MAINTAINING & REPAIRING

VIDEOCASSETTE RECORDERS

BY ROBERT L. GOODMAN

Maintaining and Repairing Videocassette Recorders

by Robert L. Goodman

- A to Z maintenance and repair data for home video cassette recorder owners *and* professional service technicians!
- Full coverage of mechanical systems and electronic circuits found in all popular brand models—Betamax and VHS!
- Complete how-to's for using VCR test equipment, specialized tools, even how to make your own test tapes!
- Detailed service data on VCRs made by Sony, Zenith, General Electric, RCA, Magnavox, Quasar, and JVC!

The most practical handbook yet on troubleshooting and repairing *all the popular brand home videocassette recorders!* From a look at the history of video tape recording to the development and operational characteristics of today's two major recording systems (the Betamax used in Sony and Zenith recorders and the VHS system used by General Electric, RCA, JVC, Quasar, and Magnavox) to specific advice on test equipment setups and servicing techniques, you'll find everything you need to quickly find trouble spots and fix them like a pro!

Here's where you'll learn about the proper cleaning, lubrication, and maintenance procedures to keep your machine operating in tiptop condition. Plus, there are more than 300 block diagrams, exploded views and schematics. You'll get a complete short course in test equipment usage (including how to use the Sencore VA48 Analyzer) and learn what tools are needed to repair VCR components. In fact, this book includes all the hands-on advice, practical tips, and specific how-to's anyone needs to keep any of today's sophisticated VCRs in A-1 operating condition!

Robert L. Goodman is the author of several outstanding troubleshooting and repair manuals published by TAB.

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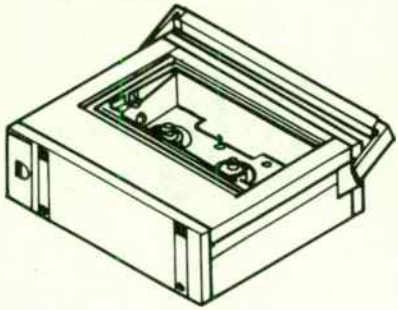

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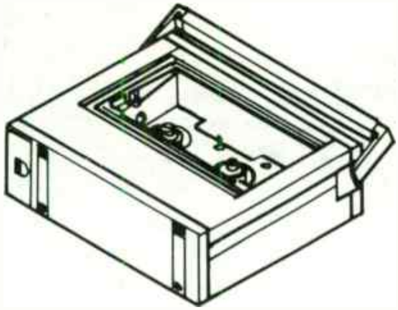


Introduction

This book begins with a brief history of video tape recording, early home VCR systems, and how the systems developed and were improved upon over the years. The first chapters contain a brief theory of operation of the Video Home System (VHS), the Sony (Betamax) video recording systems, and information on the helical VCR and slant track tape recording principles. Test equipment and test instrument set-ups required for VCR servicing is also covered.

Eccentricity, torque gauges, dihedral head adjustment, and test and alignment tapes required for VCR servicing are discussed. Then some tips on making your own test tapes and the tools required for VCR machine adjustments are presented.

This manual also contains service information for the Sony/Zenith Betamax format VCR machines. You will find circuit operation, mechanical operation and adjustments, block diagrams, circuit schematics and actual case-history problems and solutions.

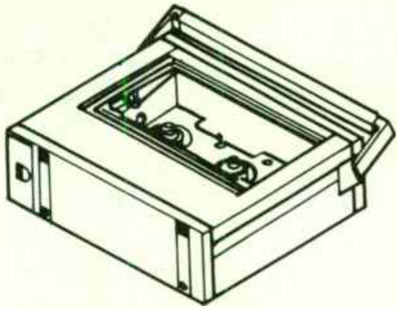
The last section of this book offers a brief overview of the VHS recording system. The brands covered are General Electric, Magnavox, Quasar, RCA, and JVC. Again, you will find circuit theory of operation, circuit schematics, and mechanical and electronic adjustments. Some of these VCR machines are manufactured by the Matsushita Electronics Company in Japan and the information contained in this section can be used for other models and brands of VHS machines. Much of the circuit operation and troubleshooting info found in the earlier chapters for Betamax machines can also be used for VHS machine service.

As you look through this VCR manual you will find some complex electronic and mechanical diagrams. The videocassette recorder (VCR) is a very sophisticated piece of equipment and should be handled and serviced with care.

In this VCR manual we will break down the machine into sections and then delve into each of these to explain basic operation and troubleshooting. My goal is to make a very complex device as easy to understand and service as possible.

Much of the information in this manual was provided by VCR manufacturers, their technical personnel, and VCR service technicians. I am very grateful to the following companies and individuals: General Electric Company, Mr. R. G. Major; JVC (US JVC Corp.), Mr. Paul E. Hurst; Matsushita Electric Corporation: Quasar, Mr. Charlie Howard; Magnavox Consumer Electronics Co., Mr. Ray Guichard; RCA/Consumer Electronics Division, Mr. J. W. Phipps; Sony Corporation of America, Mr. John S. Hanson and Mr. S. Camueli; Zenith Radio Corp., Mr. James F. White; A big thanks to Greg Carey and Jim Smith of Sencore, Inc.; and, Robert Anderson with First Television Service in Omaha, Nebraska.

Chapter 1



An Overview of Consumer Video Tape Recording

In this chapter we will look at some basic video recording considerations, a comparison of Betamax and VHS systems and a brief history of video tape recordings.

BASICS OF VIDEO RECORDING

In a very broad basic sense, video tape recording uses the same principles as audio tape recording which is a magnetic way to record a signal onto tape. However, there is a great difference between the audio and video signals that are recorded. Audio has a frequency range of approximately 20 Hz to 20 kHz. Video has a much greater and higher frequency range, from about 30 Hz to 4.5 MHz. These high frequencies are required for picture quality, the lowest is for the sync pulses. The sources of the video signals can be from a TV camera, another tape VCR machine, a pre-recorded tape, or an "off the air" TV station signal.

FREQUENCY LIMITATIONS

The gap effect of the heads is the most important limitations on the range of video frequencies that can be recorded and played back. In Fig. 1-1 you will see an illustration of this effect. It is a curve of the playback frequency response. As the signal to be recorded rises in frequency, a steady increase in the play-back signal occurs. This rise is at the rate of 6 dB per octave, an octave being a doubling of the frequency. This rise in output continues until a maximum is

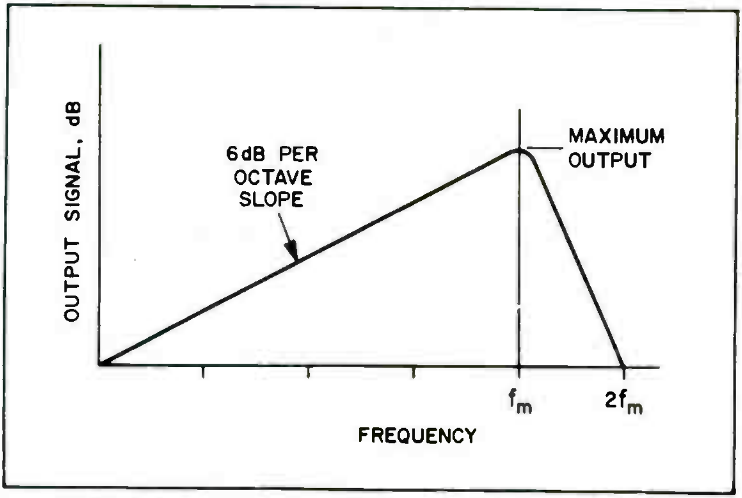


Fig. 1-1. Playback frequency response.

obtained. The frequency where this occurs is indicated in Fig. 1-1 as F_m, that is, the maximum frequency. Beyond this frequency value, the output will rapidly drop, reaching zero at twice the frequency of maximum output. The points F_m and 2 F_m are determined by the size of the head gap and tape speed. The more narrow the gap is, the higher will be the frequency for maximum output. But a very narrow gap restricts the output at the low frequencies.

The speed of the tape movement past the head also effects the frequency response of the record-playback system. The greater this speed is, the higher will be the frequency of maximum output, but the lower will be the signal output at the lower frequencies.

The audio frequency range of about 10 octaves (20 Hz to 20 kHz) applied to the output curve of Fig. 1-1 would show the 20 kHz limit equal to 2 F_m and the low end, 20 Hz, at a very low level of output. The frequency of maximum output would be 10 kHz. Frequency compensation to raise the low and high ends of the curve and reduce the middle, could produce a more constant output with frequency. Several different methods have been used in audio devices for this compensation. A frequency range that can be practically recorded and played back of 10 octaves, with compensation is about the maximum range.

The approximate range of video frequencies to be recorded and played back for TV video of 30 Hz to 4.5 MHz, is 18 octaves. The signal output curve for a head designed to give maximum output at 4.5 MHz would show the 30 Hz output down about 110 dB. These extreme differences of signal level would make compensation and equalization of output at all necessary frequencies impossible. Thus, some other method must be used.

FM VIDEO RECORDING/PLAYBACK

If the range of frequencies for video recording and playback, an overall difference of approximately 4.5 MHz, is converted to a higher frequency spectrum, the ratio of the high and low video frequencies can be greatly reduced. For example, if the frequency spread were changed to a variation between 5 MHz and 10 MHz, the difference being about equal to the video frequency range used, the frequency spread becomes 1 octave rather than 18. If the head gap is designed for maximum system output at 7.5 MHz, the outputs at 5 MHz and 10 MHz would be down only a small amount and equalization would be easy. The frequency variations in the video signal could occur within this altered frequency spectrum, that is, by *frequency modulation* (FM).

Frequency modulation of the video signal to be recorded and played back is then the answer to the video frequency response problem. For example, a high frequency sine wave strong enough to saturate the tape becomes the carrier for the FM process. This carrier is modulated by the video frequencies. The lowest frequency corresponds to the sync pulse tips, with the highest corresponding to peak white. See Fig. 1-2. The actual frequencies selected for this method of FM vary from recorder to recorder. FM systems also strictly control the signal amplitude levels, thus reducing noise problems. This is another advantage of the use of FM in the recording/playback process.

The high carrier frequency used for the FM signal process requires a small head gap and high tape speed. The high tape speed, of course, means fast consumption of the tape, and thus, larger tape reels. In most cases, this is an impractical situation. Also, the high tape speeds are difficult to control complicating the drive mechanism. This method of recording by moving the tape past a stationary head is called *longitudinal recording.* This is the method still used successfully for audio recording, but not for video recording.

TRANSVERSE RECORDING

Longitudinal recording results in a recorded, magnetic track that is along and parallel to the length of the tape. Another method of recording that uses much less tape is transverse recording. This method produces tracks *across* the tape at right angles to the length

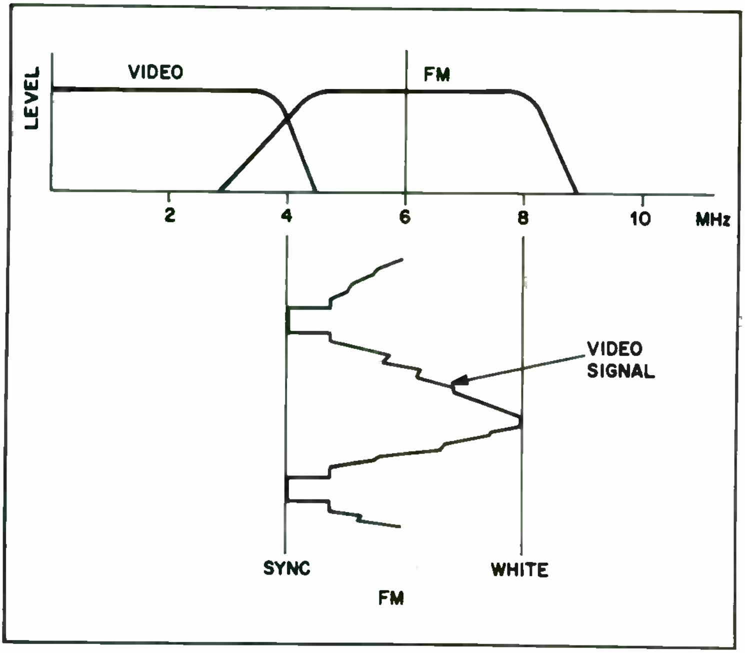


Fig. 1-2. FM modulation of the video signal.

of the tape. This is illustrated in Fig. 1-3. The head is not stationary in this process; it moves across the tape at a relatively high speed, as the tape moves rather slowly past the head mount. This results in a high head-to-tape speed, also called writing speed. This idea of a moving head led to the development of a rotating head mechanism. Two heads are required for this operation. Head A is recording a track on the tape while head B is retracing or returning to the top edge of the tape for its next track. When that position is reached, head A is switched off and head B is switched on. Thus, properly timed switching is another requirement of the rotating head and transverse recording process.

During the playback mode, proper switching and positioning are very important, to insure that the heads retrace the exact paths made by the heads during recording. Servo systems have been developed to control the head positions—another requirement of video taping.

Small irregularities, lumps or holes, in the tape coating that are not much problem in audio recording become serious in video recording. They can cause loss of contact between the tape and the head resulting in incomplete tracks on the tape and temporary loss of the signal on playback. This signal loss is called *dropout*. It may appear as horizontal flashing on the screen—a portion of a line or up to several lines in duration. Surface bumps on the tape, dirt or residue on the heads, or non-regular tape motion can cause the dropout condition. Video recording requires the maintenance of precise contact between the head and the tape at all times. To insure this requirement, a slight penetration of the tape by the tip of the head is employed.

The best example of transverse recording is the quad-head recorder, a large and complex machine, much used by the broadcast industry, but not suitable for the general video recording consumer market. The speed of the tape and the tension on the moving tape must be very steady to guarantee reliable signal recording and, especially, accurate, steady playback. Obviously, tape tension control is another requirement of video recording/playback.

HELICAL VIDEO RECORDING

A video tape recorder that is simpler and smaller and less expensive than the quad-head machine is one that employs the helical scan method of recording and playback of the video signals. With helical scan, the tape wraps around a large drum that contains one of two heads which rotate in a plane parallel to the base of the machine. The tape leaves the drum at a different level than it approached it. The movement of the tape is along a spiral, or helical path. The track that is recorded on the tape by the rotating head is "slanted" and longer than the path for transverse recording. The

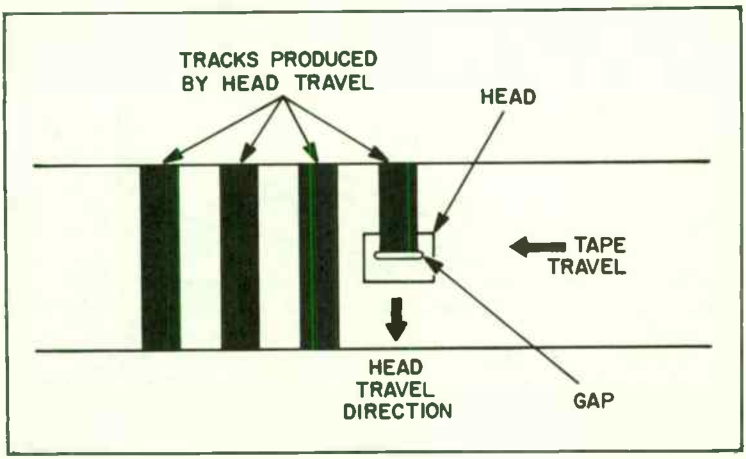


Fig. 1-3. Transverse recording.

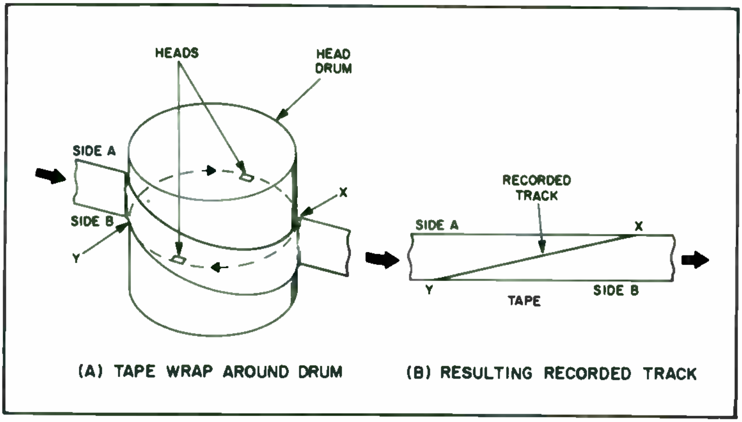


Fig. 1-4. Helical scan development.

head drum diameter and the tape width can be designed to make the recorded track long enough to include a complete TV field for head control and switching is much simpler than for the quad-head recorder. Looking at Fig. 1-4 you will see the development of the slanted tracks on the tape with this helical scan method. These tracks contain the video information. Control and audio tracks are recorded in a longitudinal manner, along the two edges of the tape. As shown in Fig. 1-5, the recorded tracks slant to the right on the tape, as viewed from the side away from the drum. The same tracks,

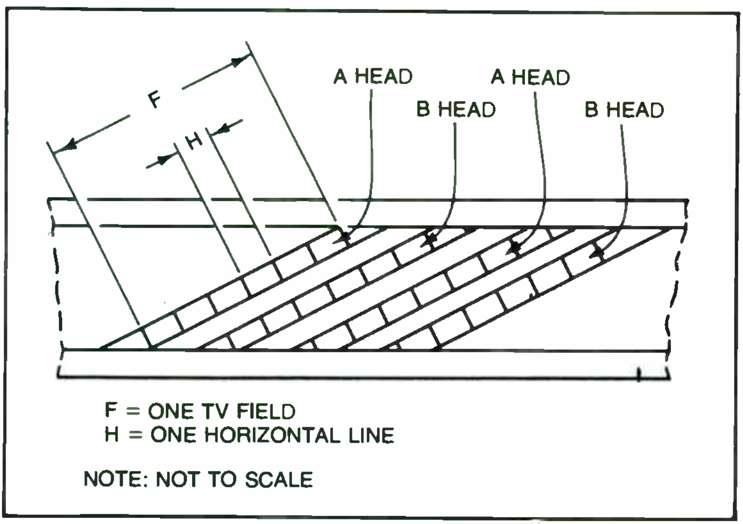


Fig. 1-5. Helical scan recording tracks.

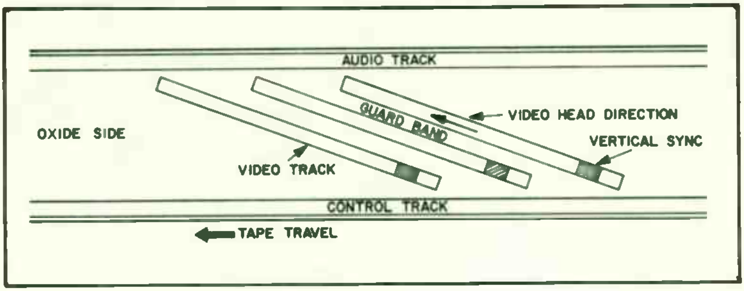


Fig. 1-6. Oxide side of tape, helical scan.

viewed from the other, or oxide side, which contacts the drum and heads, appear slanted to the left as shown in Fig. 1-6. The spaces between the recorded tracks are the guard bands. Their purpose is to eliminate "crosstalk" between tracks.

Helical scan video tape recorders have become dominant in the non-broadcasting applications of video recording. Although many different models and formats have been developed and used, the basic principles are the same for all helical machines. The tape leaves a supply reel, passes over a tension arm, past an erase head, around the head drum, past a control head and audio head and through a capstan and pressure roller to the take up reel. Refer to Fig. 1-7 for this tape path. In Fig. 1-8 you will see the relationship, timewise, between the tracks on the tape and the video information recorded on the tracks. Switching between the heads occurs during the few lines just before the vertical sync pulse.

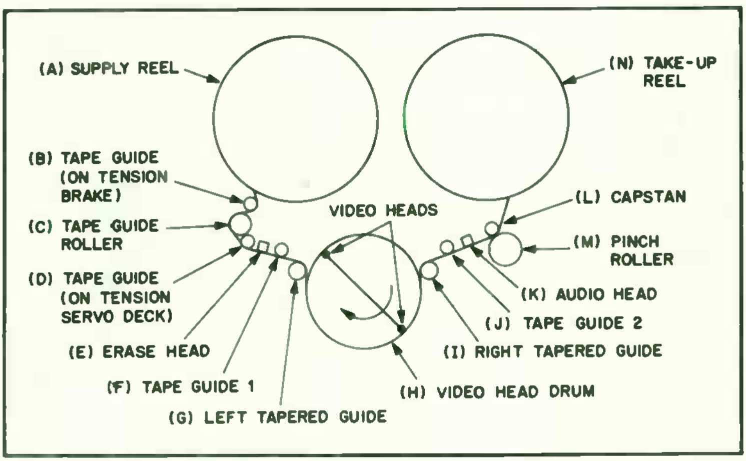


Fig. 1-7. Tape path for reel-to-reel recorder.

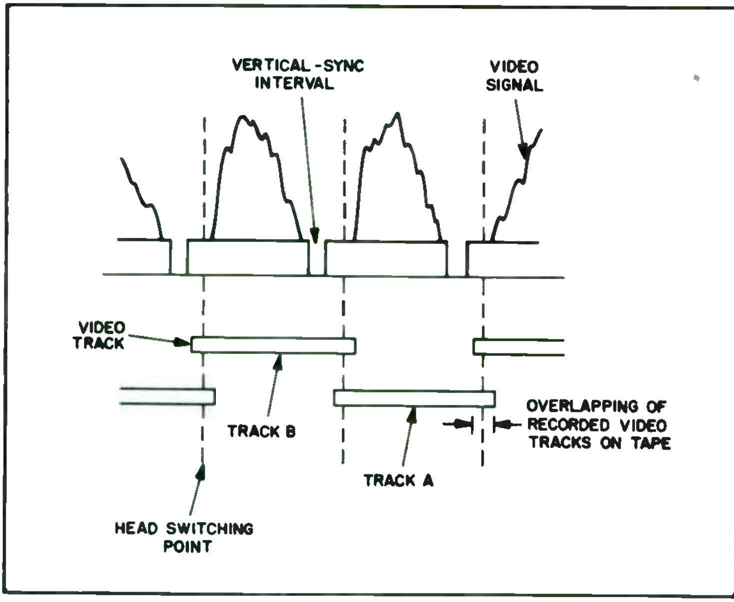


Fig. 1-8. Video signal and recorded tracks.

COLOR RECORDING

We have looked at the general form and requirements and methods for recording and playing back the luminance video signals. The first video tape recorders were for black and white signals only. Later, methods were developed that permitted the recording of color signals also. Figure 1-9 shows the NTSC signal spectrum.

The basic requirements for a system that would record and playback color information would include the following requirements:

- Compatibility with black/white television.
- Processing of the NTSC signal within the same bandwidth as used in B/W recording, without changing the tint of the color signal.

Two methods have been used in the recording of color signals onto tapes. One method is called the direct method, the other is called the color under method. In the direct method, the NTSC signal is coupled to the FM modulator, just as is done with the black and white signal. The color signal consists of an ac, 3.58 MHz signal on a dc level. The dc portion of the signal determines, through the FM modulation action, the carrier frequency for the video and color signal modulation. The ac portion of the signal produces sidebands of this FM carrier. The color signal can be easily demodulated as

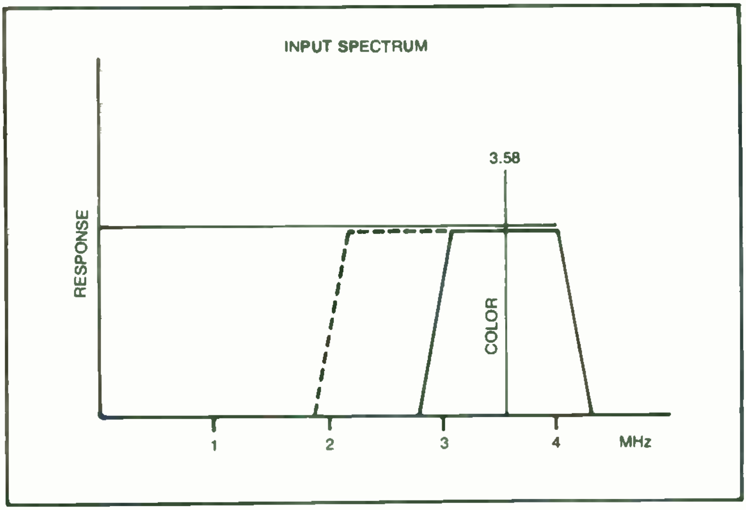


Fig. 1-9. NTSC signal.

with the black and white signal. One problem with this direct method is that the sidebands on demodulation can cause interference beats in the picture.

The *color under method* separates the color and luminance signals from the incoming signal. Each portion of the total signal is processed individually. The color is hetrodyned down from 3.58 MHz to a lower carrier frequency and recorded directly onto tape. The FM carrier is used as a bias that is amplitude-modulated. During playback in this method, the color carrier is recovered and hetrodyned back up to 3.58 MHz. See Fig. 1-10.

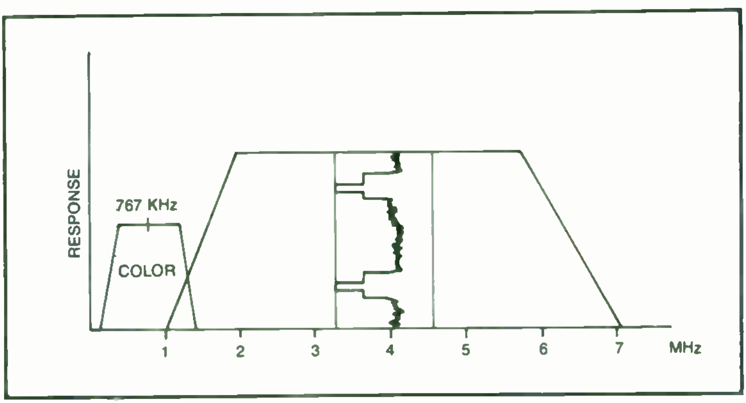


Fig. 1-10. Color under method.

COLOR PLAYBACK

The successful playback of color signals recorded onto the tape is a more critical operation than that for B&W recording and playback. The major problems of color playback are as follows:

1—Tension changes in the tape movement.
2—Tape stretch.
3—Wow and flutter in the tape movement.
4—Servo instabilities and corrections.
5—Noise problems in the signal.
6—Beats in the picture.

If these effects occur, tint can change or color can be lost or interference bands appear in the picture. Thus, some means of correcting for possible color problems is a definite requirement for color recording and playback machines.

VIDEO TAPE COLOR REQUIREMENTS

Among the basic requirements of a reliable, successful color video tape recorder machine are the following:

1—Properly timed switching of the heads.
2—Properly positioned heads.
3—Tape tension control.
4—Continuous head-to-tape contact.
5—Crosstalk reduction.
6—Correction or avoidance of color recording or playback problems.
7—Steady head-rotation speed.
8—Steady tape movement speed.

HISTORY OF VIDEO TAPE RECORDING

The recording of video information onto tape and the successful playback of this information has represented a great stride forward in communications. Development work that began in the late 1940s led to the first application of this technique in TV broadcasting. Amprex is credited with the inventing, in 1956, of a video tape recorder (VTR) that was used for this purpose. The machine was a model 1000, a quad head recorder, using the transverse recording method and a 2-inch wide video tape. Improvements have been consistently made since then, in the original product and in other versions of video recording. The VTR has definitely become an essential piece of equipment for all TV broadcasters. Tape recordings eliminate the live programs and can be used for delayed and repeated programs.

The development of "helical scan" video recorders in the early 1960s made possible the extension of the video recording into other fields, such as education, training and industry. The first "helical scan" recorder was developed by Ampex, the model 660, in the early 1960s. It used a 2-inch wide tape. As 1-inch machines were developed, the 2-inch version was superseded. Panasonic, as early as 1964, developed a VTR, using a 1-inch wide tape, that was used for medical purposes and also by industrial market.

The education field has been a major user of VTR playback units, connected into extensive closed circuit TV (CCTV) systems. Pre-taped programs and information have become great aids for the teacher and trainer. Combined with TV cameras for on the spot, "live" input to the TV monitors, or recorded for later use, the VTR has given added dimension for many instructional activities. Among others, Sony has been particularly successful in this application of VTRs.

The early VTRs featured the "reel-to-reel" format, with manual "threading" of the tape, from a supply reel, past the heads, to the takeup reel. This design is still used on some older video production systems. Automatic tape threading and reduced size of the tape package are made possible by the VCR cassette tape units. These VTRs have been used by the teaching profession, but are now becoming prominent as products to be used and enjoyed by the viewing public, for home video recording. The compact design of video cassettes, especially, and the easy operation of them have opened the field for sales to the consumers market.

An example of early model VTRs using the helical scan technique was marketed by Sony in 1964. The unit was a reel-to-reel machine which recorded black and white video, on ½-inch wide tape. Figure 1-11 shows the principles of this Sony recorder. The tape is wrapped around one-half or 180 degrees of the drum, which contains two rotating video heads. The top portion of the picture details the angular path of the tape across the drum head. The tape enters the drum area from the supply reel on the left at a higher level than at its exit to the take-up reel. This tape movement past the rotating heads produces the magnetic patterns on the tape as shown in Fig. 1-12. The video tracks are slanted, hence the term "slant track recording." The audio track and the control track (on opposite edges of the tape) are produced from a stationary head, located in the tape path from the video head drum to the take-up reel.

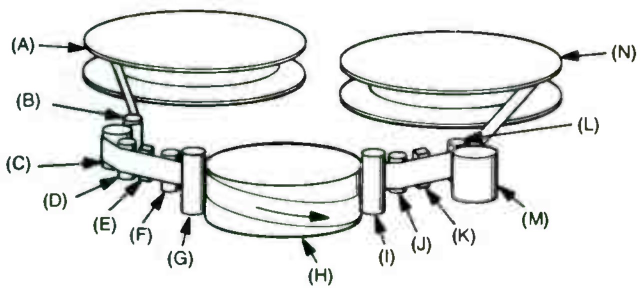


Fig. 1-11. Early model Sony helical scan video recorder.

The control track is part of an automatic servo system that insures the correct positioning of the video heads relative to the recorded magnetic tracks on the tape during the playback mode of operation. Control track pulses are compared to the pulses developed by rotating heads.

Each slanted track on the recorded tape represents a TV picture field (two fields represent a complete frame). This early Sony machine included a skip field system, the result of recording by only one of the two heads at a time. During playback, both heads play the same track. This action provides the missing field (to complete the frame). However, the vertical resolution is only half the normal amount. It is necessary to switch between the heads so

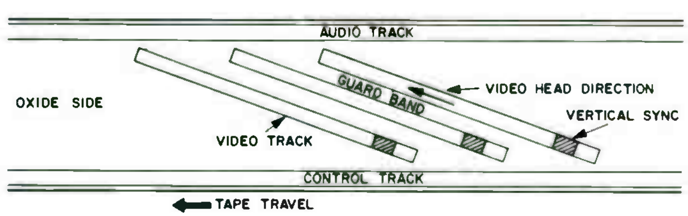


Fig. 1-12. Slant track diagram.

that the signal preamplifiers are always connected to the proper head—the one in contact with the tape. The switching is performed at a 60 Hz rate—a possible source of time base errors in the playback signal. This is also the reason why it is desirable to have faster APC circuitry in the horizontal system of TV receivers that are used with VCR machines.

Shown in Fig. 1-13 are details of the signal frequency spectrum as processed by the early model Sony black and white recorder. For both recording and playback, the signal frequency band was moved to a higher range. The luminance or brightness signal frequency-modulated a carrier during the recording. Variations in brightness (white through shades of gray to black) became variations in frequency. This FM signal was present in the recorded slant tracks on the tape.

Guard bands are positioned between adjacent, recorded slant tracks. These guard bands contain no recorded information and represent wasted space on the tape. They are necessary to prevent crosstalk between the tracks produced by the VCR.

Some measure of standardization came into the picture of video tape recording about 1968 as the previously mentioned system

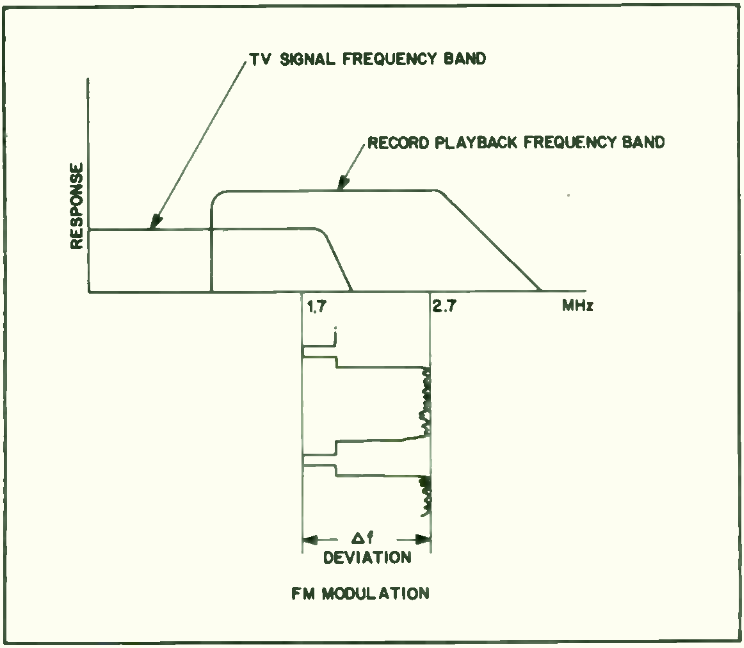


Fig. 1-13. Early Sony black and white recorder.

evolved into the EIAJ type 1 format for ½-inch wide reel-to-reel video tape recorders. EIAJ is an abbreviation for Electronic Industry Association-Japan.

Figure 1-14 shows the signal frequency spectrum for the color recorder system. The FM luminance signal was raised in frequency to the 3.2 to 4.6 MHz region. The color sub-carrier was shifted down during recording to 767 kHz, thus placing it below the luminance carrier. This conversion produces a "color under" system. The video track widths were reduced in width and the guard bands narrowed. Both video heads recorded, achieving full frame recording. These machines are used mostly in the industrial market.

The Philips VCR system, introduced in 1961, was one of the first ½-inch wide tape cassette recorders. The cassette loading mechanism used by this model is widely used today. An example is the Sony Betamax VCR machines.

Also, the Philips VCR used a rotating transformer instead of slip rings to couple the rotating head signal to the preamplifier. This design eliminates the need for slip rings and wear and pressure adjustments. This feature is also used on current VCR machines.

In 1971 Sony introduced the U-MATIC format-a ¾-inch cassette system which has been very successful in the industrial market. It is characterized by high resolution pictures and easy operation. This format represents a refined application of earlier technology, including the tape loading and rotating head transformer features of the Philips system.

Cartrivision introduced a ½-inch wide tape cassette system capable of two hour playing time in 1972. This format used a skip field, three head system, resulting in a reduction of tape consumption. Only every third TV video field was recorded. On playback, each of the three heads was played in order on the same track, producing a proper TV signal. Vertical resolution was one-half of a standard TV signal Fast motion of the picture content could not be reproduced, because of the loss of two out of three TV fields.

Cartrivision, in addition to recording live TV programs "off the air" promoted the playing of pre-recorded cassettes. These cassettes could be rented or purchased. Cartrivision was marketed by Sears, Admiral and Wards, but sales were slow. Probably the time was not quite right as the TV viewer was not ready to watch and buy.

One RCA format used four video heads, a 90 degree tape wrap of the head drum, and a ¾-inch wide tape cartridge. The head wheel extended into the inserted cartridge, pushing against the tape, permitting the head-to-tape contact. One significant result of RCA's

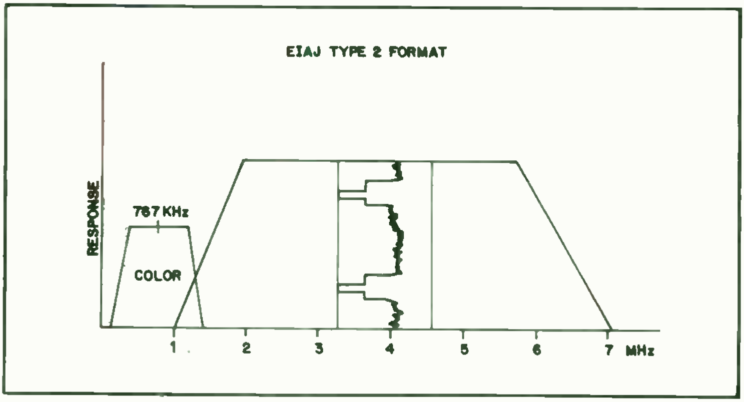


Fig. 1-14. EIAJ color recorder.

investigation of video tape recording at the time was a customer survey finding that a two hour uninterrupted playing time was desired by the TV viewers.

The next round of formats represent the present generation of home video tape recorders. All use ½-inch wide tape cassettes and have built-in tuners and program turn-on systems. At this time the VHS and Betamax are the standard format VCR systems.

The Sanyo V Cord Two format was introduced in 1976. It uses a ½-inch cartridge and is capable of one hour full frame recording or two hour skip field recording. The latter method results in one half vertical resolution pictures. Tape loading is of the Philips type. The track widths and guard bands are reduced over earlier systems, thus reducing tape consumption. The video track width is 60 microns, with a guard band of 37 microns.

The Matsushita VX2000 is a one-head machine using an "alpha wrap" of the tape around the head drum. Alpha wrap means that the tape almost completely encircles the head drum, permitting the use of only one head. This cassette type video recorder tapes up to a maximum of two hours per cassette. The first machine of this type in the US had a Quasar brand name.

Through the years of development and improvement of video tape recording since the late 1940s many variations have been tried in systems and component parts of the system. Several widths of tape have been used: 2 inch, 1 inch, ¾ inch, ½ inch, and ¼ inch. The 2-inch size has been a mainstay of the broadcast industry, although 1-inch tape width recorders have found a place in this market in recent years. Industrial and educational applications have employed the ¾-inch tape size. The ¼-inch width tape is found in special machines, such as portable color recording units. Of course, for the home video tape recorder market the ½ wide tape is now the standard.

The helical scan format is the most used system in video recording. Transverse recording is still used in the quad-head machines used by the TV broadcasters. But even this field includes recorders with the helical scan format.

The reduced tape width and the packaging in small cassettes as well as the helical scan format, has made possible size reductions of the complete video tape recording machine that make it very usable for in-home use.

The success of the Sony Betamax-1 proves this point. An important element for consumer acceptance of the VCR is the reduction, over the years, for the cost of tape usage. As Fig. 1-15 shows, the left curve, the consumption of tape, measured in square feet per hour, has been greatly reduced since 1968. The dots on the graph pinpoint his usage for the various video tape recorders indicated. Thus a machine using EIAJ-1 format in 1968 consumed more than 90 square feet of tape per hour.

The later introduced Sony Betamax-2 speed consumes only about 10 square feet per hour. This reduced tape consumption, plus improvements in the tape, increased tape production, and the 2 hour recording system have led to a sharp reduction in tape cost per hour. This curve appears on the right in Fig. 1-15. The graph shows a cost of $39.00 per hour in 1968, but only $8.00 per hour for the 2 hour Betamax in 1977. Thus the purchase price for blank tape cassettes that can hold 2 hours of video recording costs about $16.00. The Beta-3 speed machines consume 50% less tape than the Beta-2 VCR machines.

Sony's Betamax-1 was introduced in the U.S. market in 1975. It was a ½-inch wide tape cassette system, capable of one hour playing time. Two video heads are used, with full frame recording. The tape threading (pulling of the tape out of the cassette and around the head drum) is of the Philips type. The Betamax-1 recorded tape pattern is shown in Fig. 1-16.

The recorded, slanted tracks of this helical scan machine are 60 microns wide, with no spacing between tracks, thus no guard bands. This is possible because of two well-devised arrangements that reduce the crosstalk effects. Luminance signal crosstalk from track-to-track is avoided by the slanting of the two head gaps relative to the tracks. This is called the azimuth technique. Color crosstalk cancellation occurs because of a more involved signal

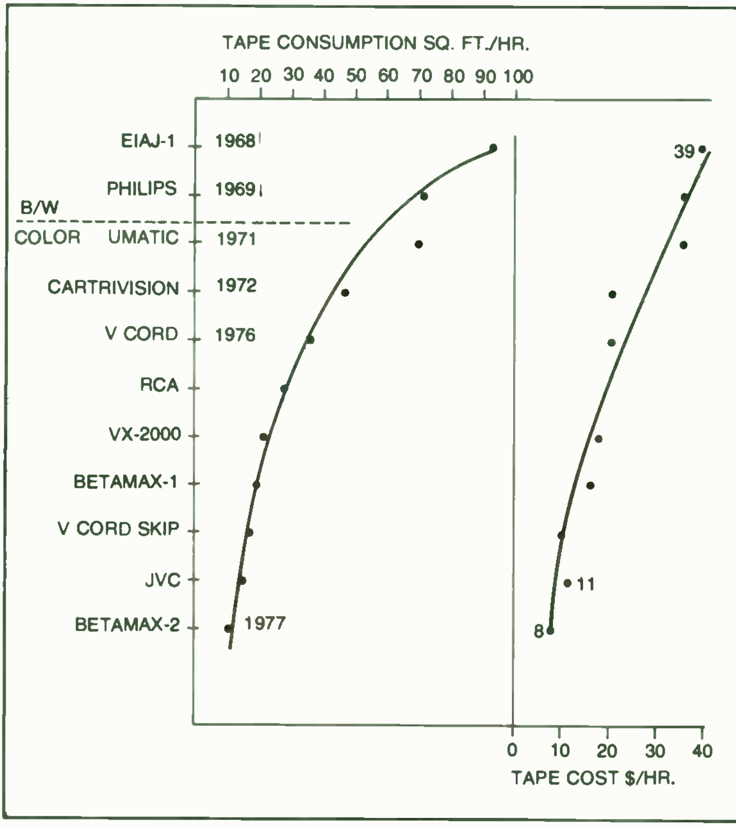


Fig. 1-15. Video tape consumption comparison chart.

phasing system involving a comb filter. The waveform drawing (Fig. 1-17) is the recorded signal spectrum for Betamax-1 tape speed.

TAPE FORMAT CONSIDERATIONS

Based on the fact that RCA had determined a 3-hour VCR system was what the TV viewers wanted, JVC set about to modify the Sony Betamax-1 to a two hour system. This was achieved by slightly reducing the capstan speed from 1.57"/sec. to 1.34"/sec. and increasing the tape length in the cartridge by 63%. This also increased the cartridge size by 31%. The video track width was left at 60 microns. To realize this, the track slant angle was increased by reducing the drum diameter. The Azimuth recording and color processing are retained. The result was a two hour version of video recording that JVC called VHS (Video Home System).

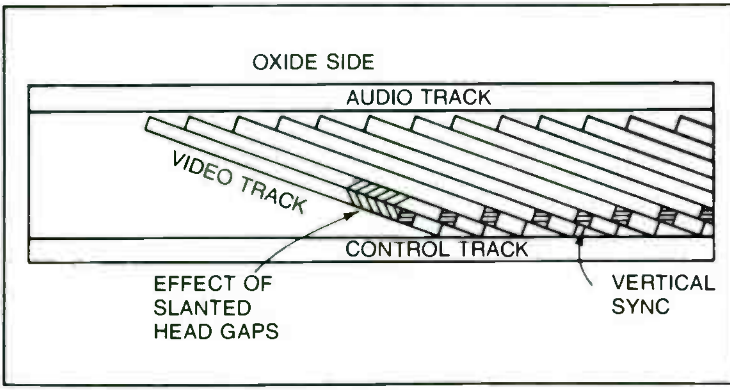


Fig. 1-16. Betamax-1 recorder video tracks.

Sony in the meantime had produced its own two hour Betamax. Sony chose to keep the same cassette and reduce the capstan speed by a factor of two. The slant track pitch was now 30 microns instead of 60. The head track was reduced from 60 to 40 microns. This results in a negative guard band and produces overlapping tracks. The azimuth and comb filter techniques, however, still provide adequate crosstalk rejection. The result is lower tape consumption.

The Sony threading produces very gentle tape handling. Note this tape threading path in Fig. 1-18. The tape guides are fixed and the guides are at 90 degrees to the tape motion and can be rotated to lower tape friction. The tape is simply wrapped around the drum. A longer piece of tape is removed from the cassette in the Sony machine, isolating the tape from cartridge feed irregularities and producing less time base error. The Sony tape has a life of approxi-

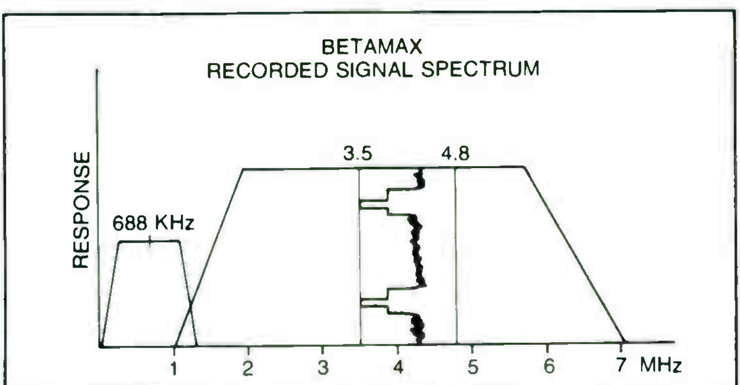


Fig. 1-17. Betamax-1 recorder signal spectrum.

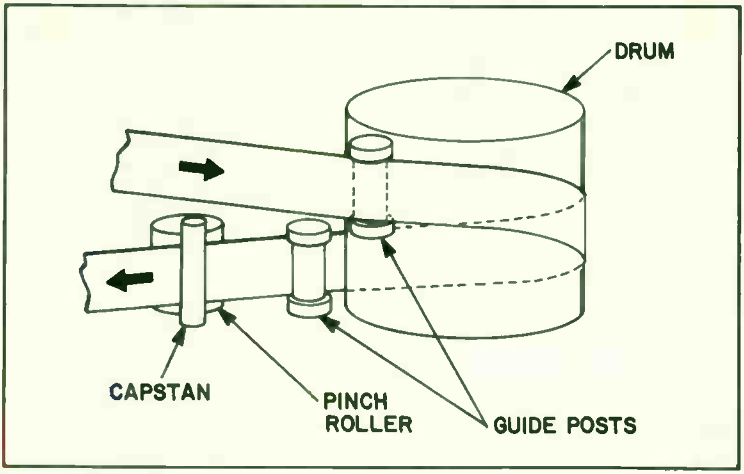


Fig. 1-18. Sony Betamax recorder tape paths.

mately 200 passes or plays. With the Sony VCR design, the tape does not leave the drum for fast forward or rewind and precise location of a section of the tape is very easy to find.

VHS VIDEO RECORDING OPERATION

Before delving into the VHS format let's take a brief look at some video recording principles.

Video Recording Basics

Like audio tape recording, video information is stored on magnetic tape by means of a small electromagnet, or head. The two poles of the head are brought very close together but they do not touch. This creates magnetic flux to extend across the separation (gap), as illustrated in Fig. 1-19.

If an ac signal is applied to the coil of the head, the field of flux will expand and collapse according to the rise and fall of the ac signal. When the ac signal reverses polarity, the field of flux will be oriented in the opposite direction and will also expand and collapse. This changing field of flux is what accomplishes the magnetic recording. If this flux is brought near a magnetic material, it will become magnetized according to the intensity and orientation of the field of flux. The magnetic material used is oxide coated (magnetic) tape. Using audio tape recording as an example, if the tape is not moved across the head, just one spot on the tape will be magnetized and will be continually re-magnetized. If the tape is moved across

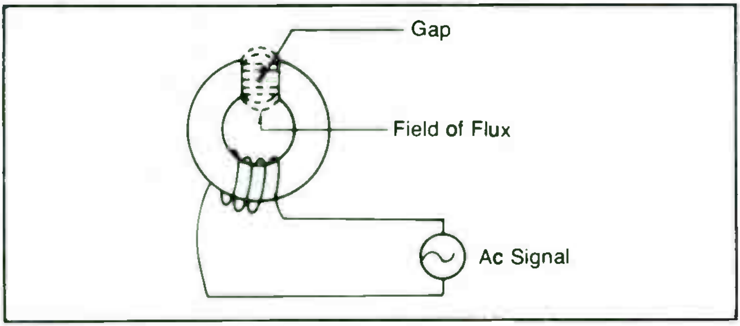


Fig. 1-19. Head gap and field flux.

the head, specific areas of the tape will be magnetized according to the field of flux at any specific moment. A length of recorded tape will therefore have on it areas of magnetization representing the direction and intensity of the field of flux.

As an example: the tape will have differently magnetized regions, which can be called north (N) and south (S), according to the ac signal. When the polarity of the ac signal changes, so does the direction of the magnetization of the tape, as shown by one cycle on the ac signal as shown in Fig. 1-20. If the recorded tape is then moved past a head whose coil is connected to an amplifier, the regions of magnetization on the tape will set up flux across the head gap which will in turn induce a voltage in the coil to be amplified. The output of the amplifier, then, is the same as the original ac signal. This is essentially what is done in audio recording, with other methods for improvement like bias and equalization.

There are some inherent limitations in the tape recording process which does affect video tape recording. As shown in Fig.

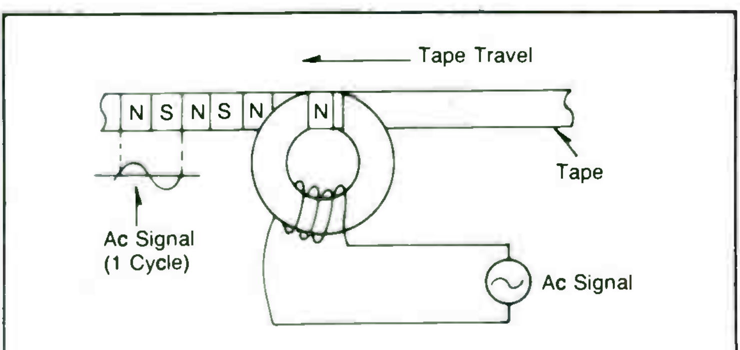


Fig. 1-20. Ac polarity change of head.

1-20, the tape has north and south magnetic fields which change according to the polarity of the ac signal.

If the speed of the tape past the head (head to tape speed) is kept the same, the changing polarity of the high frequency ac signal would not be faithfully recorded on the tape, as shown in Fig. 1-21.

As the high frequency ac signal starts to go positive, the tape will start to be magnetized in one direction. But the ac signal will very quickly change its polarity, and this will be recorded on much of the same portion of the tape, so north magnetic regions will be covered by south magnetic regions and vice versa. This results in zero signal on the tape, or self-erasing. To keep the north and south regions separate, the head to tape speed must be increased.

Then recording video, frequencies in excess of 4 MHz may be encountered. Through experience, it is found that the head to tape speed must be in the region of 10 meters per second in order to record video signals.

The figure of 10 meters per second was also influenced by the size of the head gap. Clearly, the lower head to tape speed, the easier it is to control that speed. If changes in head gap size were not made, the necessary head to tape speed would have been considerably higher. How the gap size influences this can be explained as we look at Fig. 1-22.

Assume a signal is already recorded on the tape. The distance on the tape required to record one full ac signal cycle is called the *recorded wavelength.* Head A has gap width equal to one wavelength. Here, there is both north and south oriented magnetization across the gap. This produces a net output of zero since north and south cancel. Heads B and C have a maximum output because there is just one magnetic orientation across their gaps.

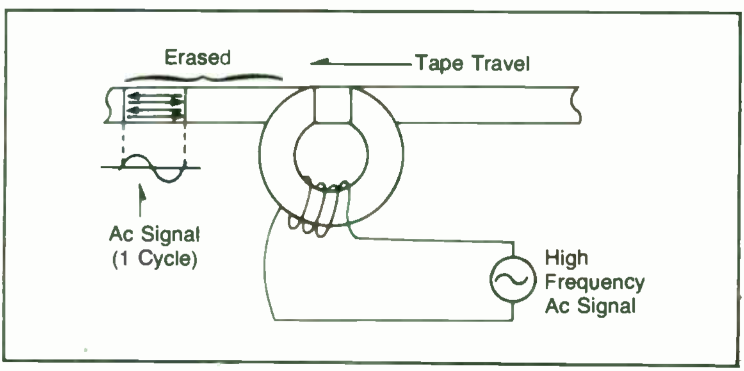


Fig. 1-21. High frequency ac signal considerations.

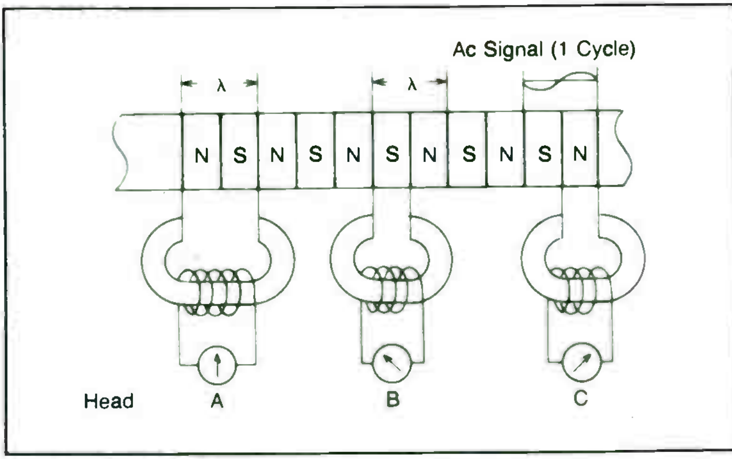


Fig. 1-22. How gap size influences tape recording.

Maximum output occurs in heads B and C therefore, because their gap width is ½ wavelength. Heads B and C would also work if their gap width is less than ½ wavelength. The same is also true for recording. A head to tape speed of 10 meters per second is a very high speed, too high in fact to be handled accurately by a reel-to-reel tape machine. Also, tape consumption on a high speed machine is tremendous.

The method used in video recording is to move the video heads as well as the tape. If the heads are made to move fast, across the tape, the linear tape speed can be kept very low. In 2-head helical video recording (the only format which will be discussed here) the video heads are mounted in a rotating drum or cylinder, and the tape is wrapped around the cylinder. This way, the heads can scan the tape as it moves. When a head scans the tape, it is said to have made a track. This is shown in Fig. 1-23.

In 2-head helical format, each head, as it scans across the tape will record one TV field, or 262.5 horizontal lines. Therefore, each head must scan the tape 30 times per second to give a field rate of 60 fields per second.

The tape is shown as a screen wrapped around the head cylinder to make it easy to see the video head.There is a second video head 180 degrees from the head shown in front. Because the tape wraps around the cylinder in the shape of a helix (helical) the video tracks are made as a series of slanted lines. Of course, the tracks are invisible, but it is easier to visualize them as lines. The two heads "A" and "B" make alternate scans of the tape.

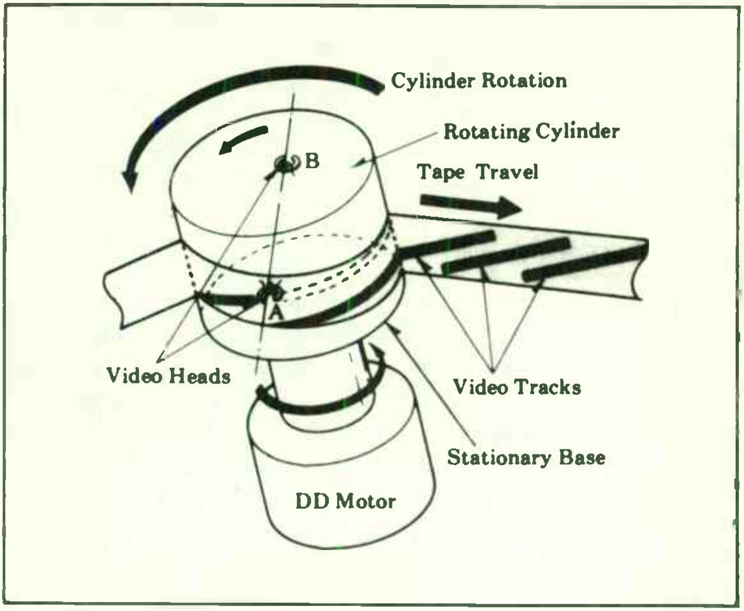


Fig. 1-23. Head scan and tape tracks.

An enlarged view of the video tracks on the tape are shown in Fig. 1-24. The video tracks are the areas of the tape where video recording actually takes place. The guard bands are blank areas between tracks, preventing the adjacent track's crosstalk from appearing on the track where the video head is tracing.

