United States Patent [19]

Camras

[11] **3,821,786**

[45] **June 28, 1974**

[54] **VIDEO TRANSDUCING APPARATUS**

[75] Inventor: **Marvin Camras,** Glencoe, Ill.

[73] Assignee: **ITT Research Institute,** Chicago, Ill.

[22] Filed: **Sept. 20, 1971**

[21] Appl. No.: **182,212**

Related U.S. Application Data

[60] Division of Ser. No. 34,504, May 4, 1970, Pat. No. 3,705,954, which is a division of Ser. No. 649,256, June 27, 1967, Pat. No. 3,596,008, which is a continuation-in-part of Ser. No. 528,934, Feb. 21, 1966, abandoned.

[52] **U.S. Cl.** **358/4**

[51] **Int. Cl.** **H04n 9/02**

[58] **Field of Search** ..... 178/5.2, 5.4 R, 5.4 CD

[56] **References Cited**

UNITED STATES PATENTS

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Primary Examiner—Richard Murray

Attorney, Agent, or Firm—Hill, Gross, Simpson, Van Santen, Steadman, Chiara & Simpson

[57] **ABSTRACT**

Monochrome and color television recording and playback circuitry for coupling of a video magnetic transducer head with a standard broadcast television receiver, the receiver having a matrixing circuit with X and Z inputs and R-Y, G-Y and B-Y outputs, and the head playback amplifier supplying R-Y and B-Y signals to the X and Z inputs of the matrixing circuit during reproduction of color television signals from the record medium.

7 Claims, 5 Drawing Figures

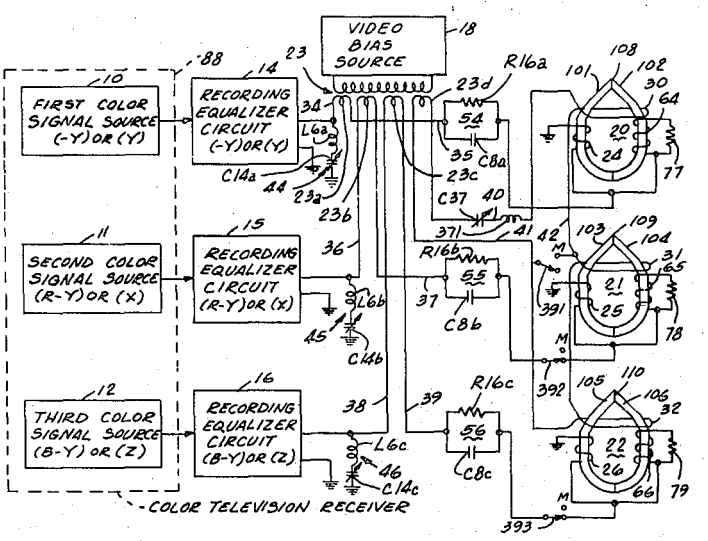


Fig. 1

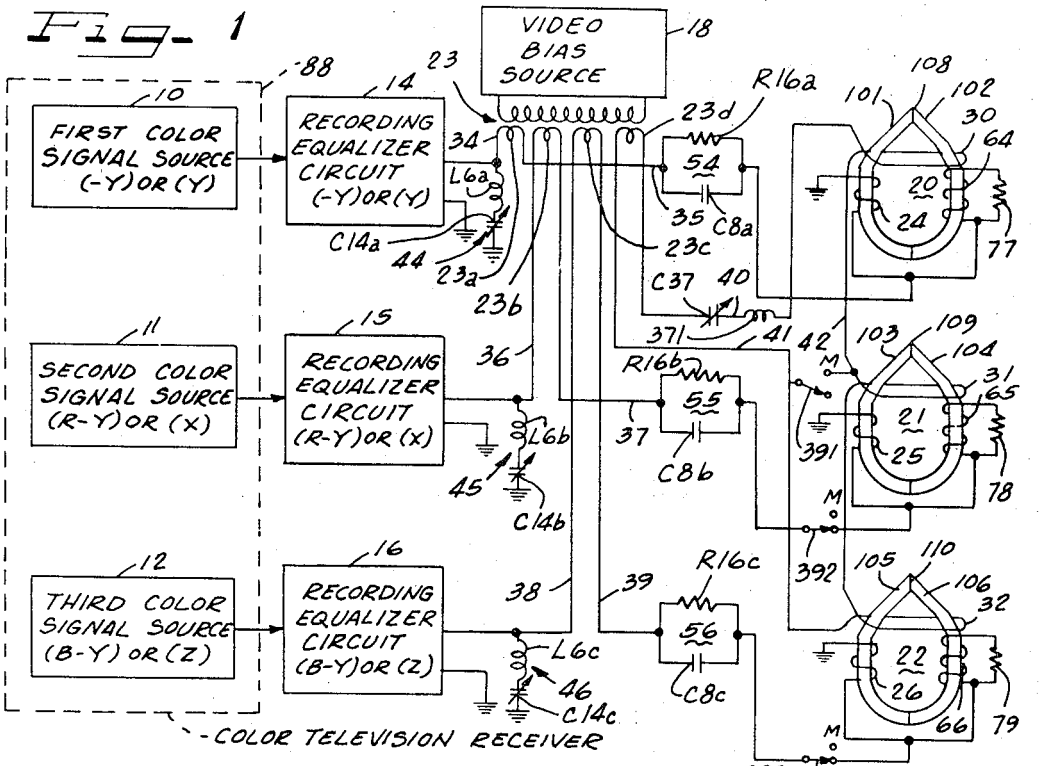
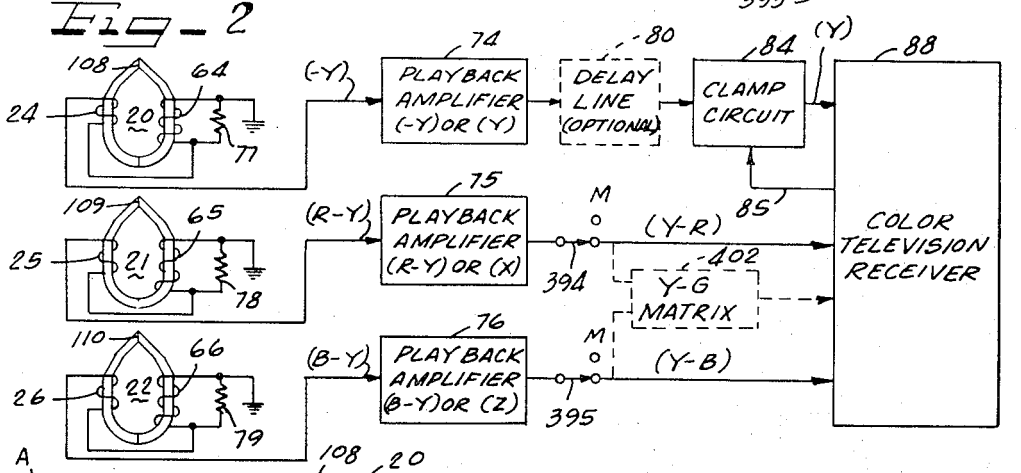


