United States Patent [19]

Broline

[11] **3,881,185**

[45] **Apr. 29, 1975**

[54] **ELECTRONIC MULTI-MEDIA PROGRAMMER**

[75] Inventor: **Eric Nicholas Broline,** Austin, Tex.

[73] Assignee: **Columbia Scientific Industries Corporation,** Austin, Tex.

[22] Filed: **July 30, 1973**

[21] Appl. No.: **384,088**

[52] **U.S. Cl.** **360/80;** 353/15

[51] **Int. Cl.** **G11b 31/00;** G11b 27/22

[58] **Field of Search** ..... 179/100.2 S, 100.2 MD, 179/100.1 PS, 100.1 R, 100.1 TC; 340/174.1 B, 174.1 G, 174.1 H; 353/15; 360/79–80, 27, 31, 67, 72–74; 352/15; 329/112

[56] **References Cited**

UNITED STATES PATENTS

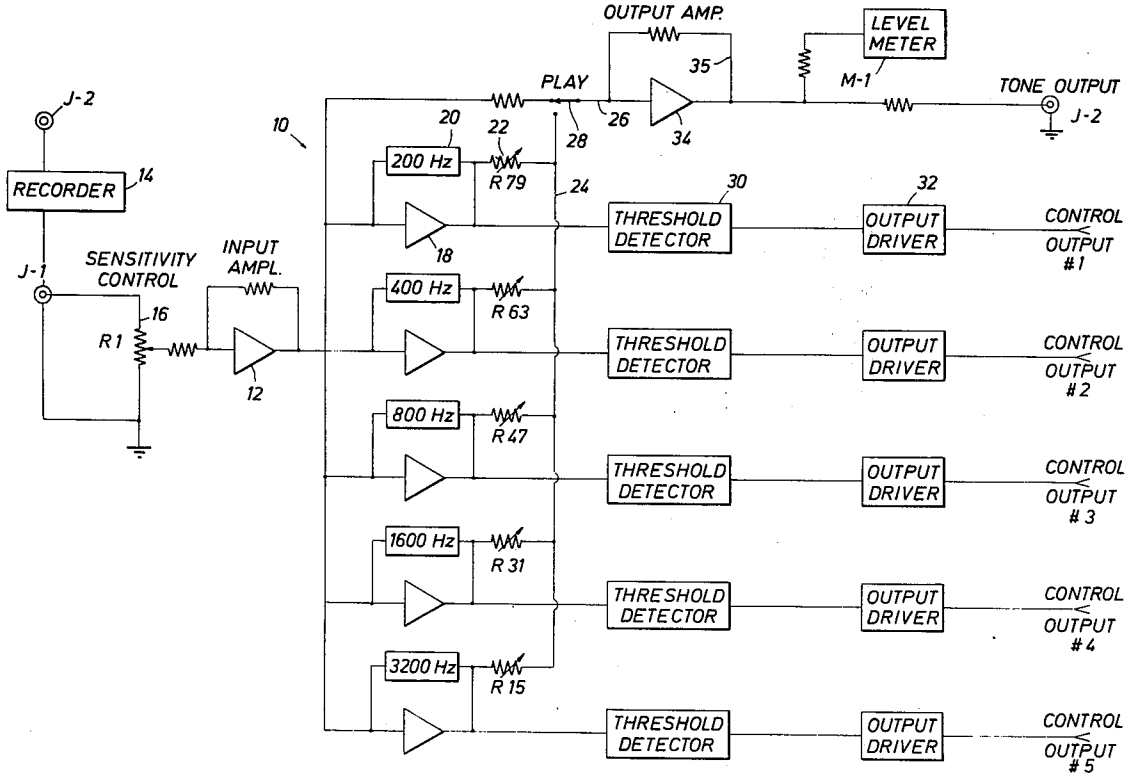
3,480,738	11/1969	Meyer et al.	179/100.2 S
3,591,734	7/1971	Abbott	179/100.2 S
3,678,221	7/1972	Miller	179/100.2 S
3,691,544	9/1972	Gallina	340/174.1 B
3,756,715	9/1973	Naf	179/100.2 S
3,772,473	11/1973	Parham	179/100.2 MD

Primary Examiner—Alfred H. Eddleman

[57] **ABSTRACT**

An electronic multi-media programmer system for providing control signals responsive to specifically related tone signals introduced to the programmer system in the form of electrical signals provided by an input amplifier. The programmer system includes a plurality of tone channels each being connected in parallel with the input amplifier and being preset to provide a control signal responsive to detection of the particular audio tone for which the channel is programmed. Each of the tone channels may include a filter-oscillator circuit that may be selectively controlled between playback and record modes. In the playback mode, audio tone signals, received and introduced into the programmer system through the input amplifier, may be discriminated by the various tone channels for selective operation of remotely located devices responsive to the control signals of the various channels. In the record mode, the filter-oscillator circuit will be caused to oscillate and may transmit audio frequency signals through an output amplifier to a tone output in order that the audio signals may be recorded by suitable recording means. The tone input may be generated by and the tone output may be received by any suitable recording means such as a tape recorder, for example.

