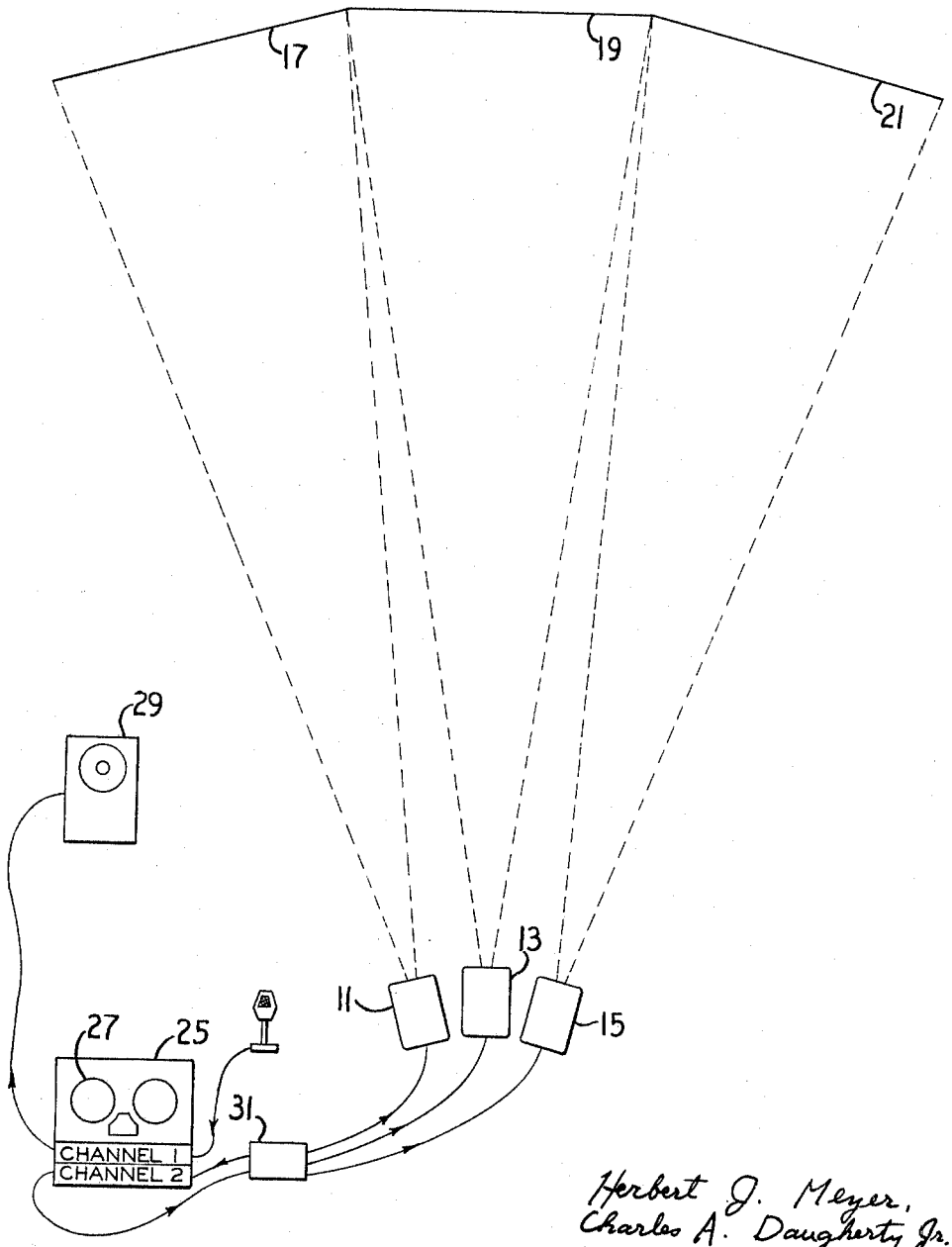
Nov. 25, 1969 H. J. MEYER ET AL 3,480,738

