Jan. 24, 1967 E. J. GUSHUE ET AL 3,300,591

AUDIO PLAYBACK UNIT

Filed Oct. 30, 1963 4 Sheets-Sheet 1

Fig. 1

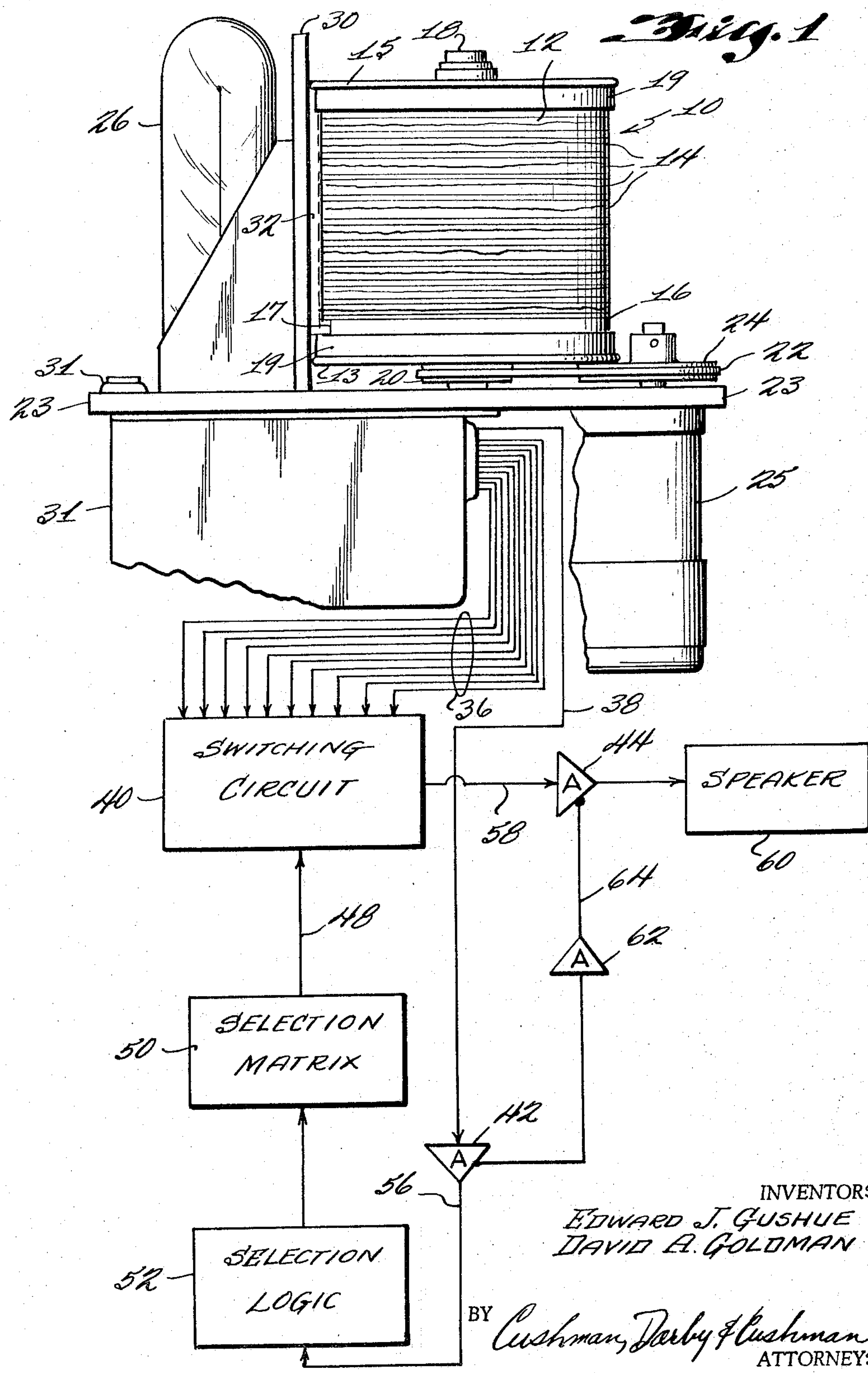

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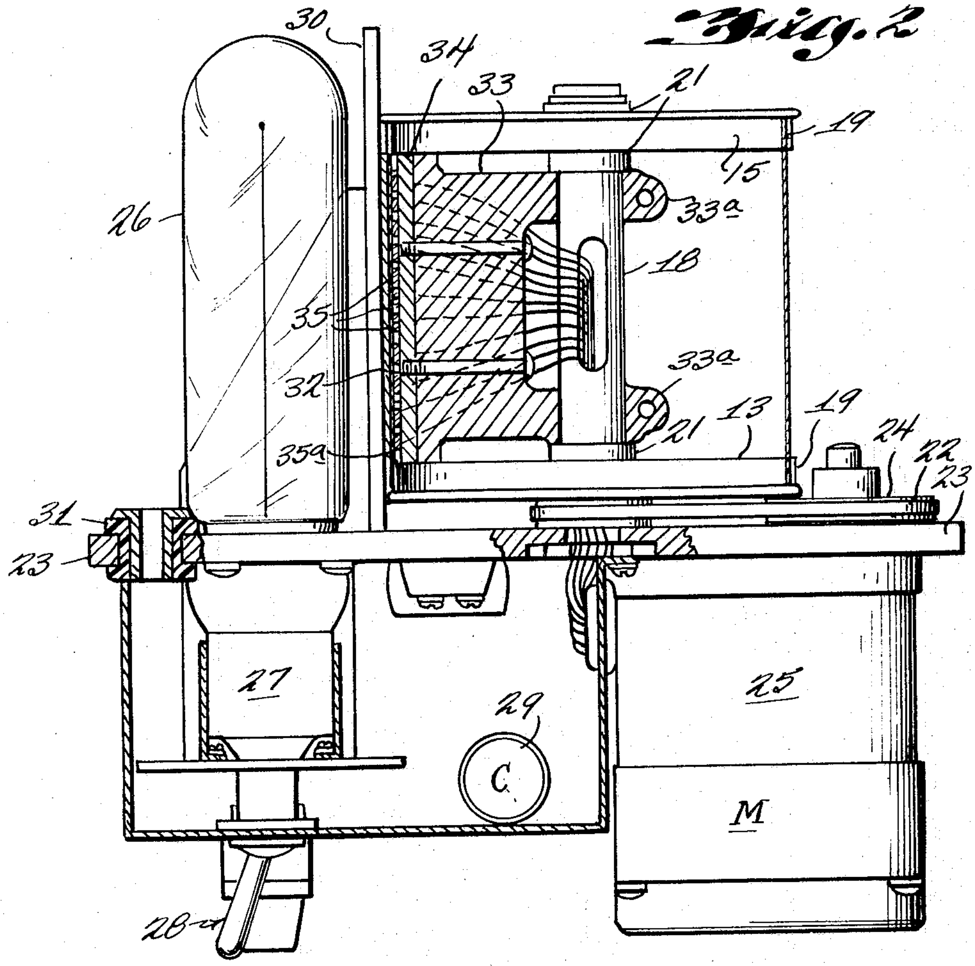
Fig. 2