Fig. 2



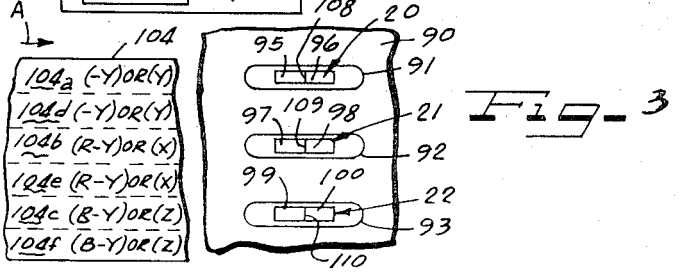


Fig. 3

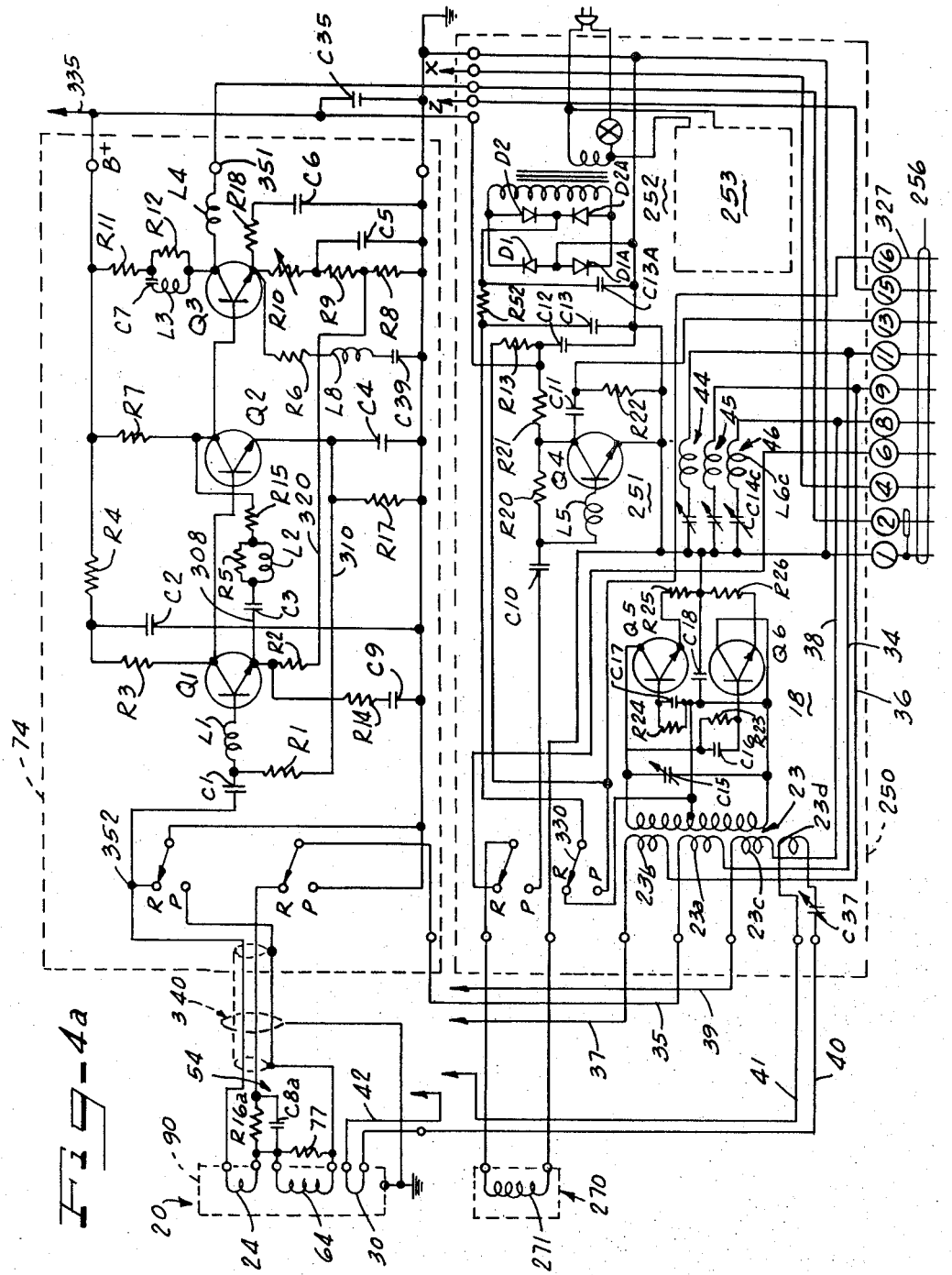

335
B+
C35
X
Z
Y
D2
D2A
252
253
D1
D1A
C13A
R18
351
C6
C5
R11
R12
L4
C7
L3
Q3
R10
R9
R8
R7
Q2
R6
L8
C4
C39
R4
R15
320
L2
C2
308
R5
C3
310
R17
R2
C9
R3
Q1
L1
R1
C1
R14
352
R
P
330
C10
R20
R21
R13
C11
R22
Q4
L5
251
R52
C12
C13
44
45
46
C14
L62
R26
Q5
R25
C17
C18
Q6
R24
R23
C16
C15
23
23d
23a
23b
23c
C37
250
38
34
36
18
256
327
74
90
20
24
64
30
271
270
340
54
R16a
C8a
77
42
37
35
39
41
40