IMAGE DISPLAY APPARATUS AND METHODS

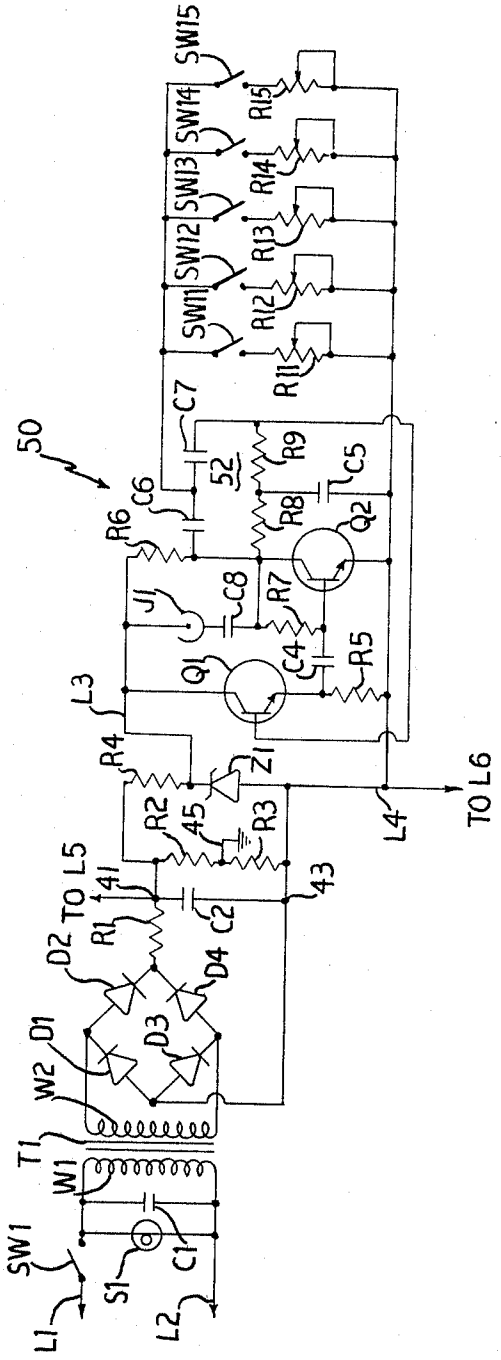
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FIG. 1.



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FIG.2.