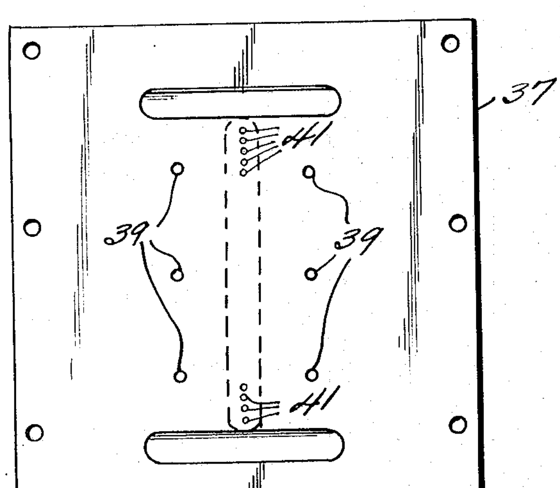


Fig. 3

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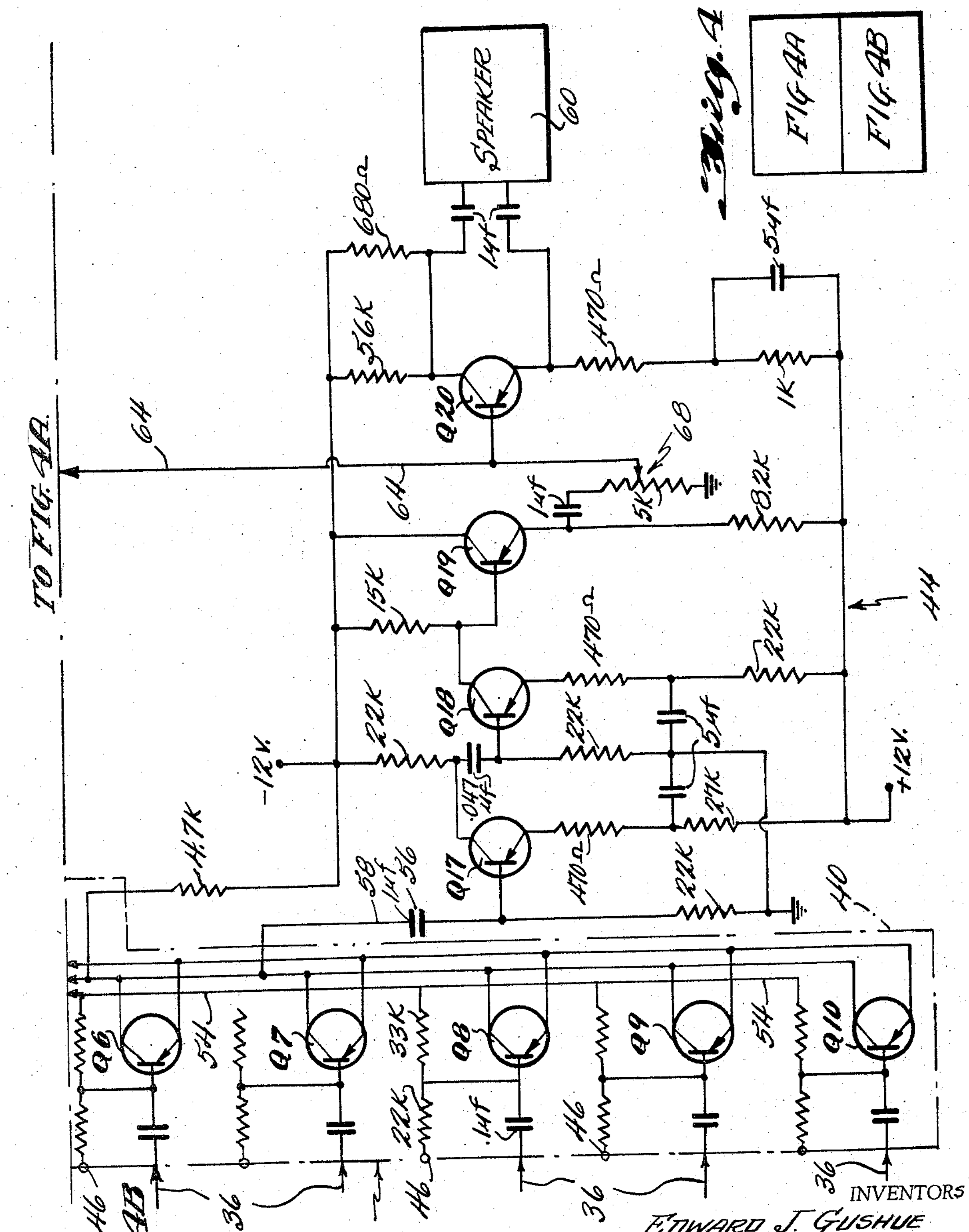