There is one more point about video recording which will be discussed now. Magnetic heads have characteristics of increased output level as the frequency increases, which is determined by the gap width. In practice, the lower frequency output of the heads is

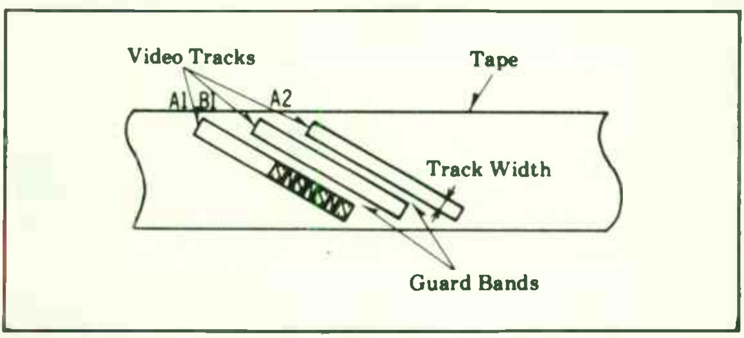


Fig. 1-24. Video tracks and guard bands.

boosted in level to equal the level of the higher frequencies. This process, as used in audio recording is called equalization.

Video frequencies span from dc to about 4 MHz. This represents a frequency range of about 18 octaves. Eighteen octaves is too far a spread to be handled in one system or machine. For instance, heads designed for operation at a maximum frequency of 4 MHz will have very low output at low frequencies. Since there is 6 dB/octave attenuation, $18 \times 6 = 108$ dB difference appears. In practice this difference is too great to be adequately equalized. To get around this, the video signal is applied to an FM modulator during recording. This modulator will change its frequency according to the instantaneous level of the video signal.

The energy of the FM signal lies chiefly in the area from about 1 MHz to 8 MHz, just three octaves. Heads designed for use at 8 MHz can still be used at 1 MHz, because the output signal can be equalized. Actually, heads are designed for use up to about 5 MHz. Therefore, some FM energy is lacking but it does not affect the playback video signal, because it is resumed in the playback process. Upon playback, the recovered FM signal must be equalized then demodulated to obtain the video signal.

Converted Subcarrier Direct Recording Method

The one method of color video recording that will now be discussed is the converted subcarrier method. In order to avoid visible beats in the picture caused by the interaction of the color (chrominance) and brightness (luminance) signals, the first step in the converted subcarrier method is to separate the chrominance and luminance portions of the video signal to be recorded. The luminance signal, containing frequencies from dc to about 4 MHz, is then FM recorded, as previously described. The chrominance portion, containing frequencies in the area of 3.58 MHz is down-converted in frequency in the area of 629 kHz. Since there is not a large shift from the center frequency of 629 kHz, this converted chrominance signal is able to be recorded directly on the tape. Also note that the frequencies in the area of 629 kHz are still high enough to allow equalized playback. In practice the *converted chrominance* signal and the FM signals are mixed and then simultaneously applied to the tape. Upon playback, the FM and converted chrominance signal are separated. The FM is demodulated into a luminance signal again. The converted chrominance signal is reconverted back up in frequency to the area of 3.58 MHz. The chrominance and luminance signals are combined which reproduces the original video signal.

Other VHS Recorder Functions

The various VHS machines have speeds that are referred to as SP, LP, and SLP. In the SLP mode and with the proper VHS cassette the playing time will be 6 hours.

Search-forward (Cue) and Search-reverse (Review)

In order to quickly find a particular segment on the tape during playback, the user can speed up the capstan and reel tables to nine times the normal speed, either forward or reverse, by pressing *cue* or *review* buttons.

At this time, noise bars will appear in the picture because of head crossover. This is normal on some model VHS and Betamax machines. Some will show four noise bars in cue and five noise bars in the review mode. The bars for the cue and review modes are shown in Figs. 1-25 and 1-26.

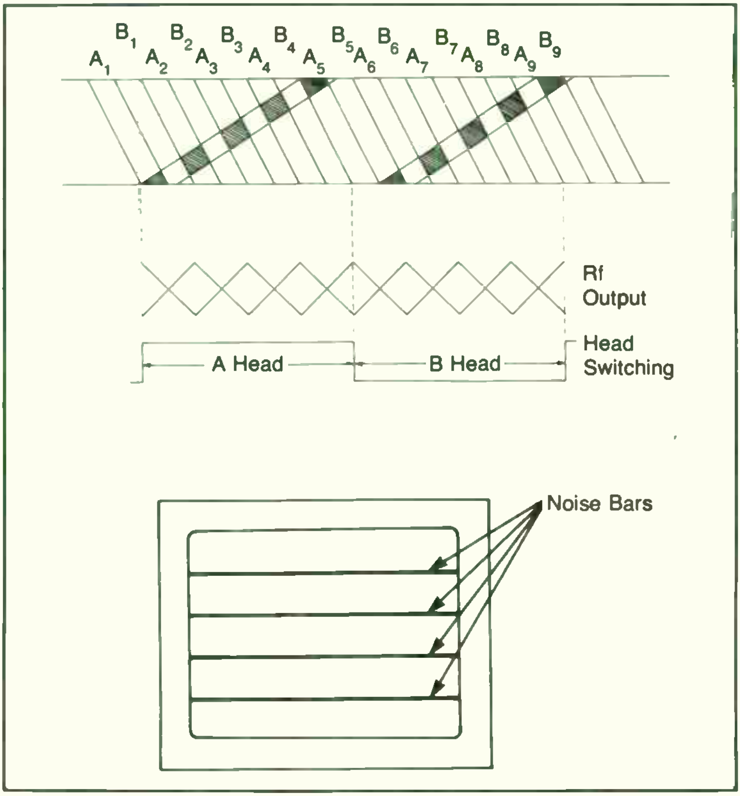


Fig. 1-25. The cue mode.

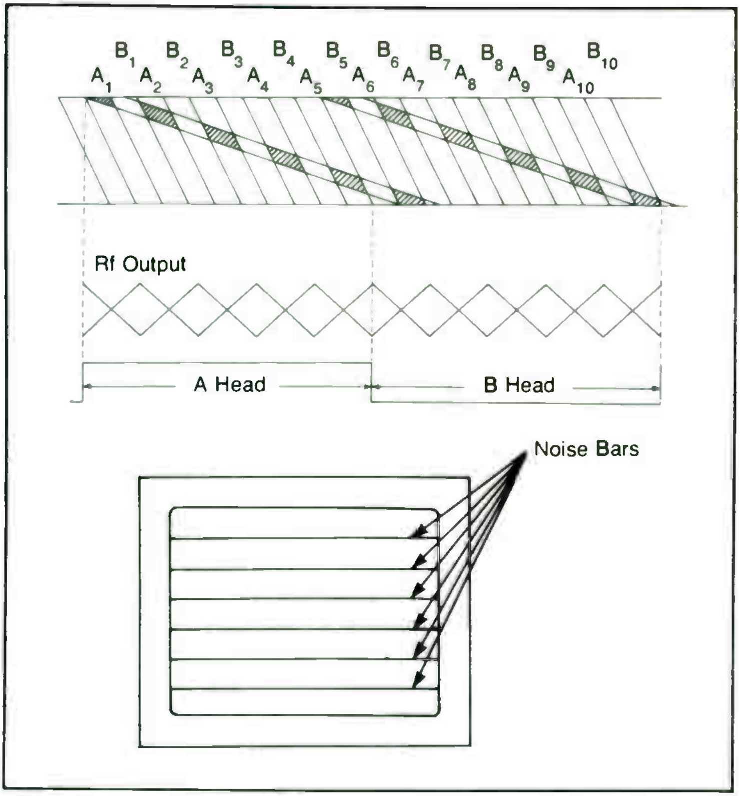


Fig. 1-26. The review mode.

½ Skew Correction

Horizontal sync alignment on the tape occurs in the SP and SLP modes, but not in the LP mode as shown in Figs. 1-27 and 1-28. Thus, when using cue or review on LP recordings, severe skew or picture bending will occur at the top portion of the screen. Also, the color AFC will malfunction for this same reason. To correct this, the playback video is delayed by 0.5 H to compensate for skew, and the AFC frequency is shifted to maintain color lock.

Add-on Recording (Transition Editing)

Most VCRs allow pause during recording. But because of the arbitrary timing, there is most likely a disturbance of the picture during playback at the place where the pause was used. To eliminate this disturbance, transition editing recording is used which backs up the tape for 2.2 seconds during *pause recording*. When the pause is

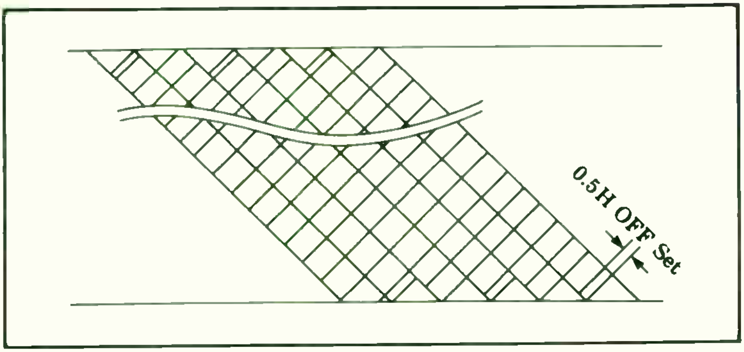


Fig. 1-27. The SLP recorded mode.

released, the deck will play back for about 1.2 seconds while aligning the control pulses already on the tape to the incoming vertical sync. After 1.2 seconds, the deck switches to the record mode, with the overall effect being no loss of synchronization during playback (Fig. 1-29). Therefore, there will be no sync disturbance during playback regardless of how many times pause was used during recording. Refer to Fig. 1-30.

Video Head Comments

We have already discussed the reduced track width. This reduction requires the use of a smaller video head. Just making them smaller does not make them better. With less of actual head material to work with, the magnetic properties of the head suffers. To offset this, a change in head material is in order. Because the VHS recorder is designed to be small, a reduction in the size of the head cylinder is called for.

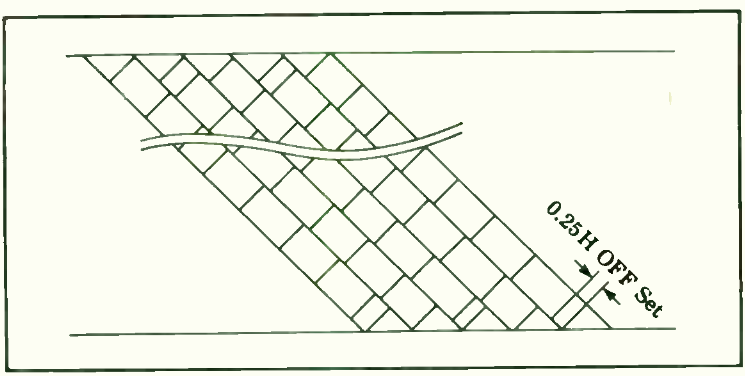


Fig. 1-28. The LP recorded mode.

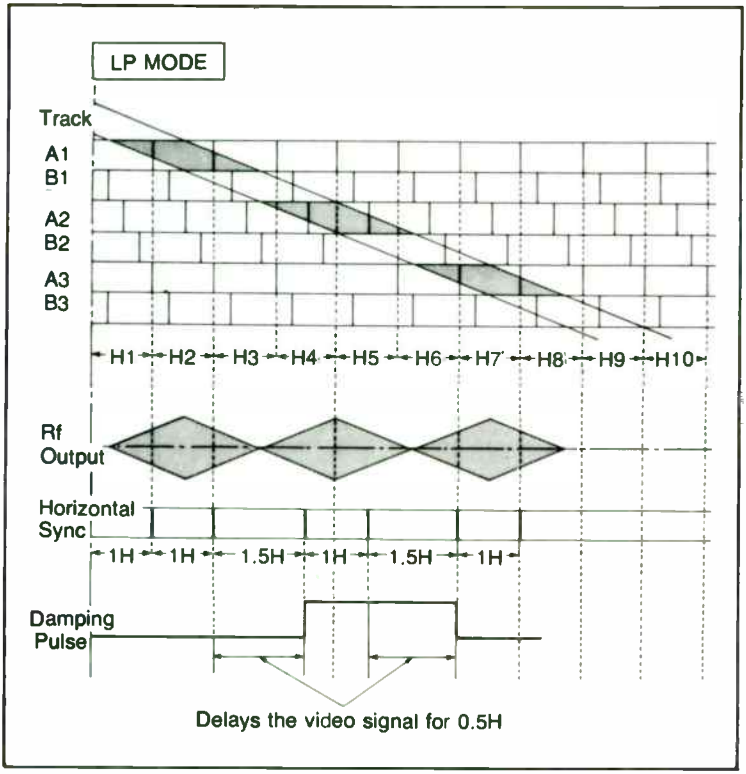


Fig. 1-29. LP mode ½ H correction.

A reduction in the size (diameter) of the head cylinder changes the head to tape speed. Remember, the head to tape speed affects the high frequency recording capability of the head. To offset this problem, the head gap size was reduced.

As is well known, azimuth recording is utilized in the VHS systems. The heart of the azimuth recording process is in the video heads themselves. This requires still another change in head design.

Hot Pressed Ferrite for the Heads

The use of hot pressed ferrite as video head material in the VHS recorder helps improve the characteristics of the smaller heads. The hot pressed ferrite also has uniform domain orientation which further improves the head characteristics. It has been proven in many tests that the use of hot pressed ferrite material produces a superior video head.

Head Gap Width

From the above explanation, the need for smaller head gap size becomes apparent. In VHS recorders, the video head gap widths is a mere 0.3 micrometers. This is in quite a contrast for ordinary video heads used in other helical applications whose gap widths are typically in the area of 1 micrometer.

Head Azimuth

Azimuth is the term used to define the left to right tilt of the gap if the head could be viewed straight on. In most VCR applications the azimuth has always been set perpendicular to the direction of the head travel across the tape, or more simply, the video track. Figure 1-31 helps to explain this. We see that the gap is perpendicular (90 degrees) to the heads movement across the tape. We can think of this standard as a perfect azimuth of 0 degrees.

In VHS, the video heads have a gap azimuth other than 0 degrees. And more, one head has a different azimuth from the other. The 2 values used in VHS machines are azimuth of +6 degrees and

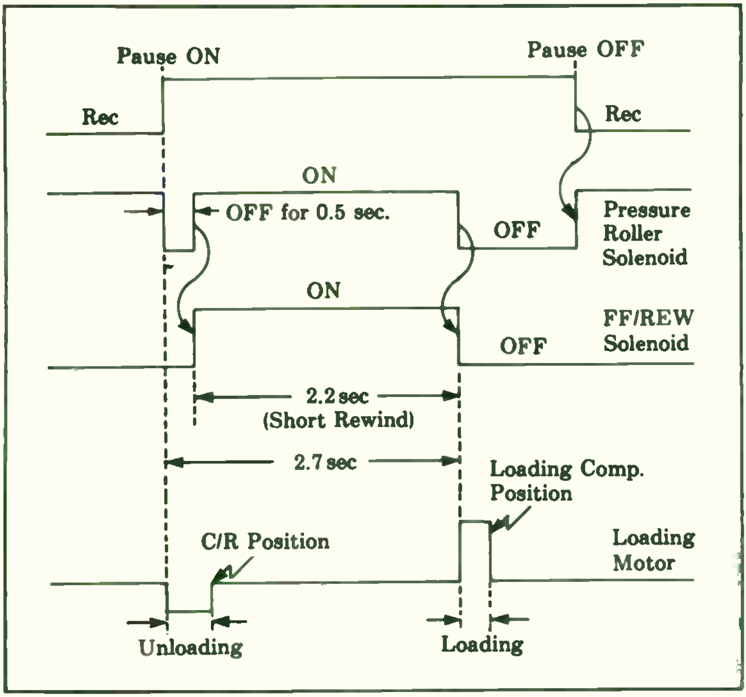


Fig. 1-30. Timing diagram VTR.

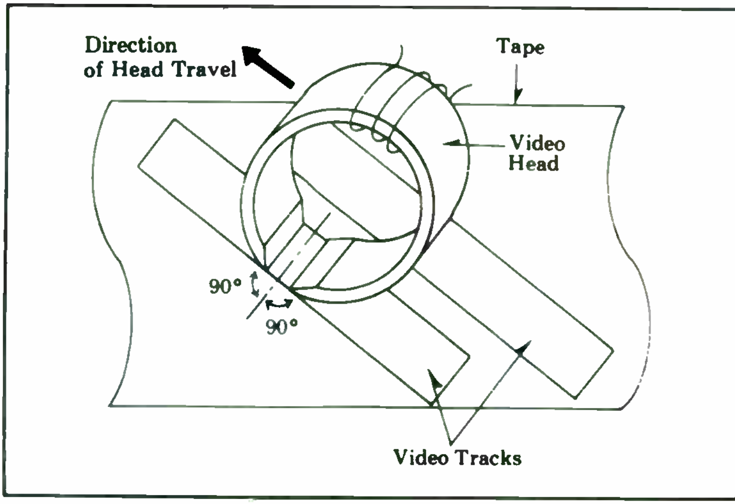


Fig. 1-31. Video head alignment to tape.

−6 degrees. Refer to Figs. 1-32 and 1-33. These heads make the VHS format different from most other VCR formats. Exactly how the azimuths of ± 6 degrees helps to keep out adjacent track interference will be explained next.

Azimuth Recording

Azimuth recording is used in VHS to eliminate the interference

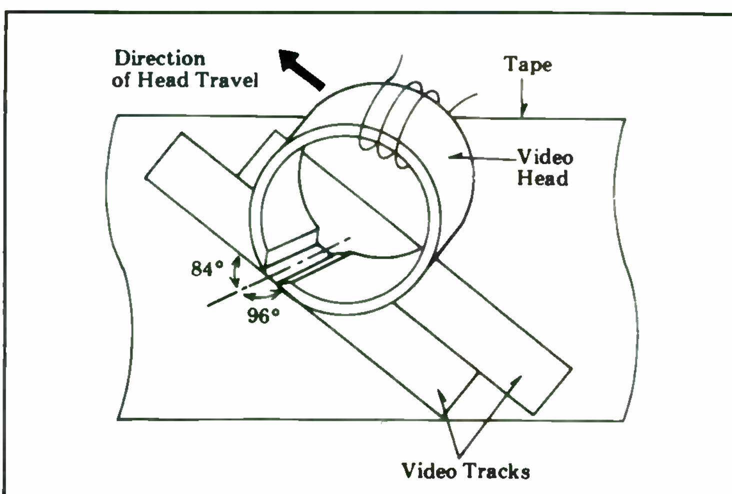


Fig. 1-32. Head and tape alignment (courtesy Magnavox).

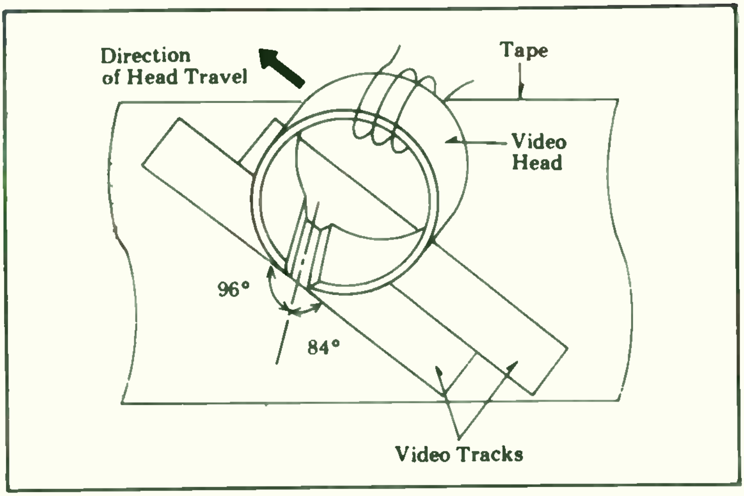


Fig. 1-33. VHS head format (courtesy Magnavox).

or crosstalk picked up by a video head. Again, because adjacent video tracks touch, or crosstalk, a video head when scanning a track will pick up some information from the adjacent track. The azimuth of the head gaps assure that video head "A" will only give an output when scanning across a track made by head "A". Head "B", therefore, only gives an output when scanning across a track made by head "B". Because of the azimuth effect, a particular video head will not pick up any crosstalk from an adjacent track. Let's now examine this more closely.

In Fig. 1-34 we see a VHS video recorder system in the SLP mode with the video tracks in a not-to-scale north and south magnetized regions on them. It can also be seen that these N and S regions are not perpendicular to the track; they have −6 degree azimuth in tracks A1, A2; and +6 degrees azimuth in tracks B1, B2. If we take track A1 and darken the N region, it becomes easier to see. Refer to Fig. 1-35.

In Fig. 1-36 we see the information on track A, made by head "A". Imagine now that head "A" is going to play back this track, by superimposing the head over the track. Clearly, the gap fits exactly over the N and S regions, so that at any moment there is either an N region or an S region or an N to S (or S to N) transition across the gap. This produces maximum output in head "A". Now, visually superimpose the "B" head over the track. Here there are N and S regions across the gap at the same time, at any given moment. Remember that simultaneous N and S regions across the gap cause

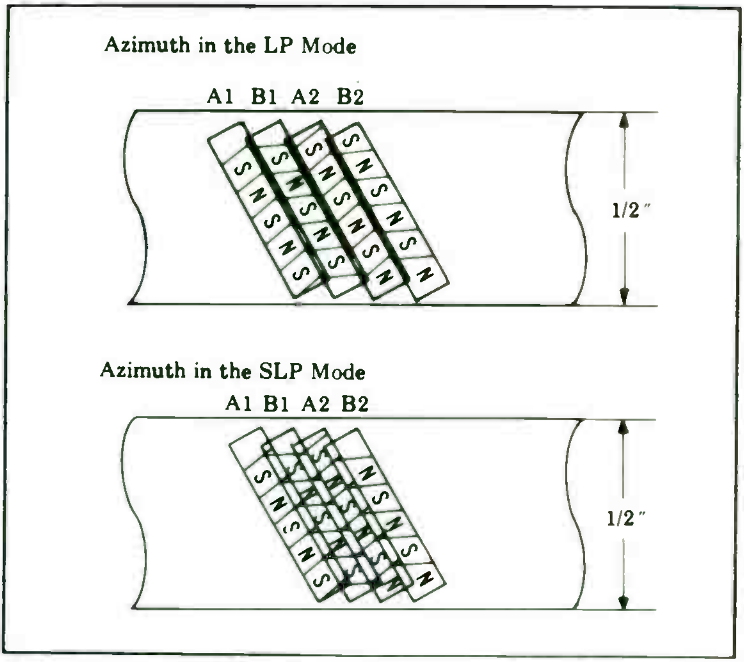


Fig. 1-34. Azimuth in the SLP mode (courtesy Magnavox).

cancellation, and therefore, no output. Looking at Fig. 1-33, we can see that the gap width is equal to ½ the recorded wavelength. Recall that this occurs at the highest frequency which is to be recorded. So therefore, the azimuth effect works at these high frequencies.

But, what happens at lower frequencies? In Fig. 1-37 we see a diagram similar to Fig. 1-36, except the recorded wavelength is longer, which represents a lower frequency.

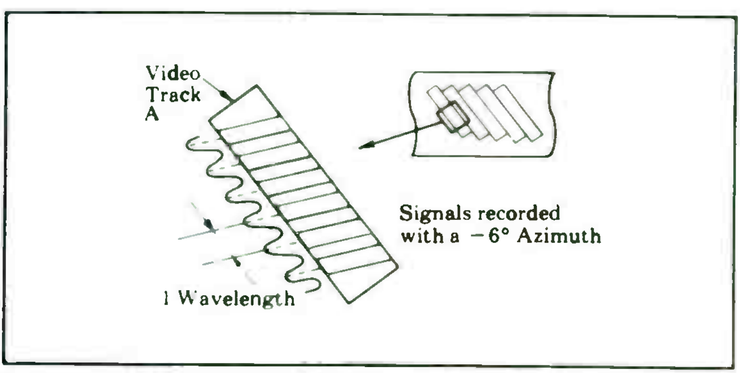


Fig. 1-35. Signals with a −6° azimuth (courtesy Magnavox).

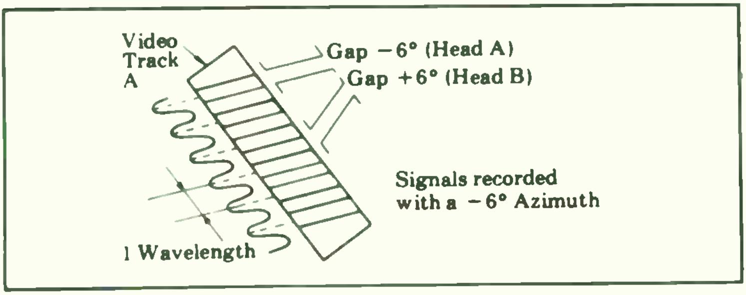


Fig. 1-36. Information made by "A" track (courtesy Magnavox).

Again, visually superimpose the heads over the track. Head "A" is the same as before. But look at head "B". There is much less cancellation across the gap, and its output is close to that of head "A." Therefore, we see where the azimuth effect is dependent on frequency. The higher the frequency, the better the azimuth effect. The lower the frequency, the lower the separation by azimuth effect.

VHS Color Recording System

Because there is insignificant azimuth effect at lower frequencies, a different type of color recording system was adopted. The fact that crosstalk occurs at lower frequencies cannot be changed, as it occurs right on the tape during playback. The method adopted processes the crosstalk component signals from the heads so that they are eliminated. It is important to realize that the crosstalk *does still occur.* It is the recording/playback circuitry that performs the crosstalk elimination.

In ordinary helical VTRs using converted subcarrier direct recording, the phase of the chrominance signal is untouched and is

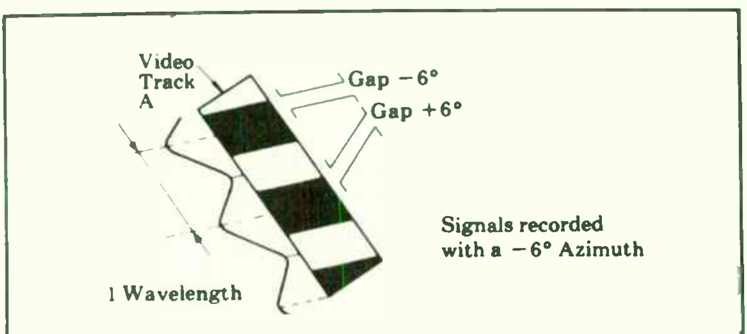


Fig. 1-37. A longer recorded wavelength (courtesy Magnavox).

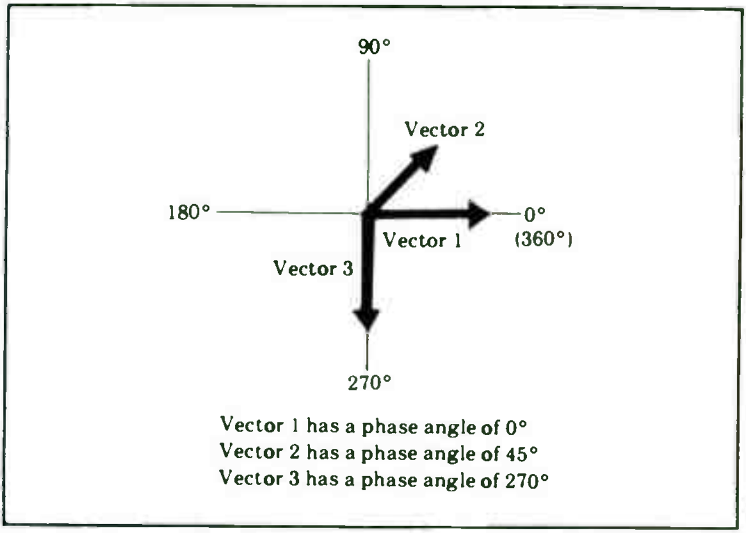


Fig. 1-38. Vector phase angles (courtesy Magnavox).

recorded directly onto the tape. The chrominance signal and its phase can be represented by vectors. Vectors graphically represent the amplitude and phase of one frequency. In this discussion, we will consider (in order to keep it simple) the chrominance signal to be only one frequency. For an example of vectors see Fig. 1-38. The length of any vector represents its amplitude.

We know that the azimuth effect will not work at the lower frequencies. And since the color information in VHS is recorded at low-converted frequencies, another technique for color recording was adopted.

Vector rotation in recording is actually a phase shift process that occurs at a horizontal rate of 15,734 Hz. The chrominance signal can be represented by a vector, showing amplitude and phase. In ordinary helical scan VCRs the vector is of the same phase for every horizontal line, on every track as shown in Fig. 1-39.

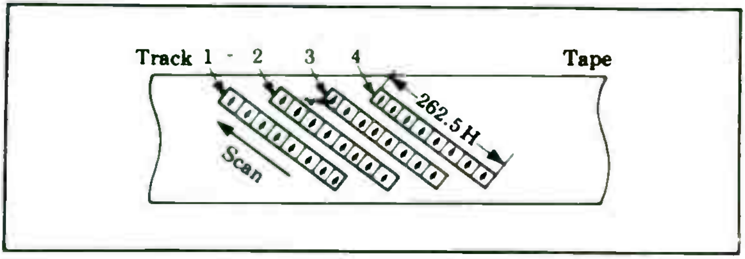


Fig. 1-39. Normal helical scan VCR (courtesy Magnavox).

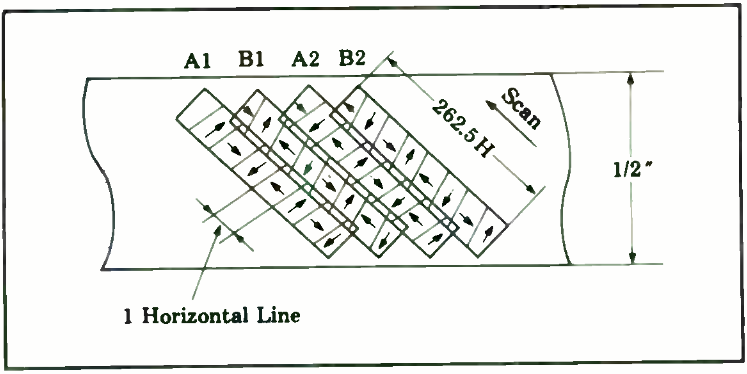


Fig. 1-40. VHS helical scan (courtesy Magnavox).

In VHS, we will still convert the 3.58 MHz down to a lower frequency, namely 629 kHz, but the color technique used in VHS format is a process of vector rotation. During recording the chrominance phase of each horizontal line is shifted by 90 degrees. For head "A" (channel 1) we advance the chrominance phase by 90 degrees per horizontal line (H). For head "B" (channel 2) we delay the chrominance phase by 90 degrees per H.

Vector (Phase) Rotation

- Channel 1 +90 degrees/H
- Channel 2 −90 degrees/H

Now refer to Fig. 1-40 to see what this looks like on the tape. Now assume that head "A" plays back over track A1 it will produce a vector output as such: head "A" when tracking over A1 will have an output consisting of the main signal (large vectors) and some crosstalk components (small vector).

Figure 1-41 is a vector representation of the playback chrominance signal from the head. One of the most important things done in the playback process is the restoration of the vectors to their

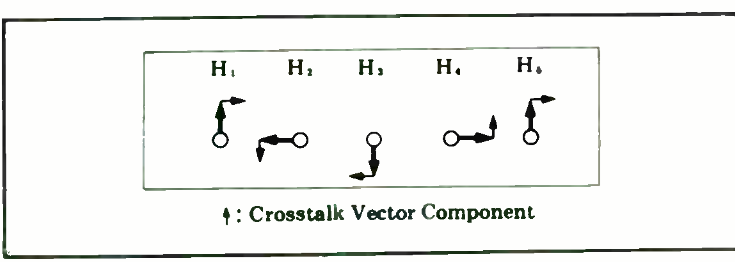


Fig. 1-41. Crosstalk vector component (courtesy Magnavox).

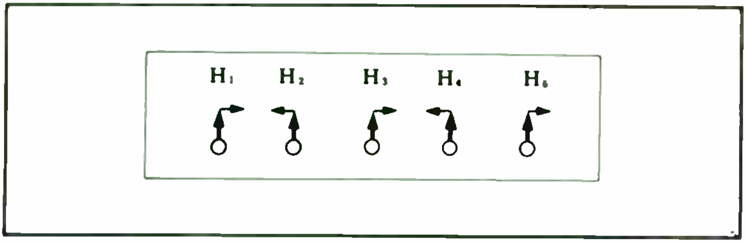


Fig. 1-42. Vector for playback mode (courtesy Magnavox).

original phase. This is done by the balanced modulator in the playback process. Note the vector representation shown in Fig. 1-42. This restored signal is then split two ways. One path goes to one input of an adder. The other path goes to a delay line which delays the signal by 1 H. The output of the delay line goes to the other input of the adder. This can be more easily seen in Fig. 1-43.

As can be seen in Fig. 1-44., the crosstalk component has been eliminated after the first H line. We now have a chrominance signal free of adjacent channel crosstalk.

The double output is not a problem because it can always be reduced. The process of adding a delayed line to an undelayed line is permissable because any two adjacent lines in a field contains nearly the same chrominance information. So, if two adjacent lines are added, the net result will produce no distortion in the playback picture.

In conjunction with the crosstalk elimination is the reconversion of the chrominance 629 kHz to its original 3.58 MHz. Now the color signal is totally restored.

LP Tape Speed Mode

The recorded signal in the LP mode is considerably different from that used in the other VHS system tape speed modes. Like the SP mode, the chrominance and luminance signals are separated as

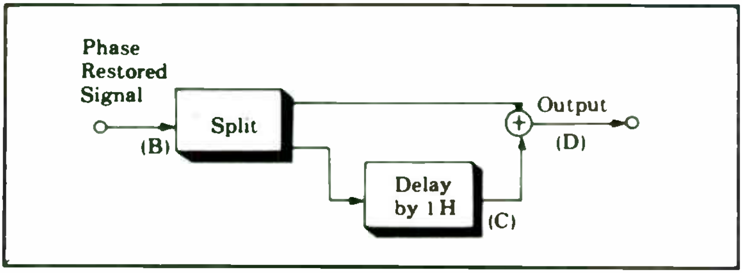


Fig. 1-43. Split of the restored signal (courtesy Magnavox).

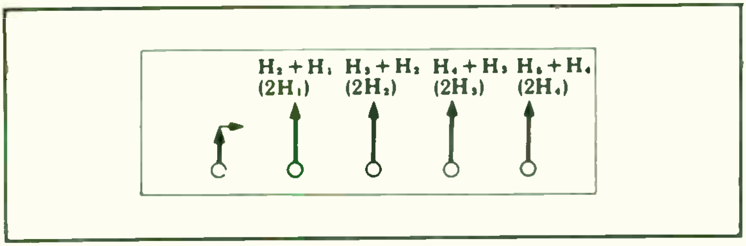


Fig. 1-44. Double output signal (courtesy Magnavox).

covered earlier. However, from here on things are treated differently. Let's examine again the video tracks on the tape of an LP recording.

Notice in Fig. 1-45 that the tracks do overlap, and that any picture area of any track does not line up perfectly with the picture area of the adjacent tracks. (No horizontal sync alignment.)

Let's now pull several horizontal line segments off of the track for greater detail. As can be seen in Fig. 1-46, the horizontal sync portion of track B lies somewhere in the picture area of track A, for any given horizontal line segment. Assume that track A was recorded first. Then, as track B is laid down, the 3.4 MHz horizontal sync section of "A" will produce a beat with the portion of track B that covers it. Although the entire overlapping region will produce beats, the beat caused by the horizontal sync is most noticeable because the sync tip FM frequency never changes, whereas the FM frequency for the picture portion is constantly changing. This beat is visible on the screen, so measures must be taken to eliminate it. The method employed is called FM interleaving recording.

Note that beats are not the same as adjacent track crosstalk. Azimuth recording prohibits crosstalk pickup. But, the beat produced is a new frequency, it was not present in the video signal, it is the result of laying one track over another. The beat signal has no true azimuth, therefore, it will be detected by both video heads. The

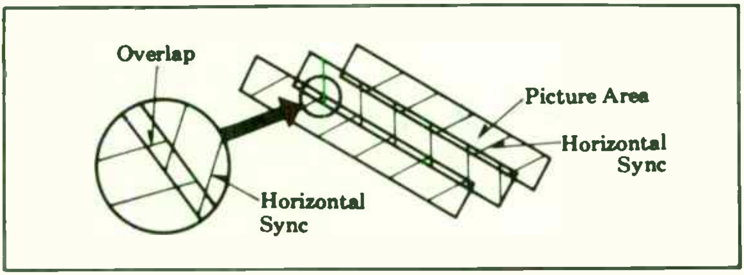


Fig. 1-45. Overlapped tracks (courtesy Magnavox).

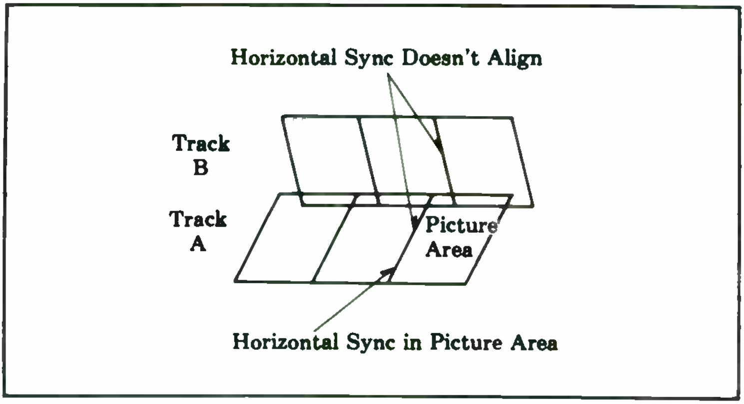


Fig. 1-46. Horizontal sync does not align (courtesy Magnavox).

FM interleaving recording method does not actually eliminate the beat, but rather places it at such a frequency so that no beat can be detected on the screen.

It is a fact in the NTSC color TV system that video frequencies which are an odd multiple of ½ the horizontal line frequency have the property called "interleaving." Interleaving signals appear on the TV screen in a rather special way. Between any two adjacent lines, the signals are out of phase, as shown in Fig. 1-47 by the solid lines. Because the two lines are very close, the human eye tends to integrate them. The out-of-phase signals will virtually be cancelled, or not seen by the viewer.

Now, when the frame is completed and the next frame begins, the signal on the top line will be out of phase with what was previously scanned. This is shown by the dotted line. This will cancel any phosphor persistance from the previous scan. Thus, interleaved frequencies, for all purposes, do not create interference on the TV screen.

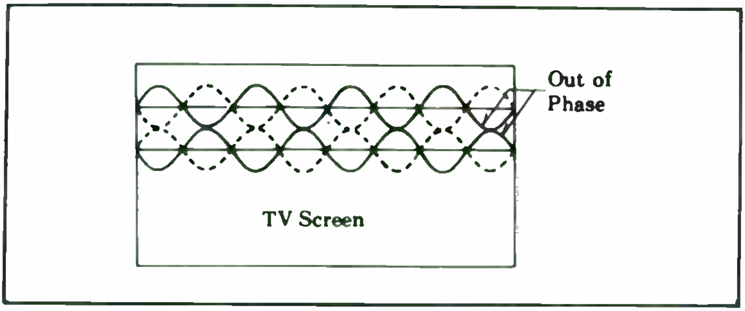


Fig. 1-47. Adjacent lines are out of phase (courtesy Magnavox).

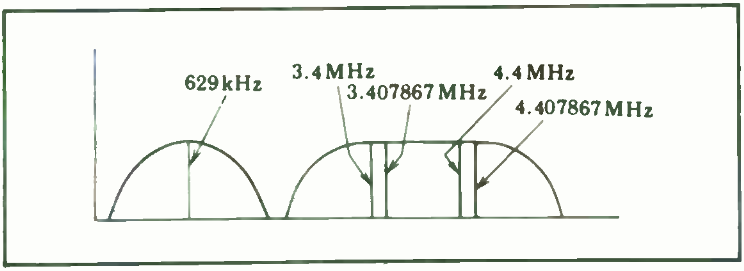


Fig. 1-48. Chrominance and FM spectrum (courtesy Magnavox).

This interleaving is accomplished by raising the sync tip FM frequency in channel 1 by 15734/2 MHz or 7,867 Hz. For channel 1, then, sync tip frequency is 3.407867 MHz and peak white becomes 4.407867 MHz. Channel 2 remains the same as before, sync tip is 3.4 MHz, and peak white is 4.4 MHz. This displacement by 7.867 kHz causes the beat produced by the overlapped horizontal sync to become an interleaving frequency, which solves the problem.

Recovery of this shifted FM signal, although somewhat different, is essentially the same as before. The chrominance and FM signals which are mixed and then applied to the tape occupy a spectrum that is shown in Fig. 1-48.

SLP Mode for VHS System

Like the other mode speeds, the video track on the tape of an SLP recording is shown in Fig. 1-49. Notice that the tracks do overlap, and that any track picture area of any track, will line up perfectly with the picture area of the adjacent tracks (horizontal sync alignment). Let's pull several horizontal line segments off of the track for greater detail.

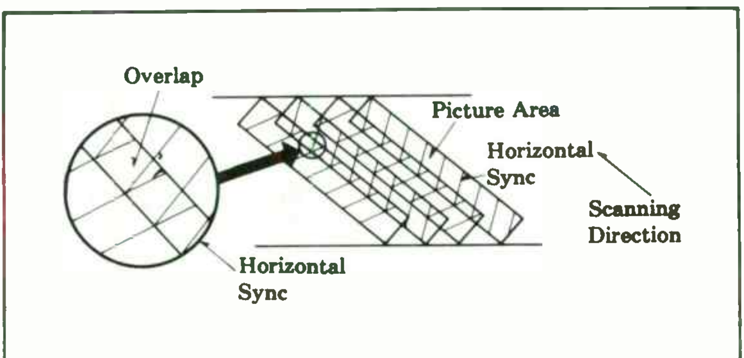


Fig. 1-49. Video tracks in SLP mode (courtesy Magnavox).

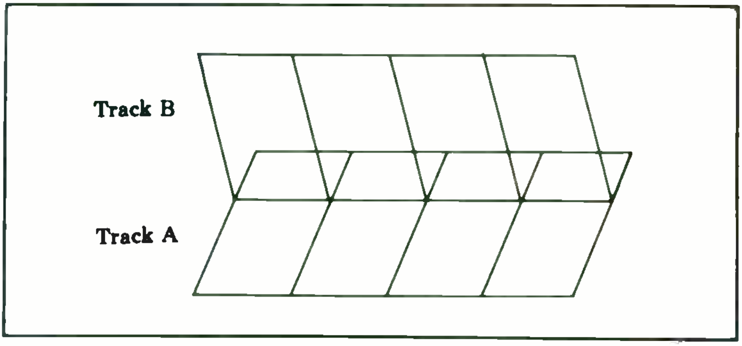


Fig. 1-50. Horizontal sync is now in alignment (courtesy Magnavox).

As can be seen in Fig. 1-50, the horizontal sync portion of track B is in alignment with one of track A. Assume that the SLP recorded tape is played back. When the A head scans the A track the A head picks up the B track signals on the overlapping region. Although the entire overlapping region will produce beats as in other modes, the beat is eliminated by the FM interleaving recording.

Tape M Loading

In this VHS machine, the tape path is out of the cassette, across the stationary heads and around the video head cylinder forming a letter "M", thus the name "M" loading. Refer to this "M" type loading diagram in Fig. 1-51. The M loading has several advantages over previous, more complex loading formats.

■ Less tape is pulled out from the cassette. This reduces the chances of tape spillage and tangles.

■ Because the tape path in the M load pattern is short, loading time is only 3 seconds, including video muting.

■ Fast Forward and Rewind are performed inside the cassette, further reducing the chances of tape damage.

TEST EQUIPMENT REQUIREMENTS FOR VCR SERVICING

In this section we will cover types of test equipment that are needed for VCR servicing, test set-ups that you will need and VCR test tapes.

Space age electronic technology has made an new era of the video tape machine for home use. These video cassette recorders (VCRs) provide an acceptable color picture at a fairly low cost for the machine and the video tape that is used. The new home VCR market developed a new electronic service market. Video tape recorder service is no longer confined to a few service centers that specialize in just the industrial recorders, as was the case a few years ago. The VCR owner expects to receive local service from the service shop that provides TV and stereo sales and service. Many dealers that sell VCRs believe that they must be able to service what they sell in order to have an advantage over their competition. This service is usually part of the same service network that services the TV receivers sold by the same dealer.

You may think that you will need the same high priced test equipment for servicing the home VCRs as that used for servicing broadcast quality tape decks. Of course, the broadcast quality test equipment will adequately service the new low-cost tape decks, but you need to look at what is the minimum equipment investment that can be made and still make sure that the VCR is operating properly. In the case of a broadcast tape deck, the cost of the test equipment that is necessary to provide service is only a fraction of the cost for the VCR machine, even if we consider only one machine. When you have more than one machine, this fraction becomes much smaller. However, when we talk about the same equipment in relation to a home type VCR, we see that the cost of the test equipment can easily run from 15 to 20 times more than the VCR unit.

THE VA48 SENCORE ANALYZER

Before Sencore introduced the VA48 video analyzer the service technician usually had to provide TV service, and avoid the VCR servicing, or equip the shop for VCR service and work with older test equipment for TV servicing. The Video Analyzer has

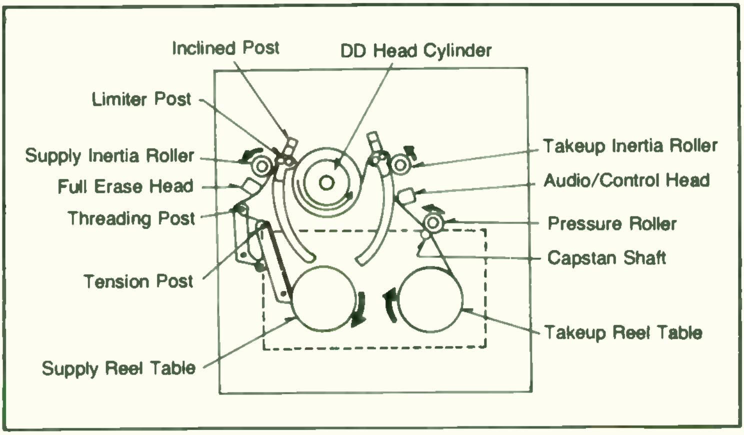


Fig. 1-51. Drawing of "M" loading (courtesy Magnavox).

eliminated this dilemma because it updates the shop for both TV and VCR servicing with one piece of test equipment.

Special considerations were made at the time that the VA48 was designed to make sure that the signals would be compatible with the new video tape VCR systems. Extensive testing, both in Sencore's own lab and in working with the service managers of leading VCR manufacturers, has shown that these signals produce service results that are equal to, and in some cases superior to, those produced by an NTSC signal generator. This is especially true if the service shop is not equipped with an NTSC vectorscope for evaluating the output signals produced by this very high cost NTSC generator.

Using the VA48 Analyzer Patterns

The two patterns you will be using for VCR troubleshooting on the VA48 are the bar sweep and chroma bar sweep. The VA48 Sencore Analyzer is shown in Fig. 1-52. There are a few special features built into each of these patterns that make them even more versatile in VCR service than you may find in standard TV service because the TV receiver does not have all of the circuits that are part of a VCR machine. We will review then so that you will know which pattern to use for various VCR circuit troubleshooting.

The Bar Sweep Pattern

The bar sweep pattern should be used for all luminance (black and white) circuit testing. The first reason that this pattern is important is that it does not have a color burst. This gives a positive test of all automatic color killer circuits found in both the record and playback VCR circuits. These circuits should automatically switch to the black and white mode when the color burst is not present.

The bar sweep pattern produces various amounts of B&W information. The grey-scale at the left of the switchable frequency bars, for example, checks the black, grey, and white signal levels for proper amplitudes, linearity, and clipping. Each frequency bar after the grey-scale alternates between pure black and pure white levels to test the circuits for proper frequency response. The bar sweep pattern looks much like the familiar "multi-burst" pattern used in many types of video testing. You should note one difference between the bar sweep and the multi-burst is that the bar sweep is made up of square waves, while the multi-burst is made up of sine waves. The key difference is that the bar sweep will show circuits

Fig. 1-52. VA48 Analyzer and dual-trace scope setup for a VCR bench check-out.

that will ring on fast signal transitions where the multi-burst may be passed by these stages without any noticeable ringing.

The various frequencies of the bar sweep pattern then checks the video frequency response of the entire record/playback system. Certain applications of the bar sweep involve recording this pattern on a tape using a known good recorder. Many times you can use this tape in place of the expensive alignment tape and save wear and tear on your special alignment tape.

The Chroma Bar Sweep

The second pattern from the VA48 is the chroma sweep bar. This pattern contains a standard level color burst for operation of the color killer circuits and the automatic color control (ACC) circuits. The color information is phase-locked back to the horizontal sync pulses so that this pattern produces a line-by-line phase inversion just like that of an off-the-air signal. This is very important because the comb filters used in almost all playback circuits requires this phase-inversion in order to detect the proper color signal as opposed to the unwanted crosstalk information from an adjacent video stripe on the magnetic tape. The fact that the chroma bar sweep covers the entire frequency range of the color information (one-half MHz either side of the color subcarrier) makes this pattern ideal for testing the operation of all the chroma conversion circuits to make sure that they are not restricting some of the color detail information.

Recording Your Own Personal Test Tape

If you have a VA48 you will want to record your own personal VCR test tape using the patterns from the analyzer. This test tape will not replace the need for the VCR test and alignment tape, but rather supplements the alignment tape. The advantage of having a tape that you recorded yourself is that it will save much wear and prevent the possibility of damaging the expensive alignment tape. Now, should a defective machine damage your own test tape, you will be able to replace it for the cost of a blank tape rather then having to purchase a new, costly alignment tape. This alignment tape will allow you to confirm the various operations of the color circuits as well as the performance of the luminance circuits. A defective video playback head or preamplifier, for example, can be quickly determined by using your own test tape.

Any adjustments that affect compatibility with other machines should be made with the manufacturer's own test tape. This tape has been carefully prepared to provide a standard from one machine to another so that a tape recorded on one machine will play properly on another machine. This is especially important if your customer has more than one tape deck VCR and plans to play tapes on a different machine than was used for recording. The same goes for commercially prepared prerecorded programs on tapes that may be purchased and played back.

When you record your own VCR test tape, be sure to use a machine that you know is operating properly. New VCR machines generally will be set-up and aligned properly. Be sure to feed the signals directly into the "camera" input jack of the VCR rather than feeding them through the antenna input terminals. This will assure you that an improperly adjusted i-f stage or tuner fine-tuning adjustment will not cause the quality of your recording to be less than ideal for test purposes. Take advantage of the tape counter to allow you to locate specific portions of the tape so you can easily find the pattern you need to use. It is also desirable to include an audio signal for at least a portion of the tape so that you are able to test the audio playback circuits with the same tape. This audio signal is available from the "Audio 1000 Hz" position of the drive signal output from the Sencore VA48 video analyzer.

VCR Test Tape Recording Steps

1.—Connect the VCR standard output from the analyzer to the camera input of a known good VCR machine. Switch the input switch to the "camera" position.

2.—Set the tape counter to 000.

3.—Select the faster tape recording speed on the machines that have more than one speed. This will be called Beta III, X1 or SP modes.

4.—Select the bar sweep position of the video pattern switch on the analyzer.

5.—Place the VCR in the record mode and record the pattern until the tape counter has progressed 50 counts.

6.—Switch the video pattern switch on the analyzer to the chroma bar sweep position and record this pattern for the next 50 counts.

7.—Switch the video pattern switch on the analyzer to the color bar position and record this pattern for the next 50 digits on the counter.

8.—Switch the video pattern switch on the analyzer to the cross hatch position and record this pattern for the next 50 counts.

9.—Switch the VCR to the slower tape recording speed. This will be the Beta I, II, LP or X2 modes.

10.—Repeat steps 5 through 8 and record these same video patterns at these slower tape speeds.

Your own test tape is now recorded. If you want the audio tone recorded during one or more of these test sections, simply connect the drive signal output to the auxiliary audio input jack of the VCR while recording the pattern or use the "Audio Dub" function to add the audio after the video is recorded.

The test tape will now have the following patterns:

Tape Counter	Pattern
000-050	Bar Sweep
050-100	Chroma Bar Sweep
100-150	Color Bars
150-200	Cross Hatch
200-250	Bar Sweep (slow speed)
250-300	Chroma Bar Sweep (slow speed)
350-400	Color Bars (slow speed)
450-500	Cross Hatch (slow speed)

VCR Servo Alignment

The Sencore video analyzer signals are ideal for performing servo alignment adjustments on a VCR. The phase-locked, broadcast quality sync makes it perfect for this alignment application. Injecting the signal from the VCR standard jack on the analyzer directly into the video or camera input jack on the VCR eliminates the fine tuning errors that can occur when using an rf air signal.

There are several adjustments that call for the counting of the horizontal sync pulses just before the vertical sync pulse. When using an off-the-air signal, the equalizing pulses are present and can cause an error in the counting, resulting in the wrong setting of a critical control setting. The VA48 analyzer phase locked sync signals do not have the equalizing pulses and the counting of the horizontal sync can be done correctly without the equalizing pulses causing confusion and the proper setting can be obtained easier. Equalizing pulses are not used in the VCR and are not important to servo alignment procedures.

VCR Audio Checks

The 1 kHz audio signal from the drive signal section of the analyzer can be used when making checks of the record and playback functions of the VCR machine. The manufacturer's alignment tape should be used for making the playback equalization adjustments. The following procedure allows injection of the audio test signal.

1—Adjust the drive level control with the drive signals switch in the audio 1,000 Hz position to about 2 volts peak-to-peak reading on the VA48 meter.

2—Inject the audio from the drive output jack on the analyzer into the audio input jack on the VCR. On VCRs not having this jack, the signal can be injected into the audio circuits at a test point that is usually noted in the service data.

3—The audio test signals can then be traced with an oscilloscope.

Servo Alignment Procedures

In some VCR servo alignment procedures, a dual-trace scope with *add* channel capabilities may be called for. The add mode means that the two channels are added together in the scope. This feature is not found on some scopes, but may not actually be needed in the alignment procedures. A Leader model LBO-515 dual-trace scope is shown in Fig. 1-53 being used for servo alignment checks.

On scope with no add mode you can utilize the dual-chopped mode to provide proper waveform information for aligning the VCR servo systems as follows:

1—Set both channels to ground and adjust the trace position control so that the two traces align in the center of the screen.

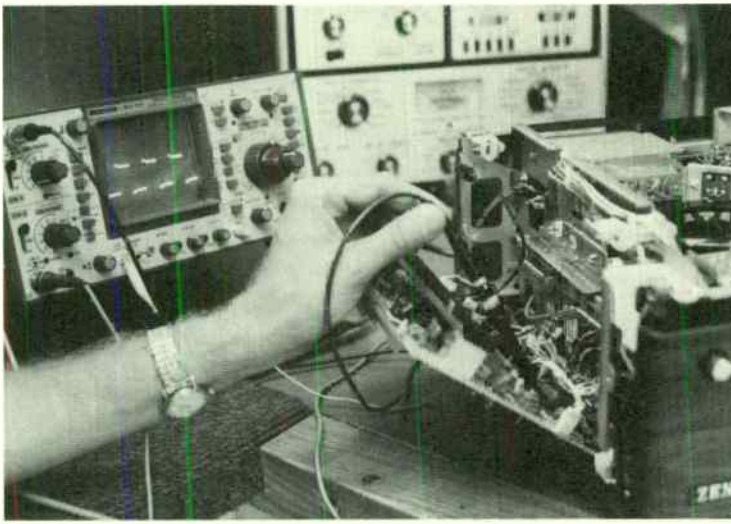


Fig. 1-53. Leader LBO-515 scope used for VCR service.

2—Connect the A and B scope channels for the servo adjustment procedure and set the scope to the dual-choped mode.

3—Now make the adjustments for the servo alignment as stated in the service data.

Note: It is recommended that external sync be used in these procedures so that the oscilloscope will be locked to the channel that is not being adjusted. All you need do is determine which channel is stationary and which one is adjusted, and connect the external sync jack to the stationary channel test point.

OTHER EQUIPMENT REQUIREMENTS

Besides a video analyzer or NTSC color bar generator you will need a dual-trace oscilloscope, frequency counter, digital voltmeter, transistor checker and perhaps a capacitance-inductance checker. Let's now look at a few of these test instruments that are now available for VCR troubleshooting.

Dual-Trace Scopes

Many of the modern electronics service shops are now using wide-band dual-trace triggered sweep scopes for their every-day TV electronics troubleshooting. If you do not now own a dual-trace scope perhaps now would be a good time to review the need of the scope for VCR servicing. The greatest advantage of a dual-trace scope, compared to a single trace scope, is that it allows comparison of two waveforms at the same time. This is very useful for tracing signals through inputs and outputs of various stages, but is essential in troubleshooting such critically timed circuits as the servo stages, where two signals must be properly timed. A dual-trace scope with a bandwidth of 20 to 50 MHz and that has a good bright trace is your best bet for VCR and over-all electronic circuit troubleshooting. The scope should also have a very stable trace with rock-solid lock-in of the waveforms. Make sure, if you purchase a new scope, that the instrument has true TV sync separators built into the trigger circuits for both vertical and horizontal sweep rates. Some scopes that have a "TV" position do not use integrator filters to allow triggering on vertical sync pulses. One scope that has the features for VCR servicing and a 60 MHz bandwidth is the Sencore SC60 shown in Fig. 1-54. Another scope that will cover your electronic service needs is the Tektronix model 5403 (shown in Fig. 1-55) which has a bandwidth of 70 MHz. This one pictured is set-up for dual-trace operation with one vertical plug-in unit. There is space on the front panel for another plug-in vertical amplifier.

