illustrated at **10**. A standard sprocket-type projector mechanism (not numbered) is mounted on table **10** for driving the motion picture film **12**. As the motion picture film **12**

is driven in either direction, an image is projected and displayed by means of a viewing apparatus **16**. A tape deck **13** containing conventional ¼ inch magnetic tape **14** is also mounted within table **10**.

A removable programmer **18** is inserted into a suitable opening in the front portion of table **10**. Four (for example) separate tape decks **20*a***, **20*b***, **20*c*** and **20*d*** are mounted at a convenient distance from the table **10** and connected to the programmer circuitry by means of a cable **22**. Programmer **18** contains the controls which determine the mode of operation of the system as explained below.

For purposes of explanation it is assumed that it is desired to prepare and mix two sound tracks containing, respectively, music and dialogue. These two tracks may be considered as the tracks which are stored on the tapes of decks **20*a*** and **20*b***. As the first step in the editing process, it is necessary to synchronize exactly the dialogue on the tape of deck **20*b*** with the appropriate frames of motion picture **12**. As explained below, this tape will have been recorded with special synchronizing pulses (derived from line frequency) in two sync tracks on the tape. Thus, this dialogue tape will be placed on tape deck **13** within the editing table **10**. A suitable switch (not shown) on the programmer control panel is then actuated to place the system in a TAPE-SYNC mode. In this mode, the synchronizing pulses on the magnetic tape are used to drive the motion picture film **12** so that exact synchronism is maintained between the sound track on tape deck **13** and film **12**. During this process, the user can move this sound track in forward or reverse directions, either manually or under the control of the motor of tape deck **13**, and the film **12** will follow the tape movement. After the film has been edited as desired, the tape bearing the dialogue is returned to the tape decks **20b** so that it can be used as part of the final mix.

In compiling all of the sound tracks, programmer **18**, as explained below, causes each of the tape decks **20*a*–20*d*** to operate its tape at appropriate intervals so that the information on the various sound tracks can be combined and recorded on a new tape on deck **13** within table **10**. After this mix has been completed, the sound track on tape **14** can be recorded at a later time on the motion picture film **12** by conversion to an optical sound track in the usual way.

FIG. 2 illustrates in block diagram form a preferred embodiment of the invention. As diagrammatically illustrated, tape **14** may be considered to include an audio channel **14A** and two synchronization tracks **14B** and **14C**. The lines **30** in tracks **14B** and **14C** represent the synchronizing pulses recorded in the respective tracks and illustrate that the pulses recorded in the synchronizing tracks are slightly offset with respect to each other. The synchronizing pulses **30** are recorded as the information in channel **14*a*** is recorded and can be derived directly from the 60-cycle line frequency which is fed to the tape-driving motor during recording. Alternatively, the synchronizing pulses may be added to a previously recorded tape.

Film **12** is driven in the usual fashion by means of a sprocket **34** which engages the standard sprocket holes within the film **12**. According to this feature of the invention, the sprocket reel **34** is rotated by a stepper motor **36** which is controlled by a logic circuit **38** in response to the sync pulses **30** on tracks **14B** and **14C** of tape **14**. The sync pulses **30** are detected by an oscillating transducer **40** and coupled through a filter **42** to the inputs of the logic circuit **38.**

Logic circuit **38** may comprise a known device which is capable of driving stepper motor **36** in forward or reverse directions depending upon the sequence in which the sync pulses **30** from tracks **14B** and **14C** are received. For example, assuming that the forward direction of tape **14** is left to right, if the pulses in track **14B** occur prior to the sync pulses in track **14C**, logic circuit **38** will drive the stepper motor **36** in a forward direction. If the pulses in track **14B** occur after those in track **14C**, logic circuit **38** will drive the stepper motor **36** in a reverse direction.