Fig. 4B

Fig. 4

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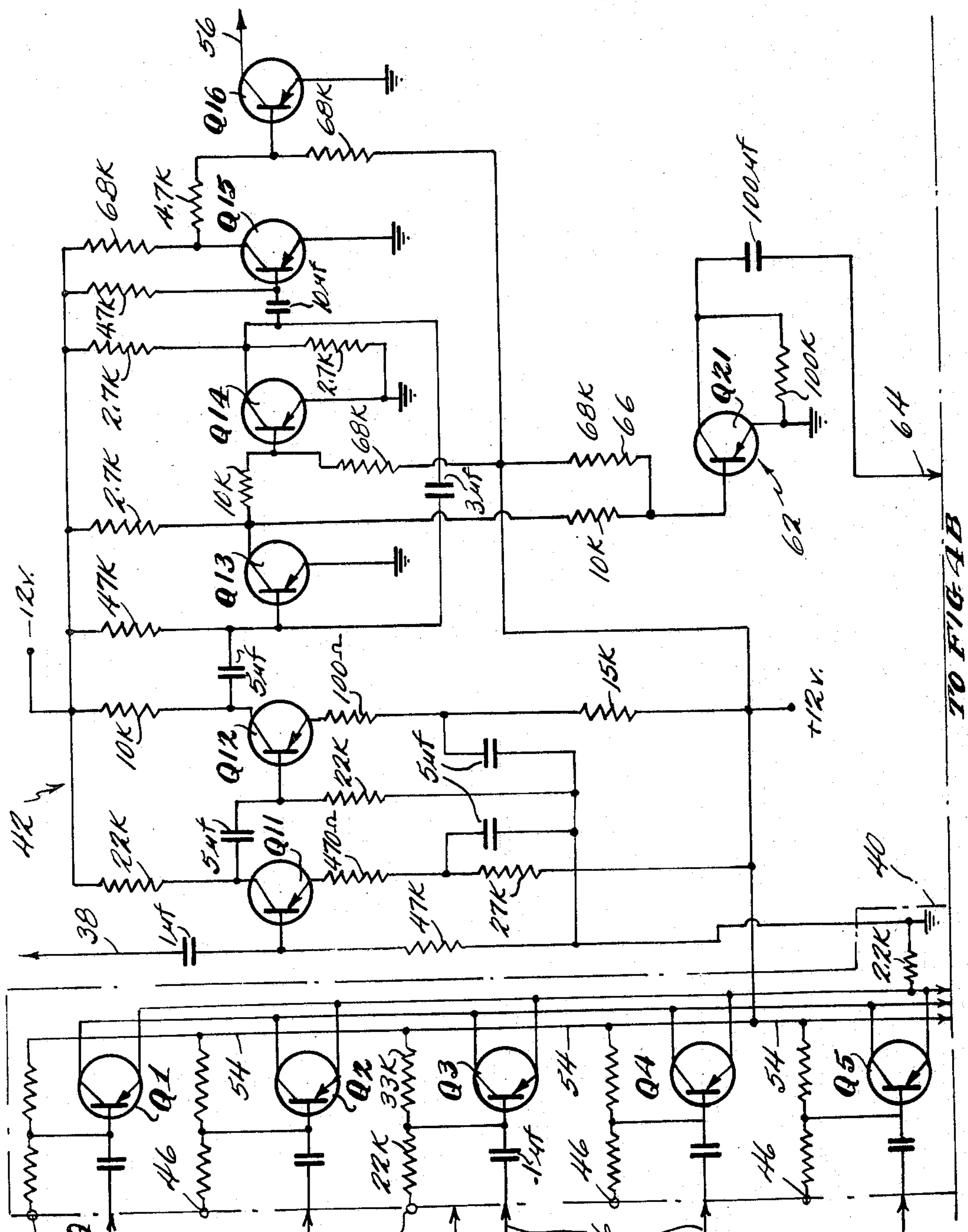

Fig. 4A

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3,300,591
AUDIO PLAYBACK UNIT

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6 Claims. (Cl. 179—100.3)

This invention relates to an audio playback unit, and more particularly to such a unit which has on photographic film a plurality of sound tracks containing optical signals representing messages which can be individually selected in any desired manner and played back in audible form.

As representative of the different types of equipment or environments in which such a unit may be employed, there may be mentioned audio alarms, paging equipment, automatic test equipment, automatic audio programing functions, and digital to audio information readout functions, to name but a few.

It is an object of the present invention to provide an audio playback unit of the type above indicated, that is inexpensive and reliable in any of such environments.

Another object of this invention is to provide such an audio playback unit which is simple in structure and operation, but which has an extremely long life and a zero wear factor on the storage of the messages, and in which there is no deterioration of playback with time yet high level playback signals are available.

Other objects and advantages of this invention will become apparent to those of ordinary skill in the art upon reading the appended claims and the following detailed description of the invention, in conjunction with the drawings, in which:

FIGURE 1 is a diagrammatic representation of one embodiment of the invention,

FIGURE 2 is an elevational view, partially in crosssection, of a portion of FIGURE 1,

FIGURE 3 is a plan view of a masking plate for use with another embodiment of the invention, and

FIGURE 4, which consists of FIGURES 4A and 4B, is a detailed schematic circuit of a portion of FIGURE 1.