Frequency Counters

A stable frequency counter is required for setting the reference oscillators found in the color circuits of the VCR and for adjusting the servo circuits. The Sencore FC45 counter shown in Fig. 1-56,

Fig. 1-54. Sencore SC60 oscilloscope.

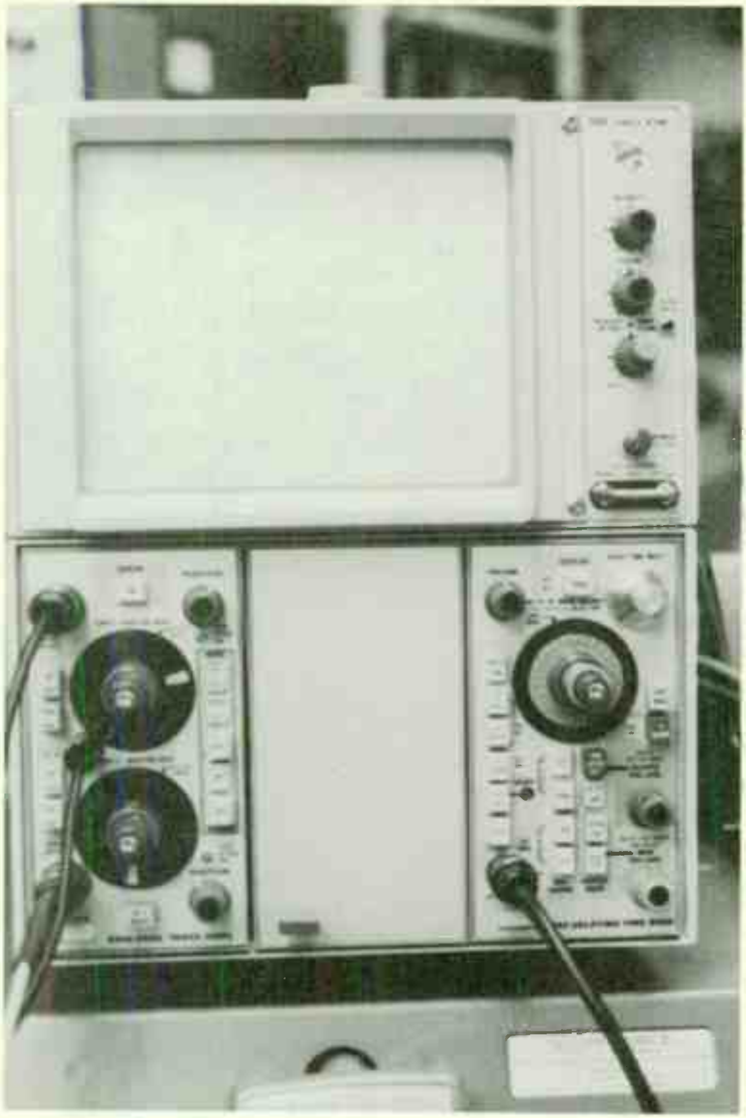


Fig. 1-55. Textronic model 5403 scope.

offers a high 25 mV sensitivity for measuring low-level signals with a full 8-digit readout for direct readings of the oscillator frequencies down to 1 Hz resolution. The versatility of the FC45 can be expanded even more with the use of the PR50 audio prescaler, which lets you adjust the 30 Hz control track signal to an accuracy of .01

Fig. 1-56. Sencore FC45 frequency counter that is an excellent aid for VCR troubleshooting.

Hz. Some frequency counters use a "period measurement" mode for measuring these low frequencies. This can be very time consuming, because the frequency is shown as a time interval instead of a frequency. You must then use a calculator to figure the actual frequency by dividing the time measurement into one (frequency=1/time). The PR50 provides a direct readout of frequency, which is updated every second or 10 times a second with 0.1 Hz resolution, to eliminate the time-consuming calculations necessary with a period counter. The PR50 also has filtering built in to prevent false double-counting due to signal noise that is often present in these low-frequency signals.

Digital Voltmeter

The use of a DVM is important for VCR servicing because most of the circuitry is contained in ICs. The DVM is used for adjusting the regulated power supplies to the correct output voltages and for measuring the low-level signals found in some of the IC chips. The compact Hewlett-Packard DVM shown in Fig. 1-57 is ideal for troubleshooting those hard to get at circuits found in some video recorders.

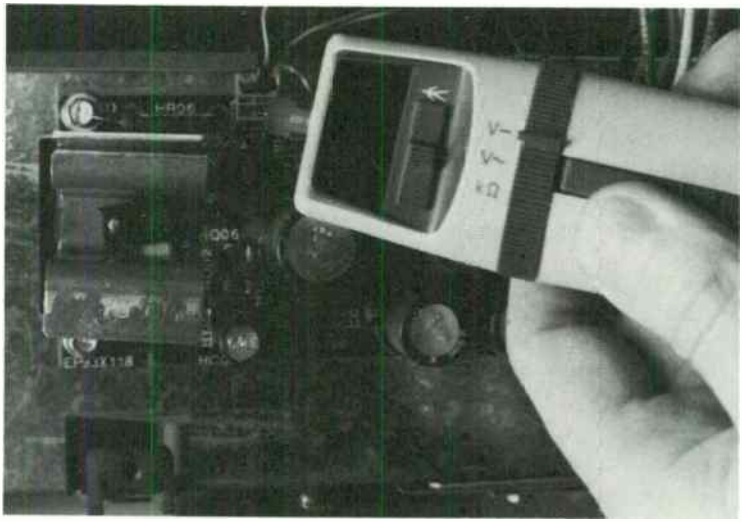


Fig. 1-57. Hewlett-Packard DVM.

Transistor Tester

Many of the circuits found in the VCRs are controlled by discrete transistors. Some VHS video recorders, for example, have over 150 transistors that are used for various control functions. The use of an in-circuit transistor checker, such as the Sencore TF46 Super Cricket (shown in Fig. 1-58) greatly simplifies the trou-

Fig. 1-58. Sencore TF46 transistor checker.

bleshooting of a transistor circuit since the suspected transistors can be checked in-circuit to confirm whether they are defective or not. The TF46 has a high in-circuit testing accuracy, for both transistors and FETs that helps to speed up the VCR circuit diagnosis. Also, the TF46 has an automatic gain test to allow grading or matching of transistors used in critical circuits.

OTHER VCR TEST EQUIPMENT

Some of the following test equipment will also be of value for VCR troubleshooting. A capacitance and inductance checker will help you to locate leaky or off-value capacitors and check out any coils or transformers. The Sencore model LC53 shown in Fig. 1-59 will do a good job for you on the VCR test bench. Another frequency counter you may consider is the Regency model EC-175 shown in Fig. 1-60. This unit counts up to 175 MHz and down to 1/10 of a cycle. The Leader NTSC color bar generator shown in operation in Fig. 1-61 can also be used for VCR servicing. One corner of my VCR service bench is shown in Fig. 1-62 and illustrates the various pieces of test equipment that can help solve the VCR troubleshooting problems.

VCR ELECTRONIC CIRCUIT CHECKS WITH A VIDEO ANALYZER

Let's now perform some actual VCR electronic checks with the Sencore VA48 video analyzer. You will see that VCR deck elec-

Fig. 1-59. Sencore LC53 capacitance and inductance checker.

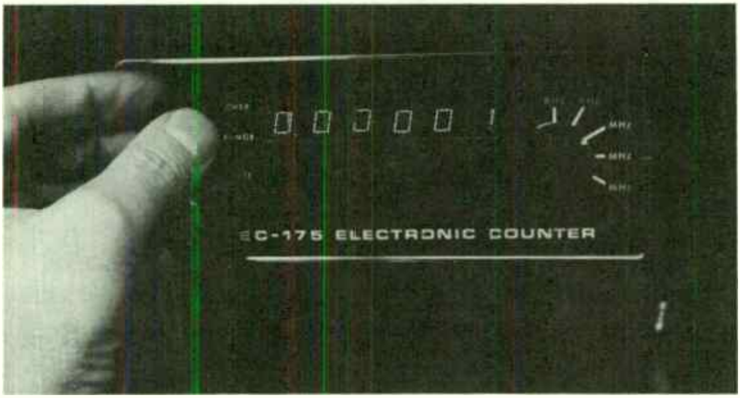


Fig. 1-60. Regency FC-175 frequency counter.

tronic circuits require correct reference signals to perform the proper troubleshooting techniques. We will show how various output signals and video patterns from the VA48 can simplify VCR servicing techniques.

The VCR Record Circuit

The first VCR recording stage is the AGC amplifier. This stage must be first tested with a reference input level of 1 volt P-P to make sure that the output is of the proper amplitude. To do this, inject the output of the VCR standard signal directly to the camera input of the VCR and adjust the AGC control for the proper output

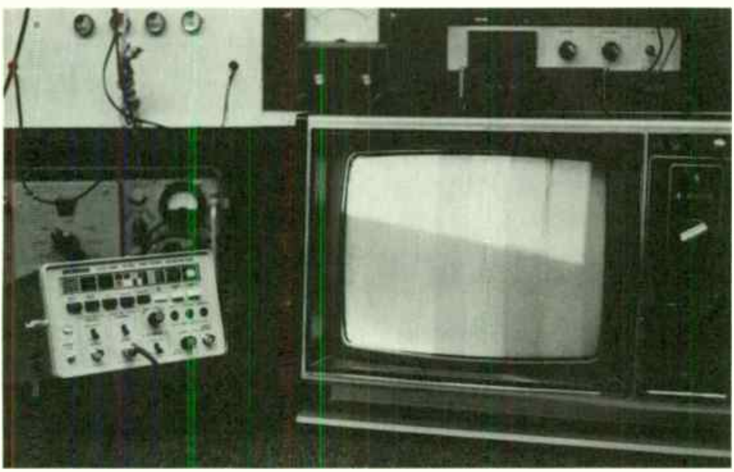


Fig. 1-61. Leader's NTSC color-bar generator.

Fig. 1-62. Partial view of the author's VCR service bench.

level using the bar sweep video pattern. The circuit is further tested by using the adjustable output supplied from the drive signals output jack instead of the VCR standard 1 volt jack. This adjustable output should be varied from 0.5 to 2 volts (negative polarity) while the output of the AGC is viewed with an oscilloscope. The top waveform in Fig. 1-63 should result if the AGC circuit is operating properly. The bottom trace is of a waveform produced by a faulty AGC circuit.

If the AGC stage is not working properly, the first step is to determine if the AGC stage, the dc amplifier, or the AGC detector is the cause of the defect. To do this, connect the bias and B+ sub

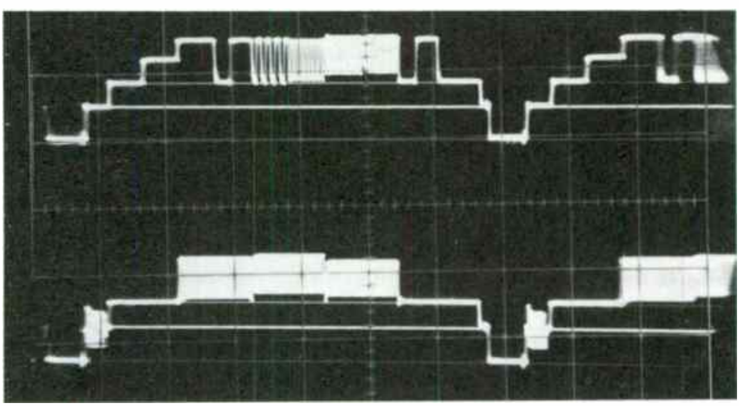


Fig. 1-63. The top waveform shows the normal AGC output while the bottom trace is of an improperly operating output.

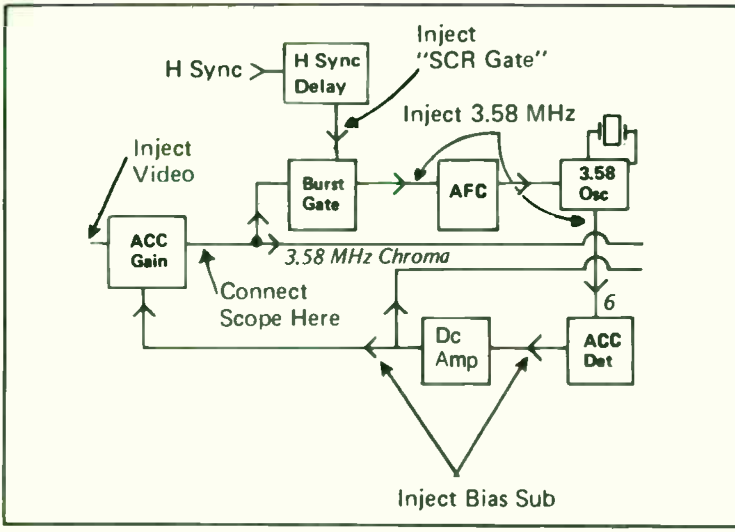


Fig. 1-64. The driver signals output from the analyzer allows each stage of this AGC circuit to be checked.

supply voltage from the analyzer to the AGC line and vary the voltage. At the same time feed the standard VCR signal into the camera input jack. Note this test set-up shown in Fig. 1-64. The signal level at the output of the AGC stage should change as you vary this voltage. If it does not, you know that the trouble is in the gain controlled stage. If the voltage does produce a change, you know to go back to the AGC detector and inject the dc voltage at its output.

Finally, you can substitute for both of the signals feeding the AGC detector itself by injecting the composite video signal at the VCR camera input (using the VCR standard jack) and then feeding the composite sync pulses supplied by the drive signal output in place of the VCRs own sync separator output. This example lets you locate an AGC defect to a single stage which is especially important when you are troubleshooting defects caused by defective ICs or poor solder connections in the signal path.

By using the bias and B+ voltage subbing supply you can tell if the color killer signal is properly switching the color/B&W filters. Set the bias supply to 4 volts and inject it into the IC that controls these filters. The injection points and scope waveforms in Fig. 1-65 show the difference in the bar sweep pattern with the color killer activated. Normal operation of this circuit should allow more high-frequency response during a black and white program as compared

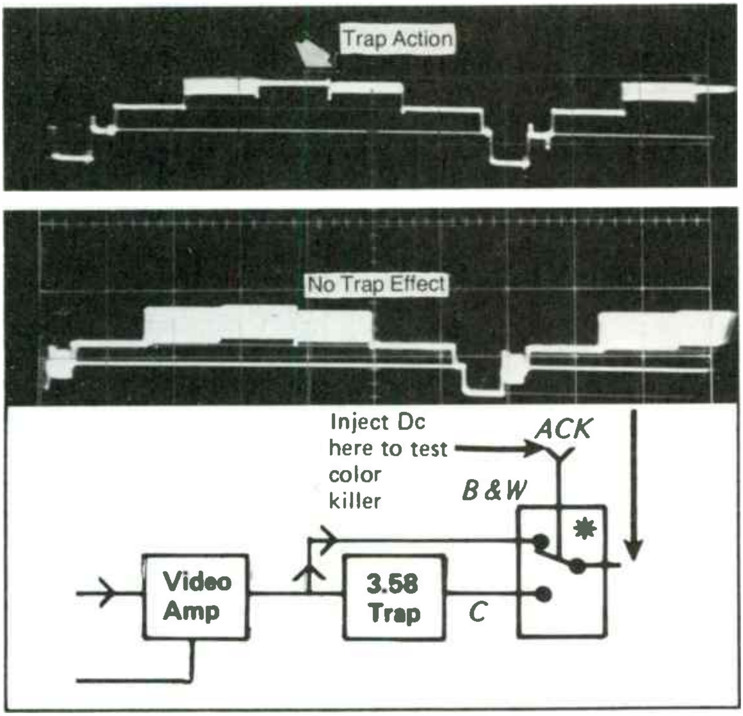


Fig. 1-65. The operation of the color killer is quickly confirmed by using the bar sweep pattern and the bias and B+ subber voltages.

to one in full color. Thus, you now have proof that the circuits are working properly.

Preemphasis Circuits

The bar sweep allows the recording preemphasis circuits to be checked for proper operation. The newer two-speed VCRs require different amounts of preemphasis for each speed. The scope waveforms shown in Fig. 1-66 show what the bar sweep looks like in properly adjusted preemphasis circuits.

White and Dark Clipping

The clipping circuits located between the preemphasis network and the FM modulator must be properly set to prevent overmodulation which causes the picture to tear-out during playback. The adjustment of these circuits require both a reference white level and a reference black level to make sure that the limiters are not favoring one portion of the signal over another. Use the bar sweep pattern for these adjustments. This pattern has a 3-step grey scale to check for proper video linearity and different frequency bars for a dynamic check of the clipping circuits at different video frequencies. This is needed when the signal is preemphasized because the higher frequency content is boosted in amplitude. It is possible for the clipping circuits to be operating at the low-frequency range of the signal (like that produced by a 10-step grey scale) but provide too much limiting to the compensated high frequency information. Thus, the bar sweep pattern allows all frequencies of the video signal to be checked at the same time (Fig. 1-67).

The VCR circuits from the FM modulator to the video heads are best analyzed by tracing the signals with the VA48 signal tracing meter, or with a scope. For general signal tracing, the high frequency response of the meter is usually faster since the shape of the waveform is not as important as the peak-to-peak amplitude.

Color Circuit Analyzing

Phase-locked signals produced by the VA48 let you quickly troubleshoot the chroma processing circuits. Direct signal substitution is used for checks of any signal up to the stage that converts the frequency of the chroma signal down from 3.58 MHz. Let's look at a few examples of how to find a defect in the VCR color processing stages.

The *automatic chroma control* (ACC) requires two input signals for proper operation. The first is the composite chroma signal.The important part of this signal that is required for ACC operation is the color burst. The amplitude of this burst signal is used to control the gain of the chroma circuits to maintain a constant color level with changing input signals. The second signal required is the "burst

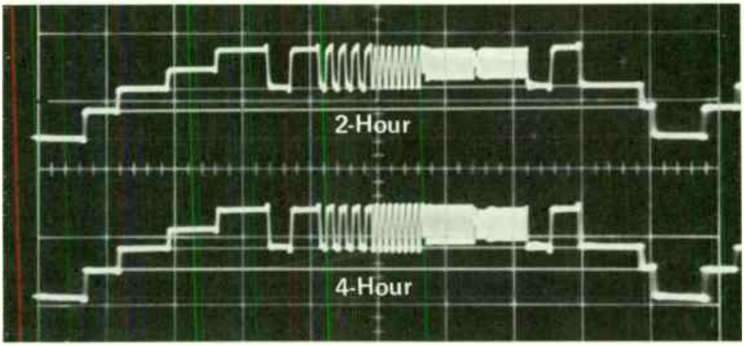


Fig. 1-66. The recording preemphasis circuits boost the high frequency content to reduce video noise.

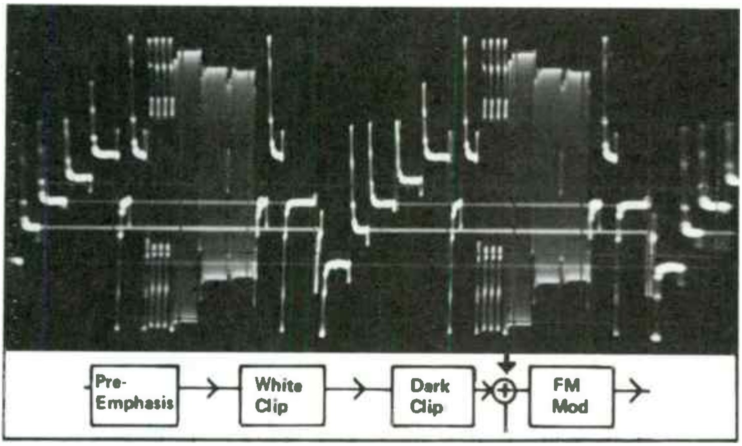


Fig. 1-67. The bar sweep pattern provides both a grey-scale and a "multi-burst" type signal which lets you check the clipping circuits at all operating frequencies.

flag". This flag signal is the horizontal sync pulse that is delayed a small amount to place its timing exactly in line with the burst signal riding on the back porch of the horizontal blanking interval. The timing of this signal is very important because it determines what portion of the color signal is used to control the gain of the color circuits. If the burst flag arrives too late, for example, the burst gate will separate the first part of the picture (just after the blanking interval) instead of the color burst. The result is that the color levels will be constantly changing because the amount of chroma information will be different in each color scene.

Let's now use the drive signals from the analyzer to check out some faulty VCR color circuits. We will start with a symptom of changing color levels when a tape is being played. The first check is to find out if the color levels are changing during the recording or playback of the color program. This can easily be confirmed by playing back a tape that has been recorded on the suspected faulty machine on a machine that is operating properly. If the color levels remain the same, we know that the defect is in the playback circuits. In this case, however, we find that the levels are changing when the signal has been recorded on the suspected machine and then played back on the good VCR unit. Thus, the recording circuits of our machine in question are faulty.

Changing color levels could be caused by a defect in any of the seven circuits shown in Fig. 1-68. These seven circuits make up the ACC circuit. A defect (such as a faulty IC or poor solder connection) anywhere in the stages would produce almost the same symptom,

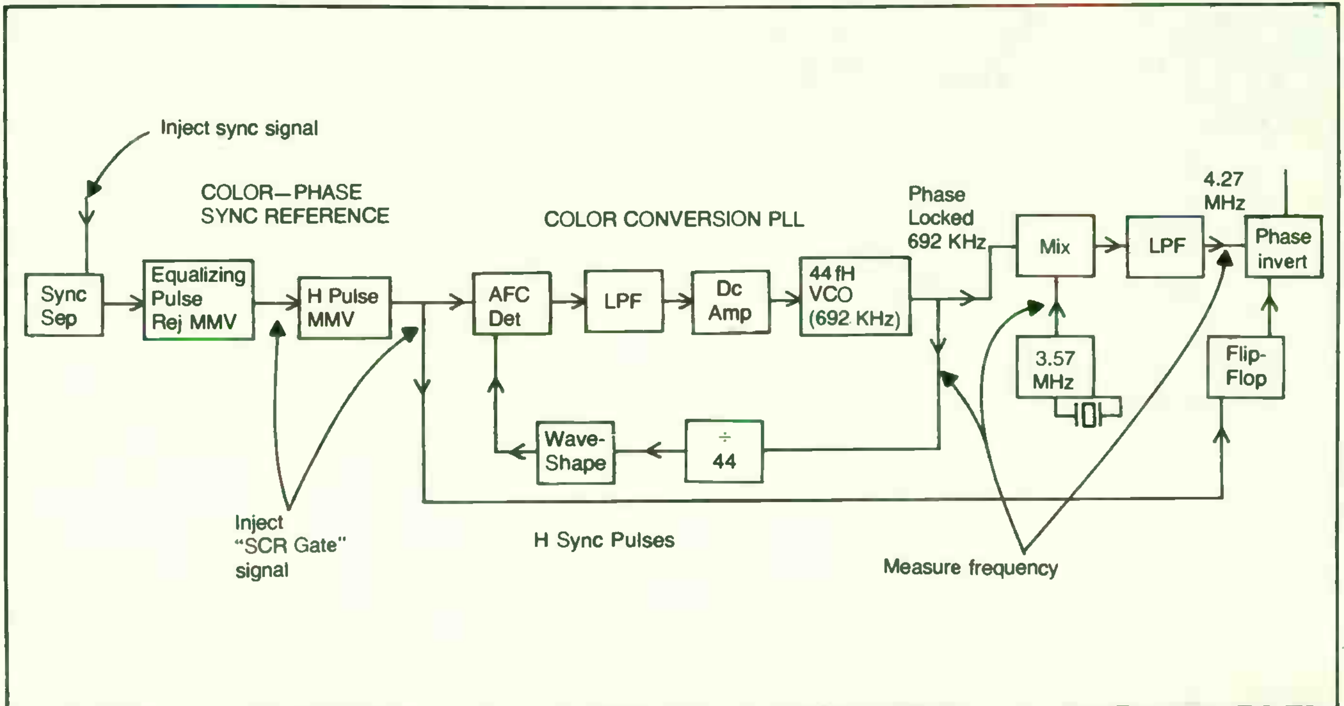


Fig. 1-68. Each stage of the ACC circuit can be substituted with the drive signals from the analyzer.

changing color levels with different input signals. A scope can be used to trace down the missing signals, but a substitute signal from the analyzer will give you a more positive check as it will duplicate the signals that should be produced at the output of each stage. The first step is to provide a reference signal at the input to the ACC stages. For this check just use the VCR standard output of the analyzer and feed it into the VCR camera input jack. Now select the chroma bar sweep pattern to provide a reference color pattern these chromas check.

Let's first check the circuits that produce the burst flag signal. The input to this stage is the composite sync pulses that have been separated from the luminance signal. The V and H composite sync test signal from the analyzer is ideal for this injection signal check. Use the solid-state mode of the drive signal switch to prevent the possibility of feeding too much signal in that could damage a solid-state circuit device. The impedance of this mode is also matched to drive the low-impedance solid-state circuits found in these stages. Use the drive signal meter to monitor so you will know the amount of the injected test signal.

These checks are started by injecting the composite sync signal into the horizontal sync delay circuit to see if proper VCR operation returns. The best place to monitor the operation of this circuit is at the output of the ACC controlled stage.

Should the injected test signal *not* return the proper amplitude at the output of the ACC circuit, you can move one stage and substitute for the burst flag. For this test change the drive signal switch from the composite sync position to the SCR gate drive signal. This signal provides a proper substitute for the burst flag because the pulse produced by the SCR gate signal is "stretched" the same amount as the burst flag. The pulse is present during the color burst and will therefore operate the burst flag just the same as the signal produced by the circuits inside the VCR's chroma processing stages. If the operation of the ACC circuits returns to normal, you know that the trouble is in the horizontal sync delay stage.

If the signal does not return proper operation, just continue the stage-by-stage injection at the output of the burst gate. This time, use the 3.58 MHz (phase-locked) signal. You can also check the dynamic operation of the ACC circuit with this substitute signal by just varying the amplitude of the injected 3.58 MHz test signal. As an example, if you increase the amplitude slightly, the ACC output signal should reduce in amplitude. If you see this dynamic change, you know that the ACC circuit is working and the trouble is in the burst gate stage.

The same 3.58 MHz signal can then be used at the output of the 3.58 MHz oscillator. Varying the amplitude of the substitute signal should again produce a change in the ACC output level. If not, go forward to the next stage.

The output of the ACC detector is a dc voltage whose amplitude is related to the amplitude of the burst signal. For this check use a variable B+ or bias supply as a test of both the dc amplifier and the ACC controlled stage. Begin this check by setting the output of the bias and B+ sub to the level indicated on the schematic. Then raise and lower this voltage about 10%. The results should be a change in the ACC output signal level. Should you still not obtain proper operation, inject the dc voltage at the output of the dc amplifier (input to the ACC controlled stage) and again vary the voltage. If the output level still does not change, you know that the trouble is in the ACC controlled stage itself. With these checks you are able to tie down all 7 of the circuits in this rather complicated feedback system to locate a defect in one stage.

This may appear to be a long way to go, but in actual troubleshooting, you would not have to substitute for each and every signal. As an example, you could start at the output of the ACC detector and feed in the dc test voltage. This divides the circuit in half. If proper operation is obtained, you know that the defect is somewhere in front of this stage. If correct operation is not obtained, you know that the trouble is in either the dc amplifier or the ACC controlled stage. Thus, you now know which direction to go to further analyze the stages. The key point to keep in mind is you have a signal to sub-in for every input and output stage so you won't have to guess the cause of the circuit fault.

Signal substitution is very handy when combined with oscilloscope signal tracing. You just inject the substitute signal at the input to a stage and monitor the resulting signal at the output of the same stage or one that is supposed to be controlled by the substitute signal. Then, use the scope for circuits that require both the amplitude and the waveshape of the signals to be correct. The combination of scope signal tracing and signal substitution is the best team to use for VCR circuit analyzing.

Before leaving the VCR chroma processing stages, let's look at one more example where signal substitution may be used to locate a defective stage. In this case, we will also use a frequency counter (in addition to scope and analyzer meter) to confirm that the stages are working properly. You may recall that the frequency conversion stages mix the incoming 3.58 MHz chroma signal with a second signal that is referenced back to the horizontal sync pulses via a phase-locked loop arrangement. We will be following these signals through a VCR Beta format machine although the operations of the VHS conversion is similar. You may want to follow along with some block diagrams shown in Fig. 1-68.

The first step of our frequency conversion is to separate the horizontal sync pulses from the incoming composite video signal. These pulses are then formed into a series of pulses with a fixed amplitude (and pulse width) in two multivibrator stages. These clean pulses are then fed to the phase-locked loop to maintain the proper conversion frequency at the output.

The composite sync signals provided by the V and H comp sync output can be fed directly to the input or output of the sync separator stage. These pulses (being phase-locked to the composite video) will then replace the signals that should be at these two points. We could take the composite signals past the "equalization pulse rejection multivibrator" but doing so would result in the wrong frequency at the output of the PLL. The reason is that the PLL would try to lock up to the vertical sync pulse (as well as the horizontal sync pulses) and change frequency of the "equalizing pulse rejection multivibrator" is to provide a constant pulse rate during the vertical blanking and vertical sync pulse intervals.

To eliminate this error use the horizontal output (SCR gate) signal for injection after the multivibrator stages. This signal works well because it does not contain the vertical sync pulses. It is just a series of pulses that are phase-locked to the horizontal sync pulses. Therefore, it is an exact duplicate of the output of the "horizontal pulse MMV" and can be injected directly into the AFC detector, which is used to keep the PLL output frequency an exact multiple of the horizontal frequency. Just remember when using the drive signals from the analyzer to feed in signals of the same polarity and amplitude as the signals normally found in the circuit.

The total operation of the PLL is determined by checking the output frequency with a frequency counter. The PLL output frequency should be exactly 44 times the horizontal sync pulse frequency of 15,734 Hz or 692,307 Hz. If this frequency is not correct, you will find that the VCR will record and reproduce color but that a color tape that has been recorded on another machine will not play back in color.

If you do not find the correct frequency at the output of the PLL, check the frequency at output of the divide-by 44 stage. At this point you should find the horizontal sync frequency of 15,734 Hz. If this stage is dividing properly, the trouble could be in the low-pass filter, or the dc amplifier. The dc subber supply can be connected to the output of these stages to see if the adjustment of the dc voltages will change the frequency of the PLL output. If there is no change in output frequency when the bias voltage is changed, you know the defect is in the *voltage controlled oscillator* (VCO) and that the IC is defective. As soon as you get the proper output frequency (with an injected signal) you know that the injection point is after the defective stage. Now, just check inputs and outputs until you find the stage that provides no improvement, and that is the one that is defective.

The operation of the remainder of the frequency conversion stages is analyzed with the frequency counter or scope. The second conversion frequency oscillator (in the Beta format, that is the 3.57 MHz crystal controlled oscillator) is just adjusted until you have the proper conversion frequency. The output of the mixer stage is measured with the frequency counter, and should provide 4.267918 MHz in the Beta format. If you have a scope with vector measuring capabilities you can check for proper phase shifts in the frequency conversion stages. To make this check, connect the "A" channel of the scope to the 4.27 MHz signal before it is phase inverted and the "B" channel to the output of the phase inversion stage. The waveform shown in Fig. 1-69 shows what the patterns should look like if the stages are processing the phase properly. If they are not, you will find that the VCR will have noisy color, or no color on playback at all.

Converted Color

We have discussed each of the stages up to the color frequency converter, but have not discussed the converted output. The fact that each of the two VCR formats uses a different converted chroma frequency means that direct substitution is not practical. The use of the chroma bar sweep pattern, however, allows you to check the resulting response at the output of the color conversion stages to be sure that you are not going to lose color detail in the converting processes.

An important point is that the pattern produced by an "NTSC" generator do not provide a check of the total color bandwidth of the color sub-carrier information. The actual frequencies occupied by the color subcarrier sidebands are determined by the size of the

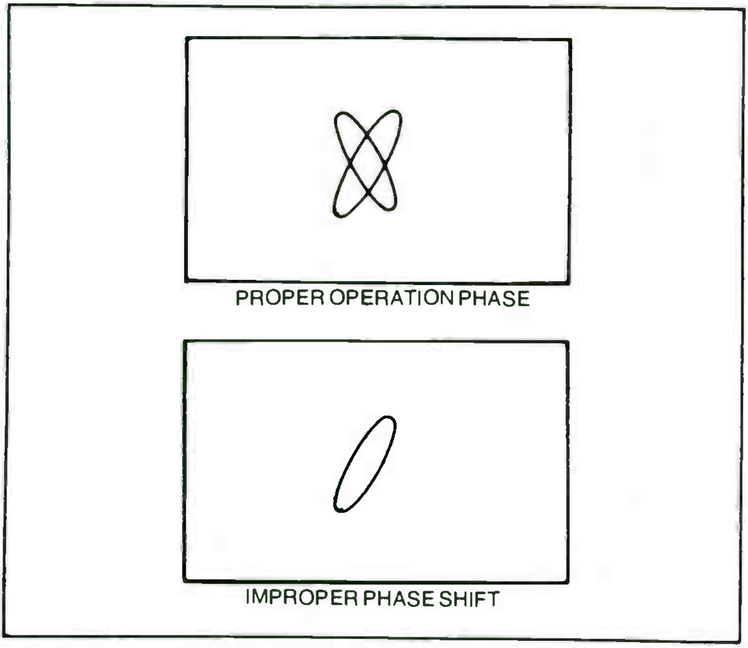


Fig. 1-69. Scope vector mode can be used to test for correct phase shifting of the chroma conversion frequency.

color information being represented. Several small colored objects in the picture, for example, will represent a higher color sideband frequency than a large object. Remember that the chroma bandpass amplifier of a TV receiver is designed to accept all color information from 3.08 to 4.08 MHz or 500 kHz either side of the color subcarrier. This frequency range determines the amount of color detail that can be reproduced properly on the color picture. The output of the video tape recorder should be able to record and play back the same amount of color detail for good color reproduction.

The signals from the analyzer's chroma bar sweep produce a dynamic check of the entire color frequency response necessary for a good color picture with color detail in even the smallest objects on the TV screen. The three bars of the chroma bar sweep represents the color subcarrier, and the points 500 kHz above and below the subcarrier frequency. Each of the bars is generated at the same amplitude so they can be used as a reference of the total system's frequency response. Use a scope to trace the converted chroma bar sweep through the amplifier stages to make sure that the machine is not losing some of its color detail during the recording process. The scope waveform shown in Fig. 1-70 illustrates how these patterns are processed in a properly operating VCR. Note that there is a loss of the high frequency color signal detail.

We will now be looking at some more uses of the chroma bar sweep in troubleshooting the playback portions of the VCR. The key requirement is to have these signals phase-locked to the horizontal sync pulses for troubleshooting or alignment of the playback comb filters used to eliminate color crosstalk.

The VCR Playback Circuits

The test signals produced by the VA48 analyzer provides important checks of the playback circuits of the VCR. Let's now look at some common VCR defect areas and some methods for troubleshooting them. A reference tape from the VCR manufacturer should be used for most of these playback checks. Let's see how you can put this reference test tape to use with a tape recorded with the VA48 test signals.

The big advantage of using your own test tape is the lower cost as compared to the pre-recorded alignment tape. Thus, you can easily record another tape if it is accidentally damaged during repair of the VCR. The chroma bar sweep pattern provides an additional check of the color processing circuits that is not found on the prerecorded tapes. Finally, the use of the same patterns for testing the playback circuits as ones used for the record circuits, can be a benefit as you learn to interpret the different patterns. Let's now look at some tests you can make with your own reference tape.

Video Frequency Response

The most important test of the playback system is to make sure

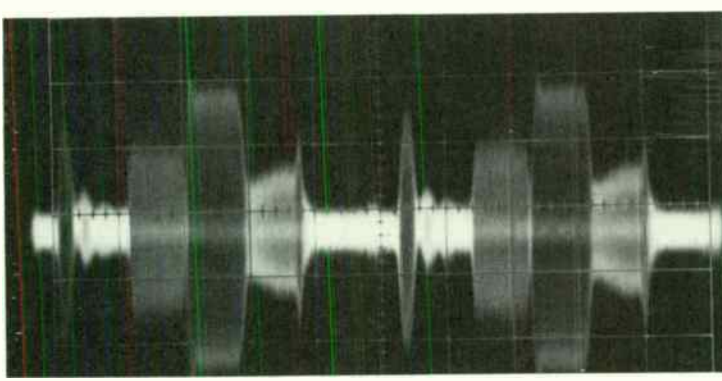


Fig. 1-70. The chroma bar sweep tests full chroma bandwidth of the color circuits.

that the entire system is providing the best possible frequency response. The use of the bar sweep pattern will produce a dynamic test of the entire system's video response. All you need do is connect a scope to the output of the VCR. Remember to terminate this output with a 75 ohm resistor to make sure that the signal levels at the output are at the proper amplitude.

The top scope trace in Fig. 1-71 shows the output of a properly operating VCR. Notice that the output is flat to the 3 MHz bar, then drops off at frequencies above this level. If the bars dropped off more quickly as shown in the bottom trace, this would indicate a loss of frequency response somewhere along the line. The first place to suspect is the adjustment of the head equalization circuits that are used to compensate for the non-linear output of the video heads. The best way to check for proper equalization is to use the manufacturer's alignment tape and follow the recommended procedures for that VCR.

The chroma bar sweep provides a check of the chroma frequency response. This test is one of the advantages of using the analyzer patterns to record a test tape because there is no other test that is as complete for testing all of the circuits that are used to process the color signals. The chroma bar sweep checks the color circuits at both the upper and lower frequency limits that are necessary for good color details. The center (3.56 MHz) bar provides a reference level for a comparison of the frequency detail 500 kHz above and below the subcarrier. A key point about all three of the bars produced by the chroma bar sweep is that they are phase-

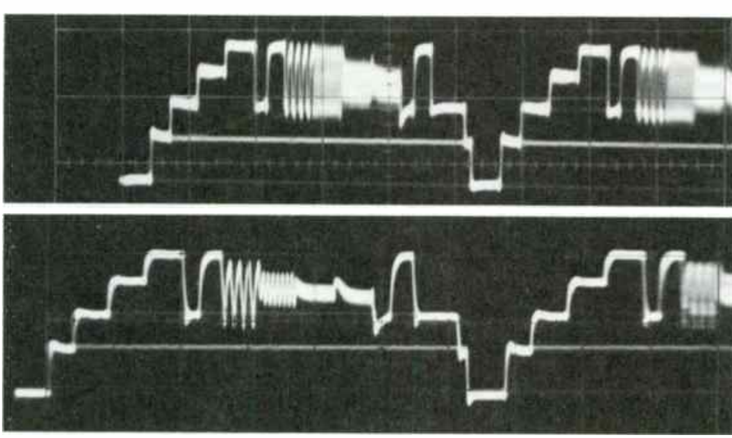


Fig. 1-71. Top trace of bar pattern is of a properly operating VCR. Bottom trace shows defective head alignment that causes loss of high frequency detail.

locked back to the horizontal sync pulse and have a 180 degree phase shift every horizontal sweep line. This means that they will be properly separated by the comb filters used to cancel color crosstalk during the playback mode of operation. This is a test not found in the "NTSC" color generator, but is very important for good color detail.

Setting the comb filter used in the playback portion of the color circuits is easy to do if you use a scope with good vertical amplifier sensitivity. Start by using a direct scope probe to connect the scope to the output of the comb filter bridge that *is not* connected to the chroma amplifiers. This output point will show the crosstalk rather than the chroma output. The signal at this point does not have sync pulses, so the external trigger input should be connected to the video output jack for triggering. Set the scope to trigger at the horizontal rate. Scopes with built-in sync separators will give you a stable trace with the composite video signal used as a reference.

Now, play back the portion of the alignment test tape that has the chroma bar sweep pattern. Adjust the comb filter's mixer control until the amplitude of the signal has the least amount of the second (3.56 MHz) bar as shown in Fig. 1-72. Be sure to use a direct scope probe and have the scope set for maximum sensitivity as the signal level is very low at this point. The two phasing coils used in the comb filter of the VHS tape systems should not be aligned as a broadcast vectorscope is required for alignment.

Locating Video Head Problems

Most VCR service technicians say that one of the most difficult stages to analyze is the low-level input circuits associated with the video playback heads. The reason for this difficulty is that the signal levels produced by the spinning playback heads are so low that an oscilloscope will not be effective in tracing a signal. The symptom for a defective head is the same as a dirty switch contact, a bad rotary transformer, or a defective head pre-amp. Thus, a technique is needed to determine which of these components in the low-level head signal circuit is actually causing the problem.

The symptom for a defective head circuit is easy to recognize. The picture (on playback) has a severe flicker and is very noisy. The cause of this symptom is that only every other video field is being viewed on the sets screen. The two head system, you may recall, uses one of the heads to pick up every odd field and the other head to pick up every even field. When one of the signal paths is defective, you have one complete field followed by a period of noise informa-

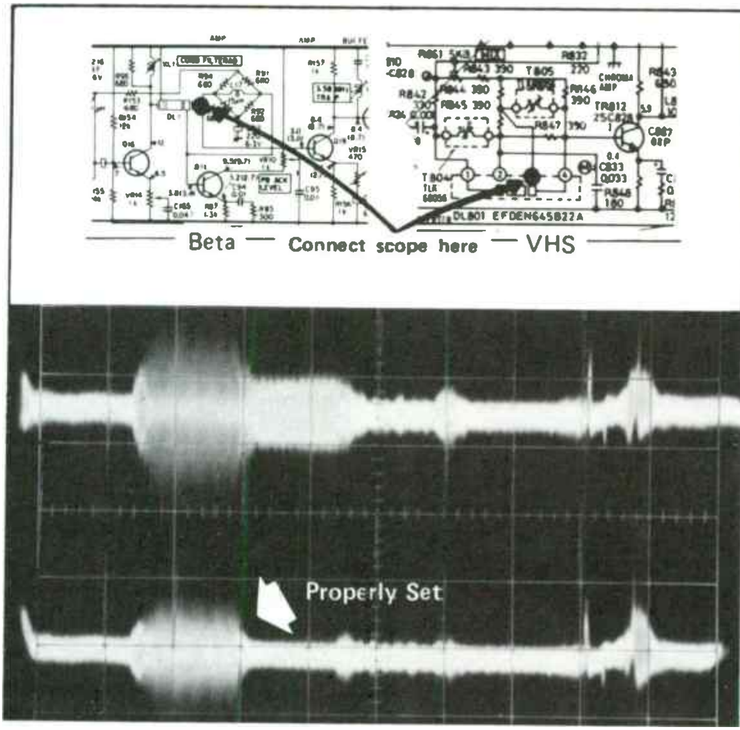


Fig. 1-72. The chroma bar sweep lets you quickly check the comb filter found in the VCR playback circuits.

tion. The result, in an interlaced picture, is the symptoms described above.

Each of the two video heads has its own rotary transformer which transfers the signal from the head output to the preamplifier. This rotary transformer is actually made up of two coils, one that is part of the moving head disk, and the other that is part of the stationary portion of the video head assembly. As the video head picks up the signal from the tape, it is inductively coupled to the stationary coil by the moving coil. This eliminates the need for slip rings or brushes that could cause intermittent operation as they wear down.

The signal that is picked up by the stationary portion of the rotary transformer is passed on to the head preamplifiers. There are two of these preamplifiers, one for each head. Each preamplifier has a set of adjustments which allows any differences in the frequency response of the two heads to be compensated. The signal level at the input to these preamplifiers is approximately 1 mV. This low signal level means that there are several points in the video head system that can cause trouble.

The first possible cause of a defect is the video head itself. If the head wears too much, its output level will drop down. Another possible defect is in the rotary transformer. A broken wire leading to the moving coil of the rotary transformer, for example, would mean that one of the two head signals would never reach the preamp. The next circuit item is a switch that is used to switch the heads between the record and playback circuits. A dirty contact here will result in the loss of the signal from one of the heads. There is also the possibility of a defect in the preamplifiers.

For these checks a test signal is needed that can be injected at any point in this low level signal path. This signal should be the proper frequency to pass through the tuned head preamp circuits just as though it was being picked up by the spinning head. The amplitude of the subber signal must be low enough to duplicate the signals normally found in these stages. If too much signal is fed in, there may be enough to cause cross-coupling from one head channel to the other and you cannot tell if the defective stage has been correctly located.

The VA48 analyzer has a test signal suited for this type of signal substitution. This test signal is normally used for troubleshooting the audio i-f stages found in TV or VCR receivers. This signal is adjustable in amplitude and uses a 4.5 MHz carrier frequency. The use of a 100:1 (40 dB) attenuator drops the level of this signal to the 1 mV level required to troubleshoot the first stages of the playback circuits. The best place to look for the signal output is at the output of the resistive matrix that is used to mix the output of the two video heads.

It should be noted that an electronic switch is used to switch between the "A" head output and the "B" head output during playback. This switch is normally switched by a pulse that comes from the servo circuits. When you are using the substitute signal to analyze the video head input circuits, connect the bias and B+ subber supply in place of the head switching pulse. When you supply the bias signal, the electronic switch will switch over to one of the head amps, and when the bias is removed it will switch to the other preamplifier.

The reason that the ability to analyze the head input circuits is so important is that the video head disk (which contains both of the video heads) is one of the single most costly parts to replace on the

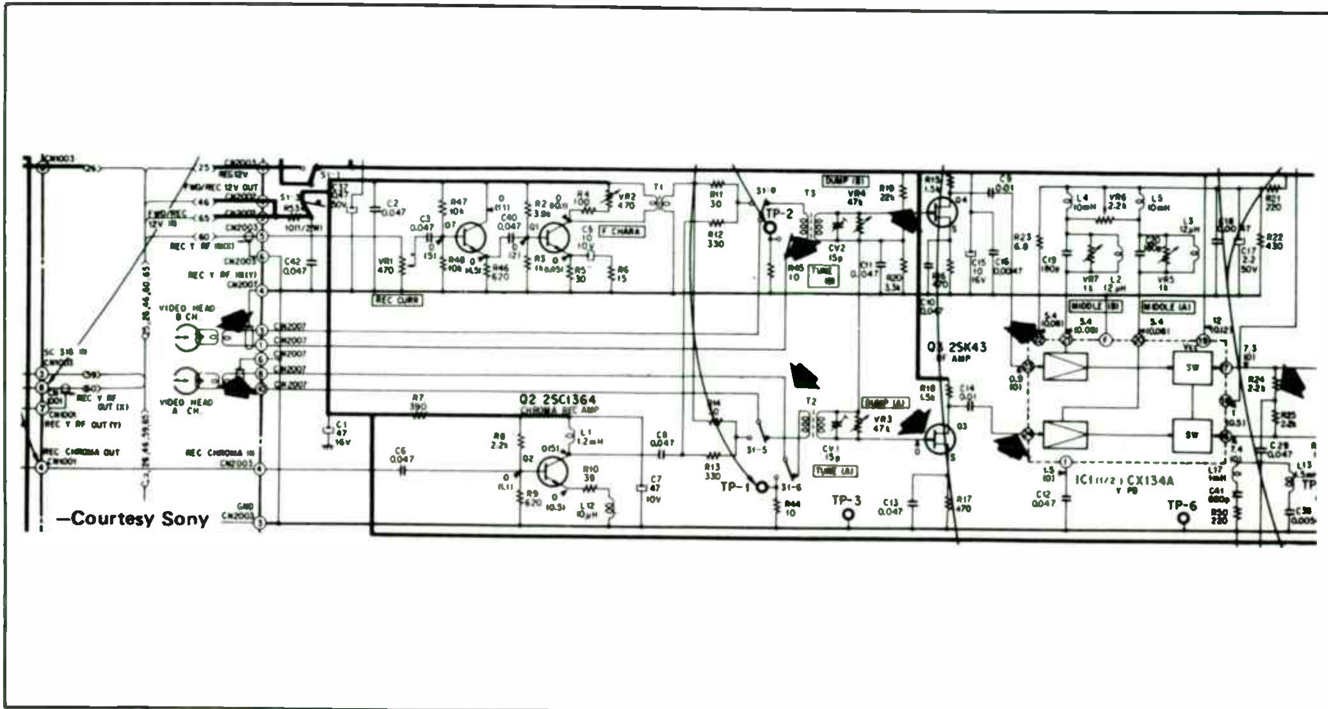


Fig. 1-73. The 4.5 MHz signal may be injected at any of these points for analyzing the video input circuits and dropout compensator.

VCR machines. I have been fooled by a severe picture flicker in a VCR that was diagnosed as a defective head but turned out to be faulty switching contacts.

The same output test signal used to troubleshoot the head preamps is also used (without the attenuator) to troubleshoot the drop-out compensator circuit. The injection test points are shown in Fig. 1-73. All that is needed is to feed in a signal to the input of the DOC detector and look at the output of the DOC circuit with a scope. This circuit is designed to switch to the delay line output any time the signal level coming from the video heads drops to a certain level.

Then you inject the 4.5 MHz signal, the DOC detector should switch the signal around the delay line. When the signal level drops below the detector trigger level, the circuit should switch back to the delay line. Since you are no longer feeding a signal into the delay line, the output quickly drops to zero.

The DOC trigger circuit is tested by increasing the rf i-f control to full output and then reducing the signal level. When the level is about 0.1 (10 mV) the output signal should suddenly disappear. Increasing the signal level should then return our output. If the DOC circuit is not operating properly, you should use a dc voltmeter to check the output of the DOC detector. The detector should provide a dc voltage to control the switching circuits inside the IC. If this voltage changes as you change the signal level at the input, you know that the detector is working properly and the defect is in the switching circuits. If the voltage does not change, you know that the defect is in the detector itself. The delay line is also checked by feeding in the 4.5 MHz signal to its input and checking for an output.

One other playback circuit that is tested with the adjustable 4.5 MHz signal is the limited circuit. The function of the limiter is to

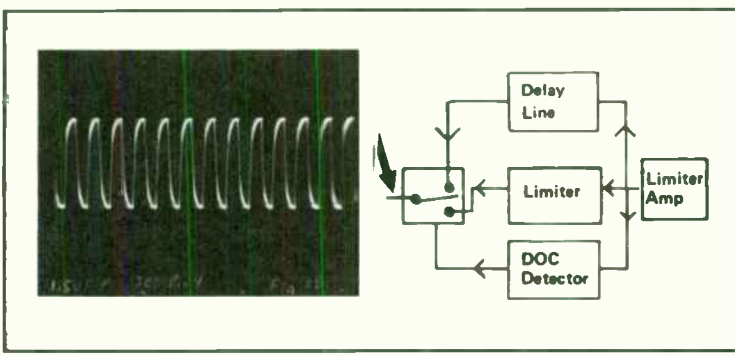
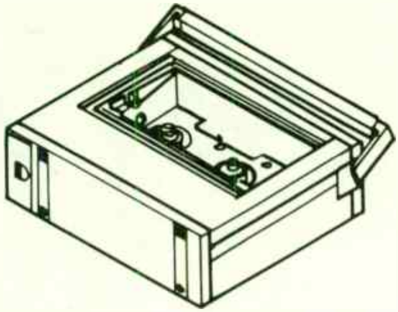


Fig. 1-74. The limiter output should remain about the same with different input signal levels.

compensate for changing levels in the playback signal so the FM demodulators always have enough signal to operate properly. To test the limiters action just feed the 4.5 MHz signal into the limiter input and look at the output level. The output level should remain almost the same over the full range of the input signal (Fig. 1-74). If the limiter is defective, you will have a playback signal that varies in detail and noise content.

The color processing circuits in the playback stages are treated the same as those found in the recording circuits. In fact, the same circuits are often used for both record and playback. The use of the bias and B+ subber output is the best way to check any of the automatic circuits as you substitute for the feedback voltage and see if you notice some change in the condition you are trying to correct.

Chapter 2



Betamax Videocassette Recorders

This chapter covers the operation of the Betamax format videocassette recorders. The Zenith model KR9000 has been selected as a representative model. This is the same machine as the Sony SL-8600. The Zenith KR9000 is built for Zenith by Sony.

INTRODUCTION AND SYSTEM OVERVIEW

Some features found in the KR9000 VCR machine are as follows:

- Built-in timer
- Tuner/i-f block and uhf splitter
- Remote pause
- Pause solenoid
- New control system
- One record/playback speed (Beta 2)
- Smaller size and lighter weight
- New functional circuit boards
- Only one (ac) motor
- More shielding to reduce interference
- Reduced mechanical jitter
- No brake solenoid

The clock readout and timer is built into this unit. The buttons for setting the clock and timer are easy to reach above the timer, on the top front of the machine. The built-in uhf splitter provides the ability to watch one uhf channel while recording another uhf channel. Note the block diagram in Fig. 2-1. The remote pause function is accomplished by connection of the special cable and the remote pause switch to the pause jack in the rear of the unit.

The control systems that control the video head drum and the tape speed have been simplified, since only one record/playback speed is available. The single speed of the tape (Beta 2), produces two hours of record/play time with L500 tapes and three hours when using the L750 tape cassettes.

The KR9000 features functional circuit boards. Each board incorporates functions and circuits formerly present on several boards of the older Sony VCR units. The functions of the three major circuit boards are as follows:

YC-2 Board. Y signal and chroma signal record/playback-processing circuits.

ARS Board. "Rf" record/playback amplifier, servo circuit, audio signal record/playback circuit.

SRP Board. System control circuit, dc power supply circuit and pause control circuit.

The older model machines used three motors (one ac and two dc motors) to drive the video head drum and the cassette reels, to move the video tape, and to actuate the threading ring. Only one (ac) motor is used in the KR9000 machine. A system of belts and pulleys connects this ac motor to the threading and capstan systems.

Extensive shielding is found inside this unit around the video head drum, the YC-2 and ARS board areas. Also added is improved filtering in the ac input circuitry. The purpose of this shielding and filtering is to reduce the interference effects from CB, ham, and police two-way radio transmissions.

SYSTEM OPERATION, BLOCK DIAGRAM, AND POWER SUPPLY

In normal usage a program received from a TV station (vhf or uhf) is recorded by the machine and later played back via a TV receiver. Thus the input to the machine is at a vhf or uhf frequency, with luminance, chroma and audio modulation.

Record Mode

Looking at the block diagram (Fig. 2-1) we see the TV input signal appears at top left of the block diagram. Each input signal is coupled through a splitter, producing two outputs for each of the vhf and uhf signals. One output is always connected to the appropriate tuner within the VCR unit. The other output is available

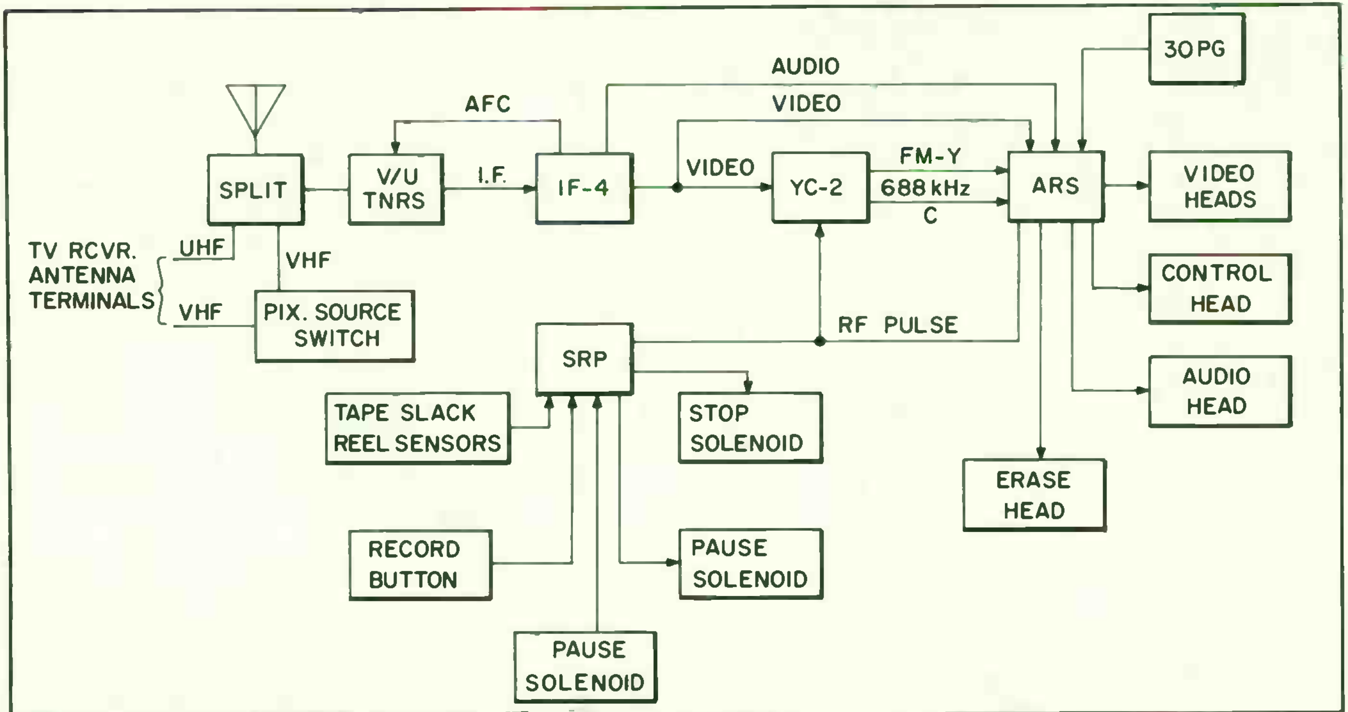


Fig. 2-1. KR9000 block diagram, record mode (courtesy of Zenith).

directly to the TV receivers tuners. The two tuners (vhf and uhf) within the VCR operate in much the same fashion as those in a conventional TV receiver. These tuners are "mechanical" channel selector-signal processing devices.