14 Claims, 7 Drawing Figures



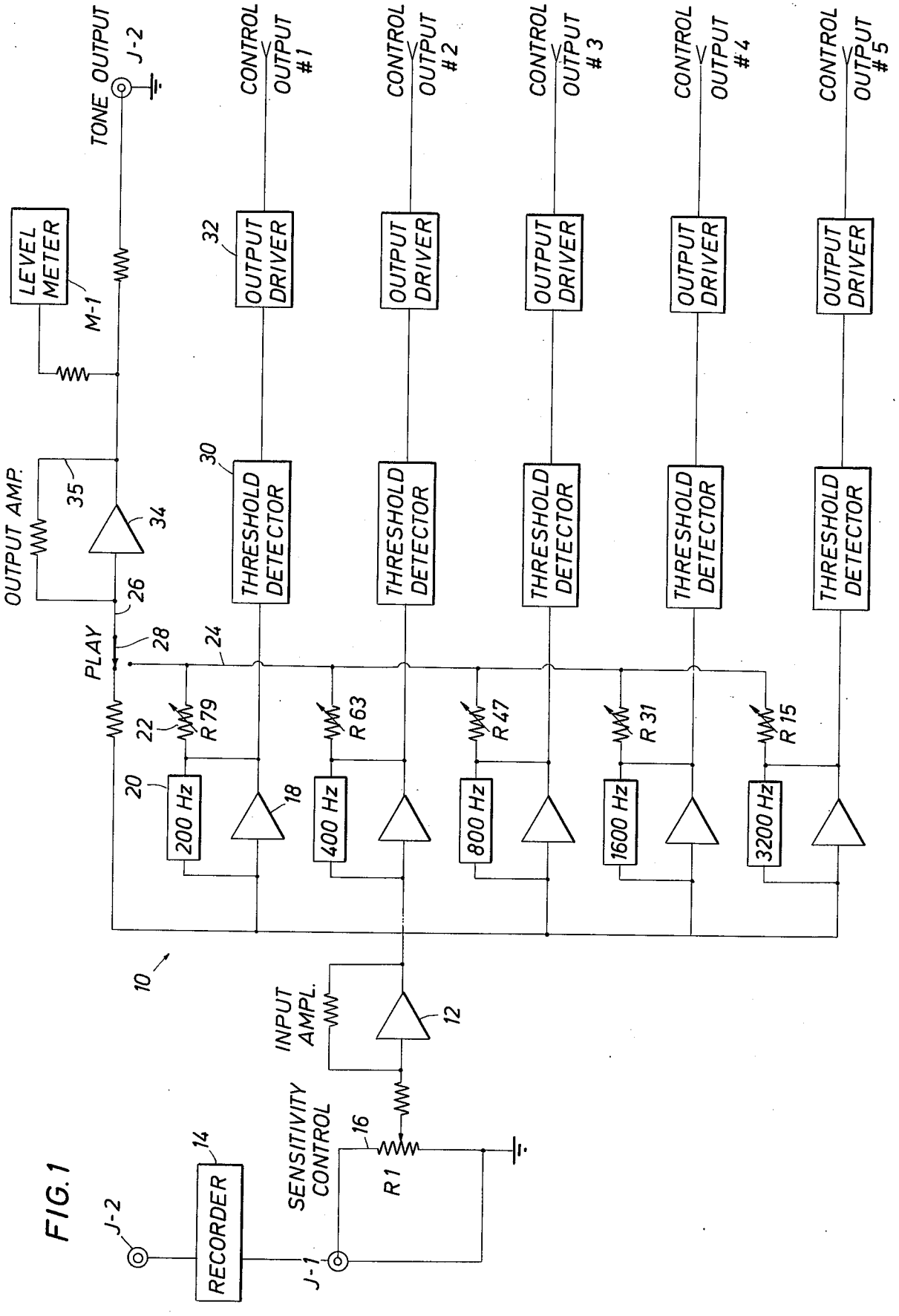

TONE OUTPUT
J-2
CONTROL OUTPUT #1
CONTROL OUTPUT #2
CONTROL OUTPUT #3
CONTROL OUTPUT #4
CONTROL OUTPUT #5
LEVEL METER
M-1
32
OUTPUT DRIVER
OUTPUT AMP.
35
34
30
THRESHOLD DETECTOR
26
PLAY
28
24
22
R 79
R 63
R 47
R 31
R 15
20
200 Hz
18
400 Hz
800 Hz
1600 Hz
3200 Hz
10
INPUT AMPL.
12
SENSITIVITY CONTROL
16
R 1
14
RECORDER
J-2
J-1

FIG. 1

FIG. 2

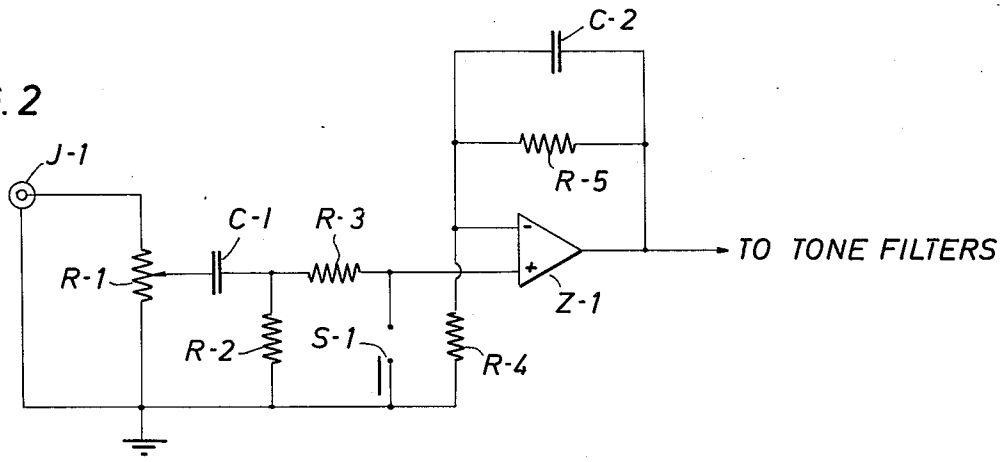


FIG. 3

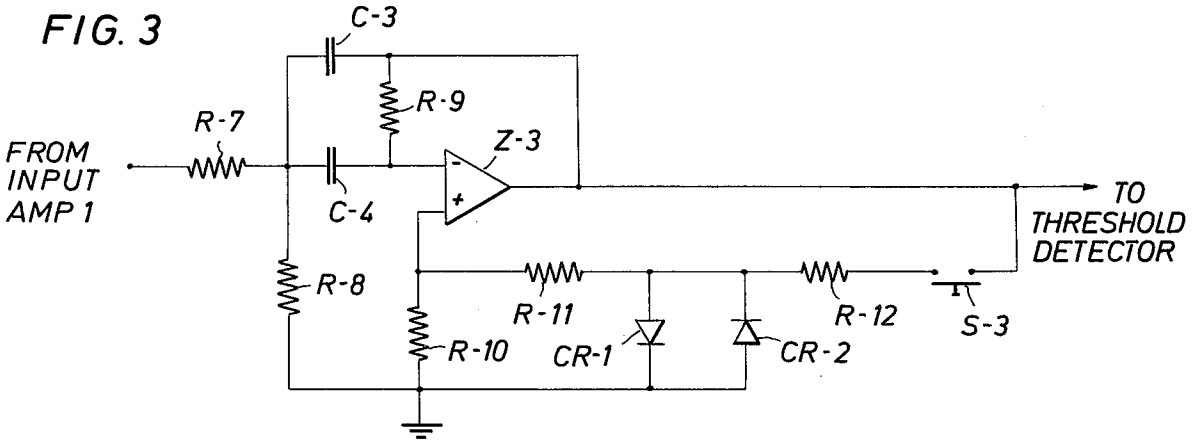
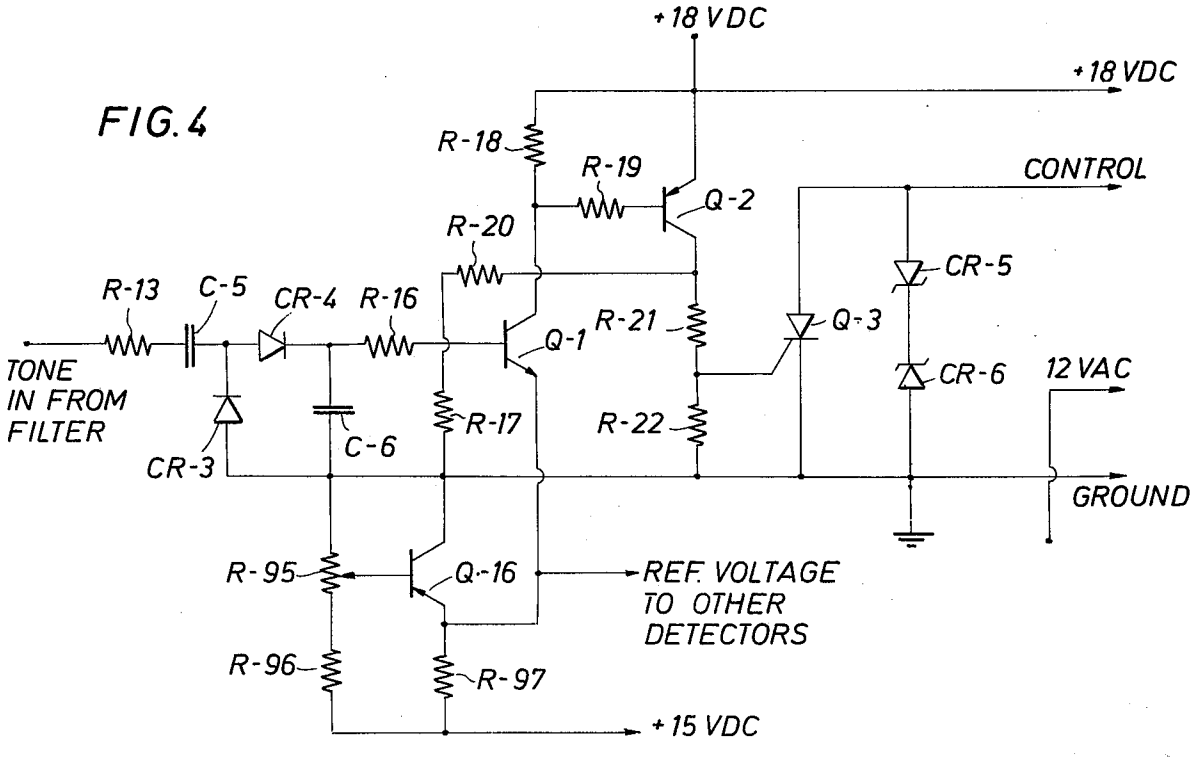