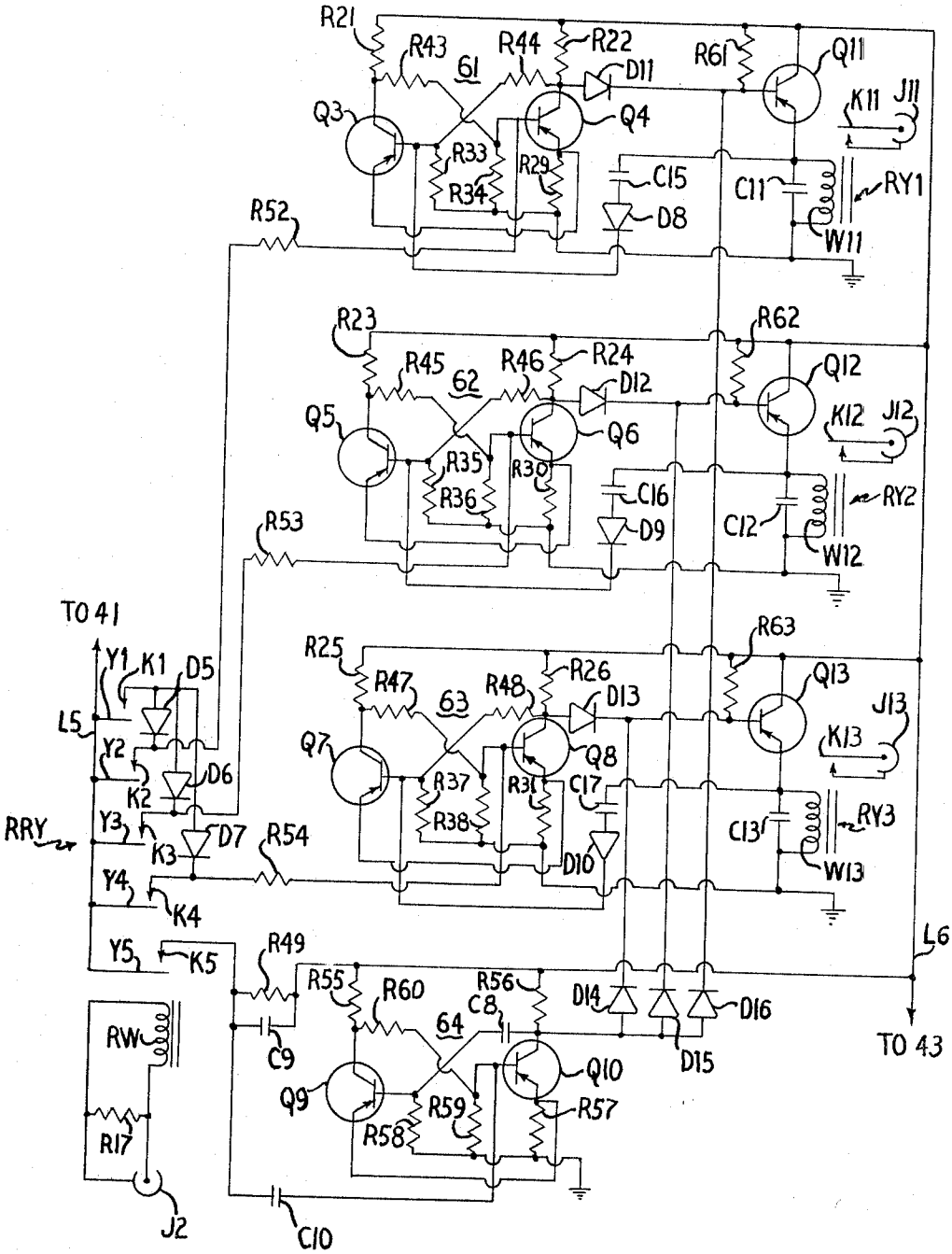

SW15
SW14
SW13
SW12
SW11
R15
R14
R13
R12
R11
C7
50
52
R9
C5
C6
R8
Q2
R6
J1
C8
R7
C4
R5
Q1
L3
R4
Z1
TO L6
L4
R2
45
R3
41
43
TO L5
R1
C2
D2
D4
D1
D3
W2
T1
W1
SW1
S1
C1
L1
L2

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IMAGE DISPLAY APPARATUS AND METHODS

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FIG.3.



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3,480,738

IMAGE DISPLAY APPARATUS AND METHODS

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Int. Cl. G11b 5/00
U.S. Cl. 179—100.2 6 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus for operating a plurality of image display devices in predetermined sequence in timed relation with the playing of a recorded audio program. A tone generator selectively provides a different tone signal for each of the display devices, the tone signals being commonly recordable with the audio program on recording media. Frequency discriminating means are operative during playback of the media for providing a respective electrical signal for each tone signal played back. Also provided are means selectively responsive to each of the electrical signals for operating the respective display device.

The present invention relates to methods and apparatus for displaying images and more particularly to such methods and apparatus for operating a plurality of image display devices in timed relation with the playing of a recorded audio program.

In communicating information by audio-visual programs and particularly when using such programs in teaching, it has been found to be highly advantageous to be able to present several images simultaneously to the viewer rather than sequentially. If several images are presented sequentially, the viewer is required to relate each image to previous ones by memory. In other words, he must carry forward in his mind whatever information is needed for comparisons and correlations. In contrast, when the information is presented by multiple, simultaneous images, related content in the images becomes readily apparent and the viewer is relieved of the extraneous burden of recollecting previously seen information in order to establish the relationships between the images. The viewer's faculties thus may be more efficiently applied to the primary task of assimilating the particular message being presented. In the presenting of such images simultaneously, it is also highly desirable that the different images can be controlled or changed independently of one another. That is, each of the separate images should be capable of being changed in its own respective predetermined sequence. Further, it is also desirable that the changing of the different images be controlled automatically in timed relation to the audio portion of the program being presented.

Among the several objects of the present invention may be noted the provision of methods and apparatus for operating a plurality of image display devices in predetermined sequence in timed relation with the playing of a recorded audio program; the provision of such apparatus which permits the sequences to be easily preselected and changed; the provision of such apparatus in which a plurality of image display devices may be operated simultaneously; the provision of such apparatus which permits the display devices to be next operated to be preselected in advance of their operation and to then be operated in precisely timed relationship to the audio program; and the provision of such apparatus which is highly reliable; the provision of such apparatus which is relatively simple and inexpensive; and the provision of such apparatus which permits the use of conventional and

readily available image display devices and audio recording equipment.

Other objects and features will be in part apparent and in part pointed out hereinafter.