The output of the vhf tuner (for either vhf or uhf input signals) is at the i-f of the normal TV. The i-f signal, with luminance chroma and audio modulation is processed by circuitry on the i-f-4 board, in a fashion similar to that used with TV receiver i-f systems. The signal is amplified and the three resultant signals developed by detection circuits are the outputs of this i-f functional block. One signal is the recovered video signal, which includes both the luminance and chroma information. Another output is the audio signal portion of the program being processed. A third output is an AFC (automatic frequency control signal) which is developed by a circuit that senses a change in i-f video carrier frequency caused by tuner oscillator drift. This dc voltage is coupled back to the tuner oscillator circuit, which then makes corrections of the oscillator drift, locking the oscillator to the correct frequency for the channel signal received.

The audio output is coupled to the ARS board for amplification and sent to the audio record/playback and erase heads, thus placing one part of the program on the video tape.

The YC-2 functional board processes the input video signal by splitting the signal into the luminance and chroma portions. As the name "YC" indicates, both Y or luminance and C or chroma signals are handled on this circuitry board. In the record mode there are two outputs from the YC-2 board.

- An FM-luminance signal.
- A down-converted 688 kHz chroma signal.

These two signals become inputs to the ARS functional board. They are amplified and mixed together on the ARS board and coupled to the two revolving video heads, through a rotating transformer. These two signals become inputs to the ARS functional board.

As the video head disc revolves during the record process, two magnets on the bottom side pass over fixed coils to create the PG pulses, that are directly related to the speed of the head rotation. These pulses are coupled into the ARS board, where they are compared with a signal developed from the video information, to control and maintain the correct speed of the video head disc.

Playback Mode

When the recorded video tape is played back, the several heads pick up the information as the tape moves past them. The audio head couples the audio information to the ARS board, for amplification and connection through the CP-3 board to the audio output socket and the rf modulator (Fig. 2-2).

The control head sends the control track signal to the ARS board where it is compared with the 30 PG pulses from the revolving video head disc for maintaining the correct speed of the video head disc. The video heads track the recorded video signal on the tape and the rotating transformer couples this information to the ARS board. The video signal is composed of the FM luminance and 688 kHz chroma signals, which are amplified and separately coupled to the YC-2 board for further processing. This processing recovers the original luminance frequencies as well as the 3.58 MHz chroma, which are mixed together to form the normal NTSC composite video output that connects to the CP-3 board and the video output socket as well as the rf modulator. The audio and video signals are used to modulate either a channel 3 or 4 rf carrier, which is coupled to the TV receiver for viewing.

System Control

During both the record and playback modes of operation the system control functions, largely operated by the SRP board cir-

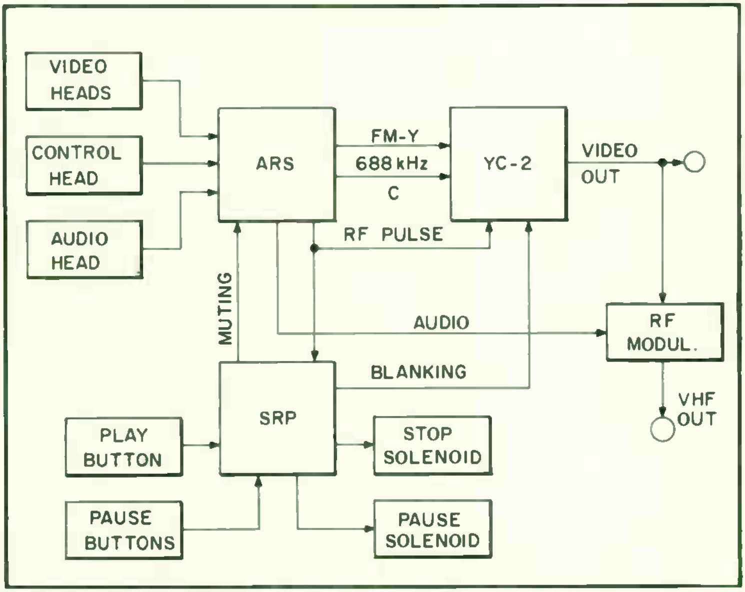


Fig. 2-2. KR9000 block diagram, playback mode (courtesy of Zenith).

cuitry, are performed, to permit the normal operation of the machine as well as to protect electronic and mechanical elements should a malfunction occur.

Among the operation functions is the pause mode, engaged by either the pause function button on front of the machine or the remote pause cable button. Activating the pause mode causes the tape movement to stop; thus no information (such as unwanted portions of a program) can be recorded, and during playback no signal reaches the television receiver.

The protective function of the system control is concerned with automatically stopping the machine operation when continued operation could damage the machine.

Timer System

Another vital section of the KR9000 machine is the built-in electronic timer control. The timer can be programmed to operate the machine at some future time, to record a desired program or to turn off all VCR operations. The timer mode selection is accomplished by operation of the mode select (or power) switch with its on, off, and timer positions.

Power Supply

The power supply in any electronic device supplies the units life blood, thus when VCR troubles are found this is the first place to check for proper or improper voltages. Figure 2-3 shows the power supply for the KR9000 machine. This diagram shows portions of the power supply which are found on five functional boards, SW-1, LF-5, SRP, TMA, and i-f-4, as well as in off-board locations within the machine. Note that Fig. 2-3 is a simplified line drawing and not every lead or wire is shown, but the system connections and the power flow are well indicated.

The 120 volt ac 60 Hz power is connected into and through the LF-5 (line filter) board to the timer transformer, T6502, which is always energized when the line cord is plugged into the ac supply voltage. Two secondary, step-down windings provide 3 volts ac directly to the TMA (timer) board as well as 12 volts ac to the LF-5 board. Diodes D9005 and D9007 (Zener) provide a 60 Hz square wave, 6 volts peak-to-peak reference voltage for the timer system (at boards TMA and TMC). Rectification of the 12 volt ac input to the LF-5 board occurs in a bridge rectifier composed of diodes D9001, D9002, D9003, and D9004, producing an unregulated 10 volts dc output. This is the third voltage connected to timer board

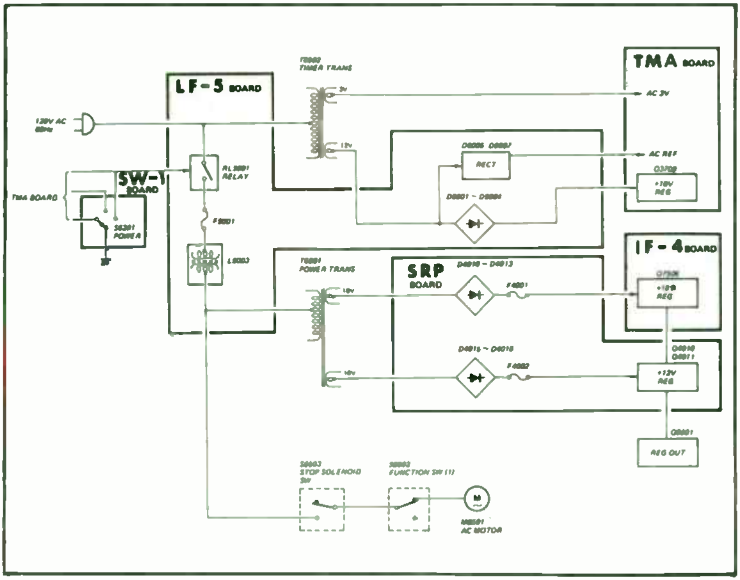


Fig. 2-3. Block diagram of the power supply (courtesy of Zenith).

TMA. The 10 volt dc supply is regulated by transistor Q3709 on the MA board to become the B+ for the timer circuitry.

If the mode selector switch is in the "on" position, or if the proper time has elapsed to operate the preprogrammed timer system when the switch is in the "timer" position, a connection is made to ground through pin 14 on LF-5 of connector CN9002. Refer to Fig. 2-4. Current then flows from the unregulated 10 volts through the coil of relay RL9001. The relay contacts close, permitting 120 volt ac power to be coupled through choke assembly L9003 and to two other outputs. One output provides the 120 volt ac to the power transformer T6501 by way of connector plug P9002. The other output, through connector plug P9004, pin 1, produces current through the stop solenoid switch (S6503) which is normally closed, when the function switch is closed (by depressing one of several operating buttons such as record). This current is connected back into the LF-5 board through pin 2, P9004, and out through connector CN6501, pin 3, to the ac motor (M6501). The ac current path from the motor is completed through pin 1 of CN9004.

The two secondary voltage outputs of the power transformer are coupled to the SRP board, entering the latter through connector CN4005 (see Fig. 2-5). These voltages are at 16 and 18 volt ac levels. A bridge rectifier on the SRP board is provided for each ac

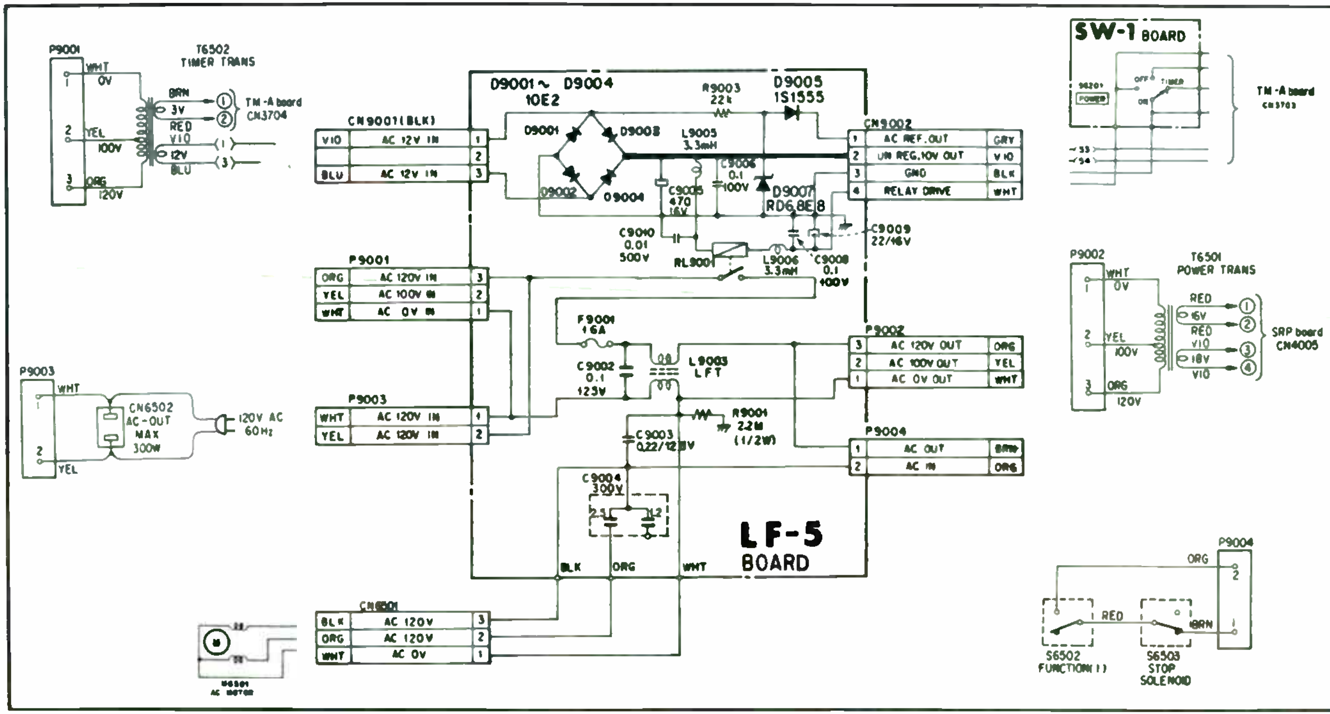


Fig. 2-4. Diagram of the LF-5 board (courtesy of Zenith).

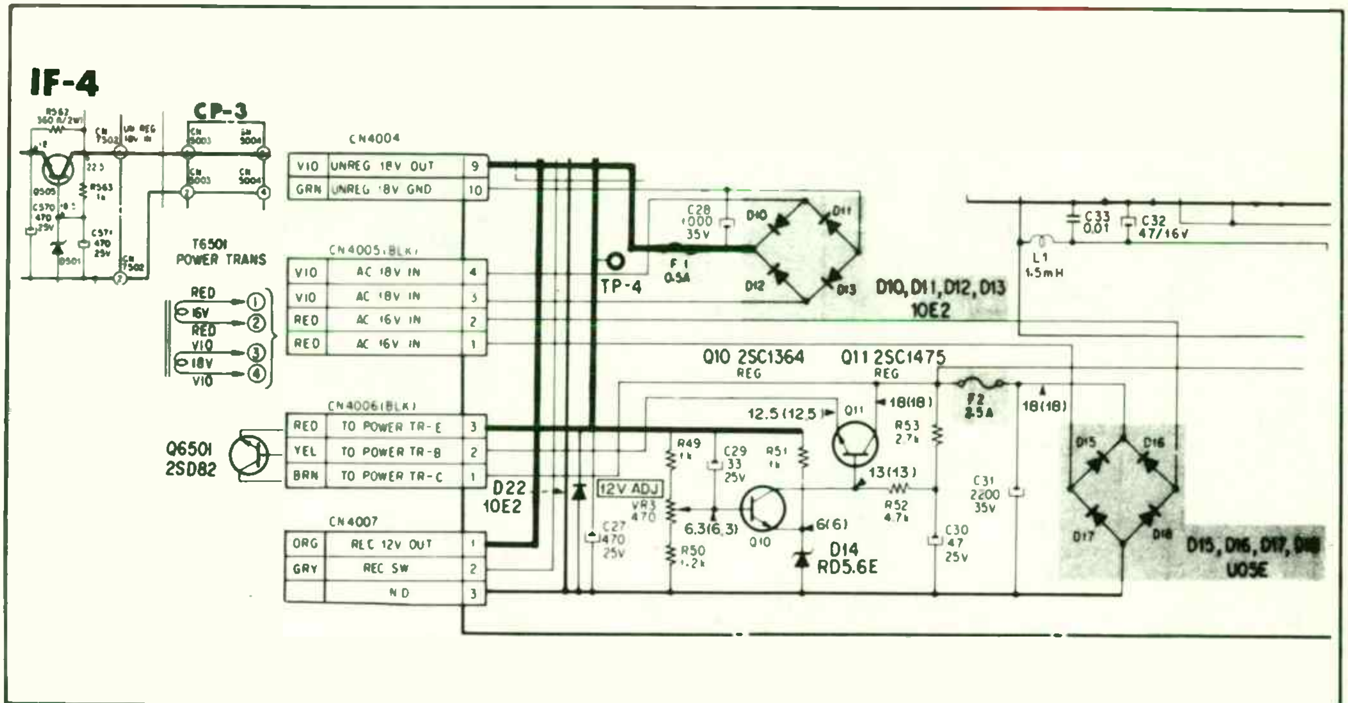


Fig. 2-5. Power supply circuit diagram (courtesy of Zenith).

voltage. Diodes D10, D11, D12, and D13 produce an unregulated 18 volts output via fuse F1 and connector CN4004, pin 9, to pin 3, connector CN5004 on the CP-3 board out of CP-3 at pin 1 of CN5003, then into the i-f-4 board at pin 1 of connector CN7502. Transistor Q7505 on the i-f-4 board is the regulator stage of the 18 volt B+ that powers the i-f-4 board circuitry as well as the tuners in the VCR machine.

Referring to the SRP board circuit in Fig. 2-5, of the other rectifier circuit, D15, D16, D17, and D18, develop +12 volts dc. Regulation of this voltage is accomplished by transistors Q10 and Q11 on the SRP board and externally mounted transistor Q6501. This +12 volt supply is the most used B+ in the KR9000 machine. This voltage is fed to the SRP, i-f-4, ARS boards, and the rf modulator.

SYSTEM CONTROL DIAGRAMS, SRP BOARD

Figures 2-6 through 2-10 show the circuitry involved in the several functions that must be performed in the operation of a VCR recorder such as the Zenith KR9000. The caption with each diagram describes what function is shown. A careful study of these diagrams will increase your understanding of how this machine operates.

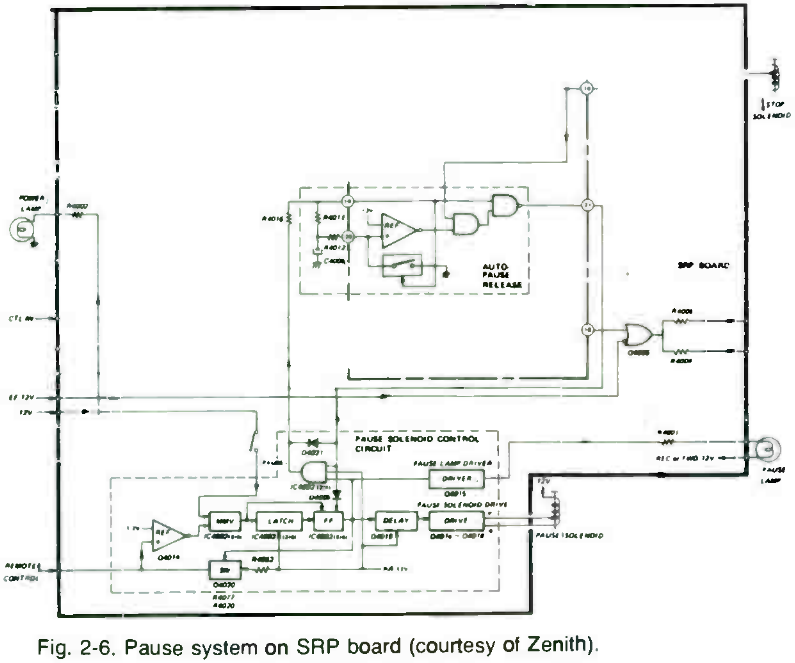


Fig. 2-6. Pause system on SRP board (courtesy of Zenith).

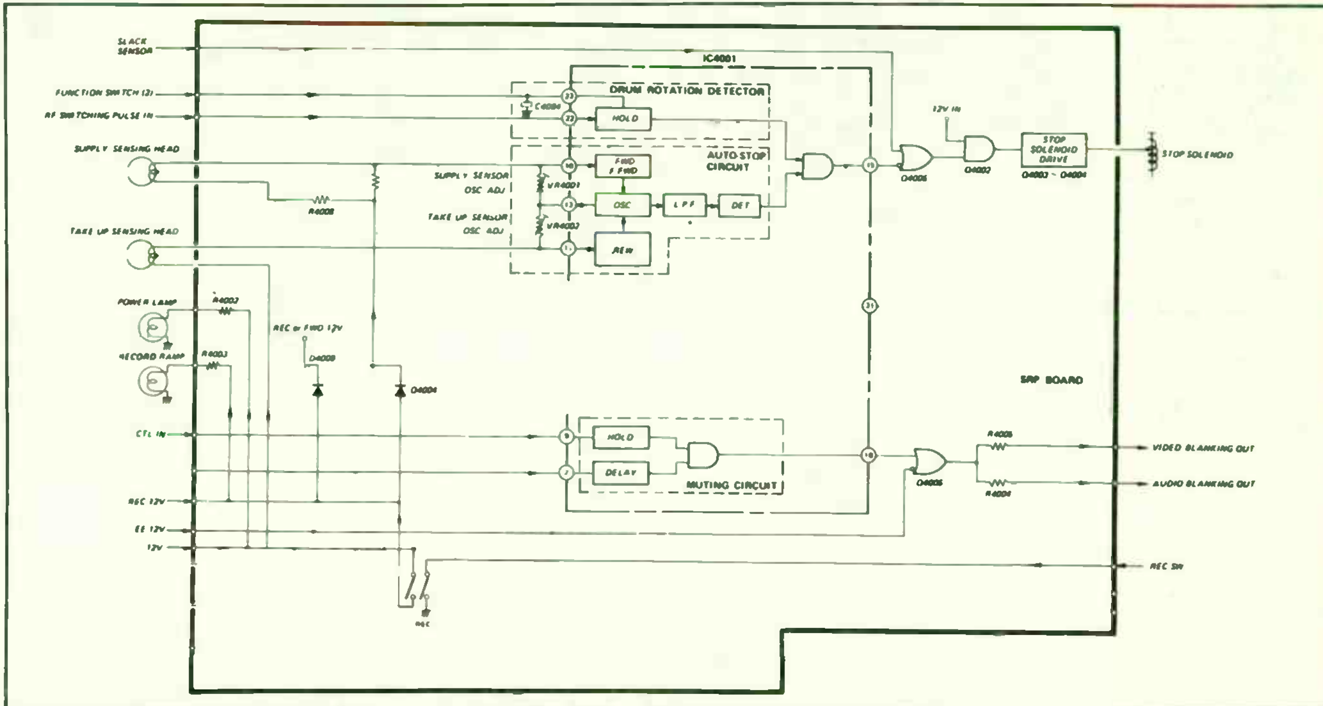


Fig. 2-7. Record system found on the SRP board (courtesy of Zenith).

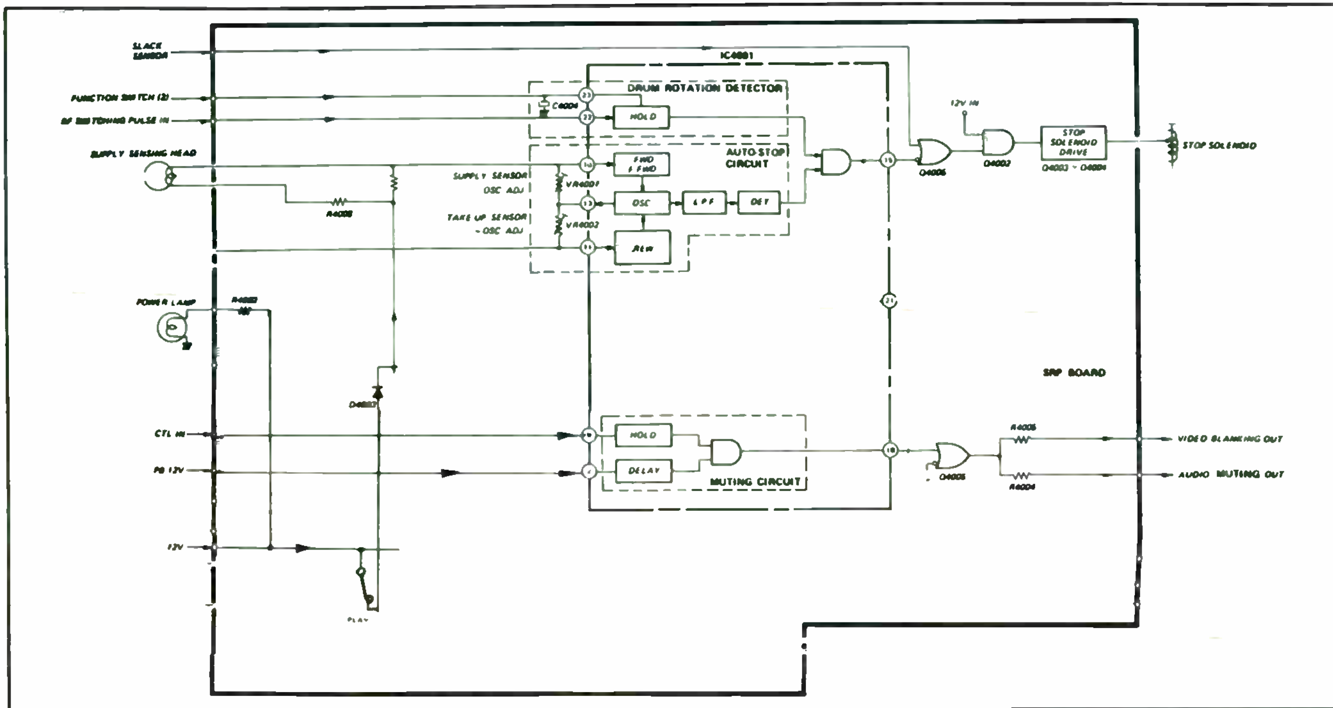


Fig. 2-8. Play system located on SRP board (courtesy of Zenith).

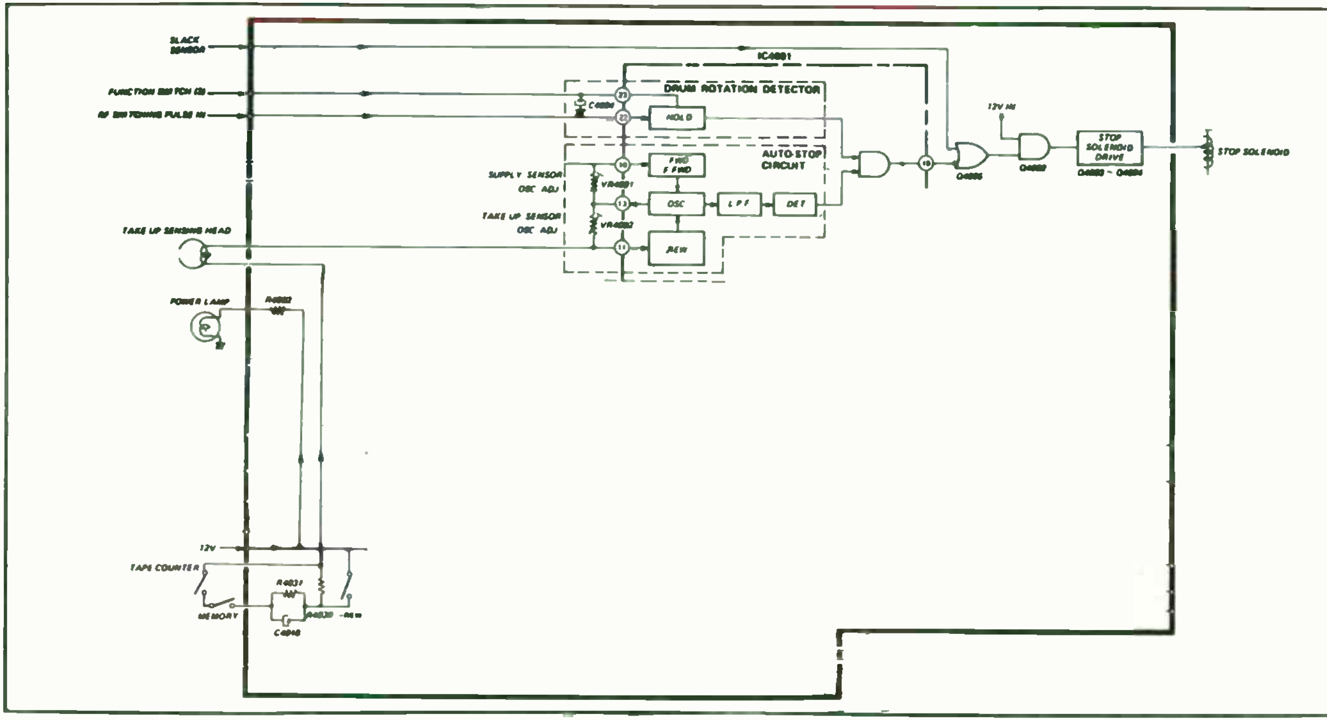


Fig. 2-9. Rewind system found on SRP board (courtesy of Zenith).

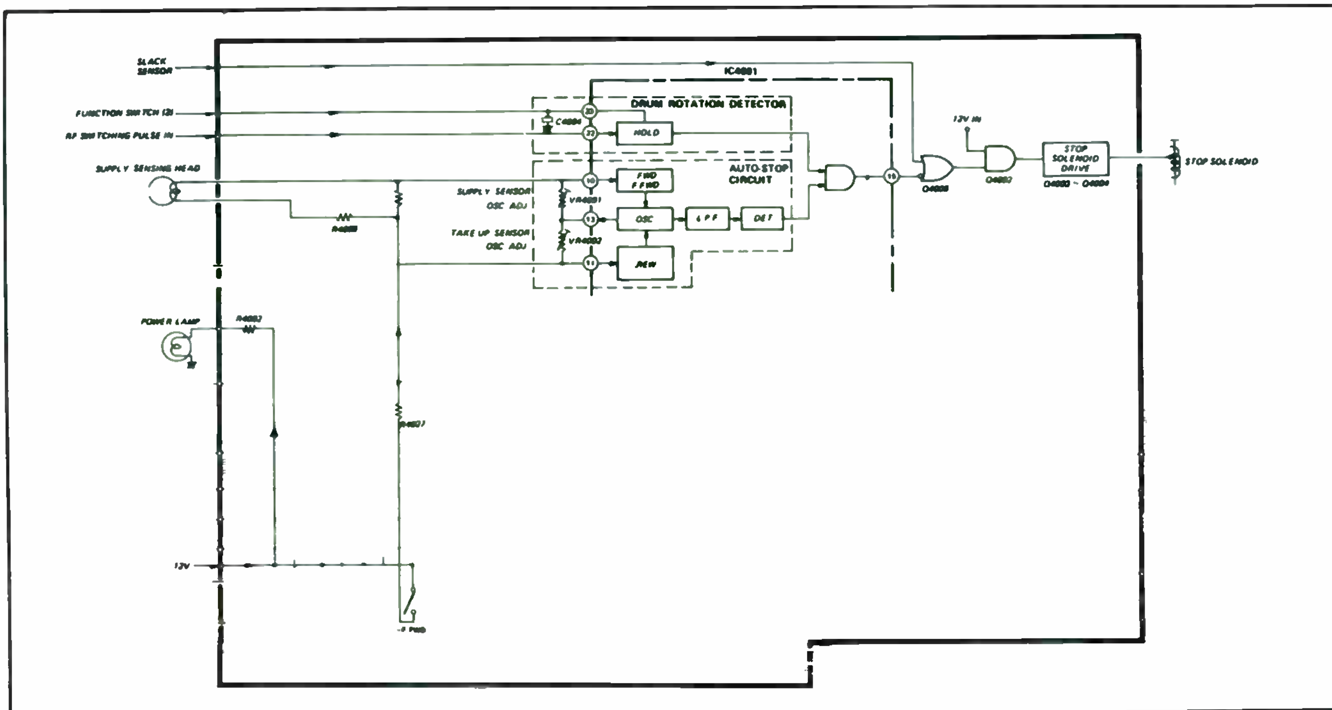


Fig. 2-10. Fast-forward system located on SRP board (courtesy of Zenith).

SERVO SYSTEM, ARS BOARD

Figure 2-11 shows a block diagram for that portion of the ARS board that is concerned with the continuous, automatic control of the drum speed. Another function of this portion of the ARS board is the development of the rf switching pulse. This important 30 Hz timing and switching signal is derived from the 30 PG pulses (both A and B) that is generated as the video head disc revolves.

RECORD DRUM SPEED CONTROL

The 30 PG pulse signal from the A head, after processing, becomes one of the two signals in a comparison gate between pins 23 and 24 of IC2502. The frequency of this pulse is a direct measurement of the head speed. The other signal in the comparison gate is developed from the vertical sync pulse, which is separated from the video signal in IC2502, pins 6 and 4. Processing in IC2501 derives a 30 Hz signal which is the reference signal for the comparison gate. Any difference or shifts between the two signals in the comparison gate will cause changes in the current through the drum brake coil, thus varying the magnetic "drag" on the drum, thus correcting the speed.

CONTROL TRACK RECORDING

The control signal is developed, during the record mode, from the vertical sync pulse, after processing and conversion to a 30 Hz signal. The control signal is coupled from pin 19 of IC2501, ARS board and Q2502, and is recorded on the tape by the control head.

PLAYBACK DRUM SPEED CONTROL

During playback, the control track signal passes through amplification and modification within IC2502 and becomes the reference signal within the comparison gate. Once again, comparison is made between this signal and the 30 Hz pulse that is directly related to the video head speed. Continuous correction of the drum speed is accomplished in the same way as in the record mode.

TIMER, AUDIO BLOCK DIAGRAMS

The block diagram (Fig. 2-12) is for the timer system. Included in this system are boards TMA, TMB, TMC, TMD, LF-5, and SW-1.

Shown in Fig. 2-13 is the audio system portion of the ARS board, with amplifiers, recording/playback head, and erase heads. A photo of the Zenith KR9000 VCR machine is shown in Fig. 2-14.

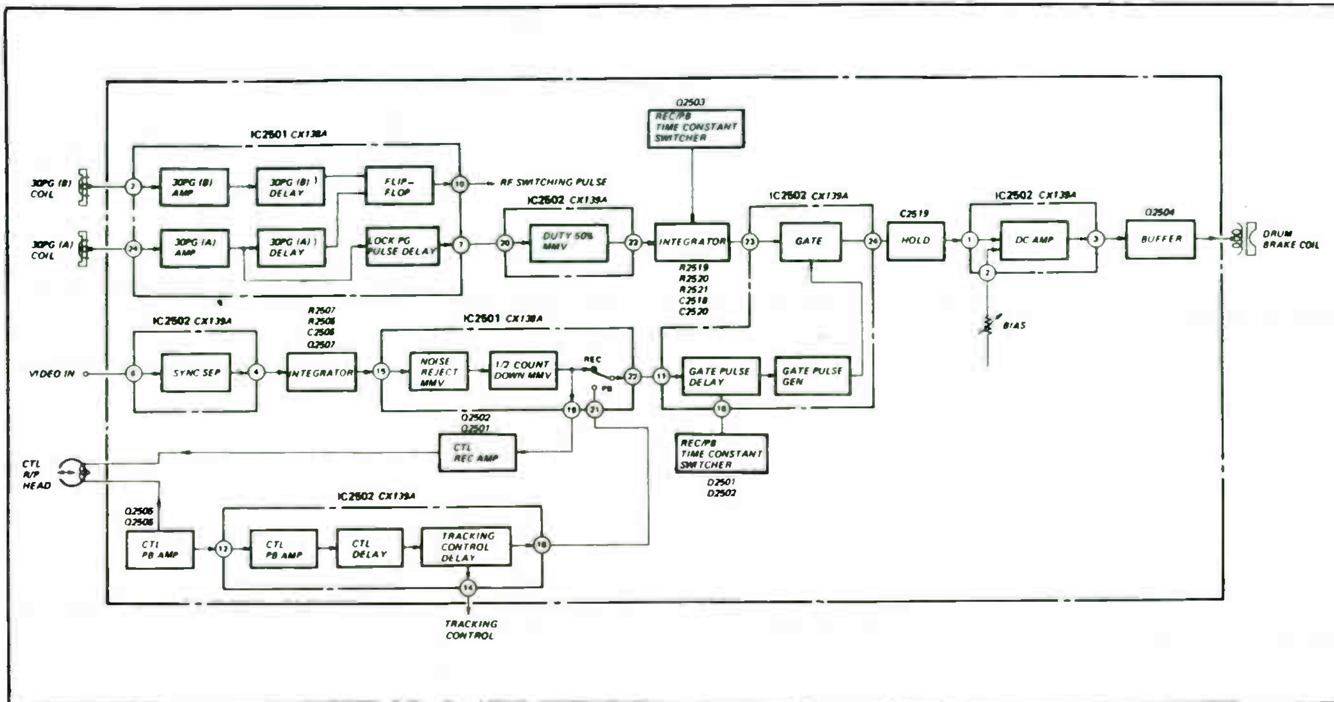


Fig. 2-11. Servo system located on ARS board (courtesy of Zenith).

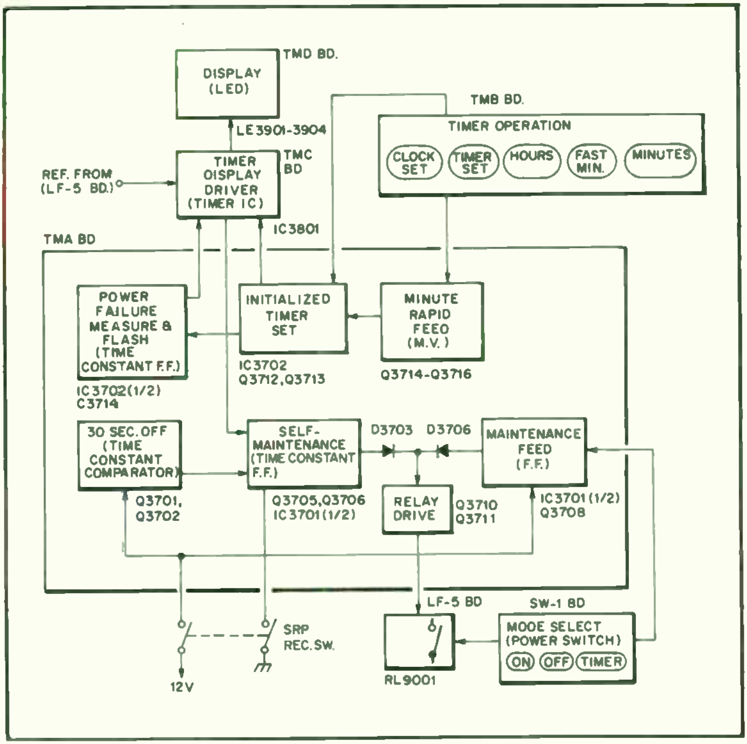


Fig. 2-12. Block diagram of the clock timer (courtesy of Zenith).

CHROMA CIRCUITRY

In this section we will cover the VCR record and playback chroma circuits. Also, comb filter circuit operation, APC and AFC loops. This will include chroma circuit theory of operation and service tips. These chroma circuits are found in the Zenith KR9000 and Sony SL-8600 Betamax VCR machines.

The Luminance Circuits

Before delving into the chroma circuitry we will touch on the luminance circuits (Fig. 2-15) so you will have a better understanding of the total VCR system. As the video heads revolve during the playback mode they pick up the recorded information from the video tracks on the video tape. The combined frequency modulated luminance (Y) and 688 kHz chroma signals are coupled through the rotating transformer to the ARS board. There is a "chain" of three functional blocks for the output signal of each of the two video heads. The blocks, mostly inside IC2001 are: the preamplifier, the

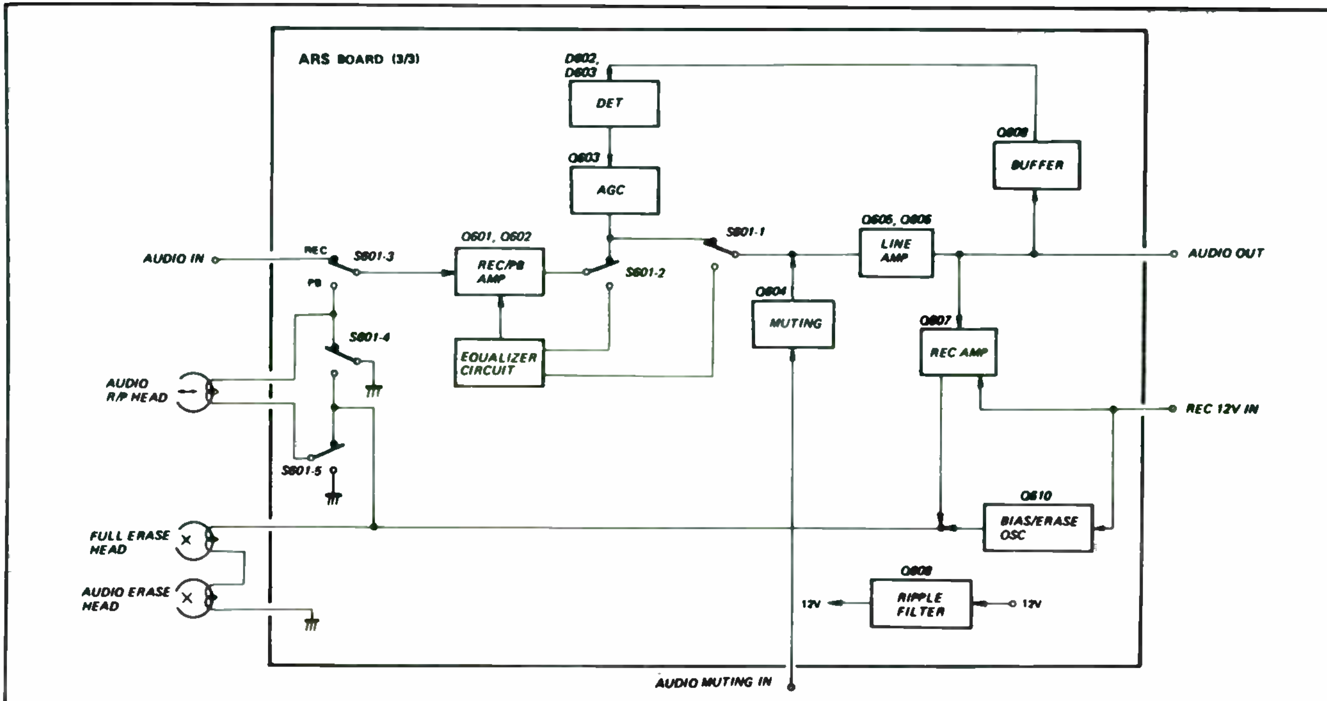
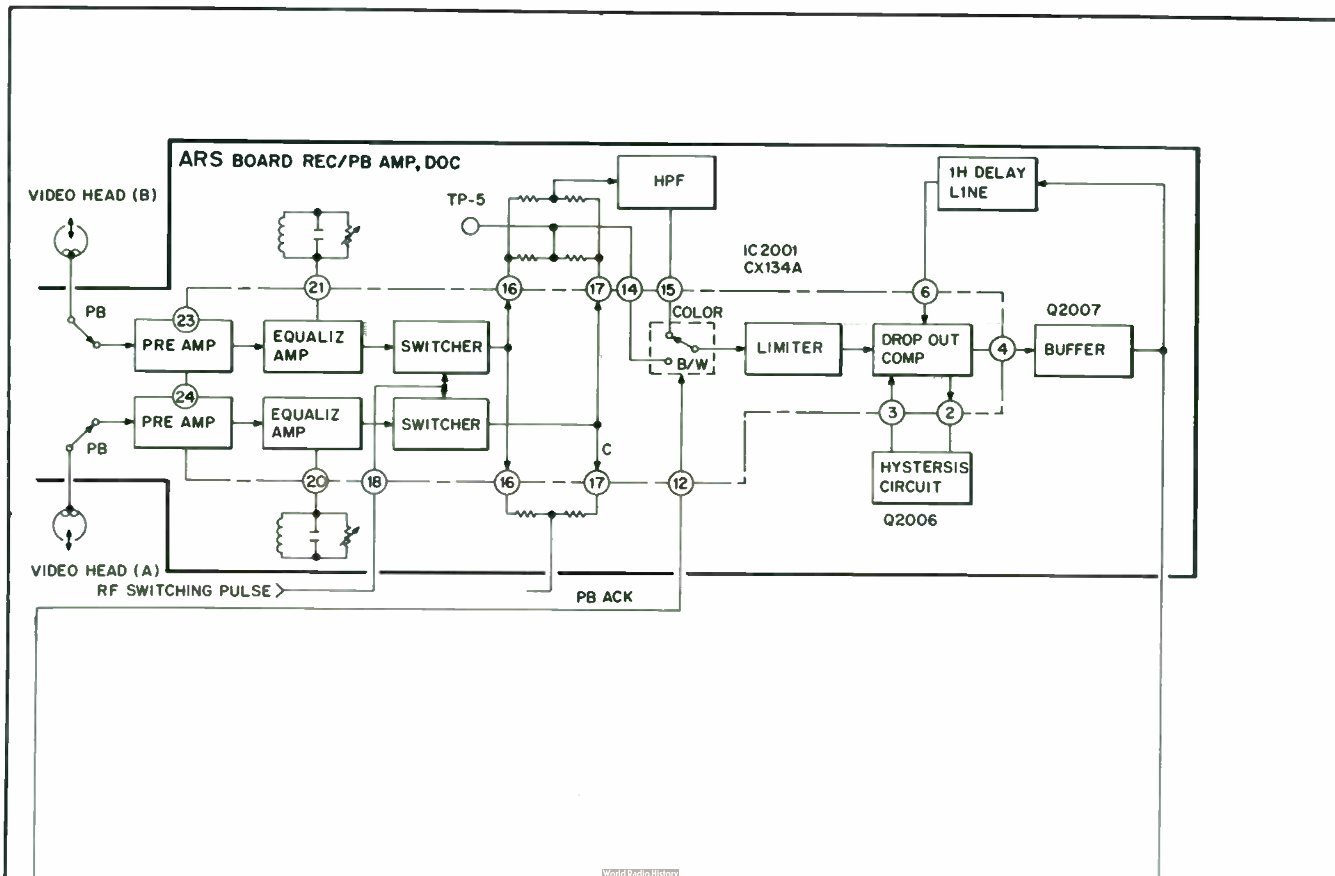


Fig. 2-13. The audio system block diagram (courtesy of Zenith).

Fig. 2-14. The Zenith KR9000 VCR machine (courtesy of Zenith).

equalizer amplifier, and the switcher circuits. Inputs to this chain of blocks enter the IC at pins 23 and 24. A 30 Hz signal, the rf switching pulse, at pin 18 switches the processed signals to pins 16 and 17, in time with the active tracking of each head. There are three possible signal outputs from the three center-tapped resistances across pins 16 and 17. These are the monochrome, the luminance portion of the color program, and the chroma (at 688 kHz).

Test Point 5 is the take-off point for a black and white signal to pin 14 of IC2001 and internally to the B/W position of a switch. The other switch position is labelled "color" and is connected to pin 15. A signal containing both color and B/W can be taken off the top pair of resistors and through the HPF block to pin 15. Only the Y-FM luminance information is connected through the high-pass filter (HPF), because the Y-FM signals are in a high range of frequency by comparison to the chroma frequency; therefore, no color information goes through pin 15. Thus the signal that is to be processed further in IC2001 is strictly luminance. The condition of the internal switch connected to pins 14 and 15 is determined by the dc voltage on pin 12. This voltage is the playback automatic color killer (PB ACK) signal. If there is no color information in the played-back video tape the pin 12 voltage is 0 and the internal switch is in the B/W position. Thus the monochrome signal is coupled from pin 14 through to the limiter block. If there is color in the video signal the


ARS BOARD REC/PB AMP, DOC
VIDEO HEAD (B)
TP-5
HPF
1H DELAY LINE
IC2001
CX134A
PB
21
16
17
14
15
6
COLOR
Q2007
23
PRE AMP
EQUALIZ AMP
SWITCHER
LIMITER
DROP OUT COMP
4
BUFFER
B/W
24
PRE AMP
EQUALIZ AMP
SWITCHER
3
2
PB
C
HYSTERSIS CIRCUIT
20
18
16
17
12
Q2006
VIDEO HEAD (A)
RF SWITCHING PULSE
PB ACK

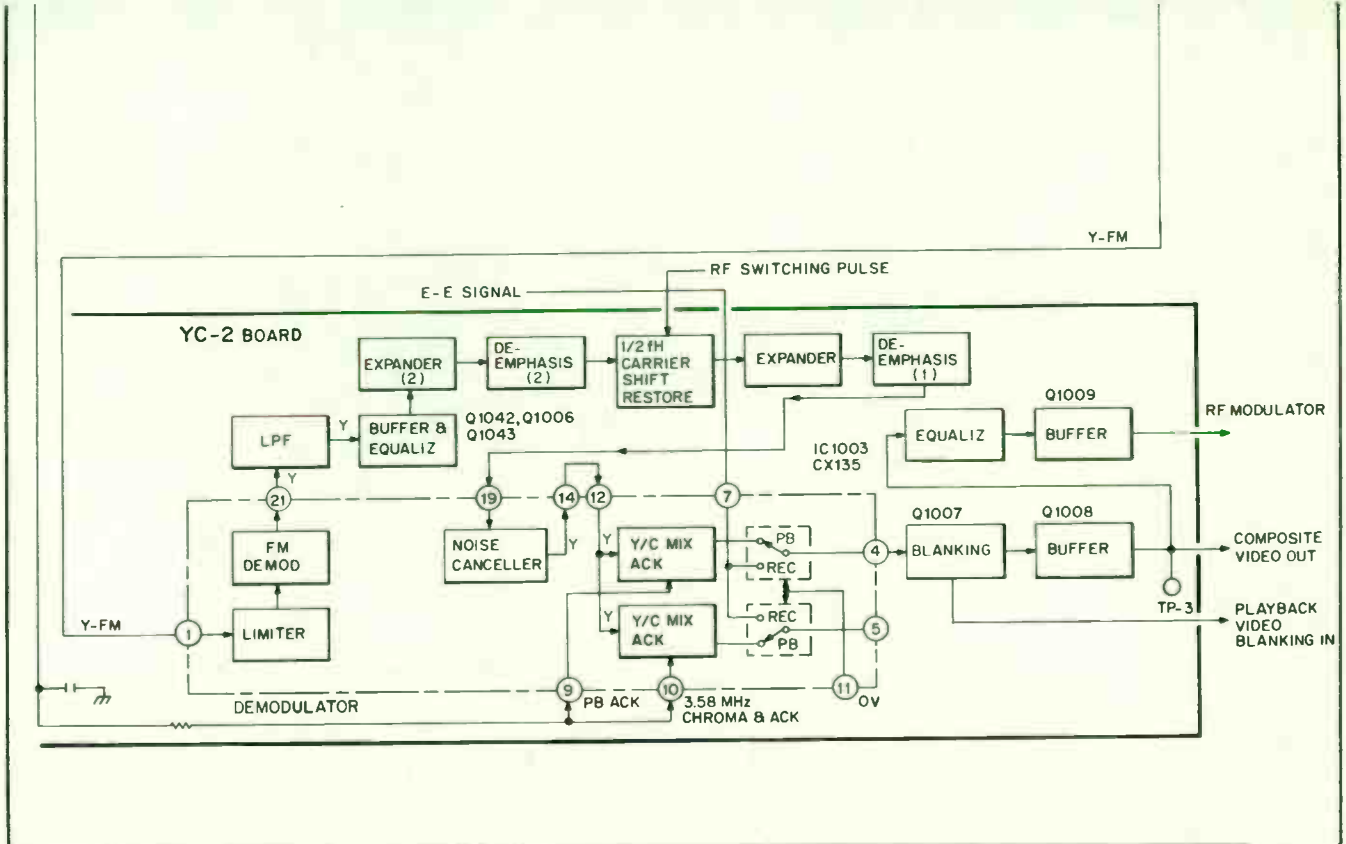


Fig. 2-15. Block diagram of luminance playback system (courtesy of Zenith).

pin 12 voltage is approximately +4 volts and the internal switch is in the color position and the pin 15 signal is coupled through to the limiter block.

In either case the luminance signal continues through the drop-out compensator block and out pin 4 to Q2007, a buffer stage. The buffer output goes in two directions. One is up and to the left through DL2001, a delay line, that delays the signal for a period of one horizontal line, about 63 microseconds. The delayed, fed-back signal is coupled to the drop out compensator by way of pin 6. The purpose of the drop-out compensator is to insert the 1H (1 horizontal line) of delayed picture information into the main signal in place of drop-out, or no information, on a horizontal line during playback.

The Y-FM signal moves out of the ARS board and into the YC-2 board and pin 1 of IC1003. Inside the IC the signal is limited to eliminate amplitude variations before it is coupled into the FM demodulator. The demodulator output, which is the original Y-FM signal as well as the recovered, lower frequency luminance signal, appears at pin 21.

A low-pass filter (LPF) selects only the demodulated low frequency luminance and couples it through to a buffer and equalizer block and then upward and on to the right through a chain of functional blocks. These blocks include expanders and de-emphasis circuits. The emphasis added to the high luminance frequencies for the record now must be counteracted, otherwise the high frequencies of the playback signal will be distorted, of higher amplitude than in the original telecast signal.

The de-emphasized signal returns to IC1003 at pin 19 and inside to the noise canceller block. Out pin 14 and back in to pin 12 goes the signal and then into two similar blocks, labelled Y/C mixers. Within these blocks the mixing of the played-back luminance and chroma signals takes place and the outputs are connected to the PB (playback) positions of the internal switches coupled to pins 4 and 5. In the playback mode of operation the pin 11 voltage is 0 volts, and the switches are in the PB positions. The played-back luminance signal couples out of pin 4, past the blanking block and through the Q1008 buffer, to the video out jack and through to the rf modulator, just as the E-E signal does.

The blanking transistor, Q1007, is in shunt with the signal path between pin 4 of IC1003 and the buffer stage. During normal operation Q1007 is not conducting and is a high impedance to ground and does not effect the video signal flow. Usually when the VCR is first turned on in the play mode, the tape movement is not up to its normal speed. Then the SRP board couples a positive voltage to the base of Q1007, turning it on to saturation. The result is a very low impedance to ground for the output luminance signal, which is thus routed to the ground. Without a video signal into the TV receiver the CRT is blanked out. When the correct tape speed is reached, the blanking stage is cut off and a normal picture appears on the TV screen.

Chroma Record System

The chroma signal is part of the composite video signal that is coupled into pin 13 of IC1001 on the YC-2 board. Refer to the block diagram (Fig. 2-16). The chroma follows the same path as that for the luminance signal, through the AGC block and onto the comb filter. The difference occurs in the output of the comb filter. The chroma portion of the signal is coupled through Q1024, a chroma amplifier, and onto the 3.58 MHz BPF (bandpass filter). The passage of the chroma signal through the comb filter materially reduces the crosstalk that could otherwise produce a noisy picture.

The 3.58 MHz chroma signal is passed by the 3.58 MHz bandpass filter, through to pin 13 of IC1002. All other frequencies that might be in the input signal, such as luminance, do not pass through the filter.

Inside the integrated circuit the chroma signal enters an amplifier whose gain is controlled by an ACC (automatic color control) voltage. The chroma continues on to the frequency converter block. Another input to this block at pin 16 of IC1002, is a 4.27 MHz cw signal generated within the YC-2 board circuitry. This latter signal beats with the 3.58 MHz signal in the frequency converter.

The frequency converter output at pin 15 includes both the 3.58 MHz and 4.27 MHz signals, as well as the sum and difference of these two frequencies. A low-pass filter (LPF) at pin 15 is designed to pass only the difference frequency, 688 MHz. This down-converted chroma signal is coupled out of the YC-2 board and into the ARS board and transistor stage Q2005, the chroma record amplifier. The output of Q2005 is added to the luminance signal and then coupled through the rotating transformer to the video heads, which transfer the video signal to the helical tracks of the video tape.

The development of the ACC voltage that controls the chroma record signal is as follows: The horizontal sync pulse available at pin 24 of IC1001 is connected to a delay block before entering IC1002 at

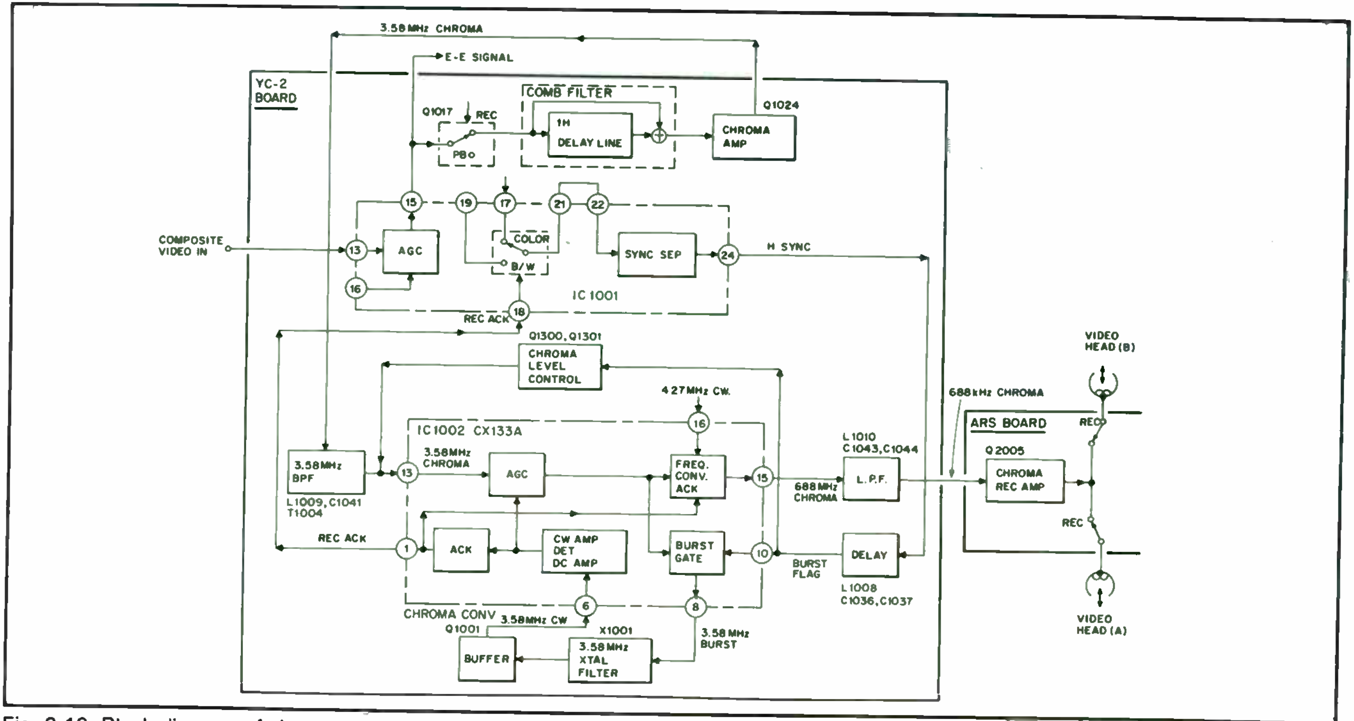


Fig. 2-16. Block diagram of chroma record system (courtesy of Zenith).