FIG. 4



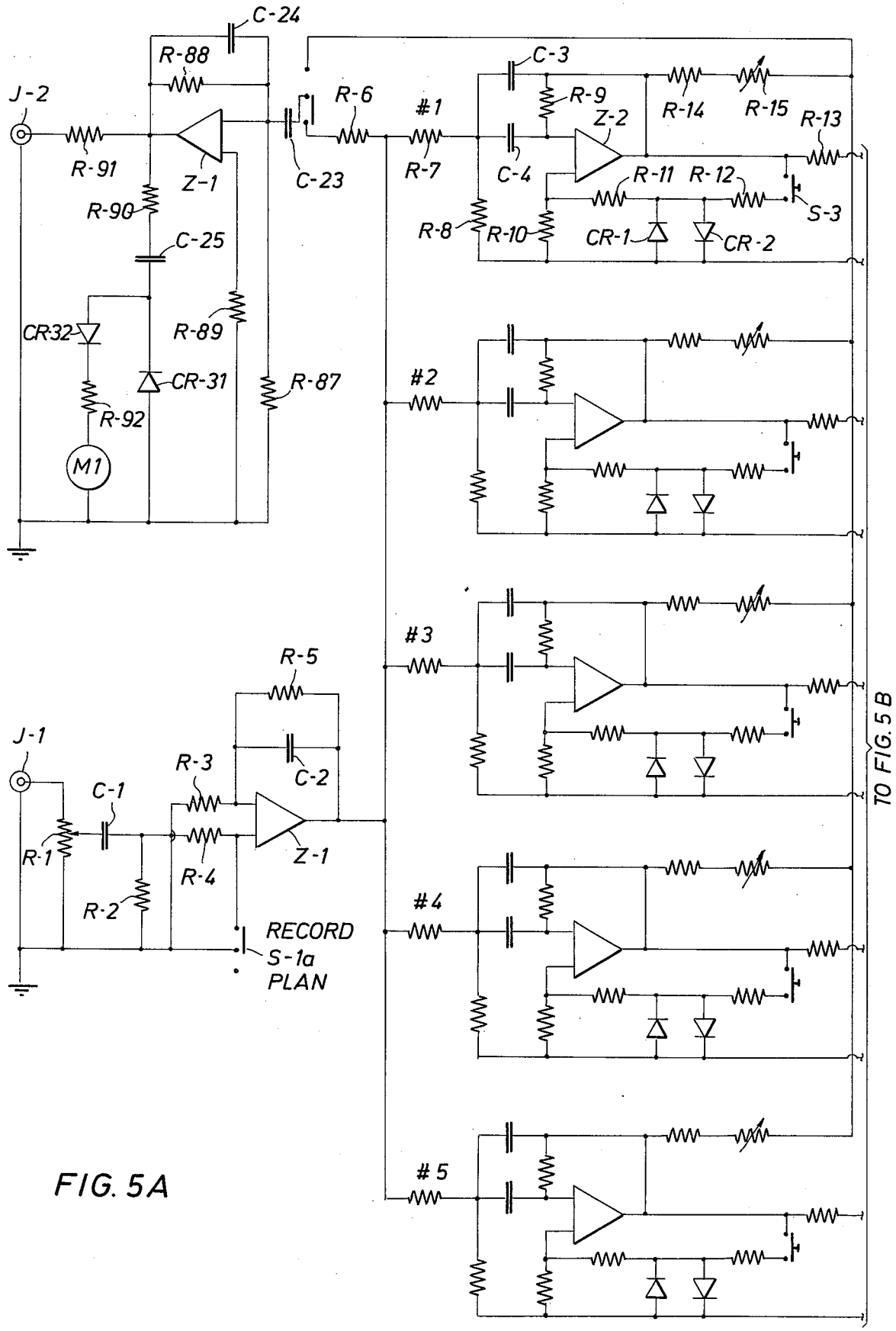
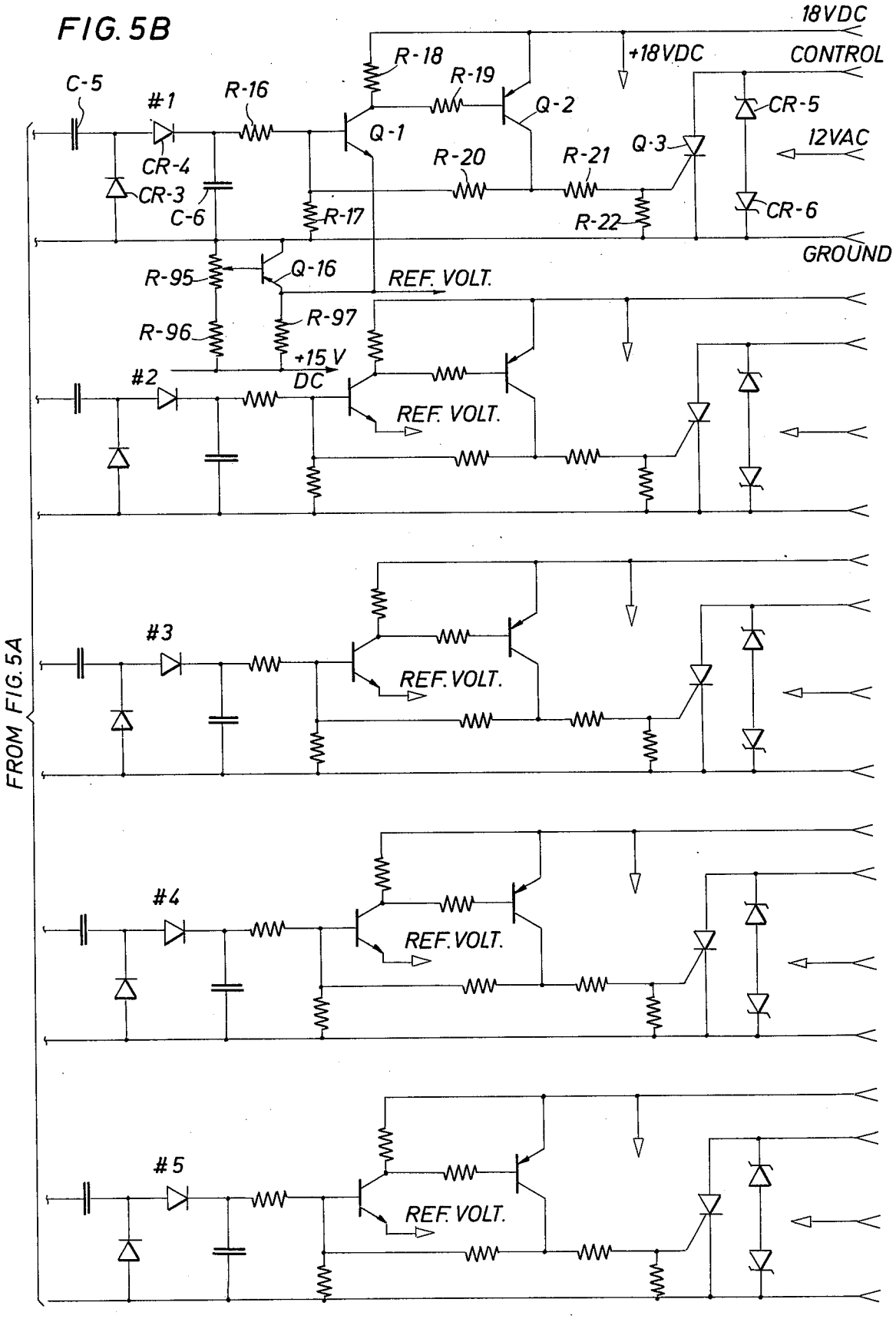