Fig. 4a

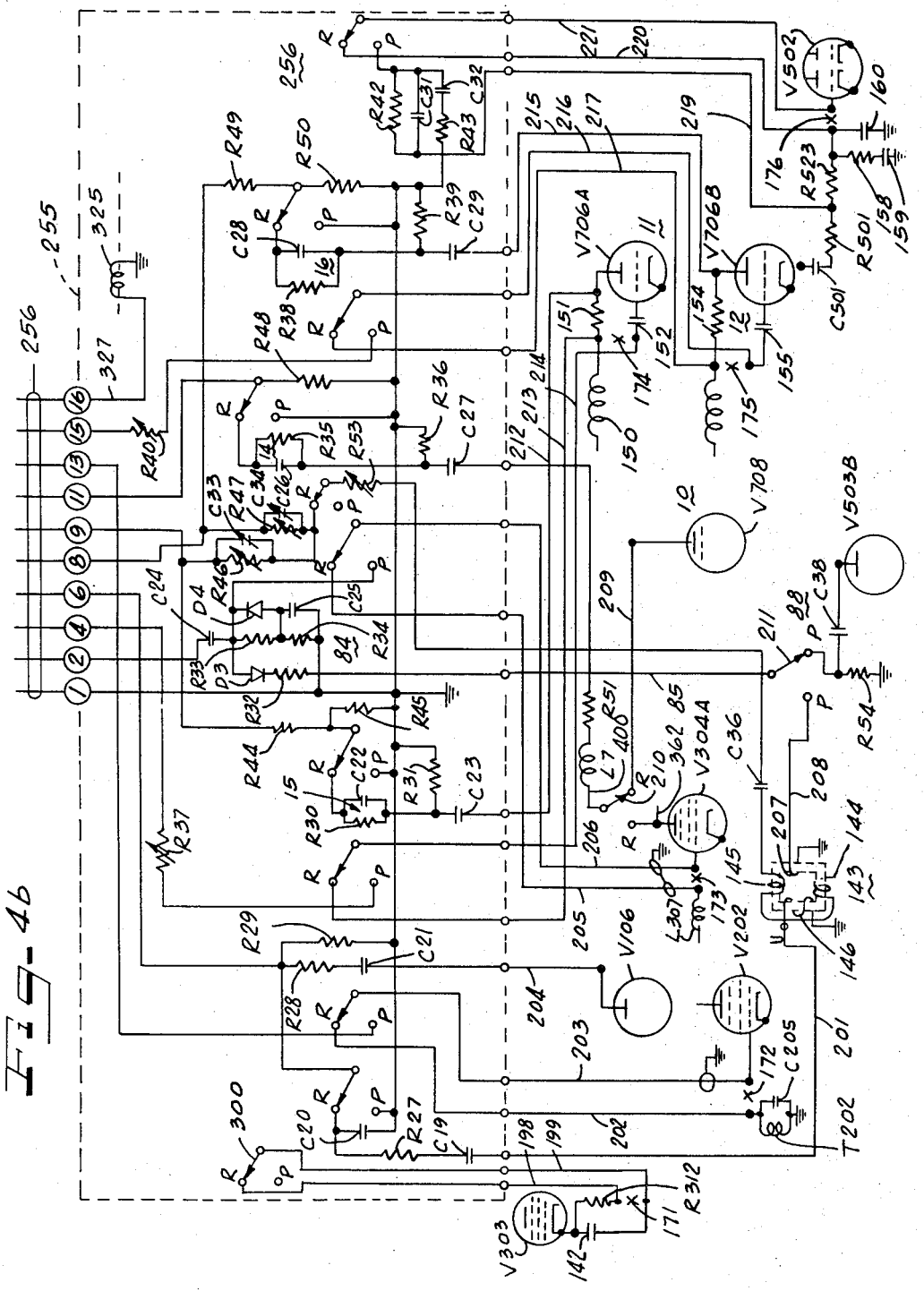

256
255
325
327
R49
R50
R42
R43
C31
C32
R39
C29
C28
R48
R38
R36
C27
R40
R35
R53
C33
R47
C34
C26
R46
C24
C25
D4
D3
R34
R33
R32
R45
R44
C22
R31
C23
R30
R37
R29
C21
R28
C20
R27
C19
300
198
199
202
R312
V303
142
171
V106
204
203
205
206
V3044
210
362
85
R51
400
C36
V307
173
V202
145
207
208
144
143
146
201
172
C205
T202
V708
10
V5038
88
C38
211
209
R54
V7068
12
154
155
175
V7064
11
151
152
174
150
214
213
212
C501
R501
R523
158
159
176
V502
160
215
216
217
219
220
221

FIG. 46

VIDEO TRANSDUCING APPARATUS

CROSS REFERENCES TO RELATED APPLICATIONS

The present application is a division of my copending application Ser. No. 34,504 filed May 4, 1970 (now U.S. Pat. No. 3,705,954, issued Dec. 12, 1972). Said application Ser. No. 34,504 is a division of Ser. No. 649,256 filed June 27, 1967 (now U.S. Pat. No. 3,596,008 issued July 27, 1971), and said application Ser. No. 649,256 is a continuation-in-part of application U.S. Ser. No. 528,934 filed Feb. 21, 1966 (now abandoned in favor of my application U.S. Ser. No. 62,601, filed Aug. 10, 1970 and issued as U.S. Pat. No. 3,683,107 on Aug. 8, 1972).

Reference is made in compliance with the requirement of 35 U.S.C. 120 to my earlier filed applications Ser. Nos. 528,934, 649,256 and 34,504.

BACKGROUND OF THE INVENTION

An important problem in the magnetic recording art relates to the need for a video transducer apparatus which can be manufactured at a reasonable cost and yet which will provide quality transducing of television signals, and particularly color television signals and the associated audio signals.