In FIGURE 1, a transparent or translucent rotatable drum **10** has its periphery covered with film **12** containing ten sound or information tracks **14** and one reference track **16**. Each of the sound tracks contains optical variations or signals, for example as in any of the manners recorded in the sound track of motion picture films, and these optical signals represent predetermined messages. Though the specification proceeds as though each track contains an independent message, it will be apparent to those skilled in the art that a lengthy message can utilize more than one track, when appropriate switching equipment is employed, for example as in the Hill Patent 2,969,525. With the presumption that each of the information or soundtracks **14** contains one full message in optical signal form, then reference track **16** contains one reference indication or mark **17** in optical form, which coincides with the end of each message on tracks **14**, all messages preferably being arranged to end at the same angular point around the drum. The reference mark may be utilized in various manners, as described below.

Consider FIGURE 2 for an insight to the structure of drum, etc. Drum **10** itself is comprised of the inner and outer end caps **13** and **15**, each of which has a removable film retainer band **19**, and the cylinder of film **12**. At the center of each end cap is a suitable bearing **21** rotatable around a stationary post **18**. This post is secured in base plate **23** in any suitable manner as shown.

The end caps are preferably apertured for air circulation to keep temperature down and constant, whereby film buckling is prevented and the light sensors mentioned below are held at a better operating temperature.

For purposes of rotating drum **10**, a gear **20** is secured externally to the inner end cap **13** around its bearing **21**, that gear being driven by a toothed timing type belt **22**, gear **24** and gear reduction motor **25**. This causes the cylinder to rotate once every ⅝ second for example, with each track having an equal playback period.

To effect a playback from the photographic film tracks, a light source such as bulb **26** is mounted outside the rotating drum **10** and extends through the base plate **23** into a socket **27** that is connected to light switch **28** this switch and socket, along with motor capacitor **29** are mounted in a housing **31** which is flexibly secured by grommet **31a** to base plate **23**. Also exteriorly of the drum, on a bracket supported apertured base plate **30** extending the length of the drum closely adjacent its surface, are two separate elements **32** (only one shown) for defining a continuous light aperture extending the full length of the total track widths with a very narrow width, for example .0005 inch. Interiorly of the film cylinder **10** is a light sensor block holder **33** which is suitably secured to post **18** as by bolts through the upstanding tabs **33a**. Holder **33** secures the light sensor block **34** which in turn has ten light sensitive cells **35** respectively for the sound tracks **14**, plus one similar light sensitive cell **35a** for the reference track **16**.

As indicated in the illustrated embodiment, none of these cells or sensors require light shielding since in the ten track embodiment they are separated enough that they receive only the light coming through their respective tracks by which each is modulated. For the same drum length however, if a thirty-two track embodiment is effected, it is preferable to use the mask plate **37** of FIGURE 3. The light aperture width defining elements **32** are secured thereto via holes **39** and the assembly secured to base plate **30**. Apertures **41** correspond in number to the number of film tracks and are separated the same amount, for example .070 inch on centers. In keeping with that example, they would be approximately .060 inch in diameter.

Though it is possible to reverse the relative positions of light bulb and sensors, such an arrangement is not by far as practical, economical, or convenient as the one here disclosed. With the lamp on the inside it would be much more difficult to effect the necessary inside light aperture of .0005 inch at a close enough distance from the film. On the outside, the lamp, and film too, can be changed easier and the heat from the lamp dissipated without warping the film. Maintenance in general is easier too. The light sensitive cells or sensors **35** and **35a** are optical transducers which convert the optical signals on the film into electrical signals; they may be tube type photoelectric cells perhaps but preferably are solid state solar type cells which are light sensitive.

While drum **10** is rotating, the sensors **35** and **35a** provide a continuous output on their respective output lines **36** and **38**. As shown in FIGURE 1, lines **36** are connected to a switching circuit **40** while the reference mark sensor output line **38** connects to an amplifier **42**. Switching circuit **40** and amplifier **42**, along with amplifier **44** are shown in greater detail in FIGURE 4. From FIGURE 4 it is apparent that switching circuit **40** has not only the photoelectric or sensor inputs delivered to it, but also any one of ten different selection and switching signals respectively via the ten input terminals **46**. These input terminals are collectively indicated in FIGURE 1 by line **48** which receives outputs from a selection matrix **50**. This matrix in turn is controlled by a selection logic circuit **52**. In other words, in a manner to be described, the selection matrix output signals on line **48** provide an enabling signal to just one of the ten terminals **46** in switching circuit **40**, at a time. In the FIGURE 4 circuitry, this causes the selected terminal **46** to be reduced to −12 volts for example, which in turn makes the connected transistor Q1 . . . Q10 conductive. Normally, each of these transistors is held to a non-conducting state by the +12 volts connected to line **54**, which operates to bias the base of these transistors off, notwithstanding the continuous input signals received thereby via lines **36**, since terminals **46** are each normally at zero volts or ground level, for example.