Briefly, apparatus according to the present invention will operate a plurality of conventional image display devices in predetermined sequence in timed relation with the playing of a prerecorded audio program. The apparatus includes a tone generator which is operated to selectively provide a different tone signal for each of the display devices to be operated during the program. The tone signals are recorded with the audio program, preferably on a separate channel of a multi-channel recording media. Frequency discriminating means are provided for responding to the recorded tone signals during playback of the audio program. The frequency discriminating means provide a respective electrical signal for each of the tone signals played back. Means are also provided which respond to each of the different electrical signals for operating the respective display devices.

The invention accordingly comprises the apparatus and methods hereinafter described, the scope of the invention being indicated in the following claims.

In the accompanying drawings, in which one of various possible embodiments of the invention is illustrated.

FIG. 1 illustrates one possible arrangement of a plurality of image display devices which are controlled by apparatus according to the present invention in cooperation with audio recording apparatus;

FIG. 2 is a schematic circuit diagram of a tone signal generator employed in the control apparatus of FIG. 1; and

FIG. 3 is a schematic circuit diagram of frequency discriminating apparatus also employed in the control apparatus of FIG. 1.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

Referring now to FIG. 1 there are indicated at **11**, **13** and **15** conventional magazine-loaded slide projectors. Projectors **11**, **13** and **15** are preferably of the type including a solenoid which is energized to change slides. Each projector therefore displays images in the preselected sequence determined by the order in which the slides are placed in the respective magazine. The slides displayed by the projectors **11**, **13** and **15** are projected on respective screens **17**, **19** and **21**.

A conventional stereo tape recorder is indicated at **25**. Recorder **25** employs as a recording media a conventional magnetic tape **27**. The audio portion of the program to be presented is recorded on one track of tape **27** as, for example, by means of a microphone as indicated at **28**. The audio program may then be played back through the first channel of recorder **25** by means of a loud speaker **29**.

At **31** there is indicated a controller according to the present invention. As is described in greater detail hereinafter, controller **31** includes a tone generator which may be selectively operated to provide a plurality of different tone signal. Different ones of the tone signals represent respective ones of the projectors **11**, **13** and **15**. The tone signals are recorded on a second track of tape **27** in timed relation to the points in the audio program at which the respective projectors are to be operated. The tone signals may be recorded simultaneously with the orignal recording of the audio program or the tone signals may be added to the tape during a later run-through of a prerecorded audio program.

When the audio program is played back, the recorded tone signals are played back through the second channel of recorder **25**, into controller **31**. Controller **31** responds selectively to the different tone signals, as described in

detail hereinafter, to operate each of the projectors **11**, **13** and **15** in the desired sequence and with the desired timing relative to the audio program.

Referring now to FIG. 2, A.C. current for powering controller **31** is obtained from any suitable source or supply mains through a pair of leads L1 and L2. An on-off switch SW1 is interposed into line L1. Connected across the switched power source is an indicator lamp S1, a noise filtering capacitor C1 and the primary winding W1 of a transformer T1. Transformer T1 includes a secondary winding W2 which provides A.C. power to a full wave bridge rectifier constituted by diodes D1–D4. The pulsating D.C. provided by the bridge rectifier is filtered by a resistor R1 and a capacitor C2 to provide a steady source of D.C. between a pair of terminals **41** and **43**. A voltage divider constituted by a pair of resistors R2 and R3 is connected across terminals **41** and **43** and the junction between resistors R2 and R3 is grounded, as indicated at **45**, so that the terminals **41** and **43** are of opposite polarity with respect to ground.

A voltage divider constituted by a Zener diode **21** and a resistor R4 is also connected across terminals **41** and **43** so that the Zener diode provides a source of regulated D.C. power to a pair of leads L3 and L4.

A pair of NPN transistors Q1 and Q2 are connected in a phase-shift oscillator circuit **50** which constitutes the tone generator referred to previously with reference to FIG. 1. The collector of transistor Q1 is connected directly to supply lead L3 and its emitter is connected to supply lead L4 through a load resistor R5. The emitter of transistor Q1 is also coupled to the base of transistor Q2 through a coupling capacitor C4. The emitter of transistor Q2 is connected directly to supply lead L4 and the collector is connected to supply lead L3 through a load resistor R6. Transistor Q2 is forward biased by a resistor R7 interconnecting its collector and base.