C-24
R-88
J-2
R-91
Z-1
C-23
R-6
#1
R-7
C-3
R-9
Z-2
R-14
R-15
R-13
C-4
R-11
R-12
S-3
R-8
R-10
CR-1
CR-2
R-90
C-25
CR32
R-89
CR-31
R-87
R-92
M1
#2
#3
#4
#5
R-5
C-2
J-1
C-1
R-3
R-1
R-4
Z-1
R-2
RECORD
S-1a
PLAN
TO FIG. 5B

FIG. 5A

FIG. 5B


18VDC
+18VDC
CONTROL
R-18
R-19
Q-2
C-5
#1
R-16
Q-1
CR-5
CR-4
12VAC
Q-3
R-20
R-21
CR-3
C-6
R-17
R-22
CR-6
GROUND
R-95
Q-16
REF. VOLT.
R-96
R-97
+15 V DC
#2
REF. VOLT.
#3
REF. VOLT.
#4
REF. VOLT.
#5
REF. VOLT.
FROM FIG. 5A

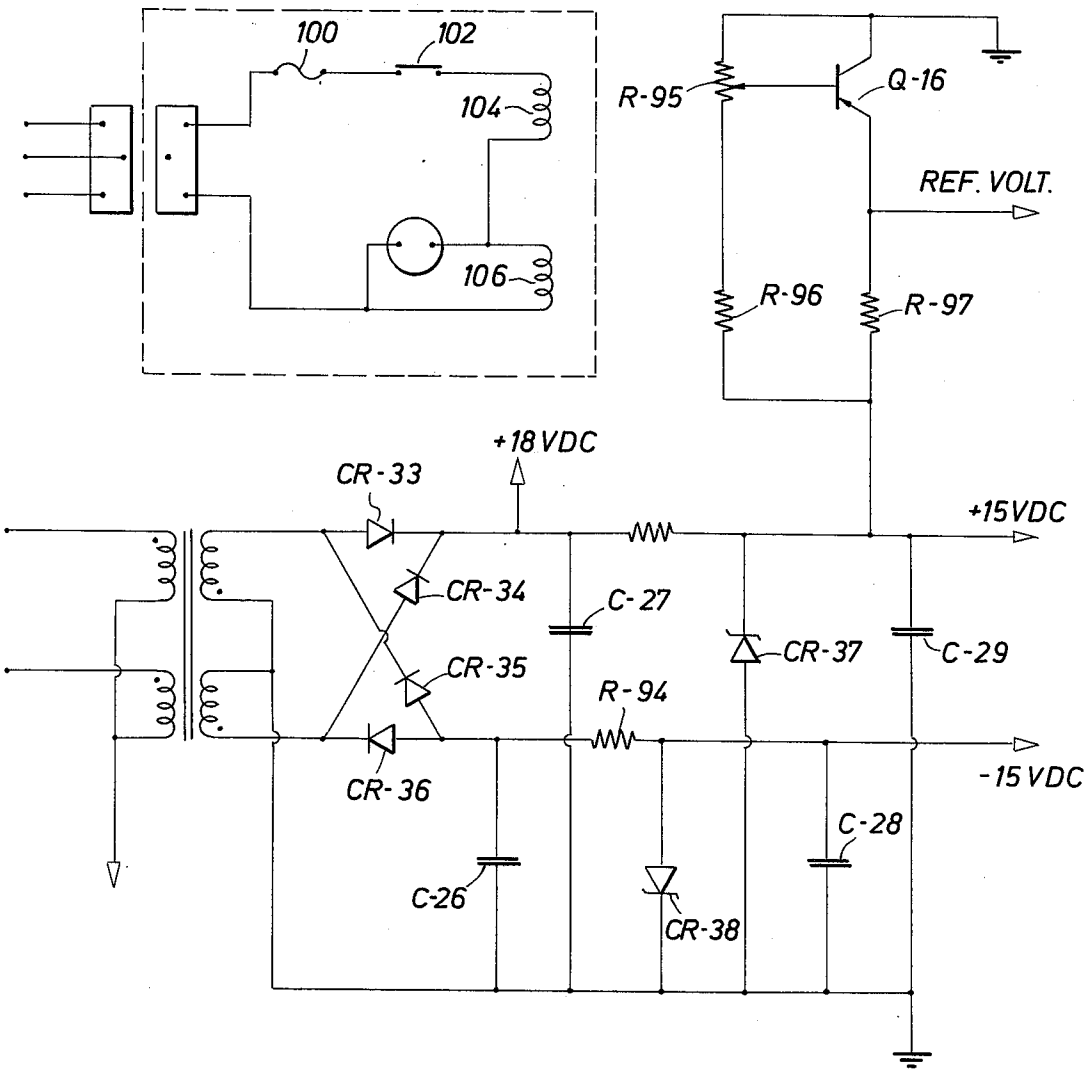

100
102
104
106
R-95
Q-16
REF. VOLT.
R-96
R-97
+18VDC
CR-33
+15VDC
CR-34
C-27
CR-37
C-29
CR-35
R-94
CR-36
-15VDC
C-28
C-26
CR-38

FIG. 5C

ELECTRONIC MULTI-MEDIA PROGRAMMER

FIELD OF THE INVENTION

This invention relates generally to controlling devices for programmed automatic control of remotely located devices capable of being energized and deenergized through switch or relay control. More specifically, the invention is directed to the provision of a multi-media programmer system including a plurality of specifically related audio tone channels that provide controlling functions for remote controlled devices responsive to detection of respective preset specifically related tones and which may be selectively controlled to transmit the respective specifically related tones to a recording mechanism thereby providing recorded signals that may provide recorded signals for programmed sequential or simultaneous control of the remote devices.

BACKGROUND OF THE INVENTION

Various multi-media programmer systems, also referred to as "programmers" have beem employed for quite some time for controlling various unrelated or cooperatively related devices to produce desired results. For example, it may be desirable to utilize a plurality of movie or slide projectors in such manner as to superimpose projected images from two or more of the projectors, or to utilize the projectors simultaneously, sequentially, alternatively, etc. For the most part, multi-media programmers have in the past been of quite complicated and expensive nature. Moreover, multi-media programmer systems have not been readily and available at low cost, that have the capability of both encoding and decoding when a plurality of frequency signals are employed. It is typically the case for a multi-media programmer to be provided with a pluality of completely separate circuits each being responsive to a particular frequency for controlling a particular channel of the programmer. It is also typical for such programmers to be provided with separate encoding and decoding means for each of the particular circuits.

As is typically the case where a plurality of control tones are employed, it is necessary to provide electronic filters having extremely high quality selectivity or sharpness, which is typically referred to in terms of "Q" or quality factor. High Q filters, for example, those having a Q factor greater than 20 and typically in the range of 100 to 150 require very precise electronic components for proper operation and, therefore, filter circuits having high Q operational capability are typically of quite expensive nature. The cost of these components adversely affects the competitive nature of the product involved. Low Q filter circuits, for example, those having a Q factor less than 20, although being quite inexpensive because extremely precise components are not required for proper operation, are not generally acceptable in plural tone multi-media programmers, because they are ineffective in proper filtering when the tones are closely spaced in terms of frequency. It is likely that a low Q filter will, because of its nature, be responsive to more than one incoming tone.