SUMMARY OF THE INVENTION

This invention relates to a wide band transducing system and method, and particularly to a system for recording and/or reproducing color television signals.

In a preferred embodiment of the present invention three demodulated color signals from a conventional color television receiver are transmitted by the circuitry of the present invention to a magnetic tape recorder.

The head units and circuit concepts of the present invention may be applied to various transducer configurations such as the right angle or skew angle rotating head configurations wherein the head units scan successive right angle or skew angle tracks on a longitudinally moving, relatively wide record tape. An important contribution of the present invention, however, resides in a system for transducing color television signals by means of stationary head units which scan longitudinal tracks on the record medium. For example, a system has been devised and usccessfully operated for recording and playing back broadcast color television signals on a 1/4 inch magnetic tape record medium with provision for more than one program on the same tape. Using the preferred head configuration, and preferred electric circuitry such color television signals may be recorded and reproduced with scanning speeds of the head relative to the record medium of the order of 120 inches per second or less and with the use of low cost tape transports, comparable in cost to present home (non-professional) type sound recorder transports. Head-to-tape scanning speeds of 60 inches per second or less are feasible using the teachings of the present invention, in contrast to head velocities of the order of 1,500 inches per second which are typical for present rotating head systems.

It is an object of the present invention to provide an economical color television transducing system such as would be particularly suitable for home or educational uses.

Still another object of the invention is to provide a system for recording and/or reproducing color television signals together with the related audio intelligence which is readily connected with present commercial broadcast receiver circuitry and which requires only three video transducer head units, or less.

Another and further object of the invention is to provide a system for recording and repoducing color television and audio signals with the use of broadcast receiver circuitry and a minimum number of additional low cost transistors of the order of 12.

Other objects, features and advantages of the present invention will be apparent from the following detailed description taken in connection with the accompanying drawings.

The objects of the aforementioned applications for patent are also applicable to the present disclosure and are specifically incorporated by reference at this point in the present specification.

It is also an object to provide simple means for phase error correction in video recording and/or playback circuitry.

A further object resides in the provision of a television recording and/or playback system with a high gain-low noise amplifier operable at relatively low tape speeds and with relatively narrow head widths.

Another object resides in a method and apparatus for high fidelity recording and/or reproduction at low cost.

A still further object is to provide a transducer system which is relatively insensitive to record speed variations.

Still another and further object of the invention resides in the provision of a relatively inexpensive and simple system for recording audio signals associated with a color video signal.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagrammatic view indicating a preferred color television recording system in accordance with the present invention;

FIG. **2** is a diagrammatic illustration of a preferred color television playback system in accordance with the present invention;

FIG. **3** is a diagrammatic partial plan view illustrating a preferred transducer system for recording and playback of color television signals;

FIG. **4***a* is an electric circuit diagram showing portions of a preferred record-playback circuit in accordance with the present invention;

FIG. **4***b* is a circuit diagram showing further portions of a preferred record-playback circuit in accordance with the present invention, the circuitry of FIGS. **4***a* and **4***b* being connected by conductors of a cable indicated at the lower center of FIG. **4***a* and the top center of FIG. **4***b*.

DESCRIPTION OF THE ILLUSTRATED EMBODIMENT

FIG. **1** illustrates in diagrammatic form a preferred color television recording system in accordance with the present invention. In this preferred system, demodulated color signals are obtained from suitable sources such as indicated at **10, 11** and **12.** In one type of commercial broadcast receiver, as for example the RCA CTC16XH chassis, demodulated signals known as the minus Y (−Y) signal, the R minus Y (R−Y) signal and

the B minus Y (B—Y) signal may be obtained, respectively, from the plate of a third video amplifier tube, from the plate of a R minus Y amplifier tube and from the plate of a B minus Y amplifier tube. In general the (—Y) signal may be obtained from the cathode drive of commonly used three green color picture kinescopes, the (R—Y) signal from the red grid drive, and the (B—Y) signal from the blue grid drive. Alternatively the undelayed (—Y) signal is obtained from the first video amplifier. Alternatively, suitable demodulated color components known as the Y signal, the X signal and the Z signal may be obtained from the grids of the monochrome amplifier and color amplifier tubes respectively, and the color signal sources **10, 11** and **12** may represent suitable sources of these signals in such receiver circuitry, as another example. The term "color television signal" as utilized herein referes to a signal which may be utilized in reconstructing a color image without regard to whether the signal represents the actual variation of intensity of a particular color component of a light image. Thus, the term "color television signal" as utilized herein comprehends the conventional Y or (—Y) signal which is found in present receiver circuitry.

Recording circuitry components **14–16** may comprise suitable equalizer circuits and optionally may include amplification circuitry.

In the preferred circuit arrangement, a component **18** is included for supplying a high frequency bias current to the respective head units indicated at **20, 21** and **22.** By way of specific example, the source **18** has been indicated as energizing a transformer **23** which has respective secondary windings **23***a*, **23***b* and **23***c* interposed in series between the respective recording circuits **14–16** and the respective record windings **24, 25** and **26** of the head units. The video bias source **18** is also illustrated as energizing cross field conductors **30, 31** and **32** in series by means of a secondary winding **23***d*.

In order to conveniently correlate the showing of FIG. **1** with the detailed circuit diagram of FIGS. **4***a* and **4***b*, conductors in FIGS. **4***a* and **4***b* corresponding to conductors **34–42** in FIG. **1** will be given corresponding reference numerals. To further facilitate a comparison of these figures, an adjustable capacitor C37 and bias frequency trapping circuits **44–46** have been indicated in FIG. **1** and have been given corresponding reference numerals in FIG. **4***a*. Similarly coupling circuits **54–56** have been indicated in FIG. **1** and the coupling circuit for the Y channel has been correspondingly designated in FIG. **4***a*. Thus, the details represented at **18, 23, 30–32, 43–46** and **54–56** are included in FIG. **1** solely for the purpose of correlation with the preferred system of FIGS. **4***a* and **4***b*, and these details are, of course, not necessary to the broad concepts of the present invention. Other modifications not falling within the scope of the embodiment illustrated in FIG. **1** will be described hereinafter.