When a given one of the transistors Q1 . . . Q10 in FIGURE 4 is so selected and turned on, the light sensitive cell output signal connected thereto over line **36** is then transferred by that conductive transistor to amplifier **44** via coupling condenser **56** in output line **58**.

Transistors Q11 . . . 16 and associated circuitry comprise amplifier **42** and effect an amplification onto output line **58** of the reference mark signals occurring on line **38**. In a like manner, transistors Q17 . . . 20 comprise amplifier **44** and operate to amplify the information signals received from switching circuit **40** over line **58**. These amplified signals are transduced into audible form by a speaker **60**.

In order to prevent hearing from the speaker any audible output such as noise which might otherwise occur from transients effected during the switching process, the output of transistor Q13 in the reference amplifier **42** is applied to its own amplifier **62**, which includes transistor Q21, the output of which is applied via line **64** to the base of transistor Q20. Normally, transistor Q21 is held non-conductive by the base bias effected through resistor **66**, but when the reference mark signal occurs in amplified form and is applied from transistor Q13 to the base of transistor Q21, the latter becomes conductive and effectively applies an A.C. ground signal to the base of transistor Q21. This turns transistor Q20 off so that any transient signal, which might otherwise be coupled from transistor Q19 through the volume control potentiometer **68** to transistor Q20, is suppressed during the switching operation. In other words the switching operation is accomplished tacitly, i.e., without development of any switching transients into audible form.

It will be noted that the output of reference mark amplifier **42** on line **56** is applied to the selection logic circuit **52**. This may be for either of two purposes one of which is to automatically update the logic by one so that conversion of the logic signals by matrix **50** causes the next optical transducer output to be switched to amplifier **44**. In other words, the selection logic **52** may be a stepping switch or the like which can operate through matrix **50**, or directly to the input terminals **46** of switching circuit **40**, to effect sequential and continuous operation of the circuit, whereby the messages on the ten different tracks **14** are readout one after the other in a predetermined sequence. Another and alternative use of the reference mark signal delivered by line **56** to the selection logic circuit **52** is to employ that signal just as a "has read" or timing signal whereby the selection logic circuit is notified that a newly selected logic can now be readout to matrix **50** when otherwise desired of course, this employment of the reference mark signal is also present in the above mentioned updating use thereof. The selection logic circuit may be of any desired type, which generates its own signals internally, or receives them externally, as required for the particular situation in which the equipment is being employed.

The suppression signal on line **64** may last for 50 milliseconds for example, in order to allot a desired amount of time for the selection logic, matrix, and switch **40** to select and switch in another track.

Matrix **50** can be of any type required to effect the desired conversion. For example, if the selection logic circuit **52** applies to the matrix a five bit binary signal, then it is necessary for the matrix to convert this into a one-out-of-ten type signal for terminals **46** in the switching circuit. On the other hand, the input to matrix **50** may be a decimal input, or it may be a one-out-of-N where N is the number of information tracks on the drum. Matrices to provide any desired arrangement are well-known in the art.

Notwithstanding the fact that the foregoing description has designated the number of information tracks at ten, it is appreciated that the number of information tracks may be more or less. Furthermore, multiple units can be interconnected to expand the available audio vocabulary, and the motor **24** may have a clutch-actuated drive for zero access time for message playback. Preferably, solid state electronics is employed throughout, but other type of electronics may be utilized as desired. As an example, the playback frequency response may be in the 10 to 4000 c.p.s. range.

From the foregoing description, it is apparent this invention has provided audio playback equipment having the advantages and accomplishing the objects indicated. An embodiment of the invention may be constructed in relatively miniaturized form or as large as desired. With the versatility available by means of the numerous types of messages which may be placed in the sound tracks, the invention conveniently lends itself to employment in a large variety of situations in all of which operation may be accomplished automatically or manually as desired.