Another problem that typically adversely affects the competitive nature of most multi-media programmers, is the requirement that electronic components for encoding and decoding tones must be matched with a high degree of accuracy. In order to achieve the degree of matching accuracy that is typically desired, the encoding and decoding circuits must be provided with high quality precision frequency determining components.

Each tone channel of a multi-media programmer is typically provided with an electronic filter system for providing a decoding function and an electronic oscillator or amplifier system capable of providing an encoding function. Employment of separate encoding and decoding circuits for each tone channel of a multi-media programmer obviously causes the programmer to be of quite expensive nature, which of course detracts from its commercial feasibility.

Where a multi-media programmer is designed for energization of separate tone channels through a single input amplifier, in order to reduce the overall cost of the system, it is typically the case that the programmer may be capable of providing only one control signal at any given time. Since it may be desirable to actuate more than one controlled device at any one time, the enability of some programmer circuits to provide simultaneous actuation of remote devices is of course a competitive disadvantage.

THE PRIOR ART

Multi-media programmer circuits have been provided that employ plural frequency circuits and provide for simultaneous control of more than one controlled device such as taught by Papaiconomou U.S. Pat. No. 3,270,323. Audio tone signals have also been employed in the past in remote control systems such as taught by the patent to Deal U.S. Pat. No. 2,378,540 which teaches incorporation of audio tones transmitted by radio carrier waves for actuation of remotely located tone responsive mechanisms. Tone generating and transmitting circuits are utilized in a wide variety of electronic devices, such as taught by Hanert U.S. Pat. 2,254,284, electrical musical instruments; Peterson U.S. Pat. No. 2,924,776 tuner for tuning musical instruments and Bonham U.S. Pat. No. 2,933,699, frequency control means for monophonic tone generating oscillator.

In view of the fact that it is very desirable to provide a multi-media programmer system capable of selectively or simultaneously controlling various remotely located devices responsive to generation of tone frequency at a cost that would enable wide-spread distribution and use of such multi-media programmer systems, it is a primary object of the present invention to provide a novel multi-media programmer system of relatively low cost without sacrificing any operational capability thereof.

It is a further object of the present invention to provide a novel multi-media programmer system that permits utilization of low cost, low-Q circuits without sacrificing any ability of the system to encode and decode a plurality of tone frequencies for selective and/or simultaneous operation of remotely controlled devices.

It is another important object of the present invention to provide a novel multi-media programmer system that utilizes specifically related frequencies to insure that the most common types of signal distortion do not cooperate to cause distortion products that result in improper operation of one or more channels of the programmer system.

It is an even further object of the present invention to provide a novel multi-media programmer system that effectively makes use of the same frequency deter-

mining components for both encoding and decoding audio tone frequencies in order that a minimum number of electronic determining components may be employed without detracting from the quality or effectiveness of the programmer system.

Among the several objects of the present invention is noted that contemplation of a novel multi-media programmer system employing individual tone circuits or channels for each particular tone that is employed and providing means for selectively or simultaneously actuating tone outputs of the various tone circuits or channels for multiple control functions.

It is also an object of the present invention to provide a multi-media programmer system that effectively provides for binary decoding of the outputs where each output is a "bit" of a multiple "bit" binary word.

Other and further objects, advantages and features of the present invention will become apparent to one skilled in the art upon consideration of the written specification, the attached claims and the annexed drawings. The form of the invention, which will now be described in detail, illustrates the general principles of the invention, but it is to be understood that this detailed description is not to be taken as limiting the scope of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

So that the manner in which the above recited features, advantages and objects of the present invention, as well as others, which will become apparent, are attained and can be understood in detail, more particular description of the invention, briefly summarized above, may be had by reference to the preferred embodiments thereof illustrated in the appended drawings, which drawings form a part of this specification.

It is to be noted, however, that the appended drawings illustrate only a typical embodiment of the invention and are therefore not to be considered limiting of its scope, for the invention may admit to other equally effective embodiments.

In the Drawings:

FIG. 1 is an electrical schematic diagram shown partly in block diagram form setting forth a multi-media programmer system constructed in accordance with the present invention.

FIG. 2 is an electrical schematic diagram depicting the input amplifier portion of the electrical circuitry set forth in FIG. 1.

FIG. 3 is an electrical schematic diagram depicting a typical tone filter and encoder circuit forming a part of the electrical circuitry set forth in FIG. 1.

FIG. 4 is an electrical schematic diagram depicting a typical threshold detector/output driver circuit forming a part of the electrical circuitry set forth schematically in FIG. 1.

FIG. 5A is the left portion of an electrical schematic diagram illustrating the block diagram circuitry of FIG. 1 in schematic form.

FIG. 5B is the right portion of the electrical schematic diagram of FIG. 5A illustrating the circuitry in detail.

FIG. 5C is an electrical schematic diagram illustrating a suitable power supply system for control of the electrical circuitry set forth in FIGS. 1–5.

SUMMARY OF THE INVENTION

The present invention is directed to the provision of a tone encoder-decoder system for multi-media programmer which may comprise an input means providing specifically related audio tone signals for the purpose of controlling actuation of remotely located devices which tone signals may be octavely related. The tone input means may conveniently take the form of any suitable record and playback device such as a tape recorder, for example, that may be encoded with the particular specifically related tones and, when played back, will cause programmed introduction of tones into the control circuitry of the system. The audio tone signals may be introduced into the multi-media programmer system through an input amplifier circuit which provides gain for the audio signals, attenuates out of band signals which are undesirably, and provides an impedance conversion to match the high impedance tone input to a very low driving impedance for the plurality of active tone filters that are incorporated into the system.

A plurality of active tone filters, each being preset to particular frequencies, may serve to amplify signals in the preset frequency range and reject all signals that happen to fall outside of the preset frequency range. A portion of the output of each of the filters may be fed back into the appropriate filter input in order to cause the filter to oscillate responsive to closure of a feedback control switch. A tone, caused by oscillation of the particular filter, may be received by the recorder when the circuitry is in the record mode thereof in order to record tones that will be played back for control purposes. The tones played back from the recorder, since generated by the oscillating filter, will exactly match the preset tone frequency of the particular filter. This is caused by the selective nature of the filters being utilized during encoding to generate pure sine wave tones exactly at the center frequency of the pass bands of the filters. Plural preset filters are provided for each of a plurality of tone responsive control channels and each of the channels includes a threshold detector circuit that receives the output of the signals from the filter oscillator circuitry and compares the same to a preset threshold. The threshold detectors may generate a detector output signal only when the signal levels received are above the preset threshold and the signals from the threshold detector may be utilized to control actuation of the remotely located devices.

An output amplifier circuit may also be provided having a mode selector enabling the output amplifier to function both as a mixer and impedance converter for the tone filters in a record mode and to function as a voltage level monitor for the tone filter circuits in a playback mode.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference now to the drawings for a more detailed understanding of the present invention and with reference now particularly to FIG. 1, there is shown a multi-media programmer system in partially schematic and partially block diagram form generally at **10**. The programmer system may include an input amplifier circuit **12** that receives tone signals from any suitable generating means **14** introduced through an input jack J-1 into a sensitivity control circuit **16** that is connected with the input amplifier. The input amplifier provides gain for the audio signals, attenuates out of band signals which are undesirable, and provides an impedance con-

version to match the high impedance tone input to a very low driving impedance for a plurality of active filters.

A plurality of active filters, provided in a plurality of tone channels may be disposed to receive the output of the input amplifier. In FIG. 1 there is shown five active tone channels identified by channel numbers 1-5 and each of the five channels may be preset to a particular one of several octavely related frequencies in order that one or more of the channels may be energized to provide one or more control output signals, depending upon the tone or tones fed from the input amplifier to the active channels.