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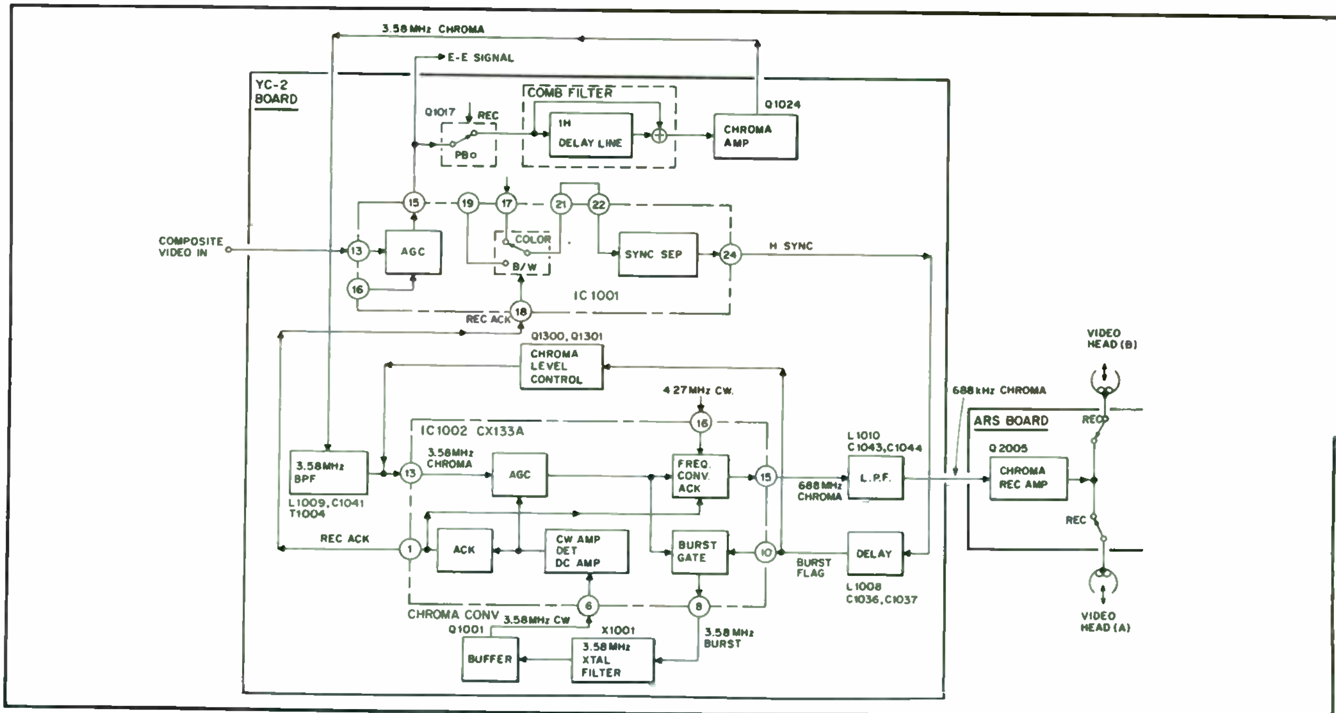


Fig. 2-16. Block diagram of chroma record system (courtesy of Zenith).

pin 10. The pulse is delayed in time so as to occur during the time of 3.58 MHz color burst on the "back porch" of the horizontal blanking pulse. This delayed pulse is called the "burst flag." It is an input internally in IC1002 to the burst gate block. Another input to this block is the 3.58 MHz chroma signal that includes the color burst. The burst flag permits conduction of the burst gate only during the time of the 3.58 MHz color burst, which then becomes the output signal at pin 8 of IC1001. The level of this color burst is a measure of the level of the chroma signal from which it is derived.

The 3.58 MHz burst is coupled to the 3.58 MHz crystal filter, a tuned circuit that is caused to ring or oscillate. The strength or level of oscillation is determined by the level of color burst. The crystal filter output, connected through a buffer stage, enters IC1002 at pin 6.

Within IC1002 the 3.58 MHz oscillation is amplified and then detected. The resultant dc voltage is amplified to become the ACC voltage. Its level is dependent on the level of the chroma signal and the burst fed back. Thus this ACC system functions to control the gain of the chroma signal through the IC by effectively sampling the output.

Another useful signal is derived by these elements. That is the ACK or automatic color killer signal, which is available at pin 1. Its value is 0 volts if the video signal being processed is monochrome, or about +4 volts if chroma is present in the video. The ACK voltage is used several times in this machine, usually for switching purposes.

Chroma Playback System

As stated previously, the luminance and chroma signals on playback share several functional blocks on the ARS board, such as the preamplifier, equalizer amplifier, and the switcher blocks in IC2001. The resultant signal across pins 16 and 17 contains both luminance (Y-FM) and chroma (688 kHz) information. These signals are coupled from the tap-off between the resistors that are connected across pins 16 and 17, to the low-pass filter (LPF), that permits only the low 688 kHz signal to move through to pin 15 of IC1004.

The 688 kHz chroma signal enters the IC (see Fig. 2-17), goes through an amplifier whose gain is controlled by the ACC voltage. This voltage is developed in about the same way as in the chroma record process. A playback automatic color killer voltage is also derived, from the ACC signal.

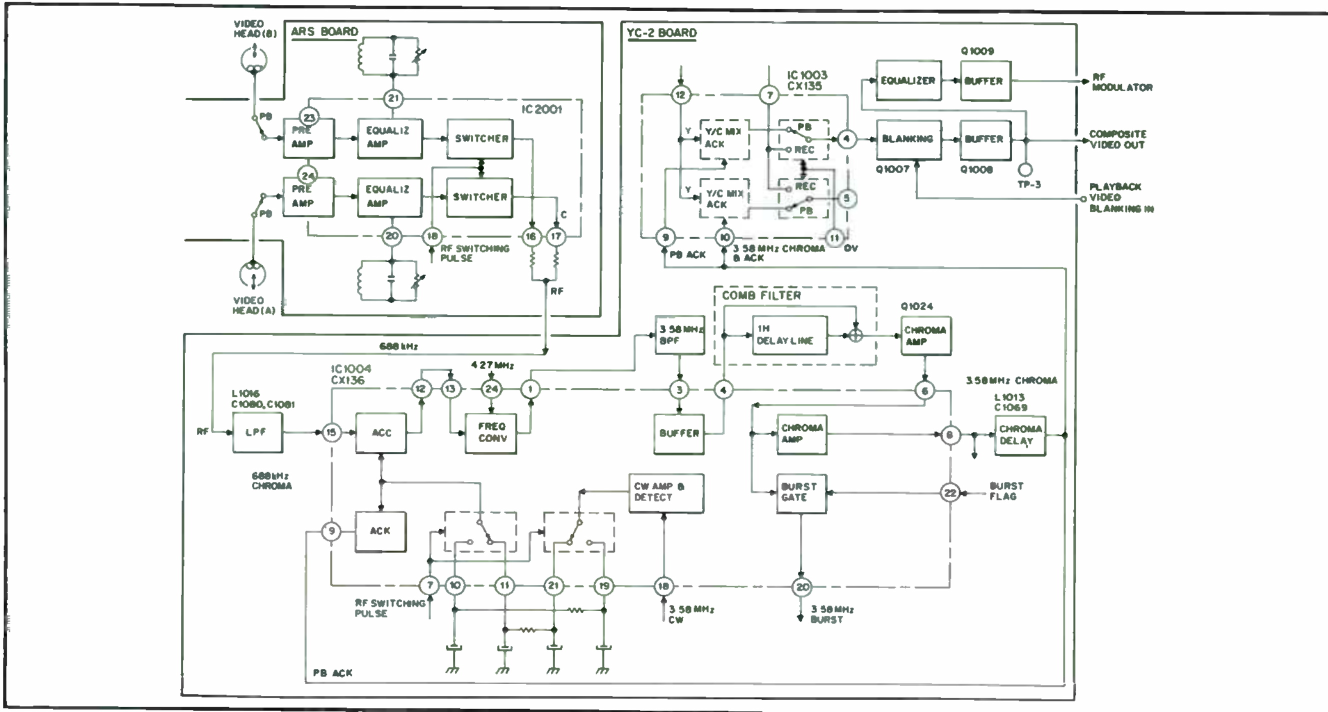


Fig. 2-17. Block diagram of chroma playback system (courtesy of Zenith).

The 688 kHz chroma signal leaves the IC at pin 12 but returns at pin 23, and becomes an input to the frequency converter. The other required input, at pin 24, is the same 4.27 MHz cw signal as that used for the record process. Of the outputs of the converter at pin 1, the difference frequency of 3.58 MHz is selected by the external 3.58 MHz bandpass filter and coupled back into the IC at pin 3. The up-converted, recovered 3.58 MHz chroma signal continues through a buffer (emitter follower) stage to pin 4 and the comb filter, for further reduction of chroma crosstalk.

The signal then moves via a chroma amplifier (Q1024) into IC1004 at pin 6. A final chroma amplifier delivers the chroma signal, by way of a chroma delay block, to the Y/C mixers in IC1003 at pins 9 and 10. The chroma is mixed with the luminance to recreate the composite video signal that is coupled through the internal switches to pins 4 and 5. These switches are in the PB (playback) positions because the activating voltage at pin 11 equals 0 volts. The path for the output follows the same route as for the E-E and luminance playback process.

4.27 MHz Signal Development

The 4.27 MHz cw signal is required for chroma processing, both in record and in playback. In each case, a frequency converter circuit will beat this 4.27 MHz frequency against a chroma frequency to secure the desired chroma signal for further processing. During record the 4.27 MHz beats with the 3.58 MHz chroma to produce the "color under" frequency of 688 kHz. On playback the 3.58 MHz is recovered by mixing or beating together the 4.27 MHz and the 688 kHz signals. Note block diagram (Fig. 2-18).

The development of the 4.27 MHz cw signal involves the use of another frequency converter, located in the upper left-hand corner of IC1005. One input signal to the converter is 3.57 MHz, delivered by a VXO (voltage-variable crystal oscillator) block within the IC and the external 3.57 MHz crystal, between pins 13 and 17. The second input signal to the converter is 692 kHz, which is equal to 44 times the horizontal frequency (44th) of 15,734 Hz. This 44th signal is precisely controlled by a phased-locked loop (PLL) that includes functional blocks between pins 5 and 11 of IC1005 and pins 2 and 4 of IC1006.

One of the products of the hetrodyning and the beating of the 3.57 MHz and 692 kHz frequencies within the frequency converter is the desired 4.27 MHz cw signal at pin 15. This signal is coupled through a 4.27 MHz bandpass filter to the primary of a small

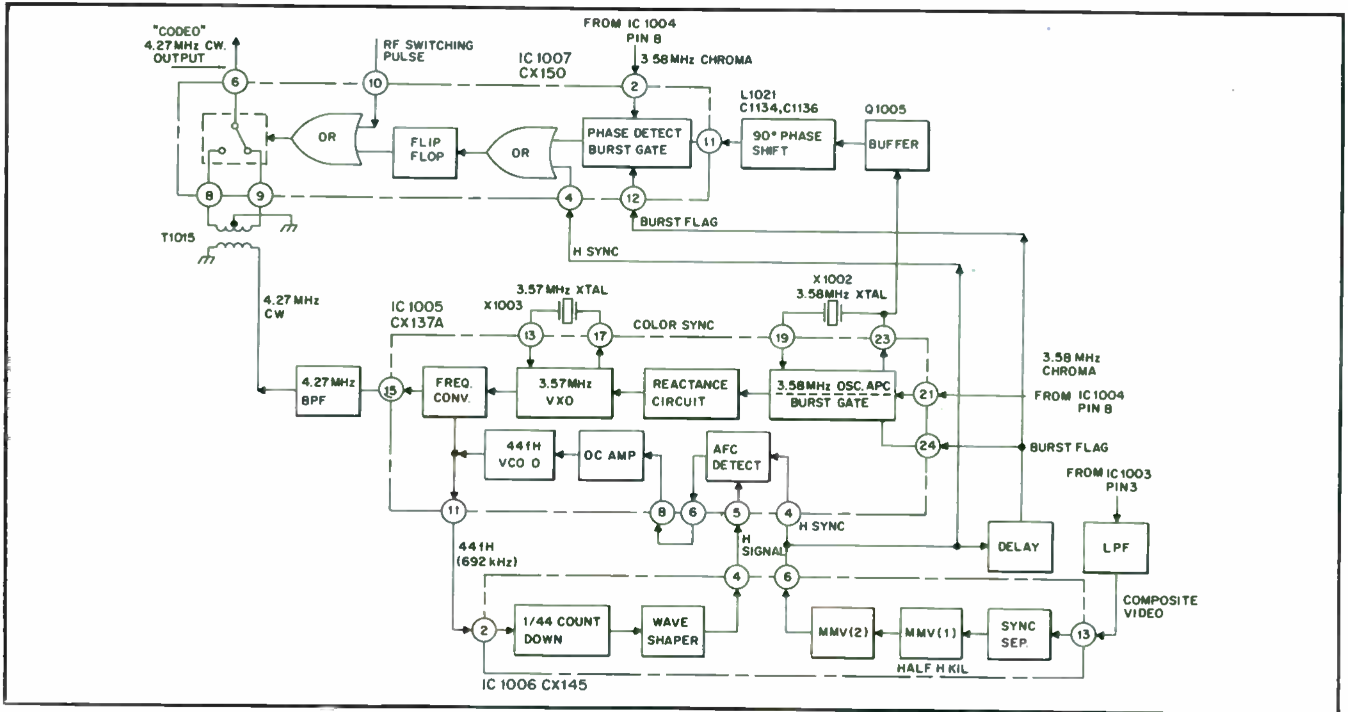


Fig. 2-18. Block diagram of 4.27 MHz development and APC circuit (courtesy of Zenith).

transformer, T1015, with a center-tapped (at ground) secondary. Two phases of 4.27 MHz are available between the center-tap and either end of the secondary winding, which is connected to pins 8 and 9 of IC1007. These pins connect the in- and out-of-phase signals to the two "contacts" of an internal switch, whose output is present at pin 6 of IC1007. The switch is driven at both 30 Hz and 15,734 Hz rates by an OR gate and other circuitry within IC1007. The results of this switching is a "coded" 4.27 MHz cw signal, at pin 6, whose phase reverses every horizontal line, for one head only. This "coding" of the 4.27 MHz is part of the crosstalk elimination process in the chroma signal processing. The output at pin 6, IC1007, the 4.27 MHz cw signal, is coupled to the frequency converters in IC1002 (pin 16) and in the IC1004 chip (pin 24).

Comb Filter Operation

The ACC output signal is applied to a frequency converter where it is up-converted back to 3.58 MHz, the difference frequency between the ACC output and the 4.27 MHz carrier frequency. In the frequency conversion in the playback mode, the output frequency and the carrier frequency are close to each other. Any imbalance in the frequency will therefore cause carrier leak. The balance is adjusted by VR1009. The phase of the playback chroma signal is inverted at a 1 H rate when the "A" head is playing back. This is restored to a continuous phase in the frequency conversion process. The restoration is done by inverting the phase of the 4.27 MHz carrier signal every 1 H. Note this relationship as shown in Fig. 2-19. As a result of this process, crosstalk components from the

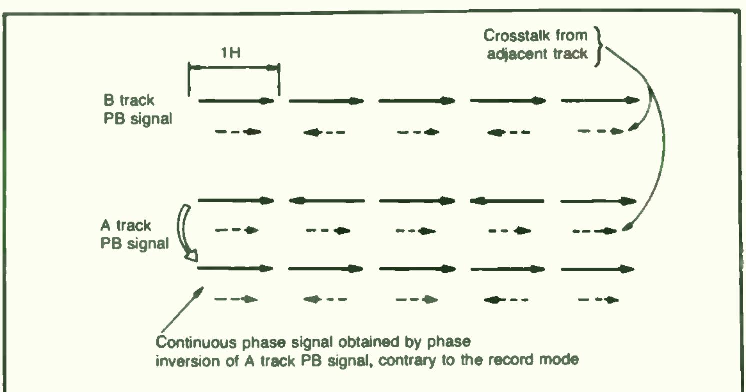


Fig. 2-19. Relationship between playback chroma signal and crosstalk signal (courtesy of Zenith).

adjacent tracks become phase-inverted every 1 H for both the "A" and "B" head signals. The chroma signal separated in the 3.58 MHz bandpass filter, is then sent to a comb filter via an emitter follower. The comb filter is formed by a 1 H delay line and a resistor mix circuit. Utilizing the fact that the signal component is in continuous phase and the phase of the crosstalk component from the adjacent tracks is inverted 180 degrees every 1 H, the comb filter rejects the crosstalk component.

Up to this point in our description of the chroma system we have stated that the chroma signal is continuously in phase when it is observed every 1 H and the crosstalk signal from the adjacent tracks is phase-inverted every 1 H. But, originally the input chroma signal is phase-inverted every 1 H in the NTSC system frequency. This explanation has been somewhat simplified for easier understanding. The actual phase relationship between the chroma signal and the crosstalk component is that the crosstalk component appears in continuous phase while the chroma signal is phase-inverted every 1 H.

The subtraction of the 1 H delayed output and nondelayed output is performed in the comb filter. It is done because both signals flow through R1092 in the opposite direction as shown in Fig. 2-20.

As the crosstalk component is in phase, it is cancelled in subtraction and the output becomes zero. The chroma signals which are phase inverted every 1 H are added and the chroma output becomes double. The chroma signal obtained across R1092 is amplified in the chroma consisting of Q1026 and Q1024 and supplied to pin 6 of IC1004. The chroma signal level is adjusted by VR1010 for correct setting of the color killer point. The output of the output amplifier is fed to the Y/C mixer of IC1003 from pin 8 via C1223, VR1024, and delay line circuit.

C1069, L1013, R1062, and R1063 from the delay circuit where the delay time difference between the luminance and chroma signals is corrected by delaying the chroma signal by 0.1 microsecond. A burst gate extracts the burst using a gate signal applied to pin 22. The extracted burst signal is supplied to a crystal filter from pin 20. This is the same crystal filter circuit used in the record system. As in recording, the burst signal is converted into a 3.58 MHz continuous wave (cw) signal in the crystal filter and is fed to pin 18. The output of the crystal filter is at a low level. It is amplified in a cw amplifier to a level high enough to drive the detector circuit.

The 3.58 MHz signal whose amplitude is proportional to burst is detected in the detector circuit and the detector output is supplied

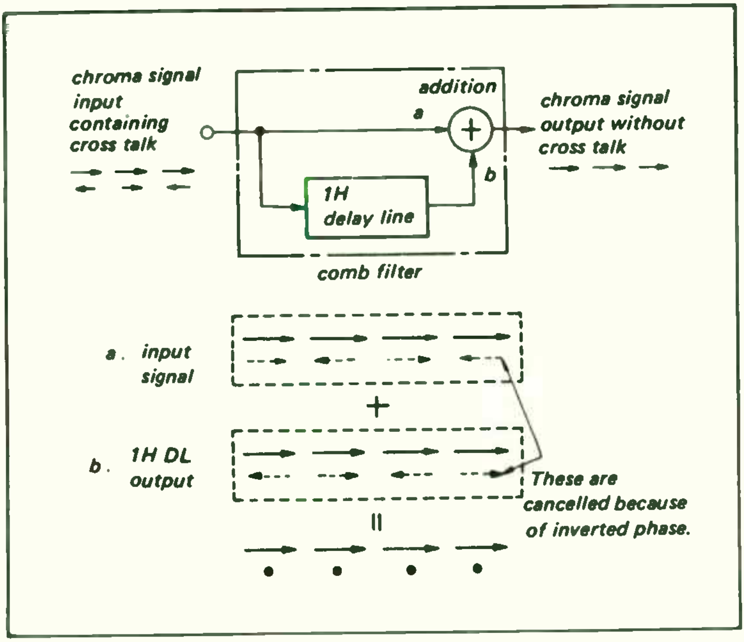


Fig. 2-20. Comb filter diagram (courtesy of Zenith).

to a hold circuit via switcher 1. Separate hold circuits are provided for each of the two video heads, and switching is done by switchers 1 and 2. Using this method, the ACC loops become independent for each channel. This results in no signal level difference in chroma output for the two combined channels, even if there is a big difference in the chroma output levels of the two heads. The rf switching pulse, applied to pin 7, drives switchers 1 and 2. For A channel, the detector output at pin 21 is held in C1086. R1079, R1090, C1099, and C1100 form an RC loop filter. The output of the filter is supplied to switcher 2 through pin 11. The output of switcher 2 is amplified in a dc amplifier to drive the ACC gain control amplifier.

The filtered detector outputs to pins 10 and 11 are applied to a color killer circuit via an OR gate. The color killer is set to actuate when the ACC detector output voltage drops below the control range of the loop. The dc voltages at pins 10 and 11 decrease so that the ACC amplifier gain increases when the chroma input signal is low. When the input signal level decreases below the control range of the ACC, the ACC locks out and the voltages at pins 10 and 11 drop to about 1 volt. The color killer functions when either of the two channels locks out and the voltage at pin 10 or 11 drops too low. The output voltage from the color killer is 4 volts in the color mode and zero in monochrome. It is supplied to a color killer circuit in CX135A, from pin 9.

AFC and APC Circuits

IC1005, type CX-137A, is involved in both the AFC and APC systems. It contains an AFC, APC, 3.58 MHz and 3.57 MHz crystal controlled oscillator circuits, and frequency converter.

AFC. The AFC circuit obtains a 692 kHz (44 fH) cw signal, which is exactly 44 times the horizontal frequency, both in the record and playback operations. A PLL (phase-locked loop) is utilized for the 44 times multiplication. As the horizontal sync signal is used for the multiplication, the loop is called AFC, as used in some TV receiver circuitry. The AFC circuit is shown in Fig. 2-21.

The divide by 44 count-down circuit, a part of the AFC loop, is contained in IC1006, type CX145. The waveform at each section is shown in Fig. 2-22. The AFC detection circuit is a sample and hold type. Phase detection is performed by sampling the trapezoid waveform applied to pin 5 using the horizontal sync pulse applied to pin 4. The detector output is applied to a dc amplifier through pin 8 from pin 6 via a low-pass filter network. The oscillating frequency of the VCO (voltage-controlled oscillator) is controlled by the dc amplifier output voltage to obtain a 44 fH frequency, phase-locked to H sync. The VCO is an RC multivibrator circuit and the oscillator frequency is determined by R1111 and C1115 connected to pin 9. VR1013 varies the discharge current of the multivibrator so as to adjust the oscillator frequency.

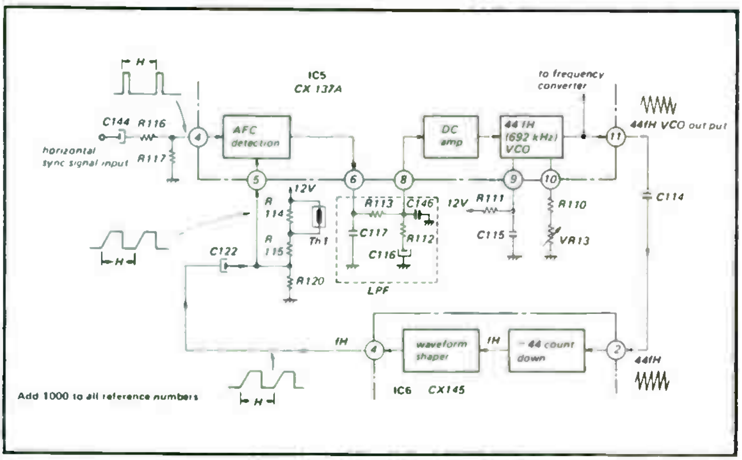


Fig. 2-21. Block diagram of AFC circuit (courtesy of Zenith).

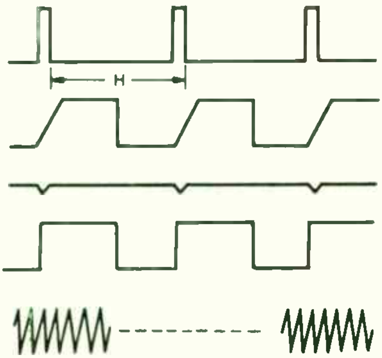


Fig. 2-22. Waveforms found in AFC circuit (courtesy of Zenith).

The oscillator output is supplied to a frequency converter in CX137A and to CX145 from pin 11. A divide by 44 circuit in CX145 counts down the 44 fH to 1/44 th for obtaining a signal of the fH frequency. The count-down output is a rectangular wave which is shaped into a trapezoidal wave and supplied to the AFC detection circuit in CX137A. The 44 fH VCO output signal is kept phase-locked to the horizontal sync signal by the AFC loop described above. The VCO output signal, supplied to the frequency converter in CX137A, is beat against the output of the 3.57 MHz crystal oscillator to produce a 4.27 MHz output. This 4.27 MHz cw output signal is supplied to the chroma signal frequency converter.

APC. The APC (automatic phase control) functions only in the playback mode. Note the block diagram (Fig. 2-23). The APC circuit consists of a phase detector, reactance circuit, 3.57 MHz (3.58 MHz fH) crystal-controlled oscillator, burst gate circuit which performs phase detection only for the burst signal, and 3.58 MHz crystal-controlled oscillator whose output signal is used as a phase reference. The reactance circuit is a variable capacitance type and is connected to the 3.57 MHz crystal-controlled oscillator to be a part of its oscillating time constant. The reactance circuit and the 3.57 MHz crystal-controlled oscillator are interconnected so that the 3.57 MHz oscillator is a voltage-controlled crystal oscillator (VCXO). In the record mode, the 3.57 MHz oscillator is a stable reference oscillator. In playback, the frequency of the VCXO output is supplied to the frequency converter where it is beat against the output of the 692 kHz (44 fH) VCO to produce 4.27 MHz.

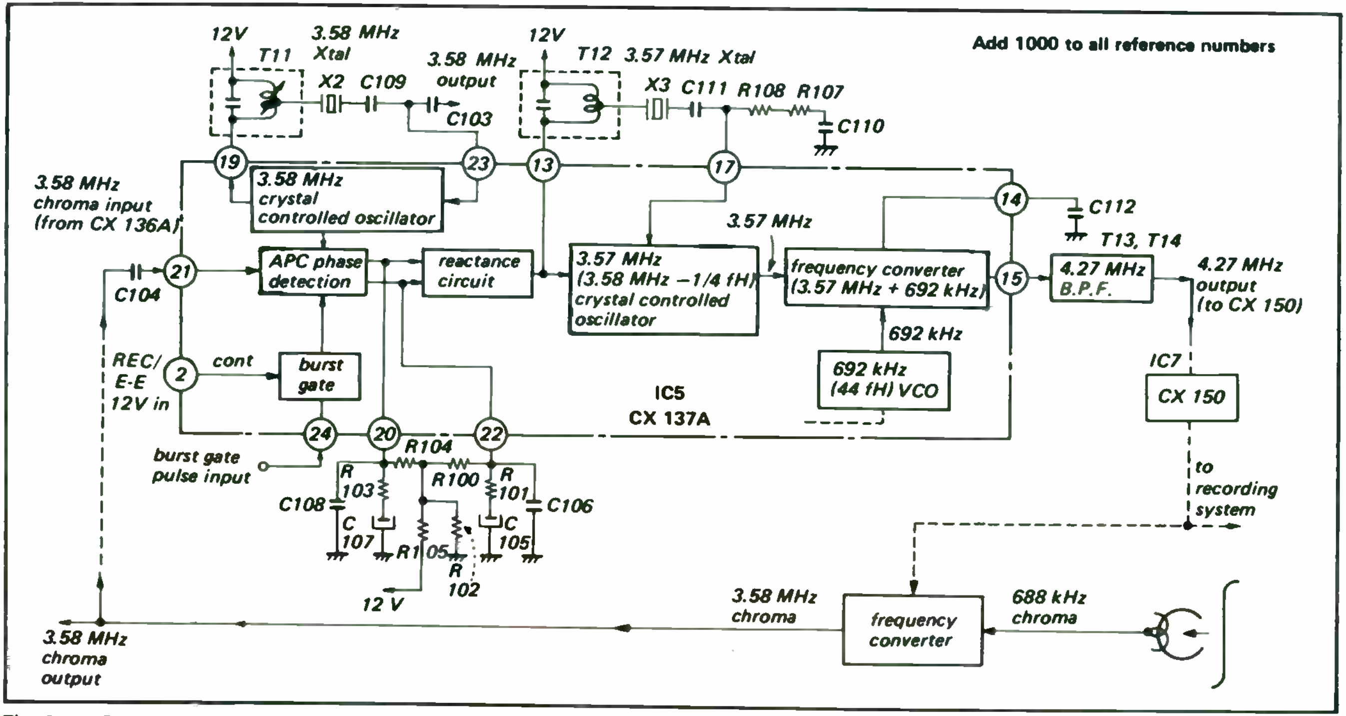
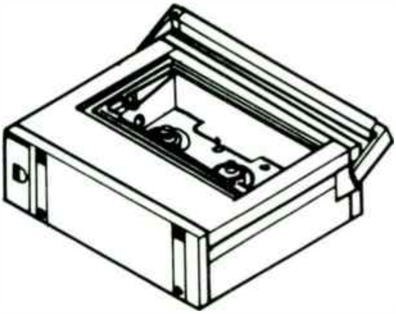


Fig. 2-23. Block diagram of APC circuit (courtesy of Zenith).

The 4.27 MHz output is fed to a bandpass filter from pin 15 and fed to the chroma frequency converters of the record and playback systems via CX150. The playback 3.58 MHz chroma signal is fed to the APC phase detector from pin 21. The reference signal is supplied by a 3.58 MHz crystal-controlled oscillator connected between pins 19 and 23. The output signal of this oscillator and the burst portion of the two (record and playback) chroma signals are phase-compared. The detector output is filtered in RC filters connected at pins 20 and 22, and supplied to the VCXO to control the 3.57 MHz oscillator frequency. Since the phase comparison is made only with the burst signal, the burst controls the phase detector so that the output of the APC phase detector is supplied only during the burst period. In the record mode, the output of the APC phase detector is blocked by applying the REC/E-E 12 volt to pin 2 as a control voltage in order to stop the operation of the burst gate. This allows the 3.57 MHz VCXO to function as a fixed-frequency oscillator in the record mode. In playback, the 688 kHz chroma signal reproduced by the video heads is at a frequency which is 43.75 times H sync and contains phase instability caused by mechanical jitter. Note that the AFC loop slightly overcorrects this phase instability since the H sync frequency cannot be multiplied by 43.75. The APC loop detects the small phase variations which result from this over correction and develops a dc control voltage which controls the instantaneous frequency (phase) of the 3.57 MHz VCXO to compensate.

Chapter 3



VCR Servo and Control Track Systems

The servo circuitry, located on the ARS board, compares the phase of the 30 PG signal to that of the vertical sync separated from the video input signal in the record mode so as to control the drum rotation and to keep its phase constant. A signal which is twice as long as the cycle of the VD signal (vertical sync) is fed to the CTL (control) head as the servo reference signal during playback and recorded onto the tape.

The system control circuitry consists of circuits on the SRP board. System control functions include auto-stop at the end of the tape, control of tape threading and unthreading, generation of the audio muting and video blanking signals, control of the pause circuit, and protection operations for such cases as tape slack, and rotational failure of the drum.

SERVO AND PULSE SYSTEM CIRCUITS

The position relationship of the video heads and the 30 PG coils are shown in Fig. 3-1. A block diagram of the servo and pulse system circuits is shown in Fig. 3-2. The servo timing chart is shown in Fig. 3-3.

The drum servo system of this machine is a common magnetic brake servo system. The rotary drum is belt driven by an ac hysteresis motor and controlled by a brake coil. The tape is also driven by the ac hysteresis motor.

The rotary head drum assembly is a "stacked" array consisting

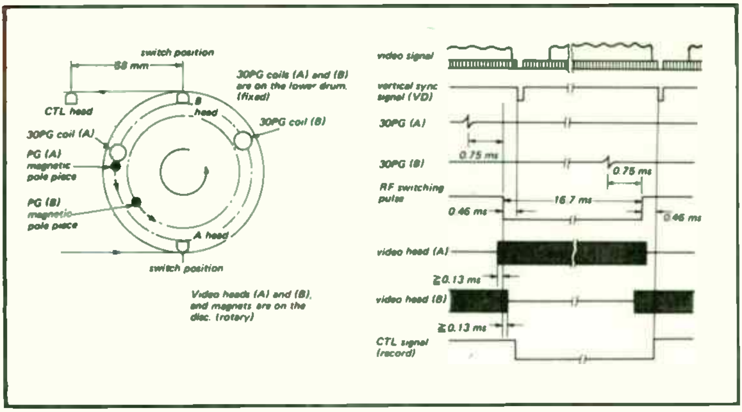


Fig. 3-1. Relationship between heads and 30 PG coils.

of the upper drum (fixed), the video head (rotating) and the lower drum (fixed). The two video heads are mounted on the periphery of the head disc. Two magnetic pole pieces, used in conjunction with the two 30 PG coils, are also mounted on the disc. The two PG coils (30 PG coils A and B) are mounted on the lower drum. The 30 PG (A) signal is used in the drum servo system. The 30 PG (A) and (B) signals are used to produce the rf switching pulses.

The drum servo circuit uses two ICs, CX138A and CX139A. The 30 PG(A) pulse triggers the lock PG delay multivibrator MMV(1) to obtain a 30 Hz rectangular wave. The output from MMV(1) toggles a second one shot, MMV(4), which squares the signal into a 50% duty cycle waveform. The output from MMV(4) is passed through an integrator network which converts the square wave into a trapezoidal waveform.

The 60 Hz VD signal, separated from the video input signal, is fed to MMV(5) which eliminates noise. The output from MMV(5) toggles a flip-flop(2), which divides and shapes the signal into a 30 Hz square wave. This signal is used in the record mode as the CTL signal. It is delayed by the gate pulse delay MMV(6), and samples the trailing edge of the trapezoidal waveform in the gate circuit. A voltage corresponding to the time from the PG pulse generation to the VD signal, i.e., the phase relationship between the generated PG pulse and the sampled vertical sync signal, is obtained.

In the playback mode, the gate pulse delay MMV(6) is triggered by the CTL signal. The sampled voltage is stored in the hold circuit until the next sampling. The stored voltage, amplified by a dc amplifier and driver which function also as a compensator,

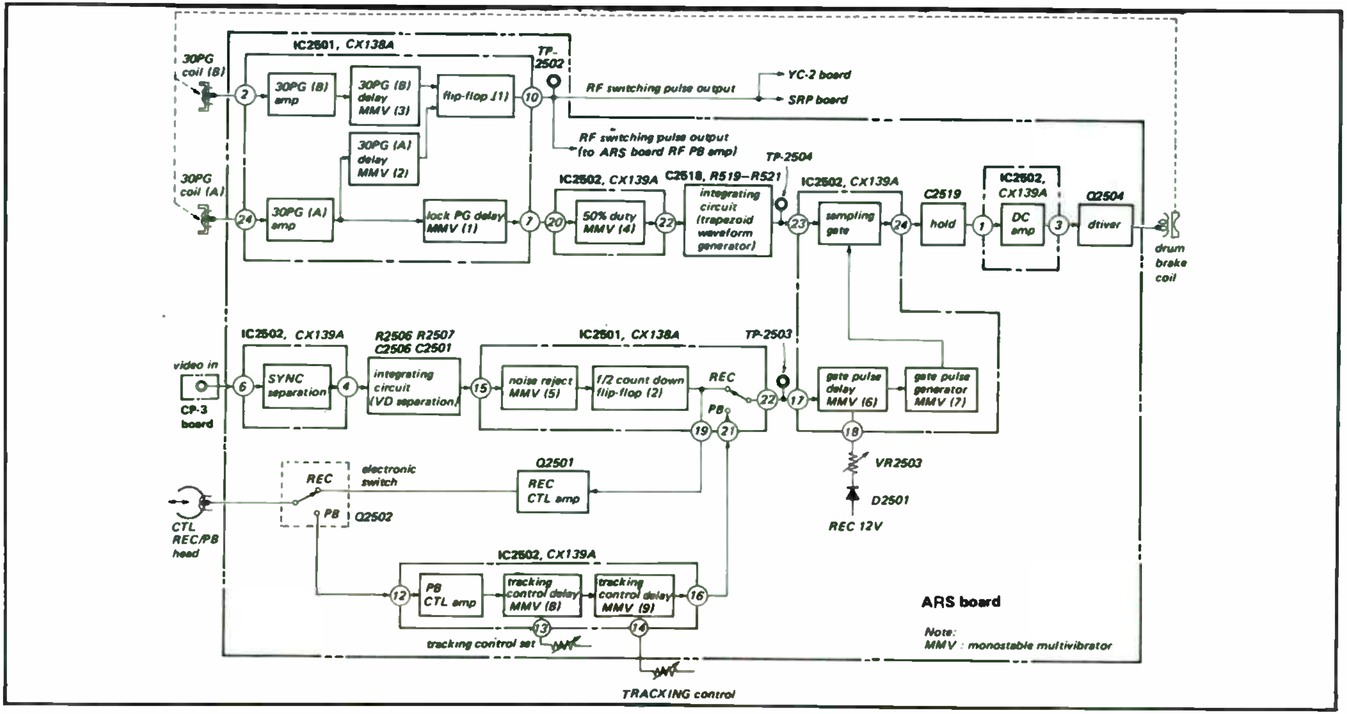


Fig. 3-2. Block diagram of servo and pulse circuits.

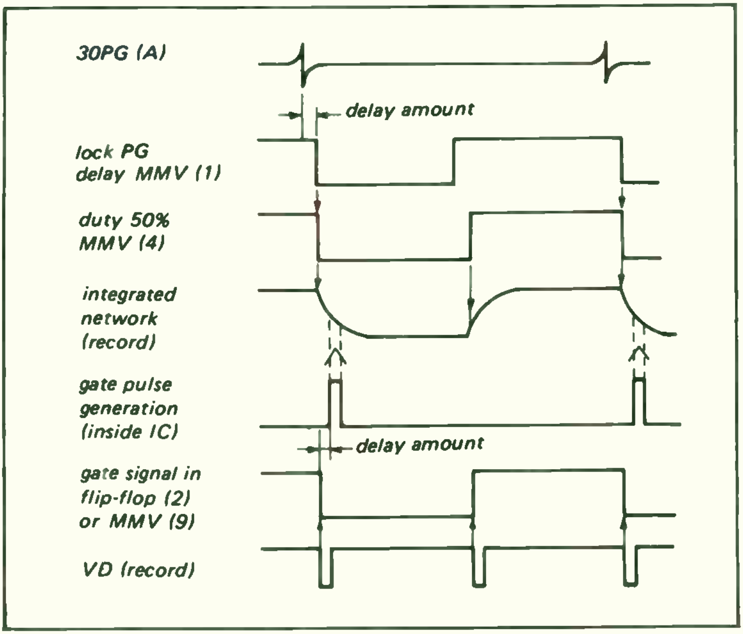


Fig. 3-3. Servo timing chart.

controls the drum brake coil. The compensator is used for stabilizing the operation of the servo system.

The correct phase relationship between the drum and the vertical sync signal is obtained by changing the delay time of the gate pulse delay MMV(6). The CTL signal triggers the tracking control MMV(8) and (9) in the playback mode. The output of MMV(9) is applied to the gate pulse delay MMV(6).

Positional errors in the mounting of the 30 PG(A) and (B) units are corrected by the delay MMV(2) and (3). The outputs of the MMV (2) and (3) trigger flip-flop (1) to obtain the 30 Hz rf switching pulse. Only the output from the flip-flop (1) at pin 10 is affected by the delay time of the MMV (2) and (3) chip.

The drum servo circuit uses two ICs which were designed for the drum servo. The CS138A chip contains a block for obtaining various pulse signals from the 30 PG pulses and a block for dividing the vertical sync signal (60 Hz) by ½. The phase comparison and sampling circuits and the output drive amplifiers are contained within CX139A. It contains also the sync separators circuit and the CTL playback system block. CX138A has a section, for the capstan servo which is unused in this machine.

30 PG PULSE CIRCUIT

The PG coils, mounted on the lower drum, generate a pulse whenever the magnetic pole pieces on the rotary video head disc pass above them (Fig. 3-4). As the magnet approaches a PG coil, a positive-going pulse is generated and when it recedes, a negative-going pulse is generated. There are two sets, (A) and (B), of PG coils and their magnetic pole pieces.

The distance of PG coils (A) and (B) from the center of the drum are different and each generates one pulse for each rotation of the drum. The negative-going pulse of the PG coil output is used to indicate the rotating phase of the drum. The pole pieces, which are strong permanent magnets, pass across the coils and induce a pulse by electromagnetic induction. The small head drum diameter used in this machine requires the use of a permanent magnet system. The pole pieces cut across the coils at a slower relative speed than in the older model VCR machines. A timing chart of the 30 PG pulse circuit is shown in Fig. 3-5 and its block diagram in Fig. 3-6.

Both positive and negative pulses are obtained across R2501 and R2502 by the electric current induced in the PG coils. PG amplifiers amplify and shape the negative-going pulses to the PG coil outputs and trigger PG delay one shots MMV(2) and MMV(3). The PG amplifier output waveform cannot be observed since it is inside the IC. The output of the PG(A) amplifier directly triggers

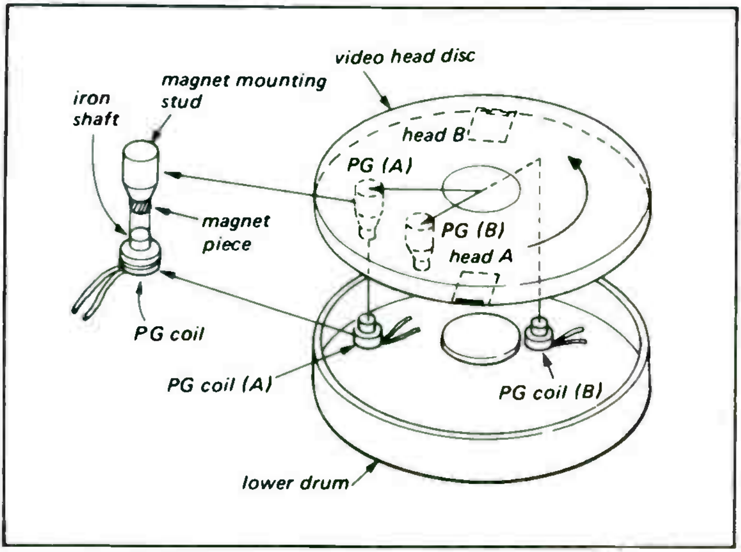


Fig. 3-4. PG pulse generating mechanism.

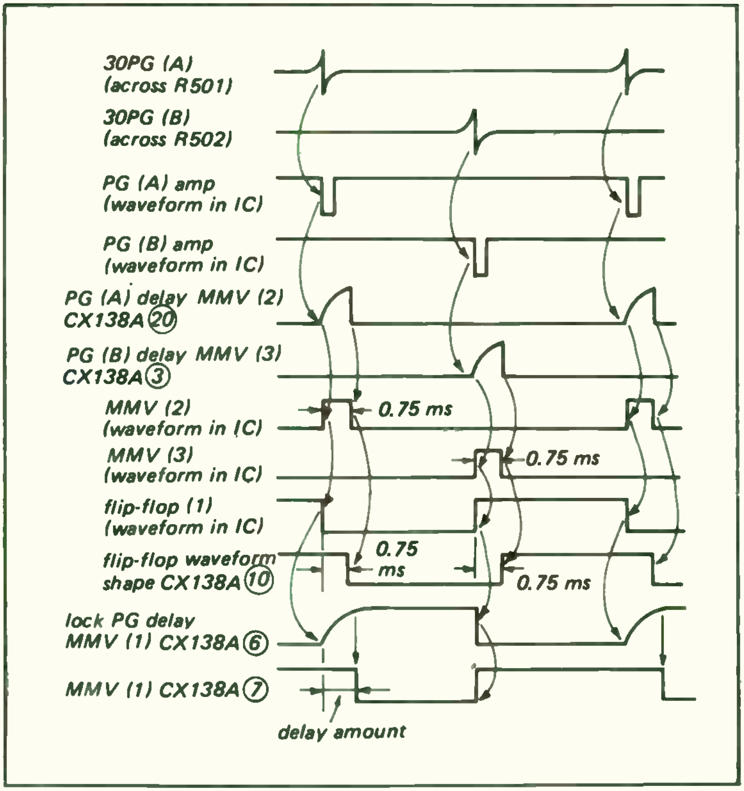


Fig. 3-5. Timing chart of 30 PG pulse circuit.

the lock PG delay one shot MMV(1). But actually the lock PG delay MMV(1) is triggered by the signal passed through the PB(A) delay MMV(2) and the flip-flop (1). The lock PG delay MMV(1) is triggered by the phase of the PG amplifier output without regarding the delay time of the MMV(2).

The PG pulses (A) and (B) trigger the flip-flop (1) after mounting position errors in the two PG coils are compensated by the MMV(2) and MMV(3) and a 30 Hz square wave is produced. This delay mono multivibrator is formed by a combination of an RC integrated network and a Schmitt trigger circuit. The external circuit connected to pin 3 or pin 20 is the time constant circuit. All other multivibrators in CX138A and CX139A have the same arrangement.

Flip-flop (1) is triggered on the positive-going transitions of the output waveforms of MMV(2) and MMV(3) producing a 30 Hz

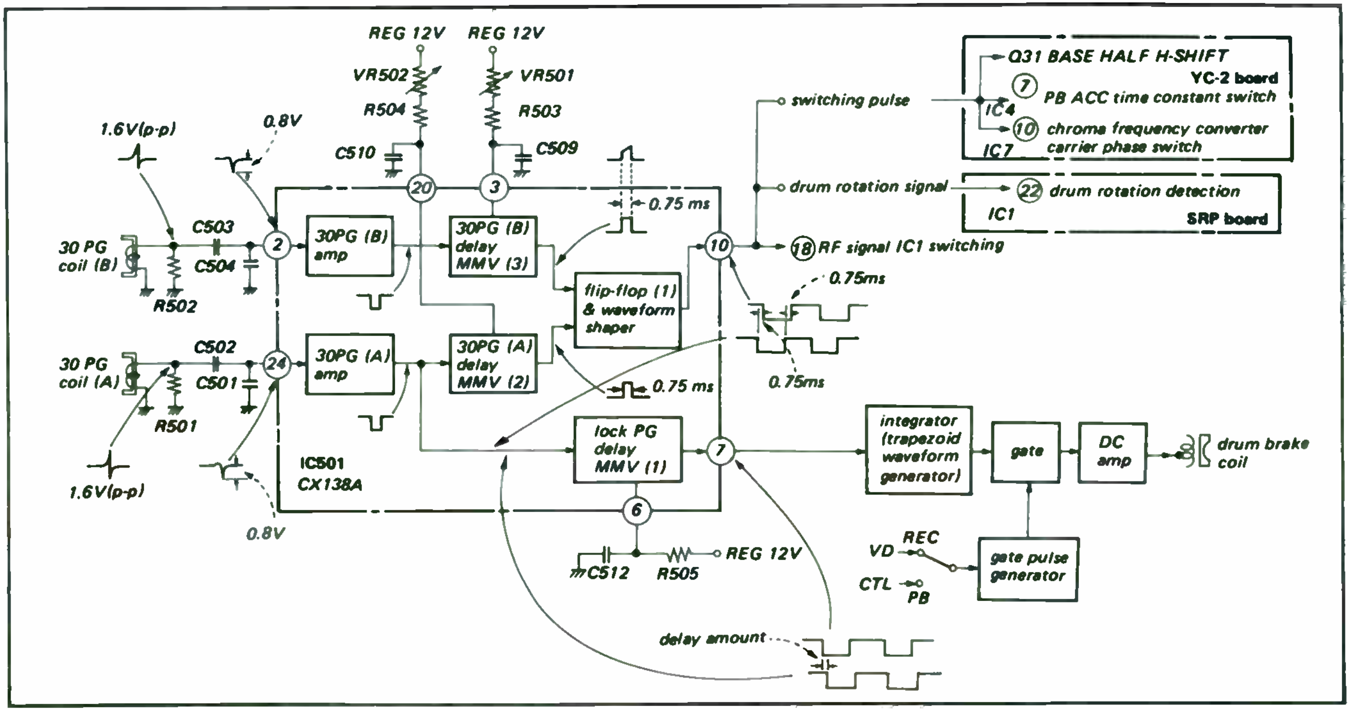


Fig. 3-6. 30 PG pulse circuit.

square wave which is not affected by the delay time of the delay one-shots.

The output of the flip-flop(1) triggers the lock PG delay MMV(1) to obtain the output whose trailing edge is delayed for a constant width. The time constant circuit for the MMV(1) is connected to pin 6. The output of flip-flop(1) is wave shaped by the outputs of the PG delay MMV(2) and MMV(3) to obtain the same square wave output as the one obtained when the flip-flop is triggered by the delay phase of the MMV(2) and (3). This square wave is the rf switching pulse obtained from pin 10. This pulse is fed to the playback rf amplifier on the ARS board, to the SRP board as a signal for indicating drum rotation, and to the YC-2 board to be used for various switching signals.

VERTICAL SYNC AND CTL SIGNAL GENERATING CIRCUITS

The block diagram and timing chart of the vertical sync signal and CTL signal systems are shown in Figs. 3-7 and 3-8, respectively.

The vertical sync signal, separated from the video input signal becomes the servo reference signal in the record mode. The video input connection is provided on the CP-3 board. R5004 and C5001 on the CP-3 board form a low-pass filter. The filter rejects the chroma burst signal and high frequency noise. The video signal is sync-separated in the circuit between pins 6 and 4 of IC2502, CX139A. The sync separation circuit consists of a feedback clamp circuit for sag correction and a switching amplifier. The external circuit connected to pin 5 is the clamp time constant. An RC integrator circuit separates the V sync from the sync separator output and triggers the noise elimination one-shot, MMV(5), via SW(1) of IC2501. SW(1) switches to the pin 15 side for a 0 volt input at pin 16 and to the pin 14 side for 12 volts. The switch is kept permanently switched to the pin 15 side in this unit and is not used as a switch. The noise elimination one-shot, MMV(5), eliminates noise by means of the fact that a one-shot, once toggled, cannot be toggled again until after it has reset itself. The exernal circuit at pin 17 is the time constant network for MMV(5). The 60 Hz VD vertical sync signal is divided into a 30 Hz square wave in the divide-by-two flip-flop. The 30 Hz square wave passes through SW(3) and appears as the gate signal output at pin 22. The negative-going transition of the flip-flop(2) output becomes the servo reference phase.

The flip-flop(2) output is inverted once in Q2501, inverted again and amplified in Q2502, and recorded on the tape as the CTL

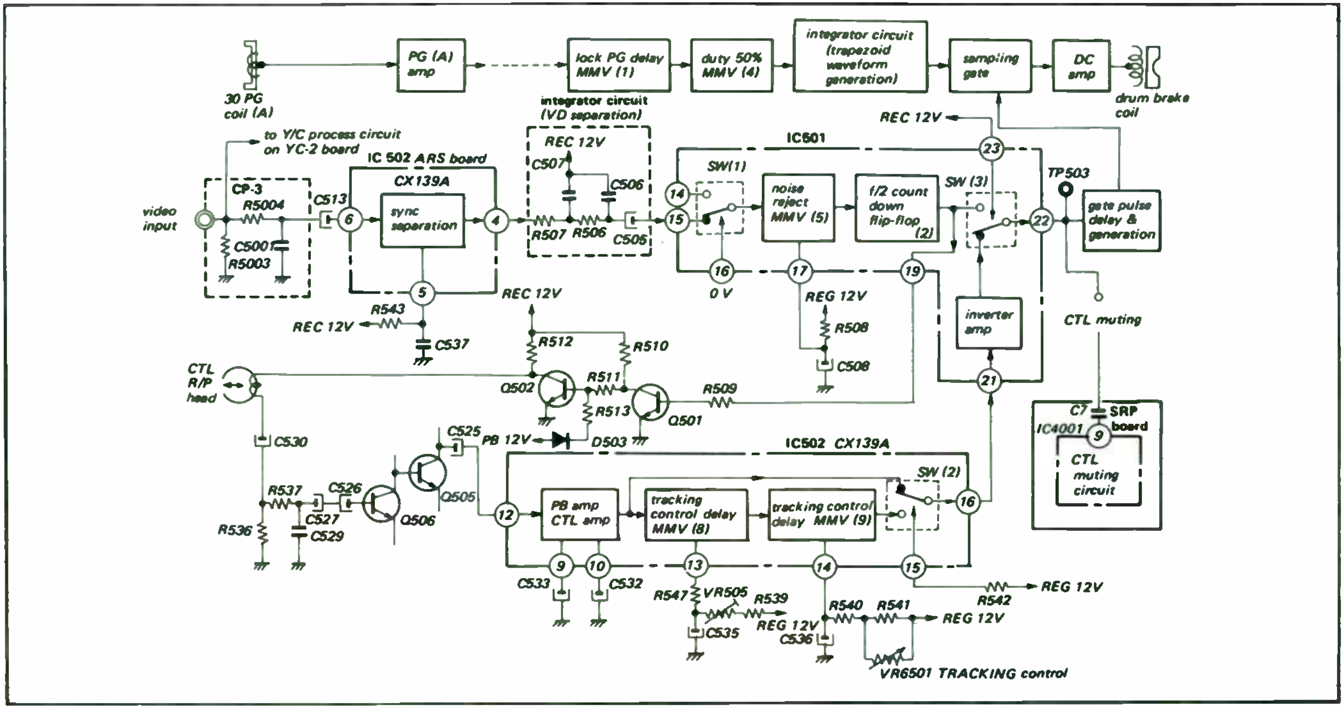


Fig. 3-7. Vertical sync and CTL signal circuits.

signal. The negative-going transition of the CTL amplifier output is used as the playback servo reference phase. The REC 12 volt is supplied as the power supply for the record CTL amplifier.

SW(3) is the servo reference signal switching circuit between the record and playback modes. It is switched to the flip-flop(2) side when pin 23 is 12 volts and to the pin 21 side when pin 23 is a 0 volt. In the playback mode, the playback CTL signal is used as the servo reference signal. The positive polarity pulse of the CTL head output becomes the servo reference phase.

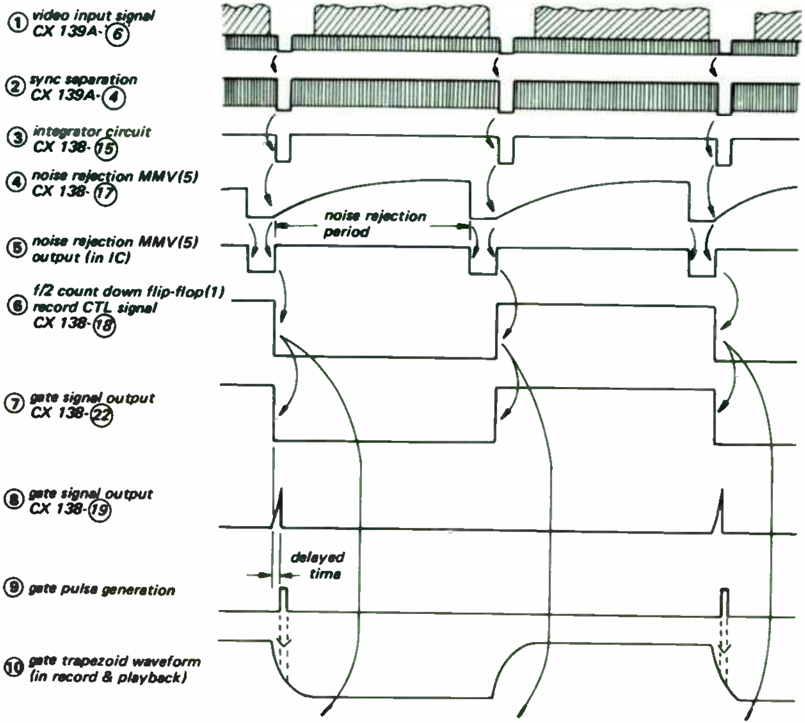
The PB 12 volts is fed to the base of Q2502 in the playback mode via D2503 and R2513 and the collector-emitter circuit of Q2502 is shorted. The terminal which was in the signal side in the record mode turns to the ground side in the playback mode and the polarity of the CTL head is inverted. A low-pass filter rejects the high frequency noise. The playback CTL amplifier amplifies the positive-going input signal in Q2502 and Q2506, and feeds it to pin 12 of IC2502 for amplification and shape so as to obtain the positive pulse output. C2533 connected to pin 9 determines the frequency characteristics of the linear amplifier stage, a low-pass filter for 1 kHz, −3 dB, C2532 connected to pin 10 is a decoupling capacitor (ac grounded). The tracking control delay MMV(8) and (9) delay the CTL signal by about 2/3 cycle for the manual tracking control in the playback mode. The MMV(9) delays the CTL signal by about ⅓ cycle.