As illustrated in FIG. **2**, the logic circuit **38** also receives an input on line **44** from a standard 60-cycle alternating current source. When the stepper motor **36** is operated from this 60-sixty-cycle source, the film **12** will be driven at a rate of 24 frames per second, as determined by the reduction gears of the motor. Determination of whether the motor **36** is to be driven by the line current on lines **44** or the sync pulses derived from transducer **40** is at the option of the user with such selection being made in an obvious fashion by appropriate switches on the control panel. Where the motor **36** is controlled by the sync pulses **30** the rate of film movement will, of course, be directly dependent upon the rate of movement of tape **14.**

In some cases, during the editing process, it may be desirable to move the tape **14** at very low speeds. In such cases, a standard transducer may be unable to pick up the sync pulses because of the low induced magnetic flux. Hence, transducer **40** is caused to oscillate when the sync pulses reach a critically low voltage due to the low speed of the tape movement. A filter **42** may be used to reject signals above a predetermined frequency to block unwanted pulses.

The tape **14** is moved under the control of a DC motor **50** which drives a standard capstan **52** diagrammatically shown in FIG. **2.** The speed of motor **50** and the direction of rotation of the capstan **52** is controlled by a standard SCR speed and direction control circuit **54** which, in turn, is responsive to the sixty-cycle line voltage applied to terminals **56.** Control circuit **54** is conventional and gives the user the capability of moving tape **14** at a desired speed in forward or reverse directions during editing. Since the film follows the tape movement during the TAPE-SYNC mode, control circuit **54** is used as the system control during editing. The tape **14** may be moved manually for precise cueing or editing in which case the film will precisely follow the tape.

As described to this point, the system is capable of operating with both the film **12** and tape **14** driven by means of the sixty-cycle line current or with film **12** driven in synchronization with the tape **14.** In addition, the system includes a further mode of operation, a tape self-resolving mode, in which tape movement is accurately synchronized with the line frequency.

For the tape self-resolving mode, a servo system employing an amplifier and wave shaper **60** and two small synchronous motors **62** and **64** is used. Amplifier and wave shaper **60** produces a sine wave from the synchronizing pulses **30** on tracks **14B** and **14C** to drive motor **50.** The motor **64** is driven from the line current. A small light **66,** powered by a battery **65,** is mounted on a lever **67** extending from the output shaft of motor **64** and thus rotates with an angular velocity dependent upon the frequency of the line current. A photocell **68** mounted on a lever **69** rotates with the output shaft of motor **62.** A feedback path to the DC motor **50** is completed by deriving the voltage from photocell **68** by means of slip rings **70,** and this voltage is coupled by line **72** to the SCR speed and direction control circuit **54.**

The servo loop is such that the voltage on line **72** causes the control circuit **54** to drive motor **50** at a speed corresponding to the line frequency when photocell **68** is slightly in front of the bulb **66.** With this arrangement, the light received by photocell **68** can be increased (if the bulb catches up with it) or decreased (if the photocell draws further ahead of bulb **66**). Thus, if for any reason, the speed of tape **14** increases, photocell **68** will move ahead of the light bulb **66.** This will result in a decrease in the light intensity reaching the photocell **68** resulting in a lower voltage on line **72** to the speed and direction control circuit **54.** This lower voltage will reduce the speed of motor **50** until the tape is again synchronized with the line frequency. Similarly, if the tape **14** tends to lag, the bulb **66** will draw closer to photocell **68** resulting in an increased voltage on line **72** which will increase the speed of motor **50,** and thus the tape speed.

In this tape self-resolving mode, the magnetic tape is maintained at precisely the same relationship to the line frequency as when the sync pulses **30** were originally recorded on the tape. When the system is used for mixing, all film and tape playback units are operated in the self-resolving mode with the common 60-cycle line being used as a reference. In the TAPE-SYNC mode the film is not driven by the line frequency but by the pulses previously recorded on the tape; hence, the film **12** is resolved to the particular tape being played and would not run in synchronization with additional self-resolved decks. This means that the tape deck **13** must be self-resolving during mixing if it is to be used as one of the synchronized sound sources in the mix. On the other hand, this deck may be used free running (non-resolving) if the sound material is non-synchronous, or it may be used (probably the most common case) as the means for recording the final mix in which case sync signals would be recorded simultaneously on the sync pulse half of the tape for subsequent synchronous playback.