Each of the active tone channels of the programmer system may be generally identical in circuit configuration although certain electrical and electronic components of differing value may be employed in order to preset each circuit or channel for operation responsive to receipt of a predetermined tone signal. As shown in the upper part of FIG. 1, active tone channel number 1 may incorporate a filter oscillator circuit comprising an operational amplifier 18 functioning in conjunction with a feedback network 20 that may be selectively energized through a mode switch to cause the amplifier circuit 18 to oscillate at a predetermined frequency, thereby providing a tone signal that may be recorded. The oscillator output of the filter oscillator combination may be conducted through a variable resistance 22 to a conductor 24 through which the signal may be introduced to an output amplifier circuit 26 through a mode switch 28.

Each of the active tone channels may also include a threshold detector circuit shown at 30 in tone channel 1 which is effective to convert the ac output of the amplifier circuit 18 to dc and then to compare the dc level with a preset threshold. Signal levels or noise below the present threshold will not be allowed to pass the threshold detector and signal levels that are in excess of the preset threshold will pass the threshold detector circuit and trigger an output driver circuit 32. Each of the output driver circuits will conduct only when drive is received from the threshold detectors and, therefore, a control signal will be provided at the control output only when the signals detected by the amplifier control 18 are able to pass the threshold detectors. The control output signals may be of momentary nature if switches are to be actuated, or may be of continuous nature if it is desired to provide a continuous signal for control purposes.

As illustrated in FIG. 1, each of the tone channels 1-5 is preset at a particular frequency by the cooperative amplifier feedback network circuits and the frequencies of the various tone channels are specifically related to insure that false triggering is not induced by any combination of the frequencies employed. The channels are shown to be octavely related to insure that third and higher order harmonics resulting from clipping type distortion cannot cause false triggering. It is not intended, however, to limit the present invention specifically to octavely related signals, it being obvious that other tone combinations might be similarly employed without departing from the spirit and scope of the present invention.

Although five tone channels are shown, it is intended obvious that any desirable number of tone channels may be employed without departing from the spirit or scope of the present invention. Moreover, although particular octavely related tone frequencies are depicted in the drawings, it is not intended to limit the present invention to the specific frequencies set forth. Tone channel 1, as shown, incorporates an amplifier-feedback network circuit presetting the channel for a signal of 200 Hz and the remaining four tone channels are shown to be preset at 400 Hz, 800 Hz, 1,600 Hz and 3,200 Hz, respectively. These particular tone frequencies, being octavely related tone progressions, insure the third and higher order harmonics resulting from clipping type distortion cannot cause false triggering. For example, the primary distortion product of a clipped 200 Hz wave will be 600 Hz, a frequency lying midway between 400 Hz and 800 Hz, the frequencies corresponding to the second and third tone channels of the multi-media programmer system. The 600 Hz distortion product will of course be sufficiently far away from the 400 and 800 Hz signals the channels two and three will not be falsely triggered by the distortion product.

The multi-media programmer system, which may also be referred to as a programmer, may also include an output amplifier circuit 26 that receives tone signals either simultaneously or separately from the filter-oscillator circuits of each of the tone channels. The output amplifier circuit may include an operational amplifier 34 which, together with a gain determining circuit 35 may effectively function as a low temperature driver for a tone output jack J-2. The output amplifier circuit may also drive the circuit of a voltage level meter M-1 during the playback mode as determined by the mode switch 28. The output amplifier circuit is switched to read the voltage level being fed to the filter inputs and during the record mode, also referred to as encoding, the output amplifier may serve as a mixer and impedance connector for all of the tone generators. Generated tones may be received in combined or separate form by the output amplifier circuit 26 and may be transmitted through the jack J-2 to the input of the recorder mechanism 14. Thus, the recorder 14 may be utilized to record tone signals from the various filter-oscillator circuits to program the recorder as desired. On playback, the output of the recorder may be conducted through input jack J-1 and through the sensitivity control 16 and input amplifier 12 to the various filter oscillator circuits for control purposes. A combined tone signal, introduced into the circuitry through the recorder 14, will be separated into the various octavely related components by the filters in the playback mode and extraneous frequency components resulting from combined tones will be effectively separated from the octavely related components. Thus, control signal will be generated only when one of the specifically related tone signals is received.

For a more detailed illustration of components that may be employed in a sensitivity control and input amplifier circuit, reference may be had to FIG. 2. In put tones appearing at the input jack J-1 may be attenuated as required by an input sensitivity potentiometer R-1. Capacitor C-1 and resistor R-2 may be of specific values to set a low frequency cut off value, thereby preventing frequencies lower than the cut off value from being conducted to the amplifier input. Capacitor C-1 also removes any direct current which may appear at the input jack. A short circuit switch S-1 may be employed to short circuit the input signal provided as an output of the sensitivity control when the multi-media

programmer system is placed in the record mode. A limiting resistor R-4 may be included to limit the input current at the input jack J-1 in the event a large voltage should appear at the input jack in the record mode.

An operational amplifier Z-1 may be employed and may operate in the non-inverting mode thereof. Gain determining components including resistors R-4 and R-5 and capacitor C-2 may function to reduce the open loop gain of the operational amplifier to a value given by the formula

$$Ae \approx \frac{R_f + R_{in}}{R_{in}} = \frac{R{-}5 + R{-}4}{R{-}4}$$

Referring now to FIG. 3, a typical tone filter circuit is depicted such as may be incorporated into the multi-media programmer system of the present invention. Assuming the resistor R-7 to be driven from a zero source impedance, a feedback network incorporating capacitors C-3 and C-4 and resistors R-7, R-8 and R-9 resemble a conventional "bridge T" null network. During the record process, the tone fillers are required to produce tones that may be transmitted to the recorder 14 as indicated above in connection with FIG. 1. Closing of a feedback switch S-3 serves to feed a portion of the filter output voltage through diodes CR-1 and CR-2 that limit the voltage excursion at the junction of resistors R-11 and R-12 to a predetermined peak-to-peak voltage that is further reduced by the restrictive divider formed by resistors R-10 and R-11 before the voltage is applied to the non-inverting input of the operational amplifier. Feeding a portion of the filter output back into the non-inverting input of the operational amplifier causes the amplifier to oscillate and thereby generate a wave. During oscillation, the feedback signal resembles a square wave carrying large amounts of harmonic distortion. This distortion is effectively removed by the filter so that the output waveform is remarkably pure and sinusoidal in nature. When the switch S-3 is open, the feedback path is broken and the oscillations will then die out at a rate determined by the quality factor or "Q" of the filter. With the switch S-3, open, therefore, the operational amplifier circuit Z-2 will provide a filtering and amplification function. With the switch S-3 closed, the filter circuit will be modified, causing the filter to oscillate and thereby generate a tone at precisely the same frequency as the frequency for which the tone filter is preset.

The signal from the tone filter of FIG. 3 will then be conducted to a threshold detector circuit that produces an output signal or allows passage of a signal therethrough only when the signal received from the filter exceeds a particular threshold value for which the threshold detector circuit is preset. Output signals of the threshold detector circuit may then be conducted to an output driver circuit that provides a control output signal that may be utilized for operation of remotely located devices.