The collector of transistor Q2 is connected to the base of transistor Q1 through a phase-shift network **52** to provide a regenerative feed-back loop at a predetermined frequency. Phase-shift network **52** comprises a so-called parallel-T filter including a low pass "T" type filter having a pair of series resistors R8 and R9 and a shunt capacitor C5 in parallel with a high pass "T" type filter having a pair of series capacitors C6 and C7 and a shunt resistance constituted by a selected one of a plurality of rheostats R11–R15. The particular resistance which is operative is selected by closing a respective one of a similar plurality of switches SW11–SW13 connected in series with the respective rheostats R11–R15.

The closing of one of the switches SW11–SW15 causes the phase-shift network **52** to have a negative transfer characteristic at some preselected frequency so that there is, at this frequency, positive feedback around the cascaded transistors Q1 and Q2. The circuit **50** will thus oscillate at the preselected frequency. In the circuit shown, five different frequencies may be produced by closing different ones of the switches SW11–SW15. An A.C. signal at the oscillator frequency is coupled to an output jack J1 through a coupling capacitor C8. By coupling jack J1 to the channel **2** input terminal of tape recorder **25** as shown in FIG. 1, the various tone signals which can be generated by oscillator **50** may be recorded at preselected points along the audio program by appropriate closing selected ones of the switches SW11–SW15. As will be understood by those skilled in the art, other type of oscillators and combinations of them may also be used to generate tone signals suitable for recording.

D.C. power is also supplied from terminals **41** and **43** to the frequency discriminating apparatus illustrated in FIG. 3, a positive supply line L5 being connected to terminal **41** and a negative supply line L6 being connected to terminal **43**, there also being an appropriate ground connection between the two portions of the controller circuit. The FIG. 3 circuit includes a resonant reed relay RRY having five vibratory reeds Y1–Y5. Each of the reeds Y1–Y5 is connected to the positive supply line L5. Associated with each reed Y1–Y5 is a respective contact K1–K5 which is contacted by the respective reed when that reed vibrates at its characteristic frequency. Resonant reed relay RRY also includes a winding RW1 for magnetically driving the reeds. Winding RW1 is connected to a jack J2 and is shunted by a resistor R17. By means of the jack J2 the resonant reed relay RRY can be coupled to the channel **2** output of tape recorder **25** so that the reeds Y1–Y5 will respond to tone signals recorded on the second track of tape **27**.

Associated with each of the reeds Y2–Y4 is a bistable multivibrator or so-called flip-flop circuit **61–63**. Each of the bistable circuits **61**, **62** and **63** includes a pair of PNP transistors Q3 and Q4, Q5 and Q6, and Q7 and Q8 respectively. Each of the transistors Q3–Q8 is provided with a respective load resistor R21–R28. The emitters of the transistors in each bistable circuit are connected together and to ground through a common emitter load resistor R29–R31. The base terminal of each of the transistors Q3–Q8 is biased to ground through a respective resistor R33–R38. Cross coupling between the paired transistors is provided by resistors R43–R48 which connect the collector of each transistor to the base of its mate transistor in conventional manner. As is understood by those skilled in the art each of the bistable multivibrator circuits is stable in each of two complementary states. In the first state the right-hand transistor is conducting and the left-hand transistor is cut-off. In the second state the left-hand transistor is conducting and the right-hand transistor is cut-off. The bistable circuit may be caused to change between the two states by appropriate signals applied to the base terminals of the transistors.

Each of the contacts K2–K4 is connected, through a respective current limiting resistor R52–R54, to the base of the right-hand transistor in the respective bistable circuit, for example, contact K2 is connected to the base of transistor Q4. Each of the bistable circuits is normally maintained in its first state with the left-hand transistor being cut-off. When one of the reeds Y2–Y4 is driven at its resonant frequency a positive pulse of current is applied to the prospective contact K2–K4. This pulse, coupled to the base of the right-hand transistor in the respective bistable circuit, causes that circuit to change states so that the right-hand transistor is turned off. The contact K1 is connected, through isolating diodes D5–D7, to the contacts K2–K4 so that operation of the reed Y1 will effectively operate in the same manner as simultaneous operation of all of the reeds Y2–Y4.

Associated with the resonant reed Y5 is a pulse generating circuit **64** comprising a pair of transistors Q9 and Q10. The collector of each of these transistors is connected to the negative supply line L6 through a respective load resistor R55 and R56 and their emitters are connected together and to ground through a common emitter load resistor R57. The base of each of transistors Q9 and Q10 is biased toward ground by a respective resistor R58 and R59. D.C. cross coupling is provided from the collector of transistor Q9 to the base of transistor Q10 by a resistor R60 and transient or A.C. cross coupling is provided from the collector of transistor Q10 to the base of transistor Q9 by a capacitor C8.