FIG. **2** illustrates a preferred playback arrangement including head units **20–22** which are identical to the head units of FIG. **1.** During playback, the low impedance windings **24–26** are connected in series with high impedance windings **64–66** to supply respective reproduced signals to playback amplifiers **74–76.** Resistors **77–79** are connected in parallel with the high impedance windings **64–66** and are for the purpose of dampening any resonance effects in the high impedance coil associated therewith. The input impedance of components **74, 75, 76** are designed to further damp the resonances in heads **20, 21,** and **22.**

As indicated in FIG. **2,** the reproduced signals may represent respective demodulated color signal components such as a (—Y) component, a R minus Y component and a B minus Y component or may represent Y, X and Z components as previously mentioned, for example. A delay line component **80** may be optionally provided in the Y channel, the delay line in the monochrome portion of the broadcast receiver being conveniently used. The three color component signals may be supplied to suitable points in a conventional color television receiver circuit, for example to the grid of a first video amplifier tube, to the grid of a R minus Y amplifier tube and to the grid of a B minus Y amplifier tube, respectively, where these are the signals normally present in such receiver circuitry. In the RCA CTC **24XH** the delay line in the monochrome circuit may be bypassed by supplying the (—Y) playback signal to the third video amplifier V708, and similarly the delay line may be bypassed in other receivers.

For convenience in correlating FIG. **2** with the detailed circuitry of FIGS. **4***a* and **4***b*, a clamp circuit has been indicated at **84** in FIG. **2** and the specific clamp circuit shown in FIG. **4***b* has been designated by the same reference numeral. To conform with FIG. **4***b*, a pulse input to the clamp circuit **84** at the horizontal line frequency is represented as being supplied by a line **85** in FIG. **2** conforming with the showing for line **85** in FIG. **4***b*. The component designated by reference numeral **88** in FIG. **2** represents commercial broadcast receiver circuitry suitably modified so as to receive reproduced signals from the other components of the system of FIG. **2.** Suitable modifications of one type of commercially available receiver using the RCA CTC16XH circuits have been indicated in detail in FIG. **4***b*. As with the embodiment of FIG. **1,** the embodiment illustrated in FIG. **2** is not intended to comprehend all modifications falling within the scope of the concepts of the present invention, certain components having been indicated, such as the disclosure of particular preferred head units and a preferred clamp cicuit **84,** for the purpose of facilitating disclosure of a preferred embodiment in conjunction with the detailed circuitry of FIGS. **4***a* and **4***b*. Modifications in the playback circuitry of FIG. **2** will generally correspond to modifications of the recording circuitry of FIG. **1.** All such modifications of FIGS. **1** and **2** may be integrated into a combined recording and playback system, one preferred embodiment of which having been disclosed in FIGS. **4***a* and **4***b*. To illustrate this point, color component sources **10, 11** and **12** have been shown as contained within a dash rectangle **88** corresponding to the modified receiver circuitry **88** of FIG. **2.** Broadly, however, the concepts of the present invention are not limited to the use or adaptation of conventional broadcast receiver circuitry, since any suitable source of color signal components may supply the signal to be recorded, and the reproduced color component signals may be supplied to any desired display or other utilization circuitry.

A preferred head configuration is illustrated in FIG. **3** taken in connection with the diagrammatic showings of FIGS. **1** and **2.** A housing **90** of magnetic shielding material may substantially completely enclose the head units **20–22,** the tape engaging surface **90***a* of the hous-

ing having three elongated openings **91, 92** and **93** for receiving the tape engaging pole faces **95–96, 97–98** and **99–100** (FIG. 3) of the respective head units **20, 21** and **22.** The poles **101–102, 103–104** and **105–106** (FIG. 1) of the head units have transversely aligned transducing gaps **108–110** therebetween for coupling of the respective head units with a tape record medium such as indicated at **104.**

DESCRIPTION OF THE SPECIFIC CIRCUITRY OF FIGS. 4*a* AND 4*b*

The general arrangement of the detailed circuitry of FIGS. 4*a* and 4*b* will be apparent from a comparison with FIGS. **1** and **2** since in FIGS. 4*a* and 4*b* reference numerals such as **10, 11, 12, 14, 15, 16, 18, 23, 24, 30, 34-46, 54, 64, 74, 77, 84, 85** and **88** have been located so as to indicate specific circuit elements corresponding to those represented in FIGS. **1** and **2.**

For purposes of specific illustration, the components in the region **88** are in general conventional components of RCA Model CTC16XH color television chassis. This circuit is representative of color TV circuits that are widely used. The conventional networks and individual components shown in FIG. 4*b* are tabulated as follows: tube V303 (type 6EJ7), capacitor 142, resistor R312, inductor **T202,** capacitor **C205,** sound demodulator tube **V202** (type 6HZ6), audio output tube **V106** (type 6AQ5A), inductor **L307,** first video tube **V304A** (type 6LF8), horizontal output transformer **143,** horizontal output winding sections **144, 145** and **146,** tube **V503B,** third video tube **V708** (type 12BY7A), inductor **150,** resistor **151,** capacitor **152,** (R minus Y) amplifier tube **V706A** (type 6GU7), inductor **153,** resistor **154,** capacitor **155,** (B minus Y) amplifier tube **V706B** (type 6GU7), capacitor **C501,** resistor **R501,** resistor **R523,** resistor **158,** capacitor **159,** capacitor **160,** tube **V502.**

The following components within the general region of the receiver circuit **88** are new components having values as follows: inductor L7–500 microhenries, resistor R51–4,700 ohms, capacitor C36–1,000 micromicrofarads, resistor R54–47,000 ohms and capacitor C38–15 micromicrofarads.

The original circuit has been broken in a number of points as will be apparent to those skilled in the art, for example at the locations indicated by a small "*x*" and designated by reference numerals **171–176.** At other places in FIG. 4*b*, tube elements, circuit components and conductive connections have simply been omitted for the sake of simplicity since such elements remain unchanged from the standard circuit.