As illutrated schematically in FIG. 4 a typical threshold detector and output driver circuit is depicted that may include a detector portion receiving output signals of a typical filter circuit, which detector portion may include a resistor R-13, a capacitor C-5, diodes CR-3 and CR-4 and a capacitor C-6. The detector portion of the circuit develops direct current that is filtered by the capacitor C-6 and is applied to a transistor Q-1 through a resistor R-16. When the direct current level at the base of the transistor Q-1 rises above the base emitter offset voltage and the reference voltage established on the emitter of transistor Q-16, having its base voltage controlled by potentiometer R-95, conduction occurs causing a transistor Q-2 to conduct also. When transistor Q-2 conducts, the collector voltage increases toward 18 volts and positive feedback supplied by resistor R-20 to the base of transistor Q-1, causes this transistion to occur rather rapidly and establishes sufficient hysteresis to prevent slight level changes in the input from causing multiple output pulses.

Conduction of transistor Q-2 causes a voltage drop across series resistors R-21 and R-22 of sufficient magnitude to cause a silicon controlled rectifier (SCR) Q-3, which is an output driver device, to conduct. Conduction of the output driver device will continue as long as a positive voltage exists on the anode and the gate is positive with respect to the cathode (ground). The output driver transistor is rated with a maximum anode to cathode voltage that effectively eliminates the output driver transistor from being overloaded. Additionally, a pair of back-to-back Zener diodes CR-5 and CR-6 may be connected across the anode-to-ground conductors of the SCR Q-3 in order to limit transient voltage spikes to a level well within the range of the output driver device. Thus, annoying transient voltages are effectively eliminated from the audio equipment and the output driver device is completely protected from voltage spikes which may result from switching inductive loads. The output driver device Q-3 is not intended to switch loads supplied by dc sources except under unusual circumstances. A SCR, by nature, will conduct whenever both gate and anode are positive and conduction will continue with removal of gate drive. For "turn off" to occur, the anode current of the SCR must drop below approximately one milliampere. In ac circuits, a sufficient current drop to achieve turn off of the SCR will occur once during each cycle at the zero axis crossing, but when dc is involved, it is necessary to control the anode current in order to achieve a sufficient current drop to achieve turn off of the transistor.

As indicated above, reference voltage for the transistor Q-1 is provided by a voltage generator circuit including transistor Q-16 and potentiometer R-95. This reference voltage is provided as shown in FIG. 5 to each of the detector transistors of each of the various channels of the multi-media programmer circuit. The base voltage for the transistor Q-16 is provided across resistors R-96 and R-97, resistor R-96 being in series with resistor R-95 of the potentiometer and reducing positive voltage across R-95.

FIGS. 5A and 5B are schematic diagrams cooperatively illustrating the electronic circuitry for a typical multi-media programmer system incorporating five tone channels for controlling at least five separate remote devices. Since the tone channels are substantial duplicates except for values of the various circuit components, for the purpose of simplicity, only the circuitry of tone channel No. 1 is referred to in detail. The circuit includes an input amplifier circuit, differing from the input amplifier circuit set forth in FIG. 2 only in the relative position of certain of the electrical components and in modification of the mode switch S-1*a* to depict a switch construction having both record and playback modes.

The circuitry set forth in FIGS. 5A and 5B may also include an output amplifier and signal metering circuit similar to that shown in block schematic diagrm form in FIG. 1. The output amplifier circuit, as indicated above, functions as a low impedance driver for the tone output jack J-2 and drives the circuit of a voltage level meter M-1. During playback, the output amplifier is switched by a mode switch S-1*b* causing the meter M-1 to read the voltage level being fed to the various filter inputs. When in the recording or encoding mode as determined by the position of switch S-1*b* the output amplifier will serve as a mixer and impedance converter for all of the tone filter and generator circuits. The output amplifier circuit may include an operational amplifier, which may be the same operational amplifier Z-1 employed in the input amplifier circuit when the amplifier is enclosed in the same package. Gain determining components capacitor C-24 and resistors R-88 and R-89 serve to reduce the open loop gain of the operational amplifier and high frequency response is limited by the network consisting of resistor R-88 and capacitor C-24. Diodes CR-31 and CR-32 cooperate with capacitor C-25 and resistor R-90 and resistor R-87 to limit voltage spikes and control current flow through the metering circuit including voltage level meter M-1.

The input and output amplifiers may be selectively coupled to the tone filter system through the double pole double throw switch including switch sections S-1*a* and S-1*b*.

The circuit components of only one of the five channels is described for purposes of simplicity because the remaining four tone channel circuits are identical to the circuit that is described. It is intended that the tone filter circuit described be considered only as illustrative of one suitable circuit capable of accomplishing the features of the present invention, it being obvious that other circuit components may be employed in other circuit configurations to achieve similar results.

Channel No. 1, as shown in FIG. 5B, incorporates a reference voltage generator circuit incorporating resistors R-17, R-96 functioning in conjunction with potentiometer R-95 and transistor Q-16 to provide reference voltage for each of the remaining four tone channels. The reference voltage generator circuit is described below in connection with FIG. 5C.

As shown in FIG. 5C, electrical potential for energizing the multi-media programmer system of the present invention may be supplied by a step down transformer and rectifier combination. The electrical potential or power that results may be pulsating direct current that is filtered and regulated to a level of plus 15 volts dc and minus 15 volts dc. A threshold voltage may be delivered to each threshold detector through a transistor Q-16. The threshold voltage may be precisely controlled by a trim potentiometer R-95 that allows the voltage to be properly adjusted during initial calibration of the control circuitry. Current rectification to provide both plus and minus direct current is accomplished by diodes CR-33, CR-34, CR-35 and CR-36. The rectified dc current being applied through resistors R-93 and R-94 respectively to Zener diodes CR-37 and CR-38. Capacitors C-26, C-27, C-28 and C-29 filter respective plus and minus portions of the current as it is applied to other portions of the circuit.

As shwon in the upper left hand portion of FIG. 5C, it may be desirable to provide a single-primary power transformer that may be substituted to the transformer set forth in the lower portion of FIG. 5C as desired. The power transformer circuit may include a fuse 100 that may be of the slow blow type that will not become easily blown responsive to current irregularities. Current from the fuse 100 may be controlled by a power switch 102 thereby controlling current flow through primary windings 104 and 106.

In view of the foregoing, it is apparent that I have provided a novel multi-media programmer circuit including a multiplicity of tone channels, each channel being preset to receive a certain one of several octavely related frequencies. Upon receiving the particular frequency, each fo the channels will be responsive to generate a control signal that may be utilized for operative control of remotely located devices. The invention is especially useful in providing a relative low cost control system for controlling a plurality of audio visual projectors that may provide the facility for superimposing images on a screen in addition to providing many other operational features not ordinarily within the capability of low cost electronic components. My invention effectively facilitates provision of a full range multi-media programmer system that effectively lends itself to selective, simultaneous and sequential control even though the system is of low cost nature. My invention effectively provides a multi-media programmer system costing substantially less than present full range multimedia programmer systems and yet provides equivalent if not identical operational capability.

In view of the fact that individual circuits are provided for each of the various tones, the circuits may be activated either selectively or simultaneously for the purpose of selectively operating a plurality of remote devices. This feature is not possible with other techniques such as sequential tones or digital actuation.

The multi-media programmer system effectively provides for binary decoding of the various outputs where each output is a "bit" of a five-"bit" binary word. When a five tone channel system is employed such as shown and described herein, a theoretical maximum of $2^5 = 32$ output signals may be generated.

It is also within the capability of multi-media programmer system of the present invention to combine the responses of two or more of the independent tone channels in order to yield a completely separate responsive output that may be utilized by separate circuitry for the purpose of providing even broader multimedia programmer features. My invention is, therefore, one clearly adapted to attain all of the objects hereinabove set forth, together with other objects which are inherent from a description of the apparatus itself. It will be understood that certain combinations and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the present invention.