Thus the output delayed ⅔ cycle is obtained. VR2505 adjusts a delay amount of the MMV(8) so that the output phase of the MMV(9) has the relationship of the output phase of the CTL amplifier (as shown in Fig. 3-9) when the tracking control knob is at the center detent position. The tracking control varies the delay amount of MMV(9) to obtain a delay or advanced CTL signal reference to the playback output of the CTL head.

The positive going transition of the MMV(9) output is the servo reference phase. The output of the MMV(9) goes through SW (2) and is fed to an inverter amplifier in CX138A. The negative-going transition becomes the servo reference phase as well as the VD signal in the record mode. The CTL signal at pin 22 of CX138A is fed to a gate pulse circuit and a CTL muting circuit on the SRP board.

PHASE COMPARISON GATE CIRCUIT

In this circuit the trapezoidal waveform produced from the 30 PG pulse is sampled using a gate pulse produced from either the VD


① video input signal CX 139A-⑥
② sync separation CX 139A-④
③ integrator circuit CX 138-⑮
④ noise rejection MMV(5) CX 138-⑰
noise rejection period
⑤ noise rejection MMV(5) output (in IC)
⑥ f/2 count down flip-flop(1) record CTL signal CX 138-⑱
⑦ gate signal output CX 138-㉒
⑧ gate signal output CX 138-⑲
delayed time
⑨ gate pulse generation
⑩ gate trapezoid waveform (in record & playback)

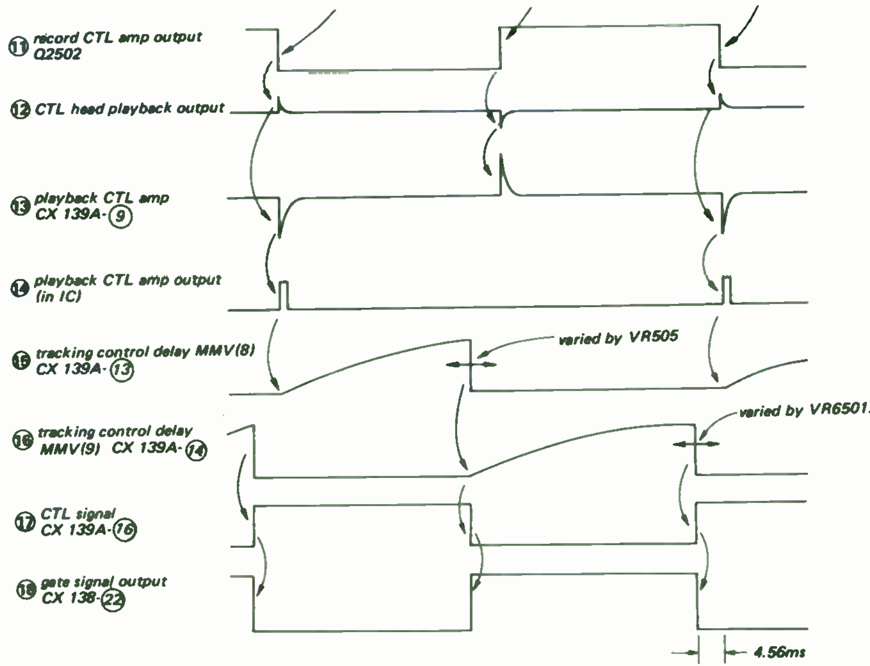


Fig. 3-8. Timing chart of vertical sync and CTL signal system.

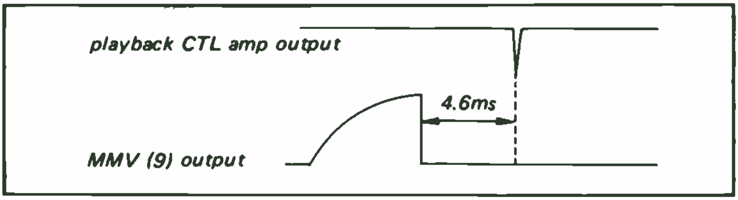


Fig. 3-9. Pulse delay.

signal or the playback CTL signal. The gate output is amplified in a dc amplifier to drive the head drum brake coil. The sampling was done by the 30 PG pulse in older units, but in the KR9000, the VD/CTL signals are used to form the sampling pulses. Because the CTL head output of this video recorder is low (positive pulse of 1 mV), the CTL signal may drop out sometimes due to clogging or dust on the heads. In the CTL/VD gate system, the hold voltage is supplied to the dc amplifier until the CTL signal returns to the normal state. In this way, the influence of the CTL dropout on the reproduced picture is minimized. The schematic diagram of the phase comparison gate circuit is shown in Fig. 3-10, the timing chart of the trapezoidal wave former in Fig. 3-11, and the timing chart of the gate pulse former in Fig. 3-12.

The lock PG delay MMV(1) output, triggered by the 30 PG(A) pulse, is shaped into a 50% duty cycle square wave by the duty MMV(4) of IC2502, CX139A. The MMV(4) supplies a comparison waveform to a gate circuit and produces the 50% duty cycle square wave output without regard to a pulse width of the trigger input. The falling slope of the input waveform is used as the reference phase. R2518 and C2517 connected to pin 21 determine the time constant of MMV(4).

The response time of the servo is shortened by making the comparison waveform 50% duty. The trigger input waveform for MMV(4) is almost 50% duty cycle in this unit but MMV(4) is utilized, since it is already available in the chip.

The integrator circuit converts the rectangular wave into a trapezoidal wave by charge and discharge of an RC network. In the record mode, the trapezoidal wave is obtained by charge and discharge of C2518. When pin 22 goes high, Q1 and Q2 in the IC are off, the 12 volt supply turns on Q3 and is supplied through a 50 ohm resistor to R2520 from pin 22. This charges C2518. When pin 22 goes low C2518 discharges through R2521. Q1 and Q2 in the IC are then on and Q3 is off. The discharge current from C2518 feeds through R2520 to pin 22, the 50 ohm resistor, the base-emitter

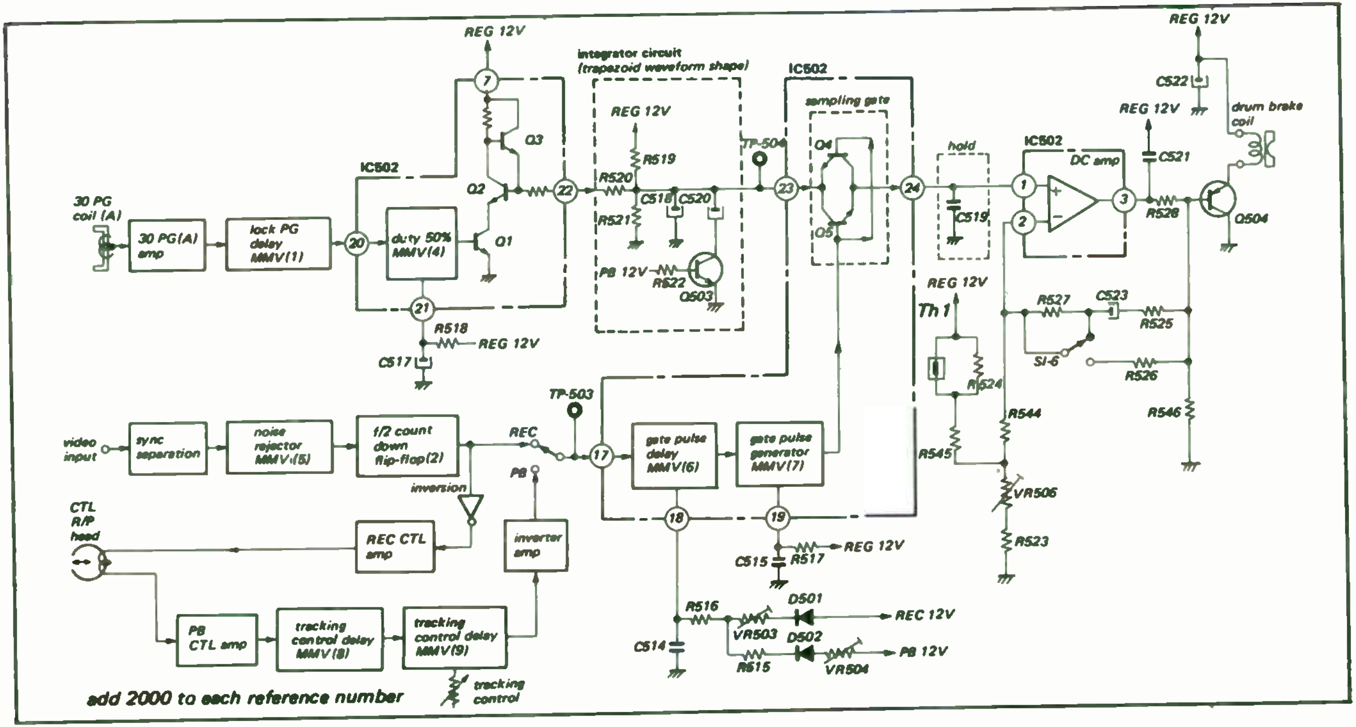


Fig. 3-10. Phase comparison gate circuit.

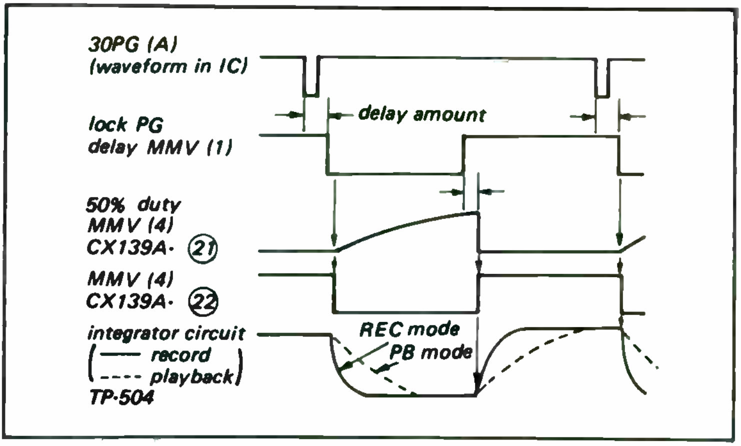


Fig. 3-11. Timing chart of trapezoidal former.

circuit of Q2, and the collector to emitter of Q1. R2519 is a biasing resistor for the dc amplifier in the later stage and raises the integrator output waveform about 6 volts dc above ground.

In the playback mode, the PB 12 volt is fed through R2522 to the base of Q2503 and the collector to emitter of Q2503 is shorted. This adds C2520 to the integrator time constant circuit. The slope of the trapezoidal waveform is reduced and the servo loop gain is reduced so that the integrator circuit does not respond to the high frequency variation contained in the playback CTL signal. The output trapezoidal waveform of the integrator circuit is fed to sampling gate. The gate pulse is produced in the MMV(6) and MMV(7). The gate pulse delay MMV(6) uses the negative going phase of the VD/CTL signal supplied to pin 17 as the reference phase and produces a constant delayed output. The RC network at pin 18 determines the time constant of the MMV(6). The time constants are switched in record and playback by D2501 and D2502. The delay amount is larger in playback than the one in record. This corrects the lock phase, because if the delay times in the MMV(6) are the same in both record and playback, the lock phase becomes incorrect due to the variation of the trapezoidal wave slope of the gate comparison waveform. The servo lock phase is adjusted by varying the delay time in MMV(6). VR2503 is used for adjusting the lock phase in recording and VR2504 in playback.

The gate pulse-former one-shot, MMV(7), is triggered by the output of MMV(6) and generates a gate pulse of constant width. R2517 and C2515 at pin 19 determines the time constant of the

MMV(7) (it cannot be observed as it is inside the chip) and is supplied to the gate sampling circuit.

The voltage held in C2519 is amplified in the dc amplifier and supplied to the brake coil driver. This dc amplifier is a type of operational amplifier (op amp). It amplifies the potential difference between pins 1 and 2, using the potential at pin 2 as the reference. This voltage is applied to pin 2 via R2544. VR2506 adjusts the bias. The output, which has the same phase as that of the input to pin 1, is obtained at pin 3. This amplifier functions as a phase compensator circuit by inserting an RC network into the feedback loop.

R2525 and C2523 from a feedback circuit for negative feedback of the output from pin 3 to pin 2 in the recording. R2527 and R2526 are added to the circuit in the playback mode to reduce the loop gain. C2522 is a high frequency bypass filter to prevent the playback rf amplifier from being interfered with by any high frequency signal flowing to the brake coil. The dc amplifier output is applied to Q2504 to drive the brake coil.

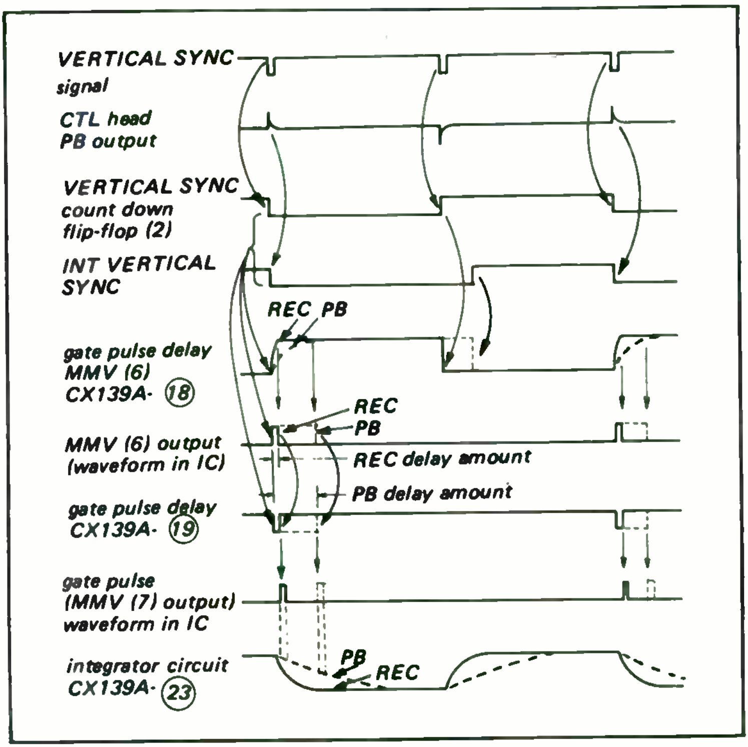


Fig. 3-12. Timing chart of gate pulse former.

SYSTEM AND PAUSE CONTROL CIRCUITS

The main function of the system control circuit is to control the mechanism during tape threading and unthreading operations, together with the subsequent control of the signal system. In this VCR the switching between function modes is mainly done by manually depressing the function buttons. Therefore, automatic controls of the mechanism by the system control are very few. What is controlled automatically by the system control circuit is the auto-stop solenoid. There are five major operations provided by the system control circuit and are as follows:

1—**Tape End Sensor.** The metallic foil attached to both the tape start and end are detected. An electrical circuit is closed driving the auto-stop circuit.

2—**Head Drum Rotation Detector.** When any of the function buttons are depressed, the system control circuit detects the head drum rotation by detecting the 30 PG pulses. If for any reason the head drum rotation should stop, the auto-stop circuit is energized.

3—**Tape Slack Sensor.** If slack tape is detected in the play or record mode, the tape must be rewound. When the tape slack is detected by the tape slack sensor element, the auto-stop circuit is energized.

4—**Auto-Stop Circuit.** Auto-stop is initiated by actuation of the devices listed in 1, 2, and 3 above. When auto-stop is initiated, the system control circuit energizes the stop solenoid to place the function mechanism into the stop mode. The ac motor power is cut off when the stop solenoid is energized.

5—**Muting Circuit.** This circuit generates audio muting and video blanking signals according to the operation of the mechanical system.

TAKE-UP SENSING COIL L6502

This coil is positioned very close to the tape in the cassette tape guide on the take-up side. It senses the tape beginning, in the rewind mode, by means of the metallic foil attached to the tape at the tapes beginning. The sensor energizes the auto-stop function.

AC MOTOR DRIVE

This is a hysteresis synchronous motor, powered by the ac line voltage. Its stability is a function of the line frequency stability. When any of the function buttons is depressed, the ac motor is powered and drives the capstan, fwd idler, fast fwd idler, rew idler, and the video head disk assembly, via a rubber belt drive.

SYSTEM CONTROL AND PULSE CONTROL CIRCUIT

The system control circuit is located on the SRP board. The complete block diagram for this board is shown in Fig. 3-13.

AUTO-STOP CIRCUIT

Whenever any of the detectors which generate the auto-stop operations senses a need to automatically stop the machine, the auto-stop solenoid is energized to release all the function buttons, putting the unit into the stop mode. The stop solenoid drive circuit is controlled by the signals generated in the respective auto-stop signal generator circuit as shown in Fig. 3-14.

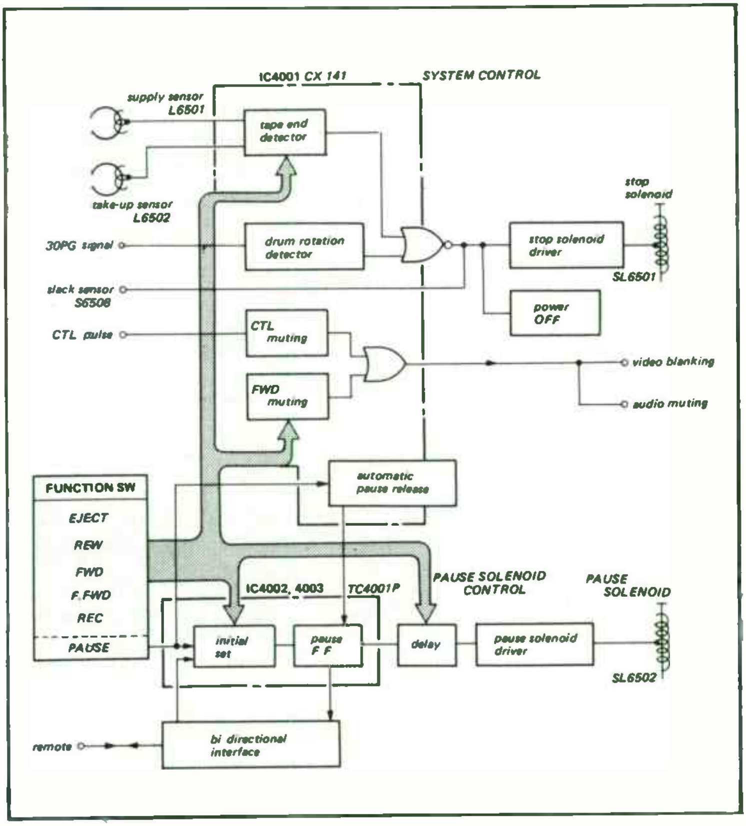


Fig. 3-13. System control and pause control block diagram.

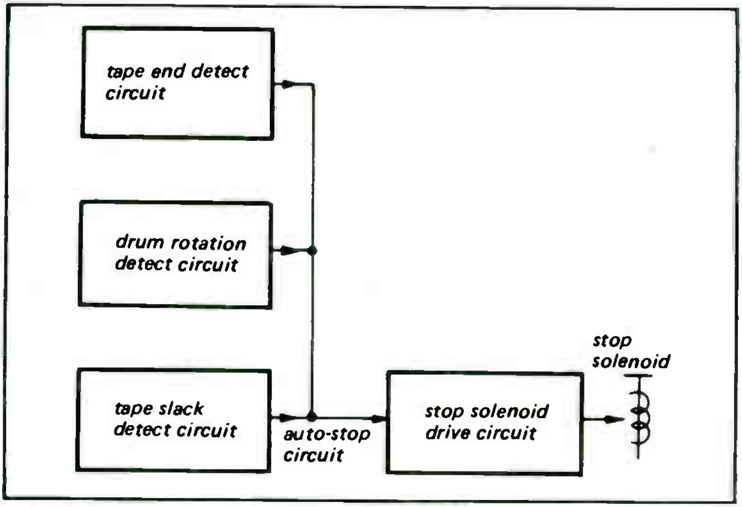


Fig. 3-14. Auto-stop circuit.

AUTO-STOP SOLENOID DRIVE CIRCUIT

The function of the auto-stop solenoid is to release the function button. The power supply for the ac motor is cut off when the auto-stop is energized. When any one of the function buttons is depressed, the button is latched mechanically by the lock slider of the function button. Release of the function button can occur in two ways: (1) manually by depressing the stop button, or (2) electrically by energizing of the auto-stop solenoid by an output from the system control (Fig. 3-15). The lock slider releases the function button in each case.

When the auto-stop solenoid is energized, the lock slider is pulled in the direction shown by the arrow in Fig. 3-15 to release the function button lock. Since the auto-stop solenoid is still energized and the lock slider remains pulled even if any one of the buttons is pushed. The ac motor does not start, even if the function button is kept depressed after the auto-stop, because the stop solenoid switch is turned on. The auto-stop solenoid drive circuit is shown in Fig. 3-16.

COUNTER MEMORY CIRCUIT

The system control of the recorder during the rewind mode is automatically placed into the stop mode by the counter memory circuit, when the tape counter reaches a 9999 indication. The counter memory circuit shown in Fig. 3-17 is included in the stop mode circuit of the tape end detector circuit. The bias voltage at pin 11 of the tape end sensor oscillator circuit is made to increase the supply voltage instantaneously when the tape counter indicates 9999. This stops the oscillation for a moment and the machine is automatically stopped. C4018, the counter switch, and the memory on/off switch are connected in parallel with R4030, bias resistor of pin 11. The counter switch located in the tape counter turns on when the tape counter reaches its (0000) position. The oscillation is stopped for the C4018 charging period when the memory on/off switch is on and the counter indication is 9999. If the rewind button is depressed once more after the machine has been automatically put into the stop mode, the rewind operation takes place because C4018 has been charged. R4601 prevents the machine from being placed into the stop mode automatically when the memory on/off switch is turned on after the tape counter reaches 9999.

DRUM ROTATION DETECTOR CIRCUIT

When normal operation cannot be performed due to motor trouble or overload, the recorder must be put into the stop mode.

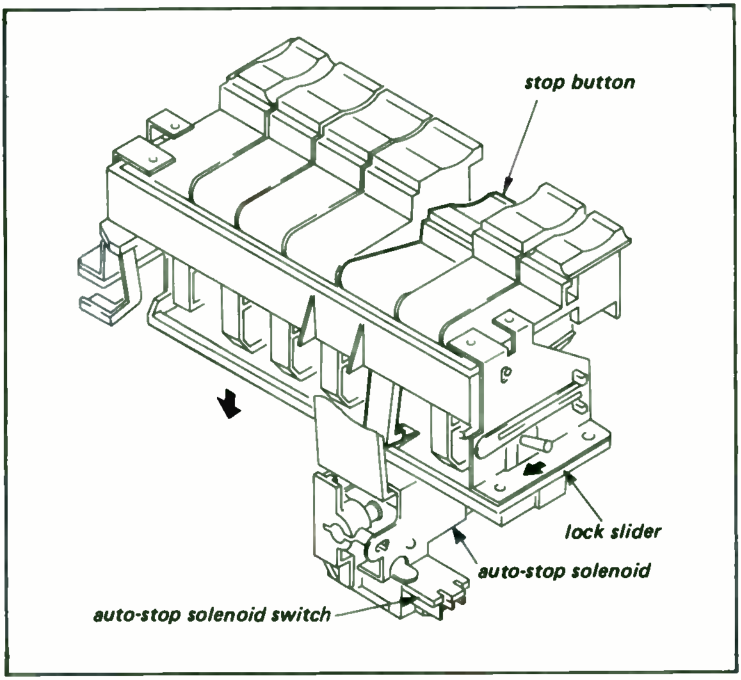


Fig. 3-15. Drawing of stop solenoid.

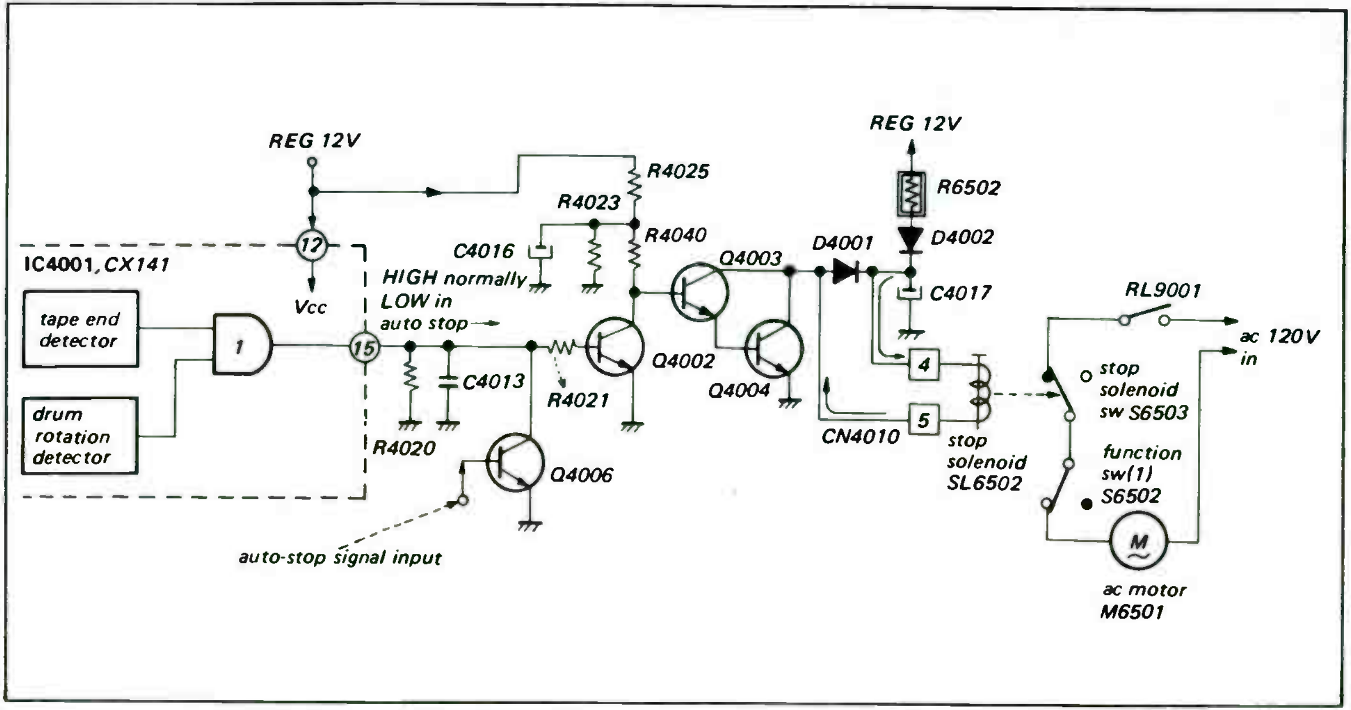


Fig. 3-16. Stop solenoid drive circuit.

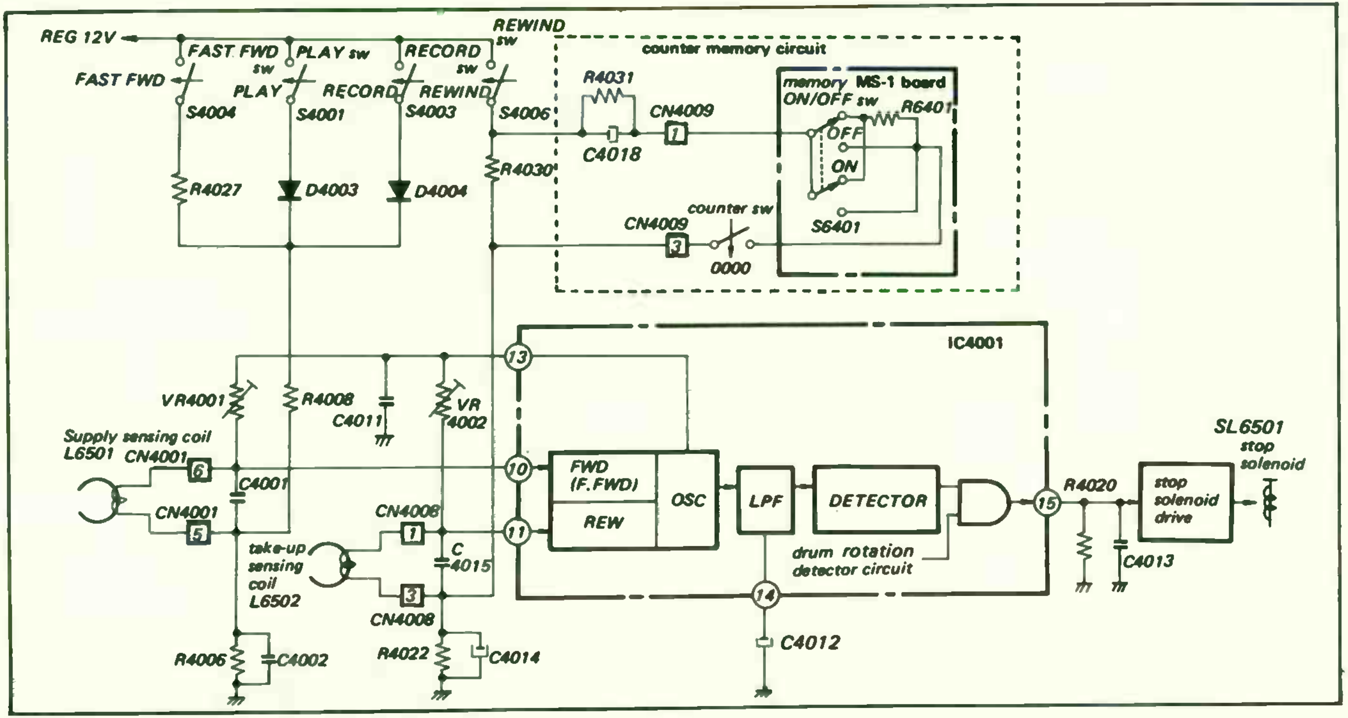


Fig. 3-17. Tape end detector circuit and memory circuit.

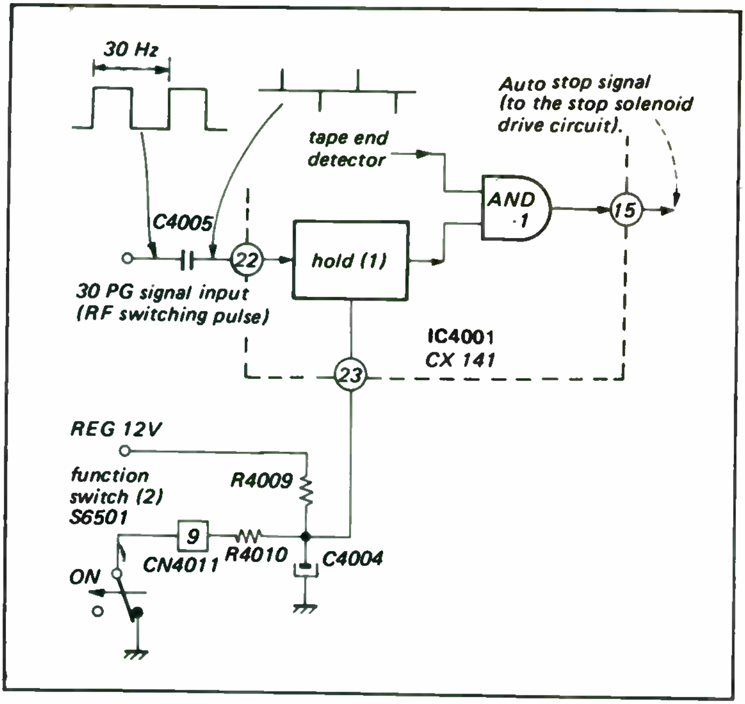


Fig. 3-18. Drum rotation detector circuit.

This is also required in the case where the head drum does not rotate due to a broken head drum belt. The drum rotation detector circuit uses the 30 PG signal to detect drum rotation. When the rotation stops, it operates the stop solenoid circuit, to place the video cassette recorder into the stop mode. The detector circuit functions when the ac motor rotates, i.e., when one of the eject, rewind, fast fwd, play, or record buttons are depressed. The schematic diagram for this circuit is shown in Fig. 3-18.

PAUSE MEMORY CIRCUIT

The pause memory circuit is located in IC4003. The four NOR gates of the IC comprise two latches for the initial set and two toggle flip-flops. The basic operation of the latch is to latch a certain state (tape running or tape stopped) and to lock the gate to ignore a change of the state. The latch operation is utilized for the initial set of the toggle flip-flop connected to the output of this machine. Gate 1 of IC4003 is connected to input P of the pause solenoid and its output is to the input of gate 2.

One of the inputs of each of gate 1 and gate 2 is a low level for (T) time. The output of gate 1 becomes P and the output of gate 2 P. The gates 1 and 2 work as inverters. Since one of the inputs of gates 1 and 2 becomes high when the latch time is (T), the inverter operation does not work, and the following flip-flop serves as an ordinary toggle type flip-flop.

The time is set for about 2 milliseconds by R4066 and C4043. Note the pause memory circuit in Fig. 3-19. The other two gates of the IC4003 chip form a toggle type flip-flop.

PAUSE SOLENOID DRIVE CIRCUIT

The pause solenoid drive circuit is formed by Q4016 and Q4017 as shown in Fig. 3-20. The pause solenoid is a two-winding three-terminal type with C (common), P (primary), and S (secondary) terminals. The winding between the C and P terminals serves for an initial pull-in, while the one between the C and S terminals works for maintenance so that any temperature increase and the pull-in power of the solenoid is reduced.

Q4016 turns on in the run state causing current flow through C-S winding through D4008, and to turn on Q4017 and Q4018 having a time constant determined by R4078 and C4046. At the same time a current flows through the C-P winding, and the initial pull-in takes place. When Q4018 turns on, the potential of the P terminal and the current between C and S is cut off. At the same time Q4017 and Q4018 turns off by the same time constant determined by R4078 and C4046. Then current flows in the C-S winding again and the pause solenoid energizing is maintained.

Q4019 connected to the base of Q4016 is delayed about 350 msec after the play or record button is pressed by the time constant circuit consisting of R4054, R4055, and C4047, and the run drive signal is bypassed during the delay (Q4019 is on for about 350 msec).

PAUSE AUTO-RELEASE CIRCUIT

The pause auto-release circuit is one of the protection circuits for the tape. The pause auto-release circuit is shown in Fig. 3-21. The pause 12V becomes a regulated voltage supply by the R4016 and R4014 resistor division. It is processed in the time constant circuit consisting of R4013 and C4006 to be a lamp voltage which increases with time in the pause mode. The lamp voltage is applied to the voltage comparator in IC4001 via pin 20. When it reaches the reference voltage in the IC, pin 21 of IC4001 goes high to set the

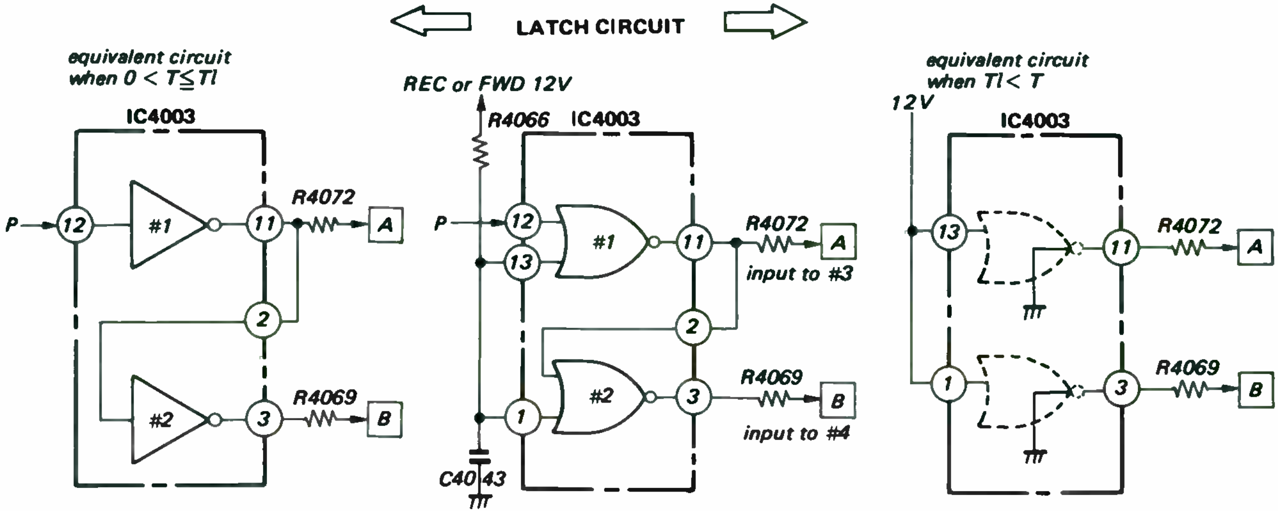


Fig. 3-19. Pause memory circuit.

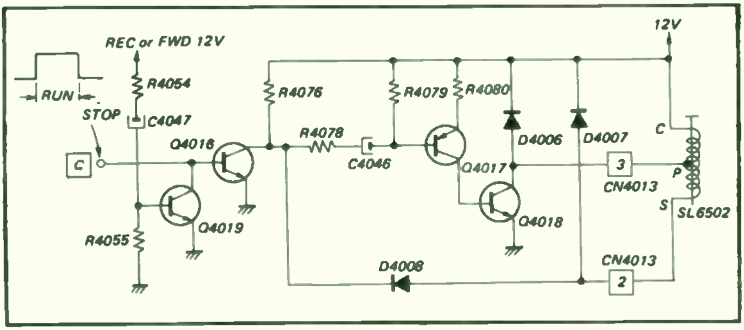


Fig. 3-20. Pause solenoid drive circuit.

pause flip-flop of IC4003 to the tape running state and release the pause state.

Resistor R4012 is for protection of the internal circuit of IC4001 and D4021. It serves to lower pin 21 to ground potential when the voltage is not applied to pin 19 in the stop mode or in the tape running state.

REMOTE CONTROL CIRCUIT

One cable in which a transmission signal and a reception signal are added is used for the remote control. The remote control block diagram is shown in Fig. 3-22. The reception signal is the control signal from the remote control to the videocassette recorder and the transmission signal is the pause signal from the recorder to the remote control. Since these two signals are transmitted with one

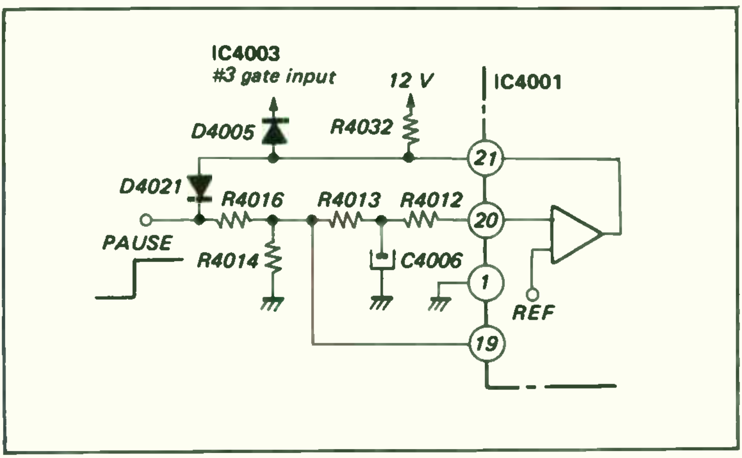


Fig. 3-21. Pause auto-release circuit.

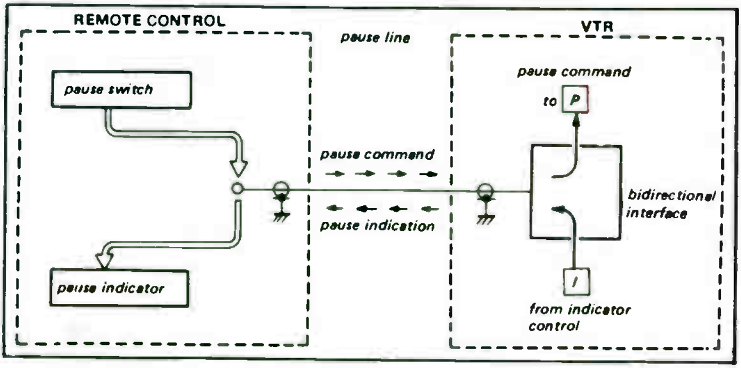


Fig. 3-22. Remote control block diagram.

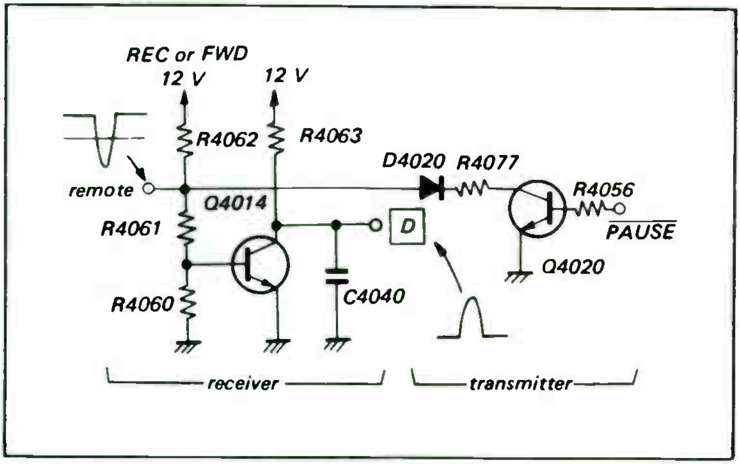
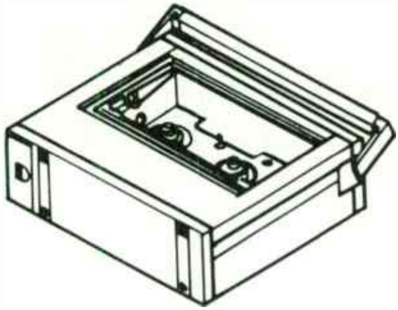


Fig. 3-23. Remote control circuit.

signal line, the reception signal is a negative pulse signal and the pause signal is a dc and three value systems.

The received remote control signal is divided by R4061 and R4060, and is applied to the base of Q4014. The threshold voltage of Q4014 is set to about 1.2 volt. When a pulse lower than the voltage comes in, Q4014 turns off and a plus trigger pulse appears at its collector. This pulse triggers the MMV formed by the two NOR gates (numbers 1 and 2 of IC4002) connected to the following stage. The MMV forms an OR circuit together with the pause switch of the recorder. Normally the output of "D" is a low level. Refer to Fig. 3-23 for the remote control circuit.

Chapter 4



Sensor Circuits and Electrical Alignment

In this chapter we will look at the various tape detector and sensor circuit operations. Will also touch on the audio record and playback circuits, and audio record/play head azimuth alignment and adjustments. Some of the most required electrical field alignment procedures will also be covered for these Sony SL-8600 and Zenith KR9000 VCR machines.

SRP SYSTEM CONTROL BOARD

The purposes of the system control and pause circuits are as follows:

1—Activate the function selected by the recorder operator.

2—Prevent damage to the tape during threading and unthreading or rotor head rotation failure, or operation of any other function.

3—Generate an audio muting and video blanking signal to keep the TV receiver's audio and CRT inactive until the tape is up to proper speed and picture is locked in.

4—Place the VCR in the pause mode on command. Refer to Fig. 4-1 for block diagram of pause and system control.

To prevent damage to the tape during any problems that may occur, the auto-stop solenoid activates, which releases the lock slider and the function buttons, and stops the VCR. The key to activation of the auto-stop solenoid is the voltage at pin 15 of IC4001

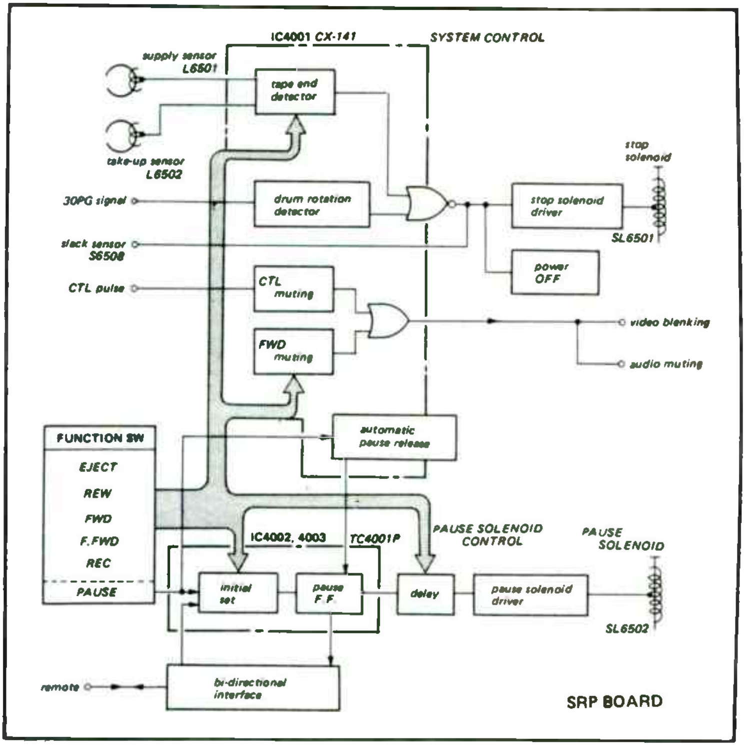


Fig. 4-1. VCR system control and pause control block diagram.

(Fig. 4-2). Whenever the output of pin 15 is high (approximately 12 volts) the auto-stop solenoid remains inactive. When pin 15 goes to low (ground) the auto-stop solenoid activates, stopping the VCR machine.

When the VCR is turned on, 12 volts is applied to pin 12 of IC4001 which puts a high on pin 15. At the same time C4017 charges to 12 volts, through D4002 and R6502. With pin 15 high, Q4002 is forward biased, putting the base of Q4003 at near ground potential, keeping it and Q4004 turned off. The auto-stop solenoid remains inactive. When pin 15 goes low, Q4002 is turned off. This allows Darlington Q4003 and Q4004 to turn on, providing a path through Q4004, for current to flow from B+ through the auto-stop solenoid, stopping the ac motor, the tape, and the video heads, releasing the selected function button.

The solenoid requires 3 amps to pull-in, which the VCR power system cannot supply. That is the function of the charge on C4017, to supply the initial pull-in current surge. After the solenoid

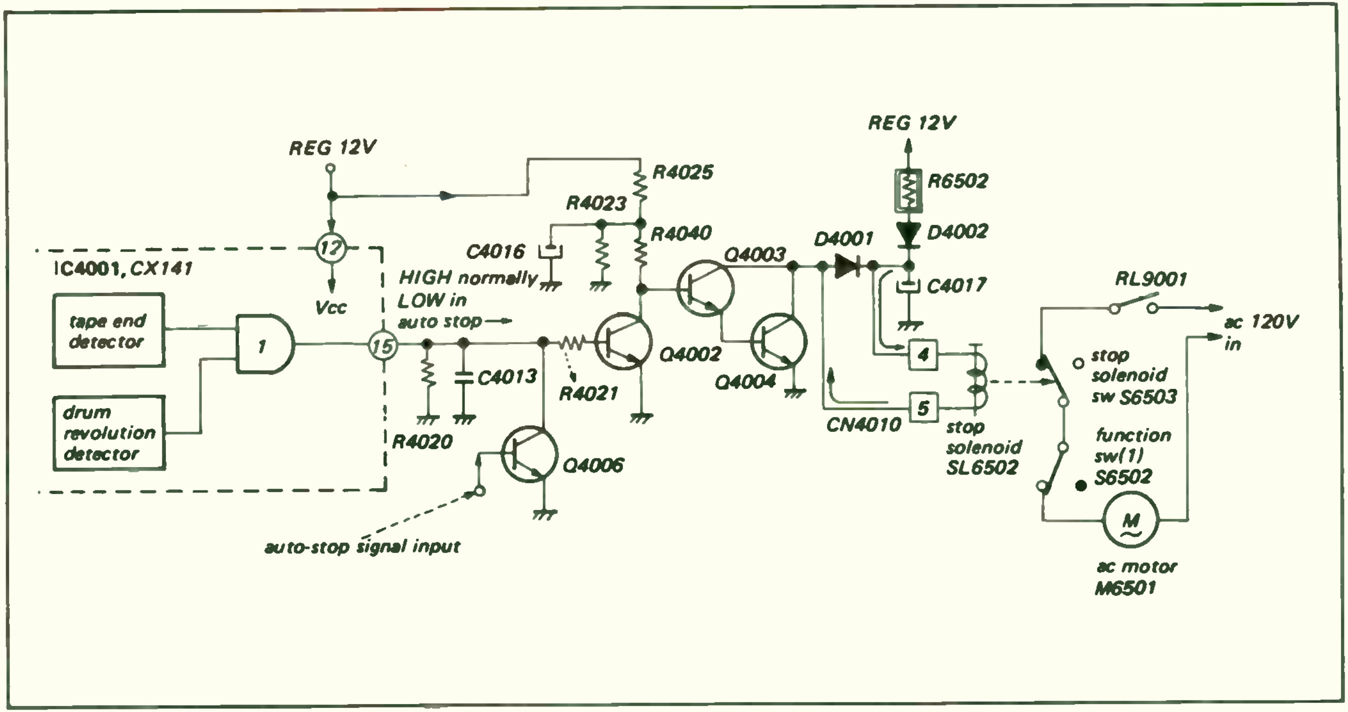


Fig. 4-2. Stop solenoid drive circuit.

pulls-in, it only requires 1 amp to hold it in. R6502 limits the current to 1 amp from the unregulated 12 volt dc supply. When pin 15 returns to a high, the circuit action once again returns to the original state, and C4017 charges up again to be ready for the next auto-stop function.

POWER FAILURE AUTO-STOP ACTIVATION

Should the power fail, it is necessary to release the tape. This requires the auto-stop solenoid to activate. When the power fails, pin 15, of course, will go low. The charge on C4016 will forward bias Q4003 and Q4004, allowing the charge on C4017 to bleed off through the stop solenoid, activating it long enough to release the tape and prevent damage.

How pin 15 of IC4001 goes low when an auto stop command occurs is explained as follows:

When either of these two modes is activated, a dc voltage is applied to pin 10 of IC4001 through either one of the switches, through R4008, through the supply sensing coil and to pin 10 of IC4001. This starts the oscillator in IC4001 and creates a feed-back loop out pin 13 of the IC through VR4001, which adjusts the amplitude of the oscillations. Then it goes back to the IC pin 10, and through the supply sensing coil, which is part of the oscillator tuned circuit, and through R4006 to ground. This signal is detected in the chip and causes a high on the input of the AND gate. The other high input to the AND gate comes from the drum rotation detector circuit. This causes pin 15 of the IC to go high and the auto stop remains inactive.

AUTO STOP AT SUPPLY TAPE END

Each end of the tape in the cassette has a metallic leader. As this leader passes over the sensing head (during play or fast/fwd), it radically changes the "Q" of the coil in the sensing head and causes the oscillator to stop. When this occurs, the output of the detector in IC4001 goes low. This causes that input to the AND gate to go low, which in turn causes the output of pin 15 of the AND gate to go low. This activates the auto-stop, causing the VCR to stop.

NORMAL REWIND OPERATION

A dc voltage is applied through the rewind switch (Fig. 4-3) when it is depressed, through R4030 and the take-up sensing coil into pin 11 of IC4001. This activates the oscillator circuit and causes

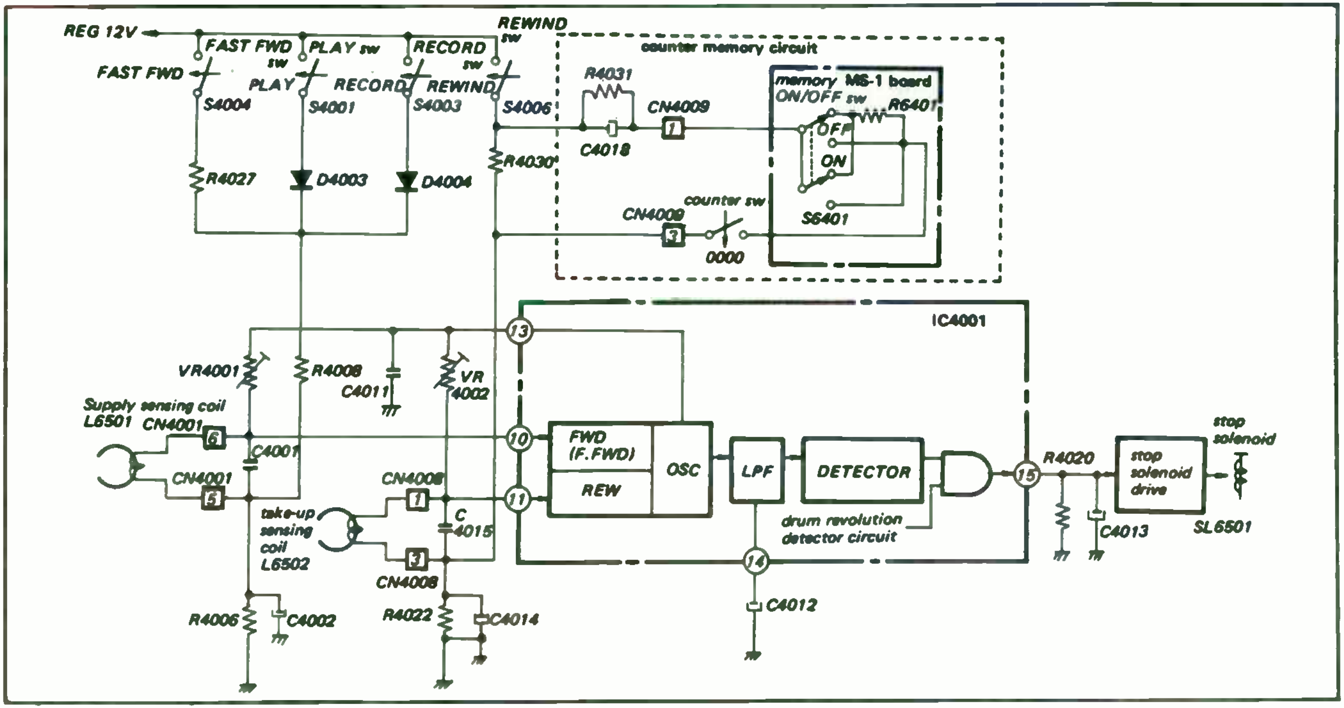


Fig. 4-3. Tape end detector and memory circuits.

a feed-back loop out pin 13 of the chip, through VR4002 and the take-up sensing coil which is part of the oscillator circuit. VR4002 adjusts the amplitude of the oscillations. The signal is passed through the detector in IC4001 and a high is applied to one gate of the AND circuit. The other gate has a high applied to it from the drum rotation detector causing a high on pin 15, keeping the stop solenoid from activating. The tape in the cassette then rewinds.

AUTO STOP AT TAKE-UP TAPE END

When the metallic leader at the end of the tape, in the rewind mode, passes over the take-up sensing coil, it causes a radical change in the "Q" of the take-up sensing coil. This causes the oscillator to stop. The detector output in IC4001 goes low, causing the AND gate output and pin 15 of the chip to go low, activating the auto-stop solenoid and, as stated before, stops the VCR. In order to thread the tape and keep the machine out of auto-stop when no function buttons are depressed, the output of the detector in the IC automatically goes to high if there is no dc bias on pins 10 or 11.

COUNTER MEMORY CIRCUIT

During the rewind mode the counter memory can be placed in the circuit by closing the memory switch. This places the circuit in parallel with R4030 and into pin 11 of IC4001. When the counter reaches 0000 the counter switch closes, allowing a large voltage, almost equal to the supply voltage, to be fed to pin 11 of IC4001. This stops the tape end oscillator, thereby initiating the auto stop mode. The oscillator stops only for as long as it takes C4018 to charge up. Then the voltage returns to the proper bias for the oscillator to run. If the rewind button is depressed a second time, the tape will rewind until it reaches the end.

DRUM ROTATION DETECTOR

When the head drum stops rotating, it activates the autostop circuit (Fig. 4-4). As the drum rotates, it develops the 30 PG pulse which is sent to pin 22 of IC4001 via C4005 from CN4003, pin 2. This pulse goes into a hold circuit which is biased-on by the regulated B+ through voltage divider R4009, R4010, out CN4011 pin 1, through S6501, and back in CN4011 pin 3 to ground.