Contact K5 is normally negatively biased by connection to line L6 through a resistor R49 shunted by a capacitor C9. Contact K5 is also coupled to the base terminal of transistor Q10 through a capacitor C10.

Since D.C. drive is provided to the base of transistor Q10 through resistor R60, the pulse generating circuit normally remains in a first state in which transistor Q10 conducts and transistor Q9 is cut-off. However, when reed Y5 is actuated at its resonant frequency, the positive pulse applied to the base of transistor Q10 through capacitor C10 causes the circuit to reverse states momentarily, transistor Q10 being cut-off with the transistor Q9 conducting. Transistor Q9 will, however, conduct only for a

preselected interval or time period determined by the charge on cross-coupling capacitor C8. Transistor Q9 will then cease to conduct and the circuit will revert to its original state. During the interval when transistor Q9 is conducting, the collector of transistor is negative with respect to ground and this voltage is employed as an enabling signal as described hereinafter.

The circuit of FIG. 3 also includes three relays RY1, RY2 and RY3, there being one relay for each of the three slide projectors 11, 13 and 15. Each of these relays includes an operating winding (W11, W12 and W13) and a set of contacts (K11, K12 and K13) which are closed when the respective winding is energized. Windings W11–W13 are shunted by respective suppressor capacitors C11–C13. Each of the windings W11–W13 is also coupled to the base terminal of the left-hand transistor of the respective bistable circuit through a respective diode D8–D10 and a respective, serially-connected capacitor C15–C17. Contacts K11, K12 and K13 are coupled to respective output jacks J11, J12 and J13 for connection to the respective slide projectors, the projectors being operated to change slides when the respective contacts are closed.

One end of each of the windings W11–W13 is grounded and the other end is connected for energization to the negative supply line L6 through a respective PNP driver transistor Q11–Q13 connected in emitter follower configuration. The transistors Q11–Q13 are forward biased by respective resistors R61–R63.

The base terminal of each of the relay driving transistors Q11–Q13 is connected to one of the bistable circuits through a respective diode D11–D13 and to the pulse providing circuit through respective isolating diodes D14–D16. The diodes D11–D13 are connected to the collector of the right-hand transistor in the respective bistable circuits and the diodes D14–D16 are connected to the collector of transistor Q10 in the pulse generating circuit.

The two diodes connected to the base of each of the transistors Q11–Q13 essentially constitute an AND gate through which the respective bistable circuit and the one pulse generating circuit control the respective driver transistor. In other words, each driver transistor can conduct only when the respective bistable circuit is in its second state as described previously and the pulse generating circuit is also in its second state with the transistor Q10 being cut-off and the negative enabling signal being provided at its collector.

The operation of the controller is as follows:

The rheostats R11–R15 in the tone generator (FIG. 2) are adjusted so that the frequency of oscillation produced by the closing of each of the switches SW11–SW15 is equal to the resonant frequency of a respective one of the reeds Y1–Y5. To prepare a tape for automatic operation of the slide projectors 11, 13 and 15, various tone signals generated by the oscillator circuit 50 are recorded on the second track of tape 27 as mentioned previously. This may be conveniently done with a tape upon which the audio program has previously been recorded on the first track. Prior to each action point in the program at which any of the slides are to be changed, a tone representing each projector to be operated at the action point is recorded by closing the respective switch SW12–SW14. If more than one projector is to be operated at the action point, the respective keys are closed in sequence to record the respective tones. If all of the projectors are to be operated at the given action point, the one switch SW11 may be operated instead of operating the switches SW12, SW13 and SW14 sequentially. When the action point itself actually arrives, the switch SW15 is closed to record the respective tone signal on the tape.

On subsequent replays of the tape, the output signal from track 2 is applied to the resonant reed relay RRY through jack J2. The reeds Y1–Y5 respond in known manner when the respective tone signal is present in the recorded information by applying a positive pulse of current from line L5 to the respective contact K1–K5. When one of the three reeds Y2–Y4 is so actuated, the respective bistable circuit is switched into its second state as described previously wherein the right-hand transistor is cut-off and the left-hand transistor is conducting. Although this change in state causes a negative voltage to appear at the collector of the respective right-hand transistor, the corresponding relay driver transistor (Q11–Q13) is not driven into conduction since its base terminal is maintained at or near ground potential by the low voltage present at the collector of transistor Q10 of the pulse generating circuit. Any bistable circuit thus signalled by energization of one of the reeds Y2–Y4 is thus merely preset for operating the respective slide projector but does not immediately cause its operation.