As many possible embodiments may be made of this invention without departing from the spirit or scope thereof, it is to be understood that all matters hereinabove set forth are shown in the accompanying drawings are to be interpreted as illustrative and not in any limiting sense.

What is claimed is:

1. A multi-media programmer system comprising:
record and playback means capable of recording and playing back audio tone signals;

an electronic input amplifier circuit providing gain for said audio tone signals and attenuating out of band signals;

a plurality of tone filter-oscillator circuits each having an electronic operational amplifier circuit and an electronic feedback network, means selectively connecting said feedback network to the input of said amplifier circuit in a filter mode and disconnecting said feedback network from said amplifier circuit during an oscillator mode, said filter-oscillator means passing only a narrow band of tone frequency signals and thereby providing a decoding function in the filter mode for decoding audio tones received from said record and playback means and generating a tone frequency signal within said narrow band of tone frequency signals to provide an encoding function in the oscillator mode, said tone frequency signals being received by said record and playback means;

threshold detector circuit means for each of said tone filter-oscillator circuits receiving the output signals fo said filter-oscillator means and including comparator circuit means comparing the output signals to a preset threshold, said threshold detector means generating a detector output only when output signal levels exceed said preset thershold;

means connecting said tone filter-oscillator circuits between the output of said input amplifier means and the input of said threshold detector means;

an output amplifier-mixer circuit having an amplifying mode for amplifying tone signals to be recorded and a mixing mode, said output amplifier-mixer means providing a voltage level monitoring function in said amplifying mode and functioning as a mixer and impedance connector for said tone filter-oscillator means in said mixing mode, said output amplifier circuit having an operational amplifier circuit; and means selectively connecting said input amplifier circuit and said output amplifier circuit with said tone filter-oscillator circuits.

2. A multi-media programmer system as recited in claim **1**, wherein:

each of said filter-oscillator circuits is preset to a different octavely related audio frequency as compared to others of said filter-oscillator circuits.

3. A multi-media programmer system as recited in claim **1**, wherein said threshold detector means comprises:

means converting said dc signals of said filter-oscillator means to dc;

means comparing said dc signals to a preset threshold and producing output signals only when the dc is above the preset threshold; and

output driver means receiving the output of said comparing means and becoming conductive only when output signals are received from said comparing means.

4. A multi-media programmer system as recited in claim **1**, wherein;

each of said plurality of tone amplifier circuits is preset to detect and amplify audio signals at a predetermined frequency range; and

said feedback network is selectively controlled to feed a portion of the amplifier output back into the input of the amplifier circuit, causing said amplifier circuit to oscillate and generate a tone frequency that is substantially the same frequency range said amplifier circuit is preset to detect and amplify.

5. A multi-media programmer system having tone encoder-decoder capability, said system comprising:

tone input means capable of selectively and simultaneously providing tone signals;

electronic input amplifier means having means fo connection to tone input means, said input amplifier means amplifying audio in put signals received from said tone input means;

a plurality of tone filter-oscillator circuits for receiving all of the audio signals from said input amplifier means, said tone filter-oscillator circuits having a filter mode and an oscillator mode passing only a narrow band of frequency signals and thereby providing a decoding function in said filter mode for decoding audio tones received from said tone input means, said filter-oscillator circuit having an oscillator mode and generating a tone frequency signal within said narrow band of tone frequency signals to provide an encoding function in said oscillator mode, each of said tone filter-oscillator circuits amplifying signals in a predetermined frequency range and rejecting the tones that lie outside of the predetermined frequency range;

threshold detector means being connected to the output of said tone filter means, said threshold detector means comparing output signals to a preset threshold and generating a detector output only when signal levels are above the preset threshold; and

output driver means receiving passed output signals from said threshold detector means and upon being triggered by said passed output signals, transmitting a control signal for operation of a remote device.

6. A multi-media programmer system as recited in each of said tone filter-oscillator circuits are specifically related to the other in such manner as to eliminate the possibility of false triggering of any of said circuits by distortion products developed by tone signal combinations; and

said threshold detector means comprises separate threshold detector circuits provided one for each of said tone channel circuits and each being preset at a particular threshold level, preventing tone signals below the preset threshold level from passing and causing a control signal to be generated responsive to passed tone signals.

7. A multi-media programmer system as recited in claim **6**, including:

a plurality of output driver circuits being connected one to each of said threshold detector circuits to receive passed signals from said threshold detector circuits and being operative to generate said control signal upon receiving said passed signal.

8. A multi-media programmer system as recited in claim **5**, wherein: said tone filter-oscillator circuits each includes an amplifier circuit;

a plurality of feedback circuits being connected to respective ones of said amplifier circuits and causing said amplifier circits to oscillate and generate audio frequency tones in said oscillator mode; and

said input means selectively receiving and recording said audio frequency tones of said amplifier circuits.

9. A multi-media programmer system as recited in claim 8, wherein:

said tone channel circuits are octavely related, thereby insuring that significant odd-order harmonics of the fundamental frequency of any tone channel circuit are not sufficiently close to the fundamental frequency of other tone channel circuits as to cause said false triggering of other tone channel circuits.

10. A multi-media programmer system as recited in claim 8, wherein:

said input means comprises recording apparatus having record and playback modes and, during said recording mode, said input means receives tone signals generated by said amplifier-oscillator circuits of said tone channel circuits and, during said playback mode, said input means transmits said recorded audio frequency tones to said tone channel circuits.

11. A multi-media programmer system comprising:

tone input and recording means providing specifically related audio tone signals in a playback mode thereof and recording audio tone signals in a record mode thereof;

mode selector means for selectively disposing said tone input and recording means in said playback and record modes;

input amplifier means receiving said audio tone signals, providing gain for said audio tone signals and attenuating out-of-band signals, said input amplifier providing an impedance conversion matching the impedance tone of said tone input and recording means with the driving impedance of active tone filter-oscillator means;

a plurality of tone filter-oscillator circuits receiving converted tone signals from said input amplifier means and selecting and amplifying only tone signals of preselected frequency range each of said tone filter-oscillator circuits having a filter mode and an oscillator mode passing only a narrow band of frequency signals and thereby providing a decoding function in said filter mode for decoding audio tones received from said tone input means, said filter-oscillator circuit generating a tone frequency signal within said narrow band of tone frequency signals to provided an encoding function in said oscillator mode;

mode selector means causing said filter-oscillator means to be operative in a playback mode to detect and amplify a preset range of tone frequency signals and in a record mode to generate tone frequency signals at said preset range of tone frequency signals;

threshold detector means receiving the output signals of said filter-oscillator means, comparing the output signals to a preset threshold and generating a detector output signal only when said output signals of said filter means exceed said threshold of said threshold detector means; and

output driver means receiving the output of said threshold detector means and generating a control signal for operation of a remote device responsive to being triggered by signals passing said threshold detector.

12. A multi-media programmer system as recited in claim 11, including:

output amplifier circuit means being controlled by said mode selector means enabling said output amplifier to function as a mixer and impedance converter for said tone filter means in a first mode and to function as a voltage level monitor for said tone filter means in a second mode; and

said tone input and recording means being switched between input and recording modes by said mode selector means.

13. A multi-media programmer system as recited in claim 11, wherein each of said tone filter-oscillator circuits comprise:

amplifier circuit means;

feedback circuit means bieng operative to feed a portion of the output of the amplifier means causing said amplifier means to oscillate and generate a tone signal;

said input and recording means being operative to receive and record the tone signal of said amplifier means upon oscillation of the same; and

mode selector means for selectively controlling the operative condition of said feedback circuit means and said input and recording means.

14. A multi-media programmer system as recited in claim 11, wherein:

said output signals of the respective output driver means each representing a bit of a binary word, said output signals being utilized in combination to develop a binary control signal.

* * * * *