The hold circuit in IC4001 causes a high on its output which goes to the same gate the tape end sensor circuit connects to. This, in turn, will cause a high on pin 15, keeping the auto-stop circuit

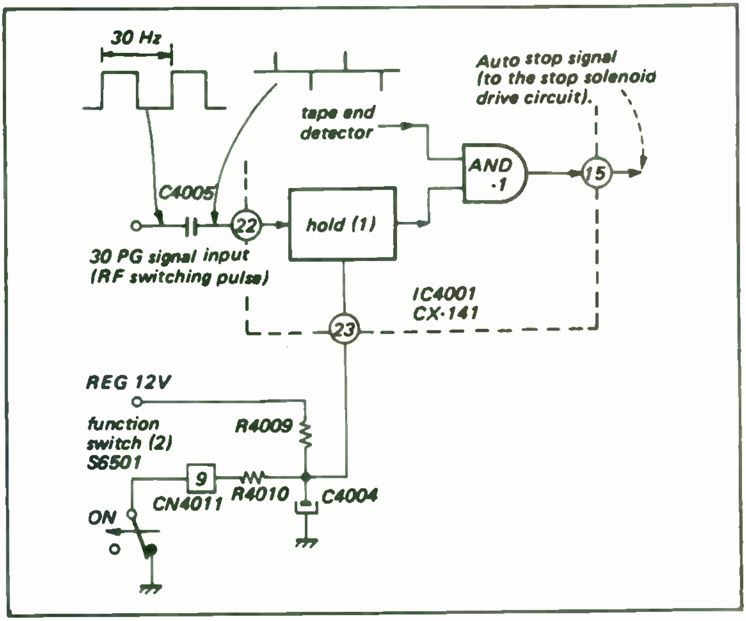


Fig. 4-4. Drum rotation detector circuit.

inactive. If the drum should stop rotating, it will cause the 30 PG pulse to disappear, which will cause a low at the output of the hold circuit, causing pin 15 to go low, activating the auto-stop mode.

TAPE SLACK SENSOR

Whenever tape slack occurs, in the play and record modes only, the auto-stop circuit will be activated. Note this circuit in Fig. 4-5. Whenever slack occurs in the tape, the tape slack lever will move in toward the head drum assembly, closing reed switch S6508 mounted on the TK board. This allows the 12 volt regulator voltage to go from the CP3 board out CN5001, pin 1, through S6508, back in CN5001, pin 3, out CN5004, pin 10, back into the SRP board at CN4004, pin 3, through voltage divider R4033 and R4034 to ground. The voltage developed at the top of R4033 forward-biases Q4006, turning it on. This causes a near zero resistance from collector to emitter ground thereby placing the voltage on pin 15 of IC4001 at ground, or low, activating the auto-stop circuit.

BLANKING AND MUTING CIRCUIT

The VCR is permanently video-blanked and audio-muted in all

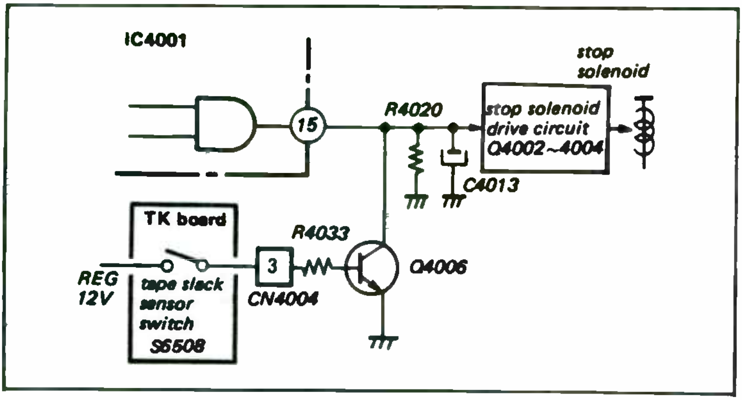


Fig. 4-5. Tape slack sensor switch.

modes, except play, record and E to E. Note the video blanking circuit in Fig. 4-6. With no input to pin 9 or pin 2 of IC4001, the inputs (1) and (2) to the AND gate are high and the output at pin 18 of IC4001 is high, causing the video to blank and the audio to mute. When the play mode is activated, the tape starts moving and the CTL pulse is applied to pin 9 of IC4001, causing a low at pin (1) of the AND gate.

When the play button is depressed, the 12 volts PB voltage is applied to pin 2 of IC4001. However, the input to pin (2) of the AND gate is delayed (remains high) for 3.5 seconds, by R4007 and C4003 on pin 24 of IC4001 and the delay circuit inside the IC. This keeps pin 18 high, keeping the video blanking and audio muting on. At the end of the 3.5 second delay, the voltage at pin (2) of the AND gate goes low. This puts pin 18 at a low, thereby releasing the video blanking and audio muting. If at any time either or both the CTL pulse and the PB 12 volt were to be removed, a high would occur at either or both inputs to the OR gate, causing pin 18 to go high and activating the video blanking and audio muting.

Since no blanking or muting at all is desired when the record mode is activated, EE 12 volts is applied to the base circuit of Q4005 when the record button is pushed, which forward-biases this transistor, thereby effectively shorting out the voltage on pin 18 of the IC and immediately releasing all blanking and muting.

AUDIO RECORD MODE

The audio information that is available for recording comes from either a separate outside source (through the audio in jack, or

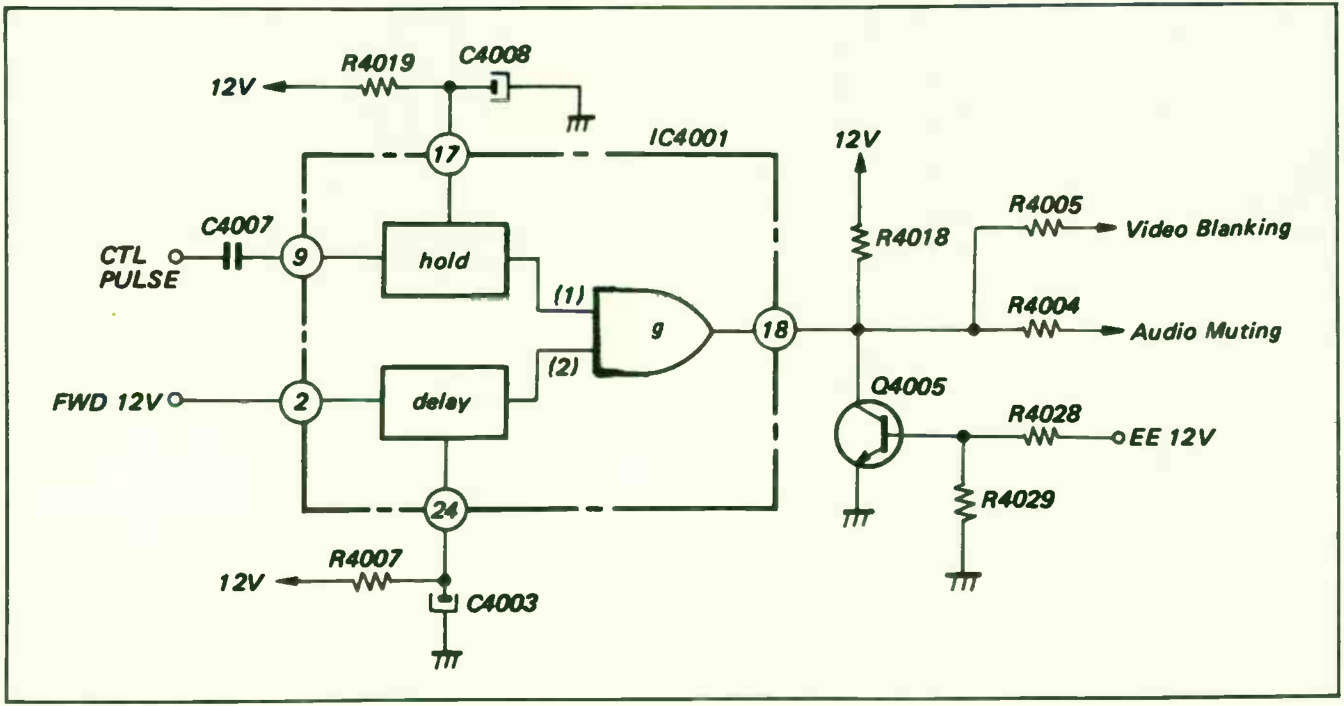


Fig. 4-6. Blanking and muting circuit.

from the i-f-4 board). The latter case is the most used mode of operation. The audio signal portion of a TV program is recovered from the i-f signal within the i-f-4 board. Refer to block diagram in Fig. 4-7. Whatever the audio signal source, it is coupled to and through the CP-3 board to the ARS board.

Audio amplification circuits within the ARS board process the signal and connect it to the audio head. The information is transferred to the tape as a longitudinally recorded track.

AUDIO PLAYBACK MODE

On playback the audio head picks up the recorded audio information from the tape's audio track and routes it to the ARS board. Amplification is accomplished and the audio signal is connected, out of the ARS board, to and through the CP-3 connection board.

The audio information is available at the audio out jack at the rear of the VCR machine (for connection to a TV monitor). Audio is also coupled from the CP-3 board to the rf modulator for development of the vhf out signal.

VCR ELECTRICAL ALIGNMENT

The following is information for the electrical alignment for various circuits found in this machine. These adjustments can be performed by the test equipment listed below and a TV signal obtained from a TV receiver.

Test Equipment Required

- Color TV receiver
- Oscilloscope—dual-trace—more than 15 MHz with a delay mode
- Frequency counter (more than four digits)
- VTVM or FET meter
- Voltohmmeter (20 k ohm/volt)
- Audio signal generator
- Audio attenuator
- Alignment and/or test tape—Sony KR5-1D
- Insulated alignment tool

Alignment Set-Up

Connect antenna or cable to the vhf input terminals on rear of the VCR machine. Since the signal received through the tuner in the VCR is utilized as the adjustment signal for the alignment of the machine, it is important that the video output signal satisfies these specifications. The VCR should be set to the channel with the best reception. The video signal should be checked with an oscilloscope connected to the Q9 emitter on the YC-2 board. Verify that the sync signal amplitude is approximately 0.3 volt P-P and the video signal amplitude is near 0.7 volt P-P. Adjust the fine tuning while observing the signal and the TV screen so that the burst signal amplitude becomes 0.3 volt ± 0.1 volt P-P. Also confirm that there are no spikes observed at the sync signal portion. Note this video output signal in Fig. 4-8.

VCR Alignment Tool

The semi-fixed variable resistors and inductances should be adjusted with an insulated alignment tool. A common screwdriver is too large for adjusting the controls from the conductor side of the PC board, plus it will detune the circuits. The proper alignment tool is shown in Fig. 4-9. The metal blade of the alignment tool is used for variable resistors and trimmer capacitors, and the plastic tip is used for variable inductances.

System Control Alignment and Checks

This adjustment requires the alignment tool. The correct alignment will not result if a common screwdriver is used.

Supply Sensor Oscillator Level Adjustment

1—Insert a video cassette.

2—Connect scope to TP1.

3—Set up the play mode.

4—Adjust VR1 for a 3.1 ± 0.2 volt (P-P) oscillator output level at TP1.

5—Place the machine into fast fwd mode and confirm that the voltage is almost the same as in the play mode.

Take-up Sensor Oscillator Level Adjustment

1—Insert videocassette.

2—Connect the scope to TP2.

3—Set up the rewind mode.

4—Adjust VR2 for an oscillator output level of 3.1 ± 0.2 volts (P-P) at TP1.

Threading Check

1—Insert the cassette.

2—Check that the threading operation is performed correctly. The threading time should be 2.5 seconds.

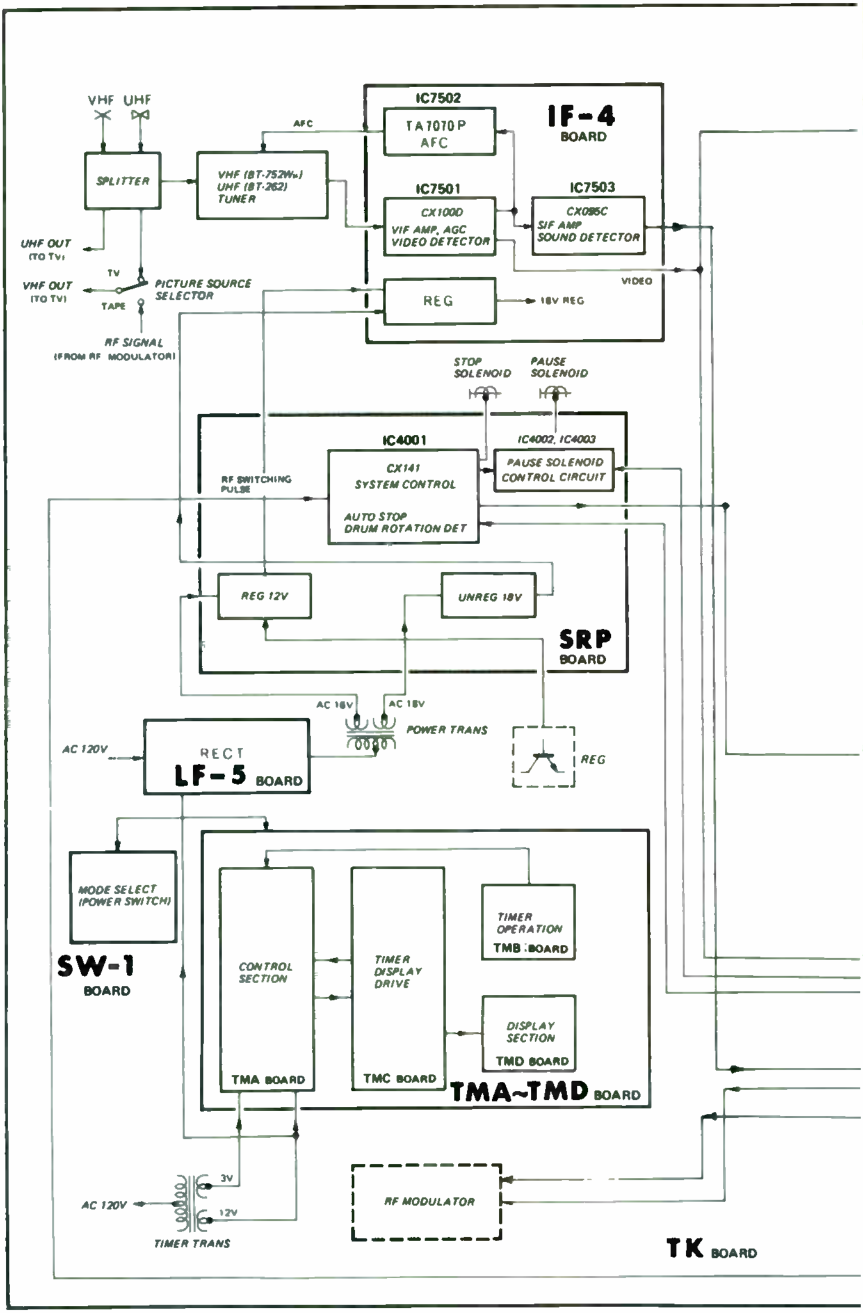
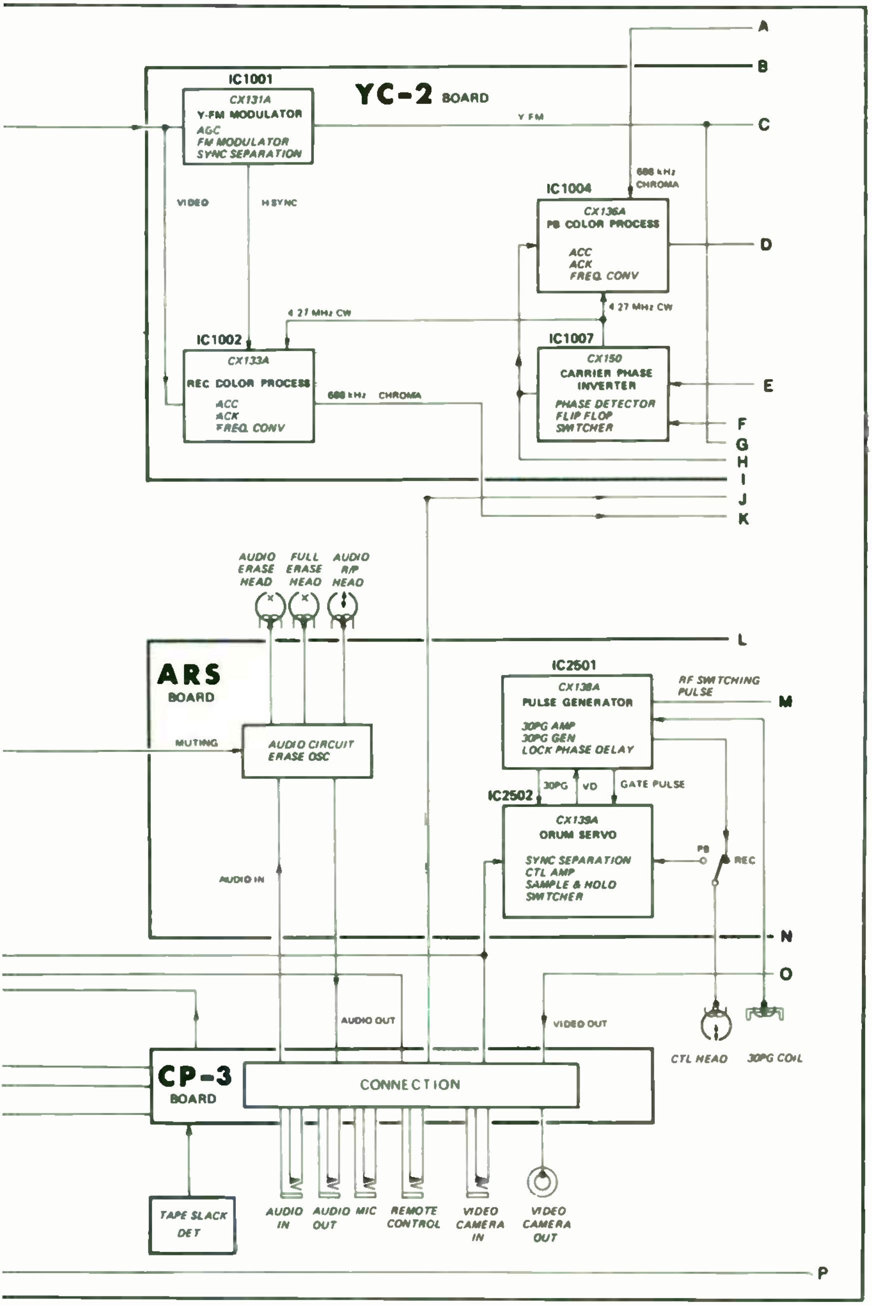


Fig. 4-7. Block diagram showing audio circuits in VCR.


YC-2 BOARD
IC1001
CX131A
Y-FM MODULATOR
AGC
FM MODULATOR
SYNC SEPARATION
Y FM
VIDEO
H SYNC
IC1004
CX136A
PB COLOR PROCESS
ACC
ACK
FREQ. CONV
688 kHz CHROMA
4.27 MHz CW
IC1002
CX133A
REC COLOR PROCESS
ACC
ACK
FREQ. CONV
688 kHz CHROMA
IC1007
CX150
CARRIER PHASE INVERTER
PHASE DETECTOR
FLIP FLOP
SWITCHER
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
AUDIO ERASE HEAD
FULL ERASE HEAD
AUDIO R/P HEAD
ARS BOARD
MUTING
AUDIO CIRCUIT
ERASE OSC
AUDIO IN
IC2501
CX138A
PULSE GENERATOR
30PG AMP
30PG GEN
LOCK PHASE DELAY
RF SWITCHING PULSE
30PG
VD
GATE PULSE
IC2502
CX139A
DRUM SERVO
SYNC SEPARATION
CTL AMP
SAMPLE & HOLD
SWITCHER
PB
REC
AUDIO OUT
VIDEO OUT
CTL HEAD
30PG COIL
CP-3 BOARD
CONNECTION
TAPE SLACK DET
AUDIO IN
AUDIO OUT
MIC
REMOTE CONTROL
VIDEO CAMERA IN
VIDEO CAMERA OUT

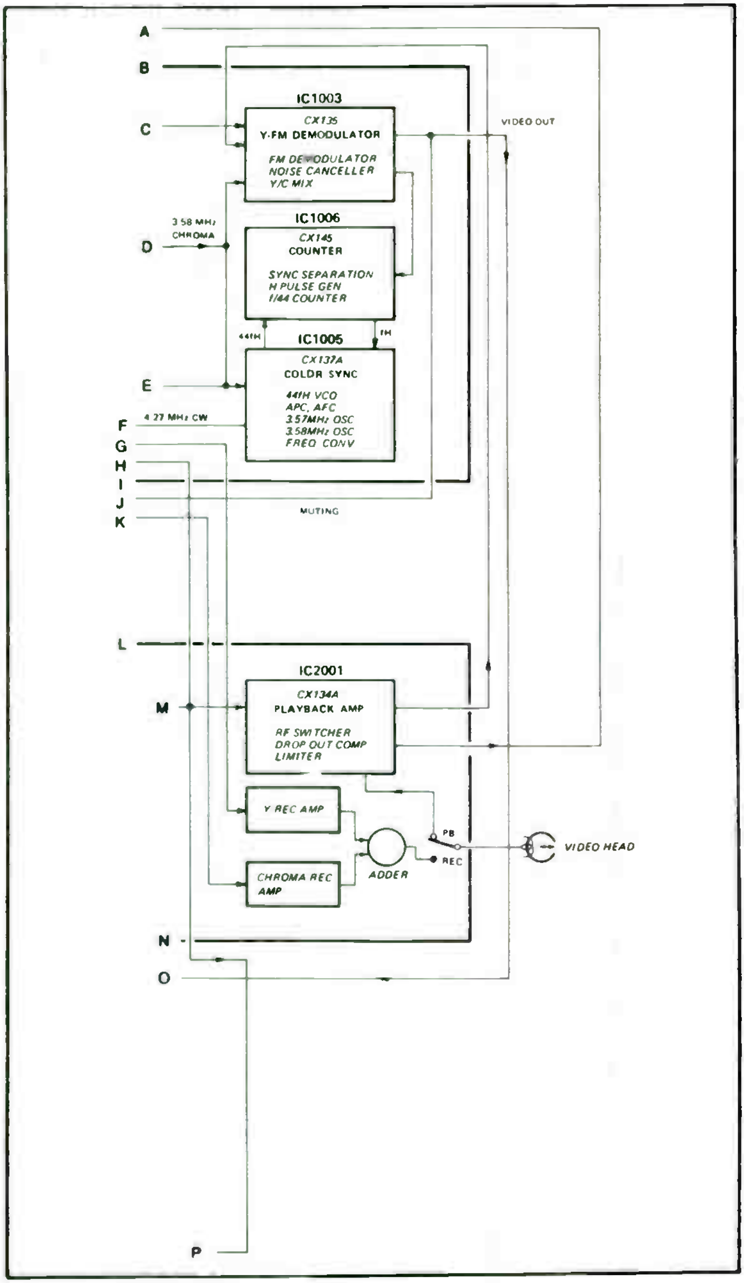


Fig. 4-7. Block diagram showing audio circuits in VCR. (Continued from page 147.)

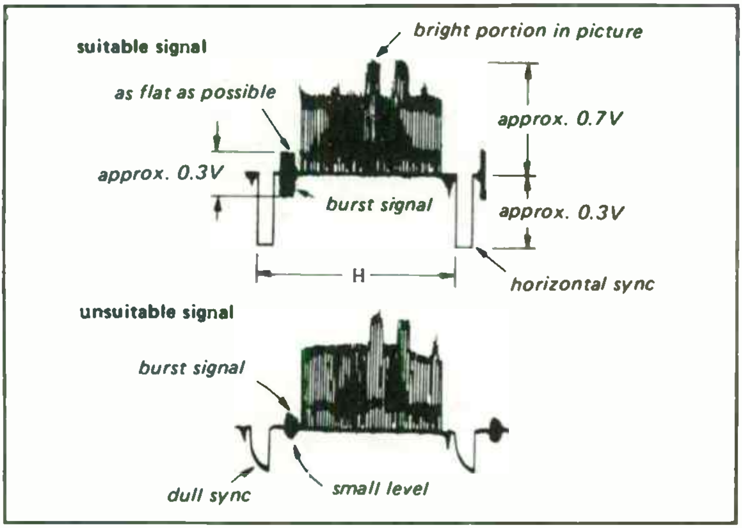


Fig. 4-8. TV video output signal.

Auto-stop check

1—Check that the auto-stop is set up at the metal tape portion in the play or fast forward mode.

2—Check to see that the auto-stop operates when the metalized leader on the tape passes the take-up sensing head in the rewind mode.

Counter Memory Check

1—Turn on the memory on/off switch.

2—Check that the auto-stop is set up during the counter indication from 0000 to 9999 in the rewind mode.

3—Check and see that the rewind mode is set up with the rewind button depressed after the auto-stop.

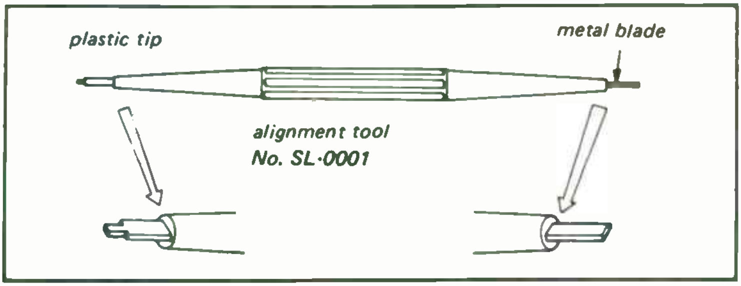


Fig. 4-9. VCR alignment tool.

4—Check that the auto-stop is not set up when the memory on/off switch is in the off position.

Power Switch Off Check

1—Put the VCR in the record mode. Check that the stop solenoid energizes and the function button is released when the power switch is turned off or switched to (off) from the timer.

2—Check that the function button is released in the play, fast fwd, or rewind mode when the power switch is turned off.

Pause Solenoid Check

1—Check that the pause solenoid energizes and the tape runs when the play button is depressed.

2—The pause lamp lights when the pause button is depressed and then the play button is depressed.

3—Connect the remote pause control unit to the remote pause terminal. Perform checks (1) and (2) as well as the pause button of the machine.

4—Set up the record mode and perform step (1) through (3) listed above.

5—Put VCR in the play or record mode and check that the tape moves forward and stops for every pushing of the pause button.

6—Turn off the power switch and depress the play (or record) button to lock the button. Check that the play or (record) mode is setup and the tape is taken up when the power switch is turned ON.

Eject Mode Check

1—Check that the unthreading operation starts after the ac motor speed increases when the eject button is depressed.

2—Check that the supply reel has stopped, and the cassette is lifted up after the take-up reel has taken up the tape completely. (Verify that the tape is taken up completely though the take-up reel cannot actually be seen.)

3—Check for correct unthreading speed.

Eject time: about 3 seconds after the eject button is depressed.

Drum Servo and Pulse System Alignment (ARS Board)

Alignment sequence is as follows (Fig. 4-10):

1—Drum free speed check.

2—Dc amplifier bias adjustment.

3—Rf switching position adjustment.

4—Record-servo lock phase adjustment.

5—Playback CTL signal check.

Drum Free Speed Check With a Frequency Counter

1—Set VCR tuner to an unused channel.

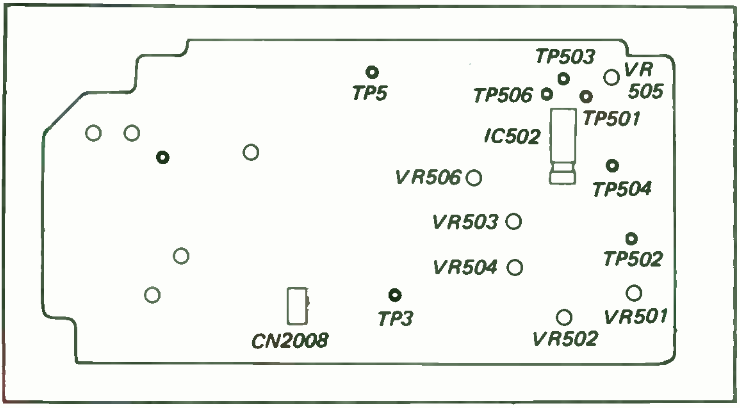


Fig. 4-10. Test point location on ARS board, component side.

2—Remove connector CN2008 connecting the brake coil.

3—Connect a frequency counter to TP502. See (Fig. 4-10).

4—Place the machine into the record mode. Verify that the counter reading is 30.68 to 30.53 Hz.

5—If not, check for stretched or worn drum drive belt. When there is no problem with the drum drive belt, change the drum pulley with a different diameter pulley in order to obtain the right specification.

6—Re-connect the CN2008 connector removed in step (1) after these checks.

When a Frequency Counter Is Not Available

1—Use a station signal from the VCR's tuner.

2—Insert a videocassette.

3—Disconnect plug from the brake coil.

4—Connect a scope to TP502, set the horizontal axis knob of the scope to 2 ms/cm, and trigger the scope from TP503.

5—Set the VCR in the record mode.

6—Confirm that it takes 20 to 27 seconds for the waveform shown in (Fig. 4-11) to move fifteen times to the left.

7—If not, check for faulty drive belt. If drive drum belt is good, then change the drum pulley with a different diameter pulley in order to obtain the correct speed.

8—Connect the brake coil plug disconnected in step (3) after this check.

Dc Amplifier Bias Adjustment

1—Tune in a TV station with the VCR tuner.

2—Insert a cassette and set up the record mode of VCR.

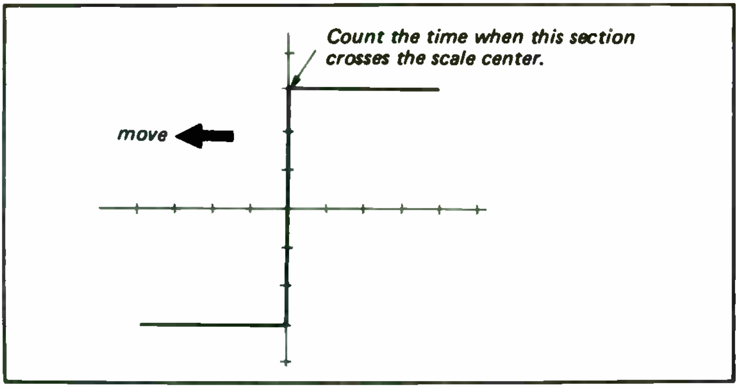


Fig. 4-11. Drum free speed check.

3—Connect the scope to pin 1 of IC502 and set it to the dc range. Trigger the scope externally from TP502.

4—Adjust VR506 for a dc level of 3.5 Vdc. Note waveform shown in Fig. 4-12.

Rf Switching Position Adjustment

1—Play back the color bar portion of the alignment tape.

2—Connect the scope to TP5 and trigger it externally from TP502.

3—Set the tracking control for maximum amplitude of the rf signal at TP5.

4—Adjust the vertical hold control of the TV monitor so that the vertical blanking portion appears on the screen.

5—Adjust the contrast control so that the sync portion of the blanking period is observed. The blanking period is arranged with front porch (3H), sync (3H), and back porch (13 to 15 H) from the top as shown in Fig. 4-13.

6—Adjust VR501 and VR502 so that the interval between the switching position and the blanking is the same as the width of the

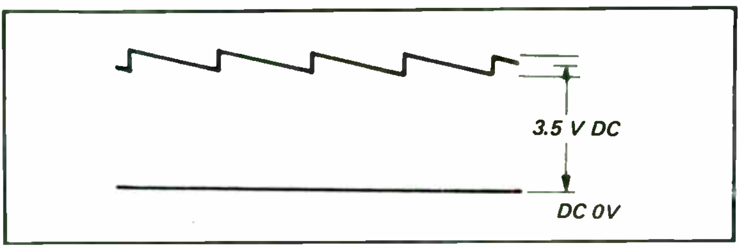


Fig. 4-12. Dc amplifier bias adjustment waveform.

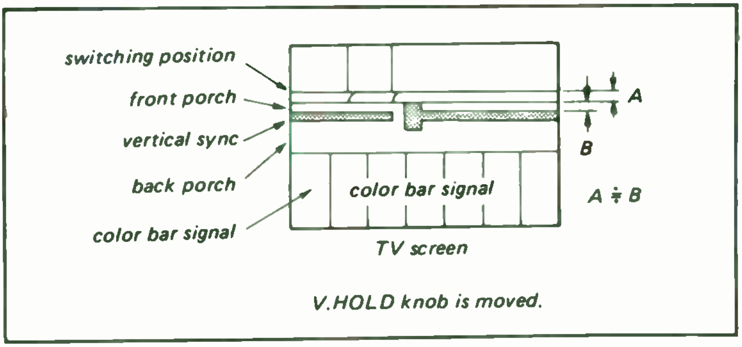


Fig. 4-13. Rf switching position adjustment.

front porch. VR501 is for the adjustment of the switching position of the 30 PG (B) and VR 502 for the 30 PG (A) switching position. When both of the switching positions are adjusted correctly, the positions are superimposed on the screen.

Record-servo Lock Phase Adjustment

1—Receive a TV station via the VCR tuner.

2—Insert the cassette and place the machine into the record mode.

3—Connect the scope to TP502 and trigger it externally from TP502.

4—Set the scope horizontal time base generator to 2 ms/cm, the horizontal sweep to ×10 (or ×5 MAG), and the scope trigger slope to (+). Adjust the scope horizontal position control until the negative-going edge of the waveshape is positioned at the exact center of the scale. See Fig. 4-14A.

5—Remove the scope probe from TP502 and connect it to IC502 pin 6. Adjust VR503 so that there are 7 horizontal sync pulses (±2 H) between the scope scale center and the beginning of the vertical sync as shown in Fig. 4-14B.

Playback CTL Signal Check

1—Tune in a TV station through the VCR tuner.

2—Insert the cassette and perform a recording for a few minutes.

3—Rewind and play back the portion on which the recording was made in step 2.

4—Connect the scope to TP506 and confirm that the CTL signal shown in Fig. 4-15 is obtained.

Tracking Control Set

1—Tune in a TV station with the VCR tuner.

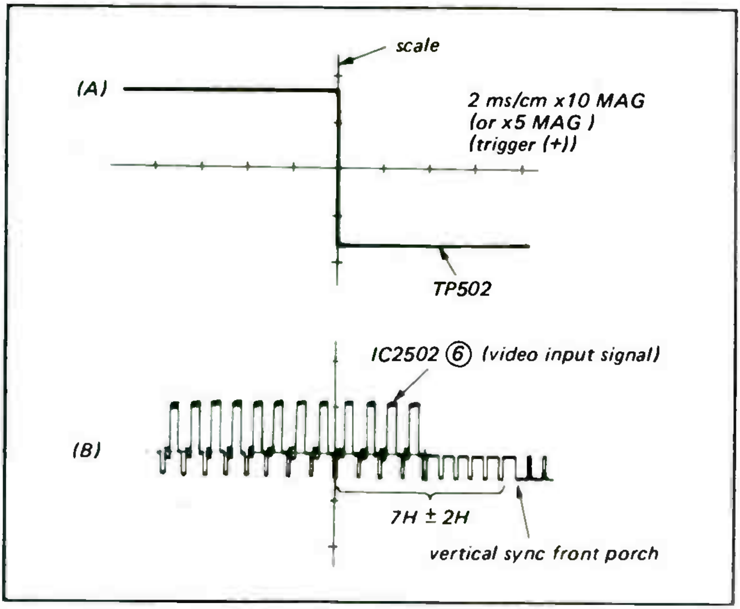


Fig. 4-14. Record-servo lock phase adjustment.

2—Insert the cassette and make a recording for several minutes.

3—Play back the recorded portion. Set the tracking control knob to the center detent position.

4—Connect the scope to TP501 and trigger it externally from TP503.

5—Set the scope trigger slope to (–), the horizontal time base to 0.5 ms/cm, and adjust the horizontal position knob so that the beginning of the waveform is positioned at the left end of the scale. See waveform in Fig. 4-16.

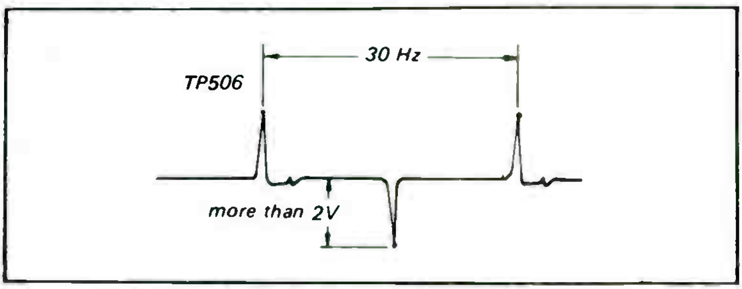


Fig. 4-15. Correct playback CTL signal.

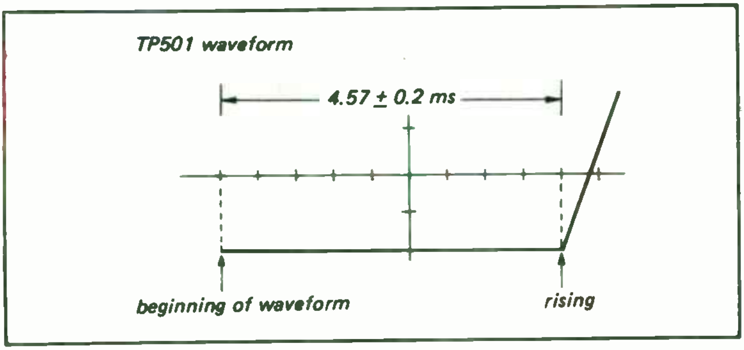


Fig. 4-16. Tracking control set.

6—Adjust VR505 so that the rising portion of the waveform is at the position shown in Fig. 4-16.

Play-servo Lock Phase Adjustment

1—Use station signal from the VCR tuner.

2—Insert a cassette and perform a recording for several minutes.

3—Play back the recorded portion. Set the tracking control to its center detent position.

4—Connect a scope to TP501 and trigger it externally from test point TP502.

5—Set the scope trigger slope to (–) and the horizontal time base to 0.5 ms/cm. Adjust horizontal position control so that the beginning of the waveform is positioned at the left end of the scale.

Playback System Alignment

For the playback rf amplifier frequency response adjustment (ARS board) the CH-A and CH-B amplifiers require independent frequency response adjustments. The adjustments for CH-B is indicated by parentheses.

1—Play back the rf sweep portion of the alignment tape.

2—Connect the scope to TP5 and trigger it externally from TP502.

3—Adjust the tracking control for the largest rf output.

4—Set the horizontal time base of the scope to 2 ms/cm. Select negative (–) trigger slope to observe the CH-A signal and positive (+) trigger slope to observe the CH-B signal. The rf sweep portion has frequency markers at 1 MHz, 2 MHz, 3.58 MHz, 4.5 MHz, and 5.1 MHz from left to right.

5—Set VR2 (VR1) to fully ccw position as viewed from the component side and VR7 (VR6) to the fully cw position.

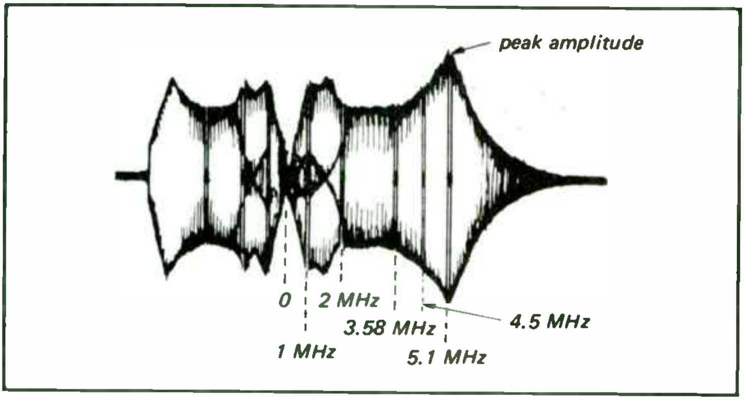


Fig. 4-17. Playback amplifier frequency response waveform.

6—Adjust VC2 and (VC1) so that the waveshape peak amplitude (tuned frequency) is located at the 5.1 MHz ± 0.1 MHz. Refer to waveform in Fig. 4-17.

7—Adjust VR2 (VR1) and VR7 (VR6) so that the waveform between the 2 MHz and 4.8 MHz markers is as flat (± 1 dB) as possible. Note the waveform in Fig. 4-18.

8—Set the scope time base generator to 5 ms/cm and adjust VR5 to equalize the levels of CH-A and CH-B at 3.58 MHz.

Dropout Compensator
Threshold Level Adjustment (ARS Board)

1—Play back any prerecorded tape known to have many dropouts.

2—Turn VR8 fully clockwise cw as viewed from the circuit board side so that dropouts appear on TV sets screen.

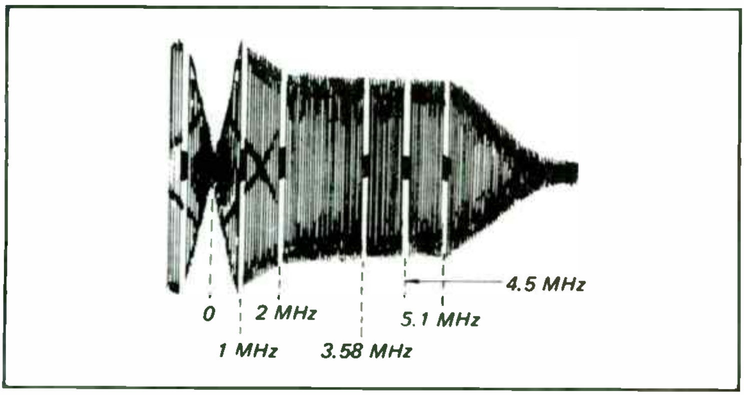


Fig. 4-18. Playback amplifier frequency response.

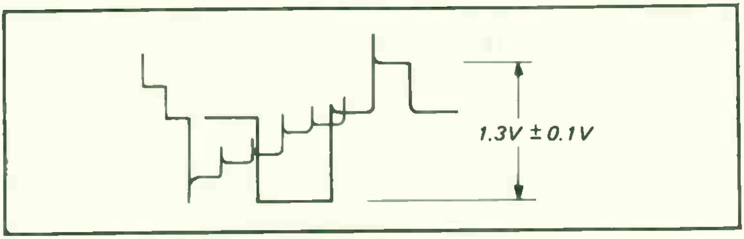


Fig. 4-19. Playback video output level adjustment.

3—Turn VR8 counterclockwise slowly until the dropouts disappear. Set VR8 to that point.

4—Rewind the tape and play back the tape. Confirm that the dropouts are compensated for at the section where they appeared.

Playback Video Output Level Adjustment (YC-2 Board)

1—Play back the color bar segment of the alignment tape.

2—Connect the slope to the emitter of Q25. Trigger the scope externally from pin 12 of IC7.

3—Set VR21 for 1.3 volt P-P ± 0.1 volt. Note waveform shown in Fig. 4-19.

4—Connect the scope to the emitter of Q9 and adjust VR8 for a 1 ± 0.1 volt reading. Refer to waveform in Fig. 4-20.

VCO Oscillator Frequency Adjustment (44 fH)

This adjustment is located on the YC-2 board.

1—Use an off-the-air station signal and set-up the E-E mode.

2—Short pins 5 and 6 of IC5 on the YC-2 board with a jumper lead.

3—Connect a frequency counter to pin 11 of IC5.

4—Adjust VR13 for a counter reading of 692.308 kHz ± 2 kHz.

5—Remove the jumper lead connected in step (2) and confirm with a counter reading of 692.308 kHz.

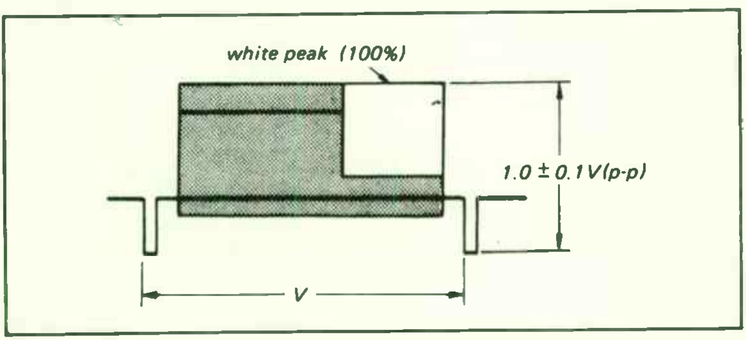


Fig. 4-20. Playback video output level waveform adjustment.

3.57 MHz VXO Free Running Frequency Adjustment (YC-2 Board)

1—Tune in a TV station signal and set up the E-E mode.

2—Connect the frequency counter for the junction of R109 and T14.

3—Turn the core of oscillator transformer T12 until the counter reads the frequency of 4,267,919 ± 5 Hz. T12 can be adjusted from the component side with the alignment tool.

3.58 MHz Osc Frequency Adjustment (YC-2 Board)

1—Use an off-the-air TV station signal and set up the VCR in the E-E mode.

2—Connect the frequency counter to the emitter of Q5.

3—Turn the core of T11 until the counter reads 3.57545 kHz ± 5 Hz.

VCR Audio System Adjustment

The connections of the equipment for VCR audio adjustments are shown in Fig. 4-21.

Adjustment sequence:

1—Azimuth adjustment.
2—Playback frequency characteristic adjustment.
3—Playback output level adjustment.
4—Bias oscillator check.
5—Bias trap adjustment.
6—Record bias adjustment.
7—Record current adjustment.
8—Overall frequency characteristic check.
9—AGC operation check.
10—S/N Ratio check.
11—Distortion check.

Audio Head Azimuth Adjustment

1—Terminate the audio out terminal with a 100 k ohm resistor and connect an ac VTVM.

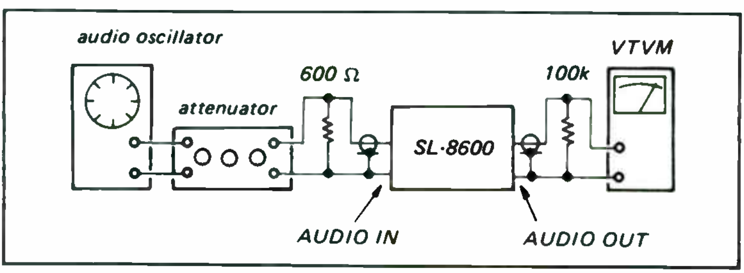


Fig. 4-21. Connections for audio test equipment.

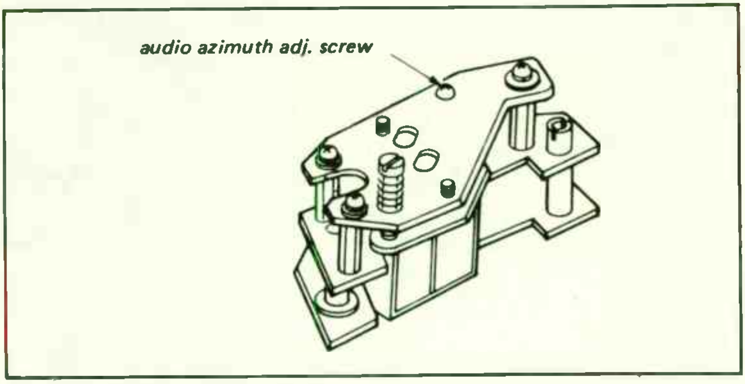


Fig. 4-22. Audio head azimuth adjustment.

2—Play back the 5 kHz portion of the alignment tape.

3—Adjust the azimuth adjustment screw on the audio head for a maximum VTVM reading. See adjustment location in Fig. 4-22.

Playback Audio Frequency Characteristic Adjustment

1—Terminate the audio line output terminal with a 100 k ohm resistor and connect an ac VTVM. Note test instrument setup and adjustment locations in Fig. 4-23.

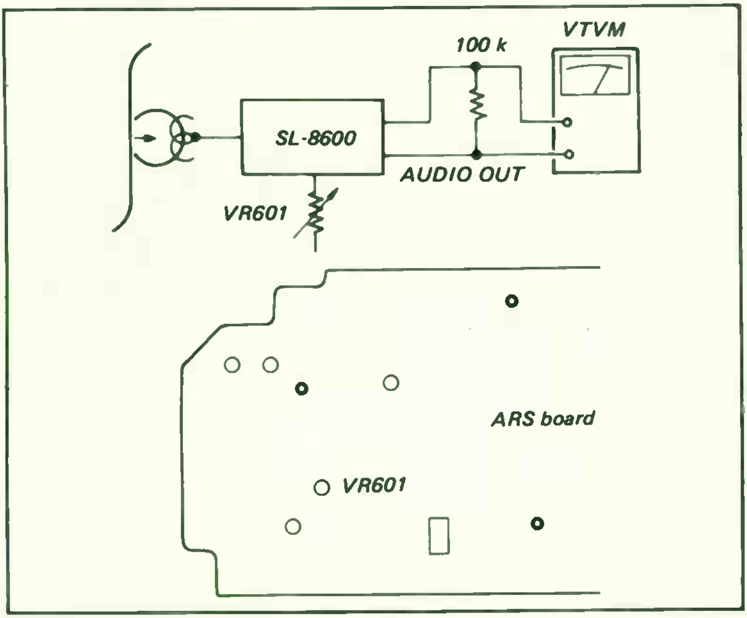


Fig. 4-23. Playback frequency characteristic adjustment.

2—Play back the 333 Hz portion of the alignment tape and measure the output level with the VTVM. Make a note of the measure value.

3—Play back the 5 kHz portion of the alignment tape.

4—Adjust VR601 so that the playback output level of the 5 kHz audio signal is zero ± 1 dB in reference to the measured level of the 333 Hz in step (2) above.

Example: If the measured value in step (2) is –25 dB, adjust the 5 kHz signal level for –25 dB with VR601. Note: Each level of the 5 kHz and 333 Hz audio level recorded on the alignment tape is at –25 dB.

Playback Output Level Adjustment (ARS Board)

1—Terminate the audio out terminal with a 100 k ohm resistor and connect a VTVM.

2—Play back the 333 Hz audio signal portion of the alignment tape.

3—Adjust VR602 for a VTVM reading of –25 dB. Note equipment setup and adjustment location in Fig. 4-24.

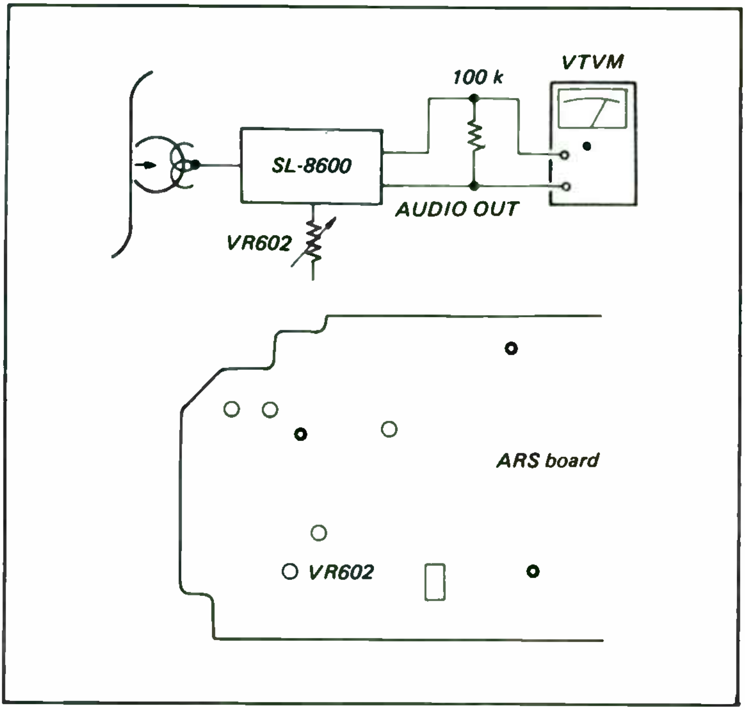


Fig. 4-24. Test set-up and adjustment locations for playback output level.

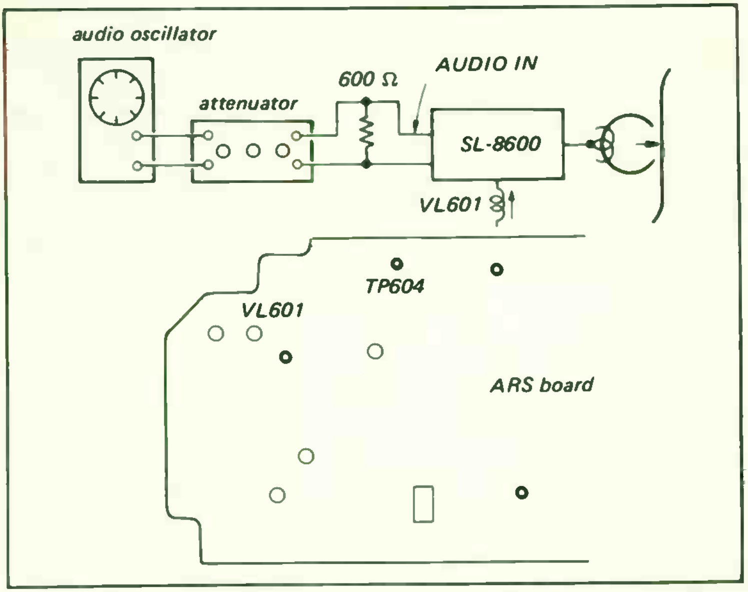


Fig. 4-25. Bias trap adjustment test setup and locations.

Bias Oscillator Check (ARS Board)

1—Set the audio oscillator to zero output and the attenuator to maximum.

2—Insert the cassette and set up VCR for the record mode.

3—Connect a frequency counter to test point TP603. Confirm that the oscillating frequency is 65 kHz ± 6.5 kHz.

Bias Trap Adjustment (ARS Board)

1—Set the audio test oscillator output to zero and the attenuator to maximum.

2—Insert the cassette and set VCR in the record mode.

3—Connect the scope to TP604.

4—Adjust VL601 for minimum bias leak value. Minimum level below 0.5 volt P-P. See Fig. 4-25 for test setup and adjustment locations.

Record Bias Adjustment (ARS Board)

Make sure that the playback frequency characteristic adjustment has been completed before making these checks.

1—Ground the TP601 with a jumper, to turn off the AGC operation.

2—Connect the 333 Hz audio signal to the audio in.

3—Terminate the audio out terminal with a 100 k ohm resistor and connect to a VTVM.

4—Insert a cassette and set up VCR in the E-E mode.

5—Adjust the audio out terminal level with the attenuator for −25 dB.

6—Depress the record button and make a recording for about five digits on the tape counter.

7—Change the audio signal to 5 kHz at −25 dB and make a recording for about five digits on the tape counter.

8—Play back the portion of the tape recorded in steps (6) and (7). Measure the playback output levels of the 333 Hz and 5 kHz signals.

9—Confirm that the playback output level of the 5 kHz is zero dB ± 0.5 dB in reference to the 333 Hz playback output level. If not, repeat steps (2) to (8) and adjust the bias current with VC601.

10—After the adjustment, remove the jumper connected to TP601.

Video System Alignment (YC-2 and ARS Boards)

The playback system of the video stages is aligned first with the alignment tape. After the playback system is confirmed to operate properly, the record system is aligned. The alignment sequence is shown below. The "Y" signal and chroma signal alignments are performed for each of the playback and record systems.

Playback System Alignment

1—Playback rf amplifier frequency response adjustment.
2—Dropout compensator threshold level adjustment.
3—Playback video output level adjustment.
4—44 fH VCO free running frequency adjustment.
5—3.57 MHz VXO free running frequency adjustment.
6—3.58 MHz oscillator frequency adjustment.
7—4.27 MHz carrier phase alternate check.
8—4.27 MHz carrier leak adjustment.
9—Color killer threshold level adjustment.
10—Playback chroma output level adjustment.
11—Comb filter fine adjustment.

Record System Alignment

12—White clip adjustment.
13—Sync tip carrier frequency adjustment, carrier balance, and dark clip adjustment.
14—3.58 MHz trap adjustment.
15—FM modulation deviation adjustment.
16—E-E output level adjustment.
17—3.58 MHz crystal filter adjustment.
18—Record ACC level adjustment.

19—Half H shift and card clamp adjustment.

20—Y-FM record current adjustment and chroma record current check.

Alignment Setup

■ Connect the color bar signal of 1 volt (P-P) to the video/camera in.

■ Connect the color monitor TV to the video/camera out. This is for terminating the video output with 75 ohms.

■ Set the tracking control to the center detent position unless otherwise required.

■ The YC-2 board can be checked when the machine is placed on the tuner block side. Refer to Fig. 4-26. Set up the record or play mode in that state. When the YC-2 board is removed from the machine, place the machine horizontally for the alignment.

Playback System Alignment

The following is for the playback rf amplifier frequency response adjustment (ARS Board). Align both the CH-A and CH-B amplifiers independently. The adjustment for the CH-B amplifier is indicated by parentheses.