Connections or additions to the standard RCA chassis comprise conductors **198** and **199,** the conductor **201** connected to terminal U of the winding section **146** of the horizontal output transformer **143,** conductors **202–206,** a single turn winding **207** on the horizontal output transformer **143** together with a conductor **208** for coupling with conductor **85** and the clamp circuit **84** shown in FIG. **2,** conductor **209** and switch **210** providing selective (minus Y) output from the plate of tube **V304A** or **V708,** inductor L7 and resistor **R51,** capacitor **C36** connected to terminal No. **3** of winding section **145** of the horizontal output transformer, switch **211** providing in a left hand position coupling between conductor **208** and conductor **85** and in the illustrated right hand position connecting conductor **85** with the plate of tube **V503B** through capacitor **C38** and conductors **212–221.**

The top rectangle in FIG. 4*a* is designated by the reference numeral **74** since the circuit elements therein represent a preferred playback amplifier for the (minus Y) channel. The playback amplifier components **75** and **76** of FIG. **2** may utilize circuitry similar to that shown for component **74** in FIG. 4*a*.

The components in the lower dash line rectangle **250** in FIG. 4*a* include preferred circuitry for the video bias component **18** as well as the bias frequency trapping networks **44–46,** an audio playback amplifier circuit **251** and a power supply circuit **252.**

A tape transport control circuit is indicated by a dash rectangle **253** which may correspond to that shown in the seventeenth figure of my U.S. Pat. No. 3,531,600 issued Sept. 28, 1970. In an actual embodiment of the present invention, however, supply and take-up reel motors are used with special torque rotors to provide drag on the supply spindle depending on the direction of tape travel, instead of the half wave rectifier and variable resistor which provide direct current drag in my previous disclosure.

The circuitry in the dash line rectangle **255** in FIG. 4*b* may be termed the adaptor or coupling circuitry and consists of a junction box that receives a cable indicated at **256** from the recorder unit (represented by block **250** in FIG. 4*a*) and contains circuitry that is best located at the television receiver to minimize undesirable capacitance or stray coupling, and to simplify the cable connections. In other words, the adaptor circuit **255** is physically disposed closely adjacent to the conventional video circuit components indicated in the lower part of FIG. 4*b*.

The adaptor circuitry **255** includes preferred circuit elements for the equalizing circuits **14–16** of FIG. **1,** and these circuits have been designated by the corresponding reference numerals to indicate this fact. Also included is preferred circuitry for the clamp circuit **84** of FIG. **2** and accordingly the reference numeral **84** has been applied in FIG. 4b. A stabilizing circuit **256** is indicated at the lower right of the box **255** and is associated with the horizontal control circuit of the receiver circuitry including elements **C501, R501, R523** and **158–160.**

A single channel audio transducer head is diagrammatically indicated at **270** in FIG. 4*a* and is shown as including a winding **271.** This audio head unit may correspond to that illustrated in the fifth figure of my U.S. Pat. No. 3,502,795, issued Mar. 24, 1970.

The operation of the video head units such as indicated at **20** in FIG. 4*a* in relation to the other circuitry of FIG. 4*a* will be readily understood by a consideration of the disclosure of my U.S. Pat. No. 3,531,600.

The overall function and operation of the circuitry of FIGS. 4*a* and 4*b* will in general be apparent from the foregoing description and from the disclosures of my aforementioned U.S. Pat. Nos. 3,531,600 and 3,502,795, and is described in my U.S. Pat. No. 3,683,107.

The circuitry of FIGS. 4*a* and 4*b* is converted from the recording mode illustrated to the playback mode by shifting the record-play selector switches from the "R" to the "P" positions.

It will be understood that during playback of a recorded video signal, the reproduced signal will be supplied to the grid of amplifier tube V304A, and that the

plate of the tube V304A is coupled by means of a connection such as indicated at **362** to succeeding stages of video amplification via existing circuits. The color television receiver **88** of course includes an image reproducing device such as a tri-color television tube.

The preferred circuit values of a successfully operating system in accordance with the present invention are given in the following tabulation:

EXEMPLARY CIRCUIT VALUES

Video Head Circuits, FIG. 4*a*

Windings **24, 25, 26**	each 200 turns
Windings **64, 65, 66**	each 1,200 turns
Resistors **77, 78, 79**	each 8,200 ohms
R16*a*, R16*b*, R16*c*	each 10,000 ohms
C8*a*, C8*b*, C8*c*	each 100 micromicrofarads

Video Playback Amplifier **74**, FIG. 4*a*

R1	39,000 ohms	C1	25 microfarads (electrolytic
R2	150 ohms	C2	15 microfarads (electrolytic)
R3	33,000 ohms	C3	0.01 microfarad (10,000 micromicrofarads)
R4	5,600 ohms	C4	60 microfarads (electrolytic)
R5	10.000 ohms	C5	250 microfarads (electrolytic)
R6	56 ohms		
R7	3,300 ohms	C6	0.005 microfarad (5,000 micromicrofarads)
R8	5.6 ohms	C7	0.1 microfarad
R9	150 ohms	C9	0.0005 microfarads (500 micromicrofarads)
R10	22 ohms (adjustable)	C39	0.03 microfarad
R11	470 ohms	L1	10 microhenries
R12	470 ohms	L2	240 microhenries
R14	22 ohms	L3	50 microhenries
R15	3,300 ohms	L4	50 microhenries
		L8	240 microhenries
R17	180 ohms	Q1	16L64 (Manufactured by General Electric Co. of U.S.A.)
R18	33 ohms	Q2	16L64 (Manufactured by General Electric Co. of U.S.A.)
		Q3	16L64 (Manufactured by General Electric Co. of U.S.A.)

The terminal B+ receives a direct current voltage relative to ground of 18 volts.