The programmer is shown in semidiagrammatic form in FIG. **3.** It includes a movable cue sheet **80** suitably mounted within a housing **82.** The sheet **80** may comprise a paper strip which is movable under the control of a pair of rollers **84.**

The cue sheet **80** includes a number of individual channels corresponding to the tape decks **20.** These channels are shown as channels ***80a***, ***80b***, ***80c*** and ***80d*** and correspond respectively to the tape decks ***20a***, ***20b***, ***20c*** and ***20d***. A fifth channel ***80x*** is used as a control track as will become apparent in the following.

Each of the channels contains data which, for example, may comprise a conductive pencil mark as indicated by the lines **85.** These marks may be contacted by feeler pairs ***86a–86d*** each pair, in a known way, causing a voltage output when both feelers are contacting a mark **85** and a lack of a voltage output when they are not contacting a mark. This information in the tracks ***80a–80d*** is used to control the starting of the respective tape decks ***20a–20d***.

The information contained in the control track **80*x*** is used to control the movement of the cue sheet **80**. This is done in response to a conductive strip **90** (see FIG. **2**) placed on the film **12** at each place where a different control operation is to occur. Strip **90** may be sensed by a feeler **92** and the output voltage coupled by lines **94** to the programmer shown in FIG. **3**.

The feeler pairs **86*a*–86*d*** are mounted on a vertically movable bar **95** so that they normally do not engage the cue sheet **80**. Each time a pulse is generated by strip **90**, bar **95** is moved downwardly by any suitable mechanism (not shown) to cause temporary engagement of the feeler pairs with cue sheet **80**. If a feeler pair is shorted by a mark **85**, its associated tape drive is energized. The tape drive may be de-energized by means of a conductive strip on the tape so that the tape turns itself off after a selected segment has played back. Rollers **94** continue to move the cue sheet **80** until the feeler pair **86*x*** is shorted by a mark **85** at which point the cue sheet **80** is stopped. When the next strip **90** on the film is sensed, another cycle starts.

The foregoing programming arrangement controls the entire mixing operation. Thus the user can correlate each of the tapes on decks **20*a*** with the film **12** by the suitable placement of these strips **90**. Those tapes which require exact synchronization are made while the film and tape are synchronized by means of the sync pulses **30** on tracks **14B** and **14C**. Thereafter, during the final mix, all of the audio tapes are driven in the tape self-resolving mode while the film is driven directly by the line current on lines **44**. Consequently, both the film and audio are accurately synchronized with the line frequency. The final mix provides the desired combination of all of the tapes in decks **20** with each tape running only during that period when its formation content is being transferred to the final tape.

What is claimed is:

1. Motion picture editing and processing apparatus, comprising

means for driving a motion picture film medium in preselected increments,

a tape deck containing a magnetic tape medium having audio data recorded thereon, said magnetic tape medium having a synchronizing track including trains of forward and reverse sync-driving pulses recorded therein,

variable speed drive means for driving said magnetic tape in forward and reverse directions,

means for viewing the frames of said motion picture film, and

means responsive to said sync-driving pulses for driving said film medium in forward and reverse directions depending upon the direction of movement of said magnetic tape, said film-driving means being responsive to the frequency of occurrence of said data pulses as determined by the rate of movement of said magnetic tape.

2. Apparatus according to claim **1**, further including self-resolving means for synchronizing said tape medium with respect to a preselected line frequency, said self-resolving means including means for comparing the frequency of occurrence of said sync-driving pulses derived from said synchronizing track with said preselected line frequency.

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