When the respective action point in the program then arrives, the channel 2 output signal applied to resonant reed relay RRY causes the reed Y5 to operate and to trigger the pulse circuit 64. As noted previously, triggering of this circuit causes the collector terminal of transistor Q10 to become negative for a preselected interval thereby providing an enabling signal to the gates constituted by diodes D11–D16. During the interval of operation of pulse circuit 64, the gates are effectively open and any of the bistable circuits 61–63 which have been previously preset will then drive the respective relay driver transistor into conduction causing the respective slide projector to be operated by means of the respective relay RY1–RY3. It can thus be seen that any combination of the different projectors 11, 13 and 15 can be operated simultaneously at a given action point even though the tone signals representing each one of the projectors are recorded serially prior to the action point.

When the relays are then deenergized at the end of the preselected interval determined by the characteristics of the pulse circuit 64, the release of inductively stored energy from the windings W11–W13 causes a pulse to be transmitted through the respective diode and capacitor (D8–D10, C15–C17) to the base terminal of the left-hand transistor of the respective bistable circuit. This pulse causes the bistable circuit to revert to its original or first state in which the left-hand transistor is turned off and the right-hand transistor is conductor. The bistable circuits are thus again cleared and ready for presetting by the operation of the respective resonant reeds Y2–Y4 in response to further recorded tone signals representing the different slide projectors.

As noted previously, operation of the reed Y1 causes a negative voltage to be applied through the diodes D5–D7 to all of the bistable circuits 61–63 so that the one tone signal corresponding to this reed is effective to preset all of the bistable circuits and the subsequent energization of reed Y5 then causes all of the slide projectors to be operated simultaneously.

While, in the embodiment illustrated, the bistable elements have been illustrated as flip-flop circuits, it should be understood that other bistable elements may also be used such as latching or stepping relays. Similarly, while each of the slide projectors to be operated is represented by a respective single frequency it should be understood that larger numbers of image display devices may be operated without a corresponding increase in the number of different tones needed by employing a coding system so that different display devices are operated in response to different combinations of the various tones. Further, if multiple tone generators are provided so that the different tones representing different display devices can be recorded simultaneously, the presettable bistable elements may be omitted and the tones representing each display device to be operated may be recorded at the action point rather than prior thereto. It will also be understood that various types of display devices may be employed in place of or in addition to the slide projectors shown.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above apparatus and methods without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. Apparatus for operating a plurality of image display devices in predetermined sequence in timed relation with the playing of a recorded audio program, said apparatus comprising:

a tone generator for selectively providing a different tone signal for each of the display devices and for selectively providing a further tone signal which is different from each of the aforesaid signals, said tone signals being commonly recordable with said program on recording media;

a bistable circuit means for each display device, each bistable means having a first state and a second state;

frequency discriminating means operative during playback of said audio program and responsive to recorded tone signals for providing a respective electrical signal for each of the first said tone signals played back;

means responsive to each of said electrical signals corresponding to the first said tone signals for setting the respective bistable means to its second state;

second frequency discriminating means operative during playback of said audio program and responsive to said further tone signal for providing an enabling signal;

operating means including gate means responsive to said bistable circuit means and said second frequency discriminating means for operating each of the display devices when the respective bistable circuit means is in its second state and said enabling signal is provided;

and means responsive to the operation of said operating means for resetting said bistable means to their first states.

2. Apparatus as set forth in claim **1** wherein each of said bistable circuit means comprises a bistable multivibrator.

3. Apparatus as set forth in claim **2** wherein the first said frequency discriminating means comprises a plurality of resonant reeds.

4. Apparatus as set forth in claim **3** wherein said second frequency discriminating means includes a further resonant reed.

5. Apparatus as set forth in claim **4** wherein said second frequency discriminating means includes a circuit for generating an enabling pulse signal of preselected duration in response to actuation of said further resonant reed.

6. Apparatus as set forth in claim **5** wherein said operating means includes a respective driver means for each of said display devices and said gate means includes a plurality of diodes interconnecting each of said driver means with said pulse generating circuit and a respective one of said bistable multivibrators.

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