Other objects and advantages, and even further modifications of the invention, will become apparent to those of ordinary skill in the art upon reading this disclosure. However, it is to be understood that this disclosure is illustrative of the invention, and not limitative thereof, the invention being defined by the appended claims.

What is claimed is:

1. Audio playback equipment comprising:

a film cylinder having fixed around its periphery a plurality of sound tracks containing optical signals representing audio messages capable of being transduced into audible form, each of said optical signal messages ending at a predetermined point on its associated track,

means for developing an electrical reference signal indicating the end of said sound tracks,

means for rotating said cylinder and thereby rotating all said tracks simultaneously,

means including a plurality of stationary optical transducers respectively disposed adjacent said tracks, for providing, during rotation of said cylinder in the same direction, simultaneously occurring, respective outputs representing a conversion of said optical signals into electrical sound signals,

means for amplifying said electrical sound signals,

means for transducing said amplified electrical sound signals into audible messages, and

automatic means using said electrical reference signal and including a switching circuit for selecting any desired one of said simultaneously occurring optical transducer outputs while said cylinder is rotating in said same direction and when said switching circuit is operatively associated with one of said message ending points and tacitly switching the corresponding electrical sound signals to said amplifying means for playback in audio form by said transducing means.

2. Audio playback equipment comprising:

a film cylinder having fixed around its periphery a plurality of sound tracks containing optical signals representing audio messages capable of being transduced into audible form, each of said optical signal messages ending at a predetermined point on its associated tracks,

means for rotating said cylinder and thereby rotating all said tracks simultaneously,

means including a plurality of stationary optical transducers respectively disposed adjacent said tracks, for providing, during rotation of said cylinder in the same direction, simultaneously occurring respective outputs representing a conversion of said optical signals into electrical signals,

means for amplifying said electrical signals,

means for transducing said amplified electrical signals into audible messages,

automatic means including a switching circuit for selecting any one of said simultaneously occurring optical transducer outputs while said cylinder is rotating in said same direction and when said switching circuit is operatively associated with one of said message ending points and switching the corresponding electrical signals to said amplifying means for playback in audio form by said transducing means, and

means for suppressing the operation of said amplifying means while said switching circuit is operative to switch the selected electrical signals to the amplifying means as aforesaid.

3. Audio playback equipment as in claim **2** wherein said reference signal means includes:

a reference track on said film cylinder for indicating the end of each optical signal message in the said sound tracks, and said automatic means includes

means for delivering a suppressing signal to said amplifying means upon sensing such indications.

4. Audio playback equipment as in claim **3** including means for coupling the sensed reference indication signals to said selecting means for indicating thereto that another one of said optical transducer outputs may then be selected.

5. Equipment as in claim **4** wherein said selecting means includes a selection matrix for operating said switching circuit and a selection logic circuit for operating said selection matrix.

6. Audio playback equipment comprising:

a film cylinder having fixed around its periphery a plurality of sound tracks containing optical signals representing audio messages capable of being transduced into audible form,

said film cylinder having a fixed reference track containing at least one reference mark for indicating the end of said sound tracks,

means for rotating said cylinder and all said tracks simultaneously,

means including a stationary light source on the outside of said cylinder and each of said tracks and on the inside thereof a plurality of stationary optical transducers respectively disposed adjacent each of said sound and reference tracks for providing, during

rotation of said cylinder, simultaneously occurring outputs representing conversion of said optical message signals and reference mark into respective electrical signals,

first means for amplifying said electrical message signals,

means including a speaker for transducing said amplified message signals into audible messages,

second means for amplifying said electrical reference signals,

a switching circuit for continuously receiving the said simultaneously occurring outputs from the optical transducers associated with the said sound tracks and switching a selected one thereof to the said first amplifying means for playback in audio form by said transducing means,

means connecting an output of said second amplifying means to said first amplifying means for suppressing the output of said first amplifying means during said switching,

an input selection logic circuit coupled to an output of said second amplifying means and operated thereby to allow an output signal representing the selection of another one of said optical transducer outputs, and

a selection matrix for converting the said output signal of said selection logic circuit to an input suitable for said switching circuit for causing the desired selection in the switching circuit of the instant one of said information optical transducer outputs desired.

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