Resistor **R19** has been replaced by a short circuit in amplifier **74.** Resistor **R19** is indicated in FIG. 4*a* so as to show its location in amplifiers **75** and **76.**

VIDEO PLAYBACK AMPLIFIERS 75 AND 76, FIG. 2

The circuit arrangement and circuit values for amplifiers **75** and **76** are the same as for amplifier **74** except that: (1) capacitor **C9** and resistor **R14** are eliminated in amplifiers **75** and **76**; (2) inductor **L2** and resistor **R5** are replaced by a short circuit in amplifiers **75** and **76**; and (3) elements **R6, L8** and **C39** are omitted in amplifiers **75** and **76.** In amplifiers **75** and **76** there is an open circuit in place of the circuit comprising resistor **R14** and capacitor **C9** of amplifier **74**, and in place of the circuit comprising **R6, L8** and **C39.**

Audio Playback Amplifier **251**, FIG. 4*a*

R20	1.5 megohms
R21	100,000 ohms
R22	220,000 ohms
C10	20 microfarads (electrolytic)
C11	0.01 microfarad
L5	10 microhenries
Q4	2N3391A Transistor Type

Power Supply **252**, FIG. 4*a*

R13	680 ohms
C12	500 microfarads (electrolytic)
C13	500 microfarads (electrolytic)
C13A	500 microfarads (elecrolytic)
R52	10 ohms
D1=1N1692	
D2=1N1692	
D1A=1N1692	
D2A=1N1692	

Video Bias Oscillator **18**, FIG. 4*a*

Frequency 3.6, 4.2, or 4.7 + megacycles per second

R23	6800 ohms
R24	6800 ohms
R25	5.6 ohms
R26	5.6 ohms
C15 (adjustable)	200 micromicrofarads to 2000 micromicrofarads
C16	300 micromicrofarads
C17	300 micromicrofarads
C18	0.05 microfarads (50,000 micromicrofarads)
Q5	7A30 manufactured by General Electric Co., U.S.A
Q6	7A30 manufactured by General Electric Co., USA

Video Bias Circuits, FIGS. 1 & 4*a*

C14*a* (adjustable)	8 micromicrofarads to 80 micromicrofarads
C14*b* (adjustable)	8 micromicrofarads to 80 micromicrofarads
C14*c* (adjustable)	8 micromicrofarads to 80 micromicrofarads
L6*a*	100 microhenries
L6*b*	100 microhenries
L6*c*	100 microhenries

Adaptor Circuit **255**, FIG. 4*b*

R27	12,000 ohms	C19	0.006 microfarad (6,000 micromicrofarads)
R28	83,000 ohms		
R29	100,000 ohms	C20	0.005 microfarad (5,000 micromicrofarads)
R30	47,000 ohms		
R31	470,000 ohms	C21	0.05 microfarad (50,000 micromicrofarads)
R32	470,000 ohms		
R33	680,000 ohms	C22	200 micromicrofarads
R34	470,000 ohms	C23	0.25 microfarad
R35	47,000 ohms	C24	0.002 microfarad (2,000 micromicrofarads)
R36	470,000 ohms		
R37	8,200 ohms (adjustable)	C25	0.05 microfarad (50,000 micromicrofarads)
R38	47,000 ohms		
R39	470,000 ohms	C26	200 micromicrofarads
R40	10,000 ohms (adjustable)	C27	0.25 microfarad
		C28	200 micromicrofarads
		C29	0.25 micromicrofarads
R42	000,000 ohms	C31	200 micromicrofarads
R43	100,000 ohms	C32	470 micromicrofarads
R44	5,600 ohms		
R45	10,000 ohms		
R46	500,000 ohms (adjustable)		
R47	500,000 ohms (adjustable)	C33	8 micromicrofarads (adjustable)
R48	10,000 ohms	C34	8 micromicrofarads (adjustable)
R49	5,600 ohms		

R50	10,000 ohms
R53	120,000 ohms (adjustable)
D3	1N463A
D4	1N463A

Television Receiver Circuitry, FIG. 4*b* (added components)

R51	4700 ohms	C36	1000 micromicrofarads
R54	47,000 ohms	C38	8.2 micromicrofarads
L7	500 microhenries		

The components **R51, R54, L7, C36** and **C38,** and particularly resistor **R54** and capacitor **C38** may be physically located on the chassis of adaptor circuit **255.** If components **R54** and **C38** were in the adaptor, switch **211** could be placed in the adaptor also, or conductor **85** could be permanenly connected to the plate of tube **V503B,** and switch **211** omitted.

An improvement in vertical synchronizing has been obtained by increasing the value of the conventional component **R504** from 200,000 ohms to 1.5 megohms.

Capacitor **C37,** FIGS. **1** and **4***a*, is adjustable from 100 micromicrofarads to 1,000 micromicrofarads; a typical setting is approximately 500 micromicrofarads, where the oscillator frequency is 4.2 megacycles per second.

Capacitor **C35** byapasses high frequencies and is associated with the B+ lead **335** energizing each of the playback amplifiers **74, 75** and **76;** its value may be .05 microfarad.

The resistor **R17** and the corresponding resistors in playback amplifiers **75** and **76** may be of adjustable value and may be adjusted to set the direct current operating bias of the amplifiers **74–76.**

The cable **256** may have a plug for fitting into a socket on the chassis of adaptor circuit **255.**

Referring to the block diagram of FIGS. **1** and **2,** in order to record the X and Z signals, suitable amplifier stages would have their respective inputs connected to be output of the X and Z demodulators, or to the grid circuits of tubes **V706A,** and **V706B** of the receiver circuitry shown in FIG. 4b. The outputs of such amplifier stages would then be connected to this recording equalizer circuits **15** and **16,** respectively. Thus, in the case, the television reciever circuitry together with the amplifier stages would constitute the signal sources **11** and **12.** Referring to FIG. 4b, the plates of the amplifier stages (whose grids are connected to the grids of tubes **V706A** and **V706B**) would be connected to conductors **212** and **215** in FIG. **4***b*, and the connection of the plates of tube **V706B,** and **V706B** with conductors **212** and **215** would be omitted. Similarly the (−Y) signal can be supplied by an amplifier stage whose input is connected to the grid of **V304***a* or **V708,** and whose output is connected to **400** with switch **210** open.

The added video amplifier stages for the X and Z signals would not mix the signals, as acutally occurs in the cathode circuits of tubes **V706A,** and **V706B.** Each such amplifier stage may conveniently be provided by one-half of a single type 6GU7 double triode, with the B+ and filament power therefor supplied from the television receiver **88.** The cathodes of such triode sections would be maintained at alternating current ground potential as by means of a large by-pass capacitor. For playback of the recorded X and Z signals, the outputs of the playback preamplifiers **75** and **76** would be applied to the grid circuits of tubes **V706A** and **V706B,** respectively, as indicated for example in FIG. **4b.**

Referring to FIG. **1,** if the (−Y), (R−Y) and (B−Y) signals are to be recorded, the sources **10–12** may include the television circuitry of FIGS. **4***b*, and the output from components **10–12** in FIG. **1** may be provided by the plate circuits of tubes **V304A, V706A** and **V706B** in FIG. **4***b*. Alternatively, to prevent loading of the television set circuits and for better matching to the recording circuits, separate amplifier stages or cathode follower stages may be used for the color channels, with their inputs connected to the plate circuits of tubes **B706A** and **V706B,** respectively, and their outputs connected to conductors **212** and **215;** or with their inputs connected to other suitable R−Y and B−Y sources such as appropriate demodulator stages of a broadcast television receiver. When recordings have been made utilizing R−Y and B−Y sources, the playback signals from amplifier components **75** and **76** in FIG. **2** may (1) be matrixed at circuit **402** to give a G−Y signal if the color television set does not have this type of matrixing; or (2) the television receiver circuits may be modified for such matrixing during tape playback if the circuits do not normally provide the correct type of matrixing. By way of example, a G−Y signal may be derived from R−Y and B−Y signals by mixing 0.51 parts of the R−Y signal with 0.19 parts of the B−Y signal, and reversing the phase of the resultant signal. The matrixing component **402** shown external to receiver **88** performs the foregoing mixing and phase inverting function where the receiver circuit lacks such a circuit or a suitable substitute. Other types of matrixing circuits for deriving a G−Y signal are known in the art.

It has been found however that unmodified X and Z matrixing of the reproduced Y−R and Y−B signals as indicated in FIGS. **4***a* and **4***b* gives excellent results, particularly when color controls corresponding to the variable resistor **R10** in amplifier component **74,** FIG. **4***a*, are used. The arrangement shown in detail in FIGS. **4***a* and **4***b* is simple and economical since it requires no power amplifiers other than those already in the commercial color television receiver. Excellent color rendition is obtained especially of orange-pink skin tones which are ordinarily difficult to reproduce even on direct broadcast reception.

In the specific circuit illustrated in FIGS. **4***a* and **4***b*, the principal color controls are variable resistors in the emitter circuits of the third transistor stage of the playback preamplifiers **75** and **76,** the variable resistors corresponding to the variable resistor **R10** of the playback circuit **74.** These two principal color controls are preferably ganged on concentric shafts which are frictionally engaged with each other so that the gains of the color amplifiers **75** and **76** increase or decrease together as the knob assembly is turned; yet either of the concentric knobs may be turned individually by holding the other one back. These two controls are sufficient to change the picture from normal coloring to exaggerated color intensity, or to a light tint, or even to a monochrome rendition, according to taste. Alternatively, only the amplifier **75** may be provided with a variable resistor having a manual control know on the user's external panel, the resistor corresponding to **R10** of the amplifier **76** either having a preset value or being a fixed resistor of desired value.

It will be apparent that many modifications and variations may be effected without departing from the scope of the novel concepts of the present invention.

I claim as my invention:

1. In combination with a broadcast color television receiver,
- a transducer head for coupling to a magnetic record medium having color television signals recorded thereon corresponding to a color image, and
- playback means connected to said head and to said receiver for receiving reproduced color television signals from the head and for supplying color difference signals to the receiver for use in reconstructing said color image,
- said receiver having a matrixing circuit with X and Z inputs and R—Y, G—Y and B—Y outputs, and designed to receive X and Z input signals and to supply R—Y, G—Y and B—Y output signals, and
- said playback means supplying R—Y and B—Y signals to the X and Z inputs of said matrixing circuit during reproduction of the color television signals recorded on the record medium.

2. The combination of claim 1 with said playback means comprising
- a pair of color signal amplifiers for amplifying R—Y and B—Y signals from the head,
- at least one of said color amplifiers having a negative feedback circuit, and having adjustable impedance means controlling the amplitude level of the feedback signal.

3. The combination of claim 1 with said playback means comprising
- an amplifier having a negative feedback circuit with capacitance means bypassing the feedback circuit, and
- adjustable impedance means controlling the amplitude of the signal supplied to the feedback circuit and to the capacitance means in parallel.

4. The combination of claim 1 with said playback means cmprising
- a pair of color signal amplifiers for amplifying the reproduced R—Y and B—Y signals from the transducer head,
- at least one of the color signal amplifiers having a negative feedback circuit with a variable resistor controlling the amplitude of the feedback signal,
- said resistor being variable over a range of resistance values corresponding to gains with respect to the frequency range from 10 kilohertz to 300 kilohertz of at least about 10 to one.

5. Transducer apparatus for transducing color television signals which comprises
- source means for providing respective color television signals representing a color image including a luminance signal, and X signal and a Z signal,
- a magnetic transducer head for coupling to a magnetic record medium, and
- coupling means connected to said source means for supplying said luminance signal, said X signal and said Y signal to said head for recording on the magnetic record medium.

6. The apparatus of claim 5 with
- said source comprising a broadcast color television receiver having demodulator circuits for supplying at the outputs thereof said X and Z signals, respectively, and
- said transducer head having respective individual head units for connection by said coupling means to the outputs of the respective demodulator circuits.

7. Transducer apparatus according to claim 5 with
- said transducer head being operative to scan a magnetic record medium to electrically reproduce recorded X and Z signals, and
- matrix means connected to said head for receiving the reproduced X and Z signals and for deriving R—Y, B—Y and G—Y signals.

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