1—Play back the rf sweep portion of the alignment tape.

2—Connect the scope to TP5 and trigger it from TP502.

3—Adjust the tracking control for maximum rf output.

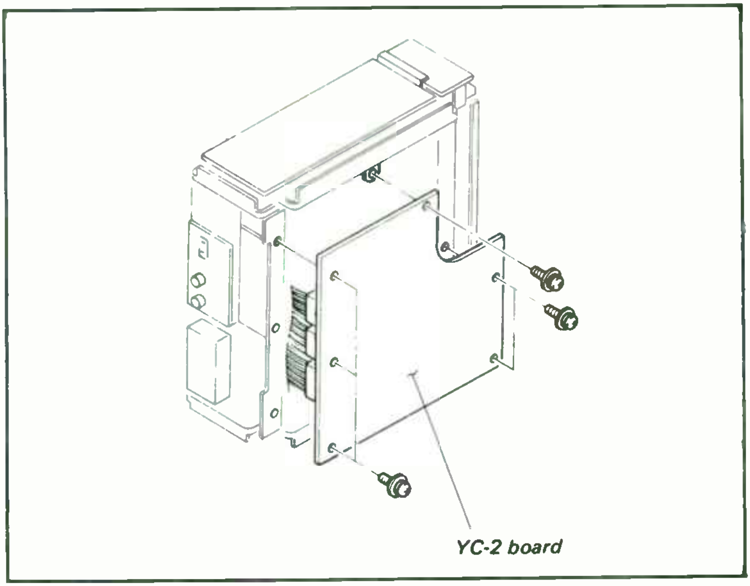


Fig. 4-26. Location of YC-2 board.

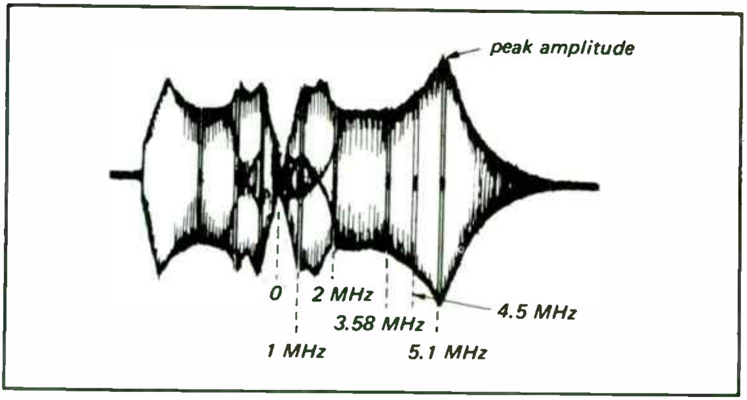


Fig. 4-27. High frequency range tuned frequency adjustment.

4—Set the time base of the scope to 2 ms/cm. Select negative (−) trigger slope to observe the CH-A signal and positive (+) trigger slope to observe the CH-B signal. The rf sweep portion has frequency markers at 1 MHz, 2 MHz, 3.58 MHz, 4.5 MHz and 5.1 MHz from the left to right. Note scope waveform in Fig. 4-27.

5—Turn VR2 (VR1) fully counterclockwise as viewed from the component side. Turn VR7 (VR6) fully clockwise. Adjust VC2 (VC1) so that the waveshape peak amplitude (tuned frequency) is located at 5.1 MHz ± 0.1 MHz, as shown in Fig. 4-27.

6—Adjust VR2 (VR1) and VR7 (VR6) so that the waveform between the 2 MHz and 4.8 MHz markers is as flat (± 1 dB) as possible. Note waveform in Fig. 4-28.

7—Set the scope time base to 2 msec/cm. Adjust VR5 to equalize the levels of the CH-A and CH-B at 3.58 MHz.

Dropout Compensator
Threshold Level Adjustment (ARS Board)

1—Play back any prerecorded tape known to have many drop-outs on it.

2—Set VR8 in fully clockwise position as viewed from the conductor side of the board. The dropouts can now be viewed on the monitor screen.

3—Turn VR8 counterclockwise slowly until the dropouts disappear. Set VR8 to that point.

4—Rewind the tape. Play back the tape again and confirm that the dropouts are compensated for at the tape portion where the dropouts were observed in step 2.

Playback Video Output Level Adjustment (YC-2 Board)

1—Play back the color bar portion of the alignment tape.

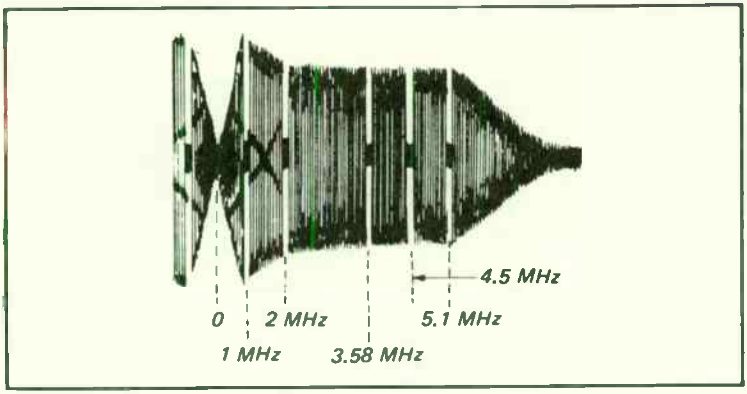


Fig. 4-28. Playback amplifier frequency characteristic adjustment.

2—Connect the scope to the emitter of Q25 and adjust VR21 for 1.3 ± 0.1 volt P-P. Note scope trace in Fig. 4-29. The scope is triggered externally from pin 12 of IC7.

3—Connect the scope to the emitter of Q9 and adjust VR8 for 1 ± 0.1 volt P-P. Note waveform in Fig. 4-30.

44 fH VCO Free Running Frequency Adjustment (YC-2 Board)

1—Supply the color bar signal to the video/camera in terminal.

2—Short pins 5 and 6 of IC5 with a jumper.

3—Connect the frequency counter to IC5, pin 11.

4—Adjust VR13 for a counter reading of 692.308 kHz ± 2 kHz.

5—After the adjustment, remove the short connected in step (2) above.

3.57 MHz VXO Free Running Frequency Adjustment (YC-2 Board)

1—Feed the color bar signal into the video/camera in terminal.

2—Connect the frequency counter to the junction of R109 and T14.

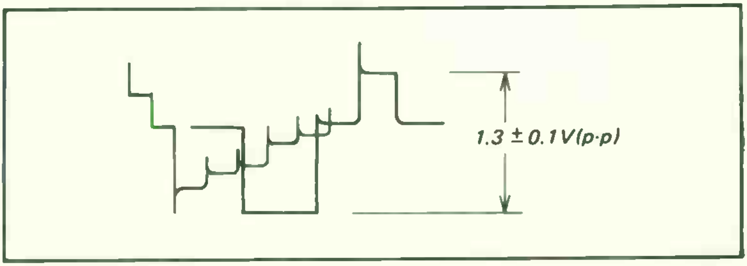


Fig. 4-29. Playback video output level adjustment.

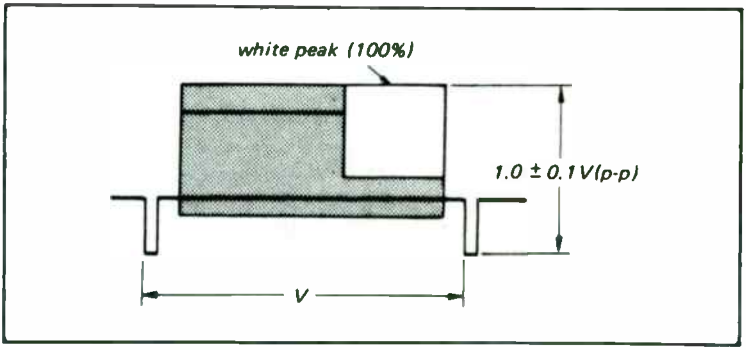


Fig. 4-30. Playback video output level adjustment.

3—Adjust the core of T12 to obtain a frequency counter indication of 4,267,919 ± 5 Hz. Utilize the alignment tool for this adjustment.

3.58 MHz Osc Frequency Adjustment (YC-2 Board)

1—Feed a color bar signal into the video/camera in terminal.

2—Connect the frequency counter to the emitter of Q5.

3—Adjust the core of T11 for a counter reading of 3,579,545 Hz ± 5 Hz.

4.27 MHz Carrier Phase Alternate Check (YC-2 Board)

1—Feed a color bar signal into the video/camera in terminal.

2—Connect the channel 1 probe of the dual-trace scope to IC7, pin 6 and the channel 2 probe to pin 8. Trigger the scope externally from IC7, pin 10. Set the time base to 5 ms/cm and adjust so that the amplitudes of both channels are equal on the scope.

3—Set the scope to add (A+B) mode and confirm that the waveform shown in Fig. 4-31 is obtained.

4.27 MHz Carrier Leak Adjustment (YC-2 Board)

1—Play back the color bar portion of the alignment tape.

2—Connect the scope to IC4, pin 8.

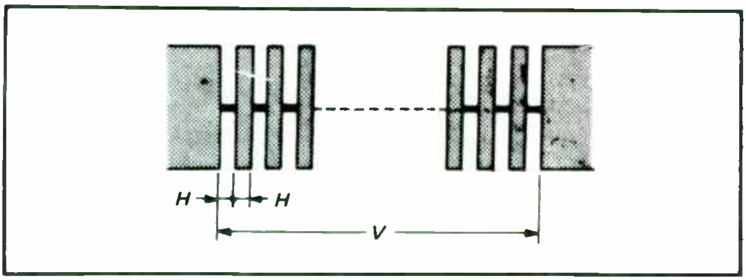


Fig. 4-31. 4.27 MHz carrier phase alternate check waveform.

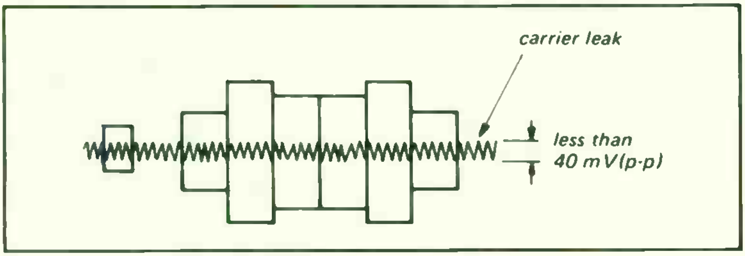


Fig. 4-32. 4.27 MHz carrier leak adjustment.

3—Adjust VR9 for minimum leak of 4.27 MHz. Refer to proper waveform shown in Fig. 4-32.

Playback Color Killer Adjustment (YC-2 and ARS Boards)

1—Play back the color bar portion of the alignment tape.

2—Connect the scope, adjusted to 5 ms/cm time base, to IC4 pin 15 on the YC-2 board and trigger it externally from IC4, pin 7.

3—Turn VR006 (channel balance) on the ARS board either

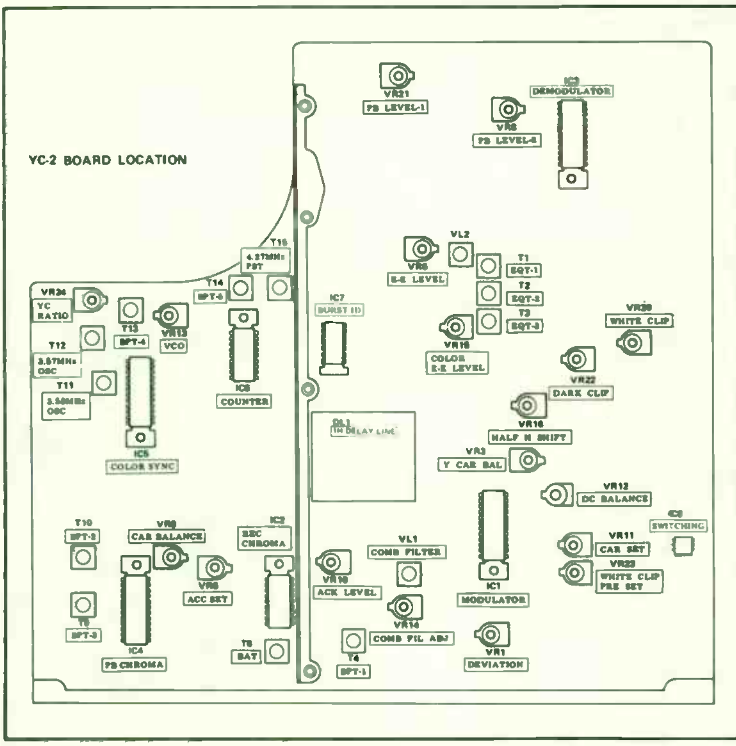


Fig. 4-33. Component locations on YC-2 board.

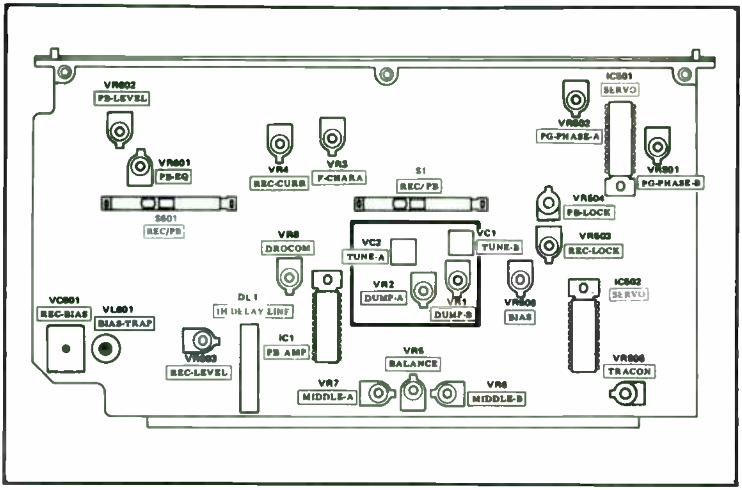


Fig. 4-34. Component locations on ARS board.

clockwise or counterclockwise to obtain 0.03 volt P-P of chroma level in either channel.

4—Turn VR10 on the YC-2 board fully counterclockwise as viewed from the conductor side. The picture displayed on the color TV monitor will be in black and white on the screen because the color killer operates.

5—Turn VR10 on the YC-2 board slowly clockwise and set it at the point where the color picture appears on the TV monitor screen.

6—The channel balance must be reset because the balance in this state is incorrect.

7—Connect the scope to TP5 on the ARS board and play back the rf sweep signal of the alignment tape.

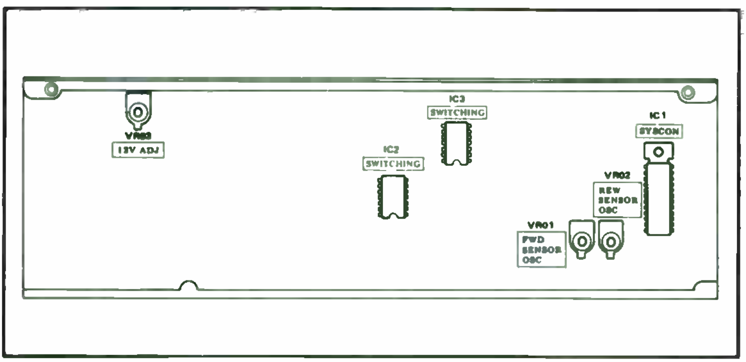
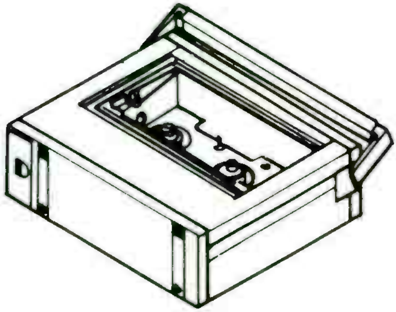


Fig. 4-35. Component locations on the SRP board.

8—Adjust VR5 on the ARS board so that CH-A and CH-B have equal amplitude at the point of 3.58 MHz.

Refer to Fig. 4-33 for adjustments and component locations for the YC-2 board. Refer to Fig. 4-34 for adjustments and component locations for the ARS board. Refer to Fig. 4-35 for adjustments and component locations for the SRP board.

Chapter 5



Mechanical VCR Operation and Drum Head Adjustments

The following chapter will cover mechanical VCR operation plus drum head change-out and adjustments for the Zenith model KR9000 and Sony SL-8600 machines. All numbers in parentheses are keyed to the specific part in the illustration that is under discussion.

TAPE MOVEMENT STATE

Figure 5-1 shows the path taken by the tape as it moves from the supply reel table assembly (1) to the take-up reel table assembly (32). The tape from the supply reel table assembly first passes the guide (2) and the tape slack preventing plate (3) inside the cassette. The tape slack preventing plate applies bracking pressure to the tape when slack occurs inside the cassette. This is necessary because the tape is damaged by the cassette lid (5) if the slack tape comes out the cassette.

The tape comes out of the cassette through the exit guide (4). The tape passes the sensing head (6) mounted on the tension arm assembly (7). When all the tape has wound onto the take-up reel in the play mode, a trailer tape, attached to the end of the video tape, appears after the normal tape passes the sensing head. The sensing head senses the trailer tape and the mode operation is shut-down.

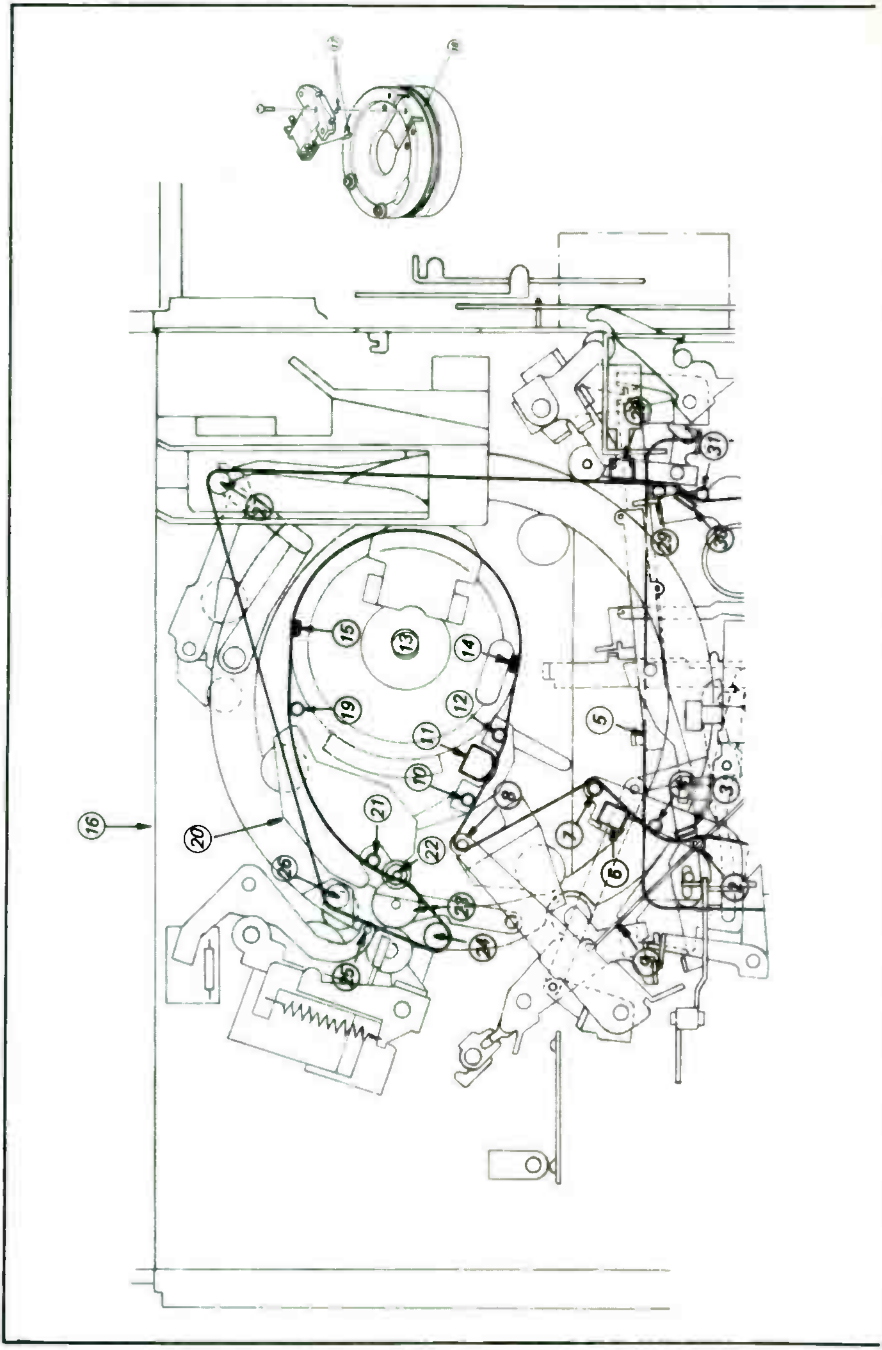
The tape passes the tension arm assembly (7), which prevents tape slack between the exit guide (4) and the supply tension regulator arm assembly (8). It also acts to keep a constant clearance between the tape and sensing head. There are two (upper and lower) tape guide bosses on the tension arm assembly. These are to regulate the height of the tape wound by the supply reel in the rewind mode.

The tape, having passed the tension arm assembly, passes the supply tension regulator arm assembly. The supply tension regulator arm assembly changes the forward direction of the tape toward the drum (13). At the same time it senses tape tension in the play operation and serves to control the braking pressure to the supply reel table assembly via the brake band assembly (9). This keeps a uniform holdback tension on the tape. The right angle of the pin on the supply tension regulator arm assembly (8) allows the best tracking around the entrance of the drum. The tape then passes the rotary tape guide A (10), the full-width erase head (11), and the tape guide B (12).

The full width erase head, erases the tape during the record mode. The rotary tape guide A and the tape guide B regulate the tape on its upper and lower edges in order to afford optimum tracking from the first contact point of the tape to the drum to the middle point. The tape guide B serves to provide a constant overlap.

The tape runs approximately 180 degrees around the drum head where the rotary video heads (14) and (15) make contact with it during record and playback. The tape path is designed to be parallel with the supply and take-up reel tables at the entrance side of the drum and to be parallel with the loading board (16) at its exit. The tape retaining springs (17), at the middle section of the drum, press down the tape running along the circumference of the drum. The tape is pressed by the springs on the top of the drum in order to keep the best tracking at the middle section. The tape, having passed the drum, passes the tape guide C (19), the ACE (Audio, CTL and Erase) head and the tape guide P. The tape guides C and P regulate the tape position from the top in order to keep the best tracking from the middle section of the drum to the exit point of the tape. The tape guide C serves to keep a constant overlap. The ACE head performs the erasure, record, and playback of the audio signal, and the record and playback of the control signal. The ACE head is an assembly and the position of the core of the head is adjusted with respect to the upper flanges of the tape guide C (19) and the tape guide P (21). It is so designed that no height adjustment of the audio head in the ACE head assembly is required if the tape runs along the upper flanges of the tape guides C and P.

The tape is squeezed between the capstan flywheel assembly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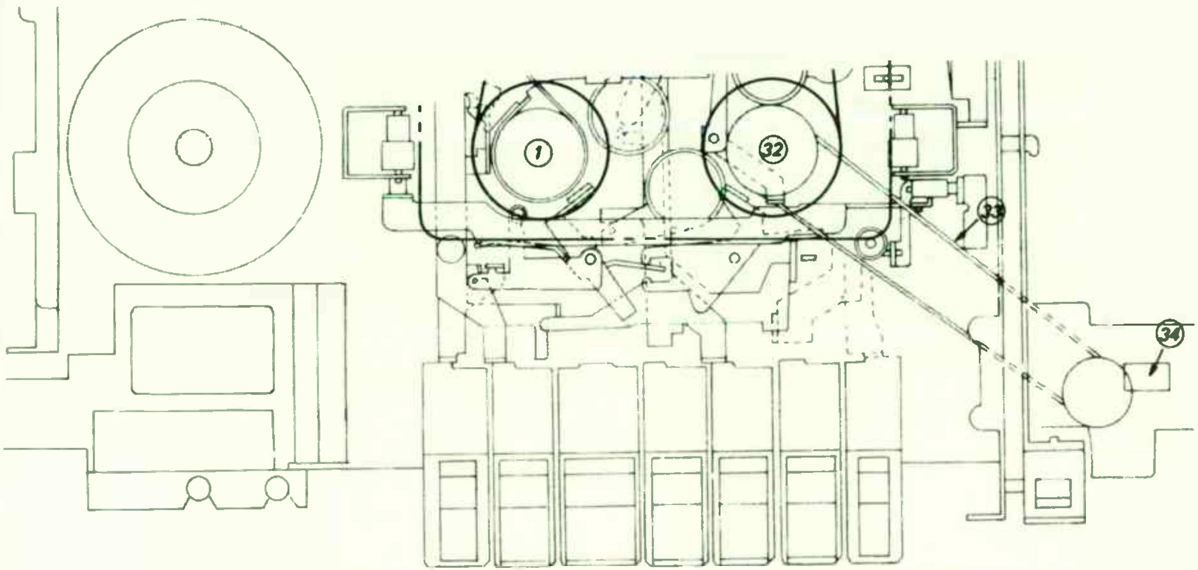


Fig. 5-1 Illustration of the path taken by the tape threading and the drum head assembly.

and the pinch roller assembly. The capstan flywheel assembly (22) rotates at a constant speed, advancing the tape at a fixed rate. The angle of the capstan assembly against the tape is very precisely set. The pinch roller (23) is pressed against the tape at an angle of 90 degrees with respect to the forward direction of the tape with automatic alignment in order to make the tape run in a stable manner. The tape, fed at constant speed, passes the guide roller assembly and the forward direction of the tape turns right about 180 degrees in order to reverse the running direction of the tape. The guide roller assembly (24) is designed to turn freely so that the friction between the guide roller assembly and the tape is minimized for the least tape wear.

The tape, having passed the guide roller assembly, passes the tape slack sensing lever assembly (25) which senses any tape slack resulting from the reduction of tape tension when in the record or play mode. The slack sensing lever assembly terminates the record or play mode and sets up the stop mode. The tape passes the fixed tape guide. The space between the upper and lower flanges on the fixed tape guide is narrower than the spaces of other flanges because it is designed so that the tape height is optimum in the fast forward, or rewind mode, or at the completion of the threading operation. In normal operation the tape runs smoothly at the beginning of the play or record mode. The tape passes the loading arm assembly (27), the forward direction of the tape turns right about 60 degrees, and the tape is positioned at the same height as that of the take-up reel table assembly. The tape then passes the take-up sensing head (28). When all the tape is wound onto the supply reel in the rewind mode the leader tape appears at the head of the video tape. The sensing head senses the leader tape and the rewind mode stops. The tape, having passed the sensing head, enters into the cassette, passes the exit guide, the tape slack prevention plate, the guide, and finally is wound by the take-up reel. As noted above, the tape advances from the supply reel to the take-up reel. Since the take-up reel rotates in the play, record, fast forward, or rewind mode, the counter belt moves it and the counter also functions.

SAFETY MECHANISM

In the record, play or fast forward modes, the trailer tape appears at the end of the video tape on the supply reel. The sensing head senses the trailer tape when it passes the sensing head, signalling that all the video tape has been taken up. Refer to Fig. 5-2.

When the sensing head senses the trailer tape, the stop sol-

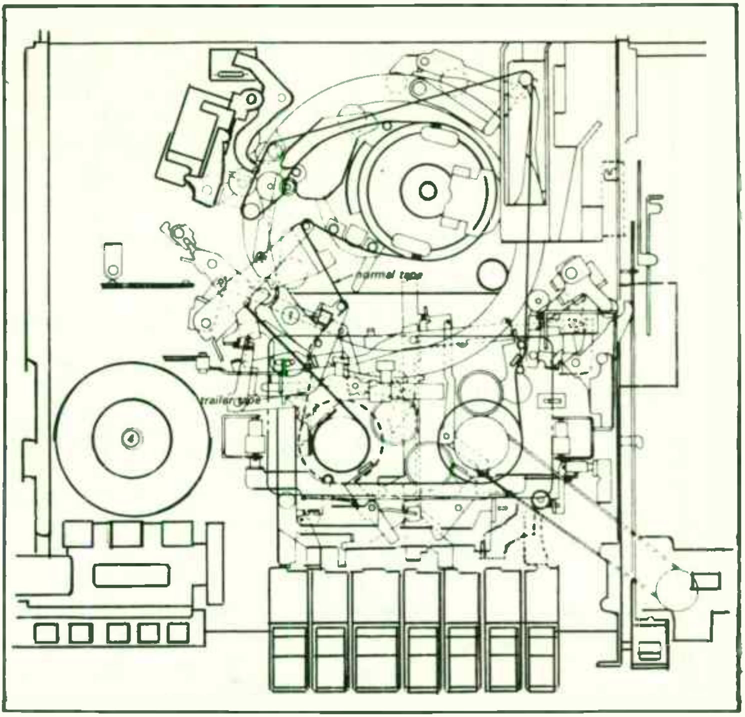


Fig. 5-2. Tape sensing mechanism and machine shut-off.

enoid (2) on the button block assembly is energized and a function button is released. At the same time the microswitch (3) is pushed by the stop solenoid (2) when the stop solenoid is energized and the microswitch (3) is turned-off, the ac motor stops. Refer to Fig. 5-3. The stop of the ac motor makes the rotation of the take-up reel stop and the tape movement stops without being wound further. If the play or the fast forward button is depressed in this state, the safety mechanism functions in such manner that the tape is not wound because the sensing head senses the trailer tape immediately, the stop solenoid (2) is energized, the microswitch (3) turns off, and the ac motor (4) does not rotate. See Figs. 5-2 and 5-3.

TAPE END SENSING MECHANISM IN REWIND MODE

In the rewind mode, the leader tape appears at the beginning of the normal video tape when all the video tape on the take-up reel is rewound to the supply reel. The sensing head senses the leader tape when it passes the sensing head. Refer to Fig. 5-4.

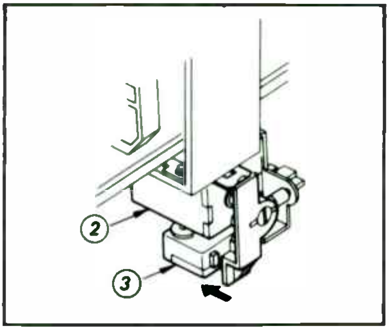


Fig. 5-3. Microswitch assembly.

When the sensing head senses the leader tape, the stop solenoid on the button block assembly is energized, the rewind button is then released. At the same time the microswitch (3) is pushed by the stop solenoid (2) when the stop solenoid is energized, the ac motor stops. Refer to Fig. 5-5. The supply reel stops its rotation and the tape is not rewound further. If the rewind button is depressed in

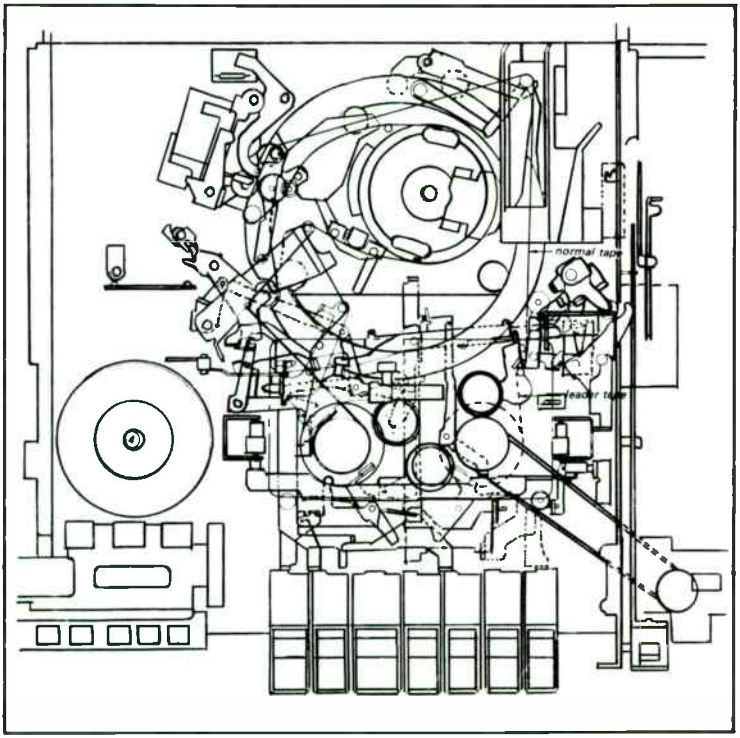


Fig. 5-4. Tape end sensing machine diagram—rewind mode.

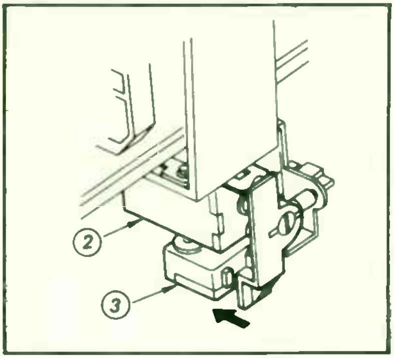


Fig. 5-5. Microswitch assembly.

this state, the safety mechanism functions in such manner that the tape is not rewound because the sensing head senses the leader tape, the stop solenoid is energized, the microswitch is turned off, and the ac motor stops.

TAPE SLACK SENSING MECHANISM

The tape, squeezed by the capstan housing assembly and the pinch roller and fed out at a fixed rate, is taken up with a certain specified torque by the take-up reel assembly. If the torque is lost due to breakage of the belt or other causes, the tape is fed by the capstan housing assembly and the pinch roller but is not taken up by the take-up reel. To prevent the tape from winding around the capstan housing assembly and the pinch roller, the following actions take place: when the take-up torque decreases, the tape slack sensing lever (1) shown in Fig. 5-6 moves in the direction shown by the arrow, thus tripping the reed switch.

When the reed switch (2) acts, the stop solenoid on the function block is energized and the play or record button is released. See Fig. 5-7. The pinch roller is then disengaged from the capstan housing. At the same time the microswitch (4) is pushed by the stop solenoid to be turned off when the stop solenoid is energized, and the ac motor stops. The capstan housing and the take-up reel stop their rotation, and the tape is not taken up. If the play or the record button is depressed in this state, the safety mechanism functions in such a manner that the tape is not wound because the tape slack sensing lever assembly (1) (Fig. 5-6) senses the slack, a function button is released, and the ac motor and the drum do not rotate.

POWER OFF SENSING MECHANISM

Rotation of the ac motor stops if the ac power is cut off for any

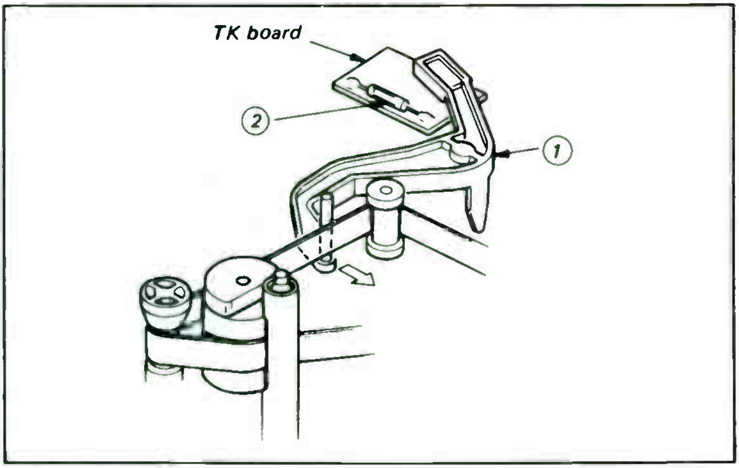


Fig. 5-6. Slack sensing mechanism.

reason in the operating modes or in the threading and dethreading operations. In this case, the reel table must be braked at once. If the reel goes on due to inertia, the tape slackens and is damaged. For this reason whenever the ac power is cut-off, the safety mechanism functions as follows to prevent the tape from becoming slack and damaged: The stop solenoid on the function block is energized, the function button is released, and the brake assemblies actuate to apply the brakes on the reel tables. This is shown in Figs. 5-8 and 5-9.

FUNCTION BLOCK OPERATION MODES

We will first look at the eject button function operation. The

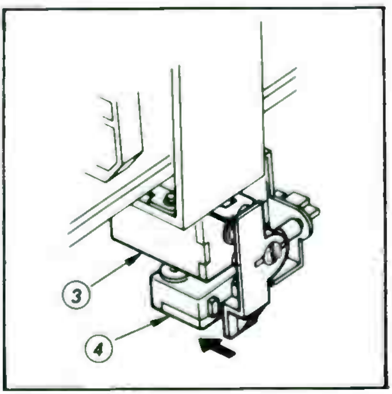


Fig. 5-7. Stop solenoid assembly.

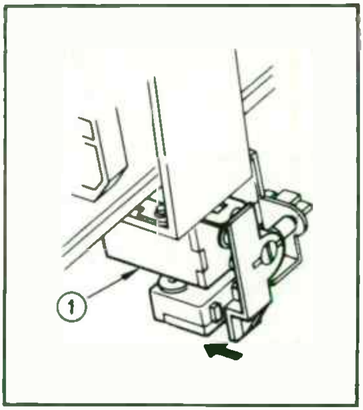


Fig. 5-8. Drawing of stop solenoid.

operation of the other buttons is basically the same. When the eject button is depressed, section A of the button pushes down the lock and it is locked by it. A safety mechanism to prevent other buttons except the stop button from being pushed is provided. When the eject button is pushed, the stopper B assembly and the stopper A assembly moves in that direction, and buttons other than the stop button cannot be depressed because they are blocked by the stopper B assembly and the stopper A assembly. The depressed eject button pushes the microswitch lever, which actuates the microswitch, and the ac motor starts up.

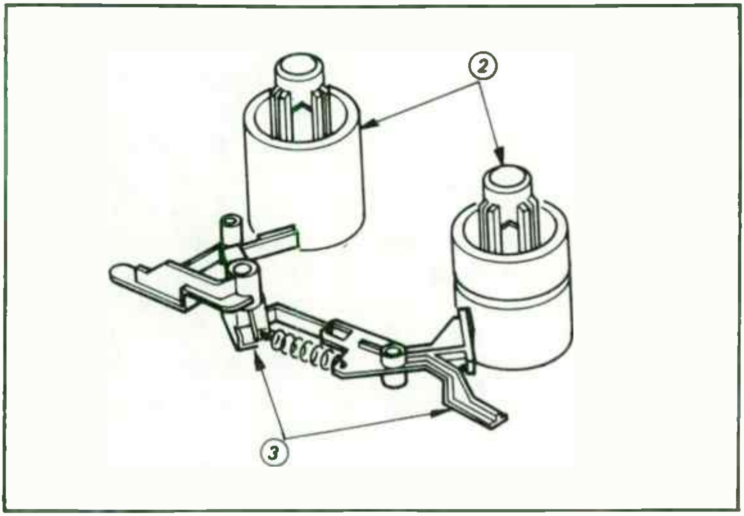


Fig. 5-9. Brake drum assembly.

OPERATION OF RECORD AND PLAY BUTTONS

When the record button is locked, the stopper B assembly and the stopper A assembly move in the opposite direction so that any button other than the stop button cannot be pressed because the stopper B and A assemblies block the depressed button and the button cannot be depressed. When the play button is depressed and locked, the stopper B assembly and the stopper A assembly moves in the same direction and any button other than the stop and pause buttons cannot be depressed.

OPERATION OF THE STOP BUTTON

When the stop button is depressed, the lock is pushed and all the buttons are released. When the eject operation is completed in the eject mode and the cassette-lift compartment moves upward, section A of the lock is pushed by the cassette-lift compartment. This is the same state as the set-up when the stop button is depressed and the locked function button is released. In any case where the safety mechanism actuates, the stop solenoid turns on, the lock is pulled, and the locked function button is released, just as when the stop button is depressed. The microswitch is pushed by the stop solenoid and the ac motor stops.

CASSETTE INSERTION AND COMPLETION CYCLE

Refer to Figs. 5-10 and 5-11 for the mechanical components at the completion of the cassette-in operation. The motor does not rotate and no mechanical component moves in this machine even when the power is turned on. When the eject button is pushed, the cassette lift (1) moves upward. The cassette (2) is inserted into the cassette lift. Section B of the cassette moves in the direction of the arrow with section A of the cassette lift. The lock mechanism of the cassette lid is released and the lid can be opened or closed freely. In this condition, if the cassette lift is pushed down, the cassette is held by the cassette guide (4) and it does not come out.

When the cassette lift is pushed down, section C of the cassette contacts the lid opener (3) and moves in the direction of the arrow. Section D of the cassette moves in the direction indicated by the arrow away from the take-up reel and supply reel. The take-up and supply reels rotate. As the cassette-lift compartment goes down further, section F of the take-up and supply reels fit into section E of the reel table assembly. Thus the power of the reel table can be transmitted to the take-up and supply reels. When the cassette-lift compartment is all the way down, the lock release lever (9), the positioning adjust lever (11), the cassette fastening lever, the adjusting plate, the right cassette retainer assembly (14), the connection link (15) and the left cassette retainer assembly (16) hold the cassette-lift compartment (1) by the force of the lock-lever returning spring.

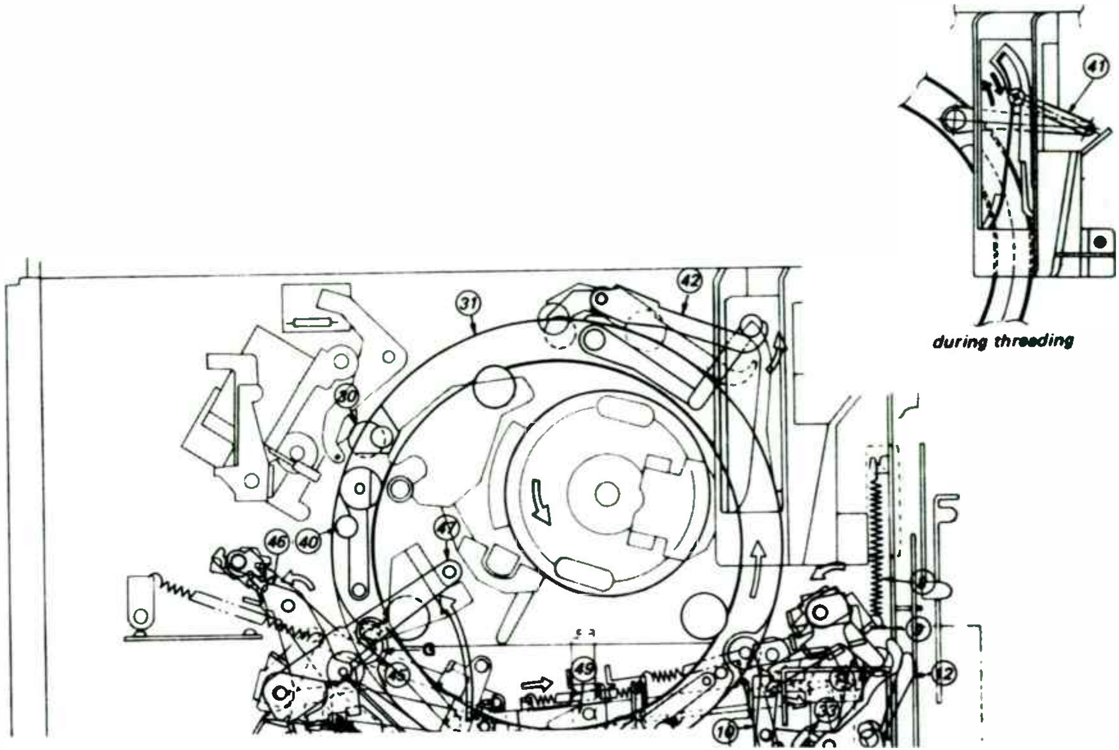
When the cassette drops into place, the cassette sensor goes down, moving the cassette switch lever and making the switch link free. The force of the spring moves the release switch link and the microswitch (21) is pushed, the ac motor starts to run.

The supply sensor relay lever is pushed down by the cassette, the threading gear base assembly moves in the arrow direction and the gear A contacts the tire section of the intermediate pulley assembly (26), starting rotation. The rotational force is transmitted to the entire threading ring assembly (31) via gear D, the gear F, and the gear G. With the rotation of the entire threading ring assembly, the positioning lever (10) moves in the direction indicated by the arrow, moving the position adjust lever in the direction shown by the arrow. The positioning lever moves the positioning limiter (32) in the arrow direction, the crank is released, the spring moves the brake link in the arrow direction and the take-up brake assembly (36) and the supply brake assembly (37) are released from the take-up and the supply reel table assemblies.

Since the entire threading ring assembly turns in the direction shown by the arrow, the guide roller assembly (40) moves in the same direction with that of the threading ring assembly and the tape in the cassette is withdrawn.

The threading arm assembly (41) and the arm lock assembly (42) move in the direction indicated by the arrow with the turning of the entire threading ring assembly. When the entire threading ring assembly reaches the position just before the completion of threading, the loading brake lever assembly is moved in the direction shown by the arrow by the entire threading ring assembly because of the cam shape of the ring and the end brake link (44) is moved in the arrow direction. The switch link is moved in the arrow direction, turning off the microswitch. At the same time the switch link (19) moves the brake link (34) and the tape-up brake assembly (36) and the supply brake assembly (37) apply the brakes on the take-up reel table and the supply reel table.

When the entire threading ring assembly stops, the positioning roller (45) drops into section G of the positioning lever (46), and the supply tension regulator arm assembly (47) and the brake band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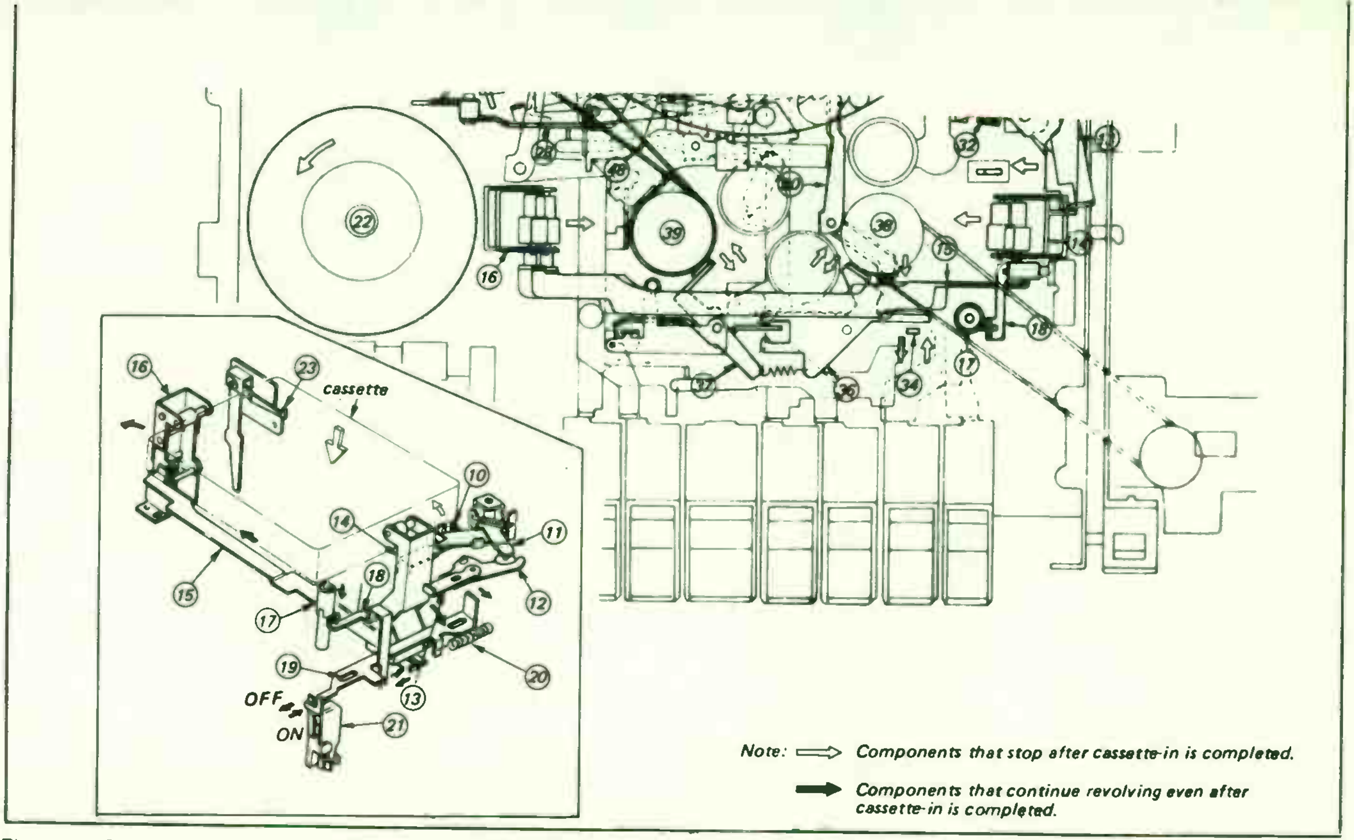
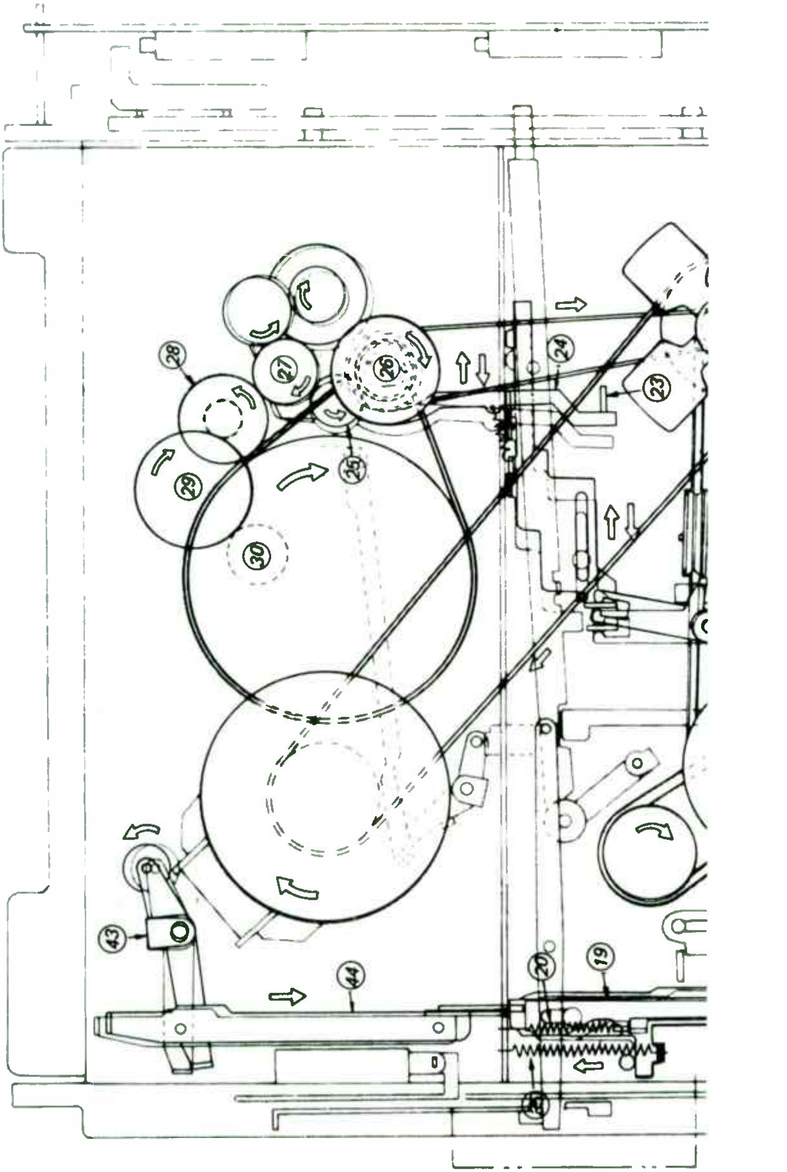


Fig. 5-10. Cassette-in operation.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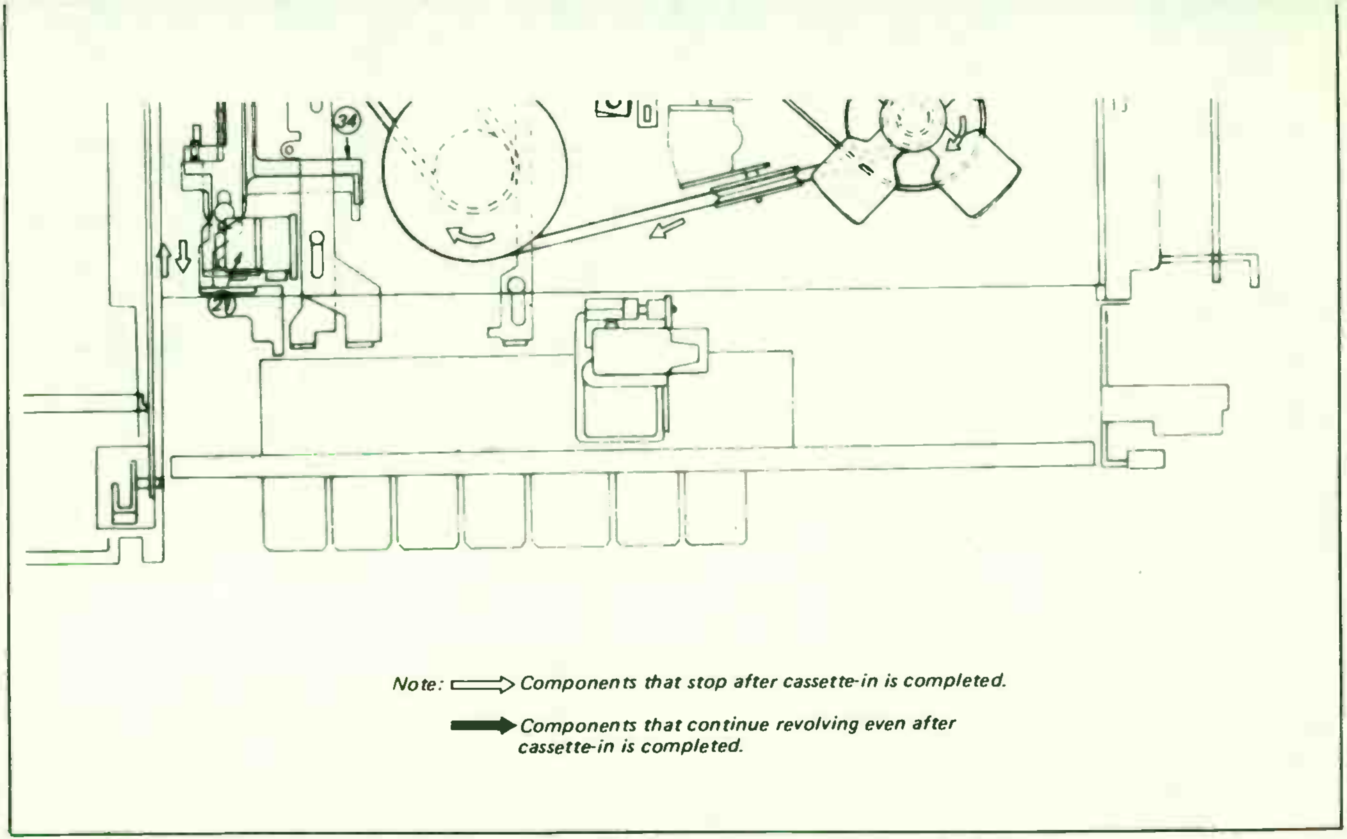


Fig. 5-11. Diagram of complete threading operation.

assembly (48) move in the direction shown by the arrows.

Since the eject stopper assembly (49) moves in the direction indicated by the arrows when the positioning lever moves in the direction shown by the arrow, the mechanical lock is released so that the fast forward, play or rewind button can be depressed. As the eject stopper assembly (49) moves, the loading brake assembly (50) moves in the direction shown by the arrow and the take-up reel table assembly brake is released.

PLAY MODE

Figures 5-12 and 5-13 show the position of the mechanical parts at the completion of the play mode. The play button, when depressed, pushes the microswitch on the SRP board in the direction shown by the arrow and the switch turns on. The play button pushes the play link and section A of the play link moves the forward link in the direction indicated by the arrow. Section B of the forward link releases the supply brake assembly (5) and the take-up brake assembly (6) and the supply reel table and the take-up reel table can then rotate.

The microswitch (10) is pushed by the switch lever (9) of the function block when the play button is depressed and turns on. As the ac motor starts rotation in the arrow direction, the capstan pulley (11), motor pulley assembly (12), fast forward idler belt, intermediate pulley assembly (14), fast forward assembly (15), fast forward idler assembly, forward belt, forward assembly, relay belt, relay pulley assembly (20), capstan belt, capstan flywheel assembly (22), drum belt, drum pulley, drum flywheel, and video head disc assembly (26) rotate, each in the directions indicated by the arrows.

When the play button is depressed, the play link is pushed in the direction shown by the arrow, the forward link and the ARS link assembly (27) are pushed in the directions shown by the arrows, and the sub-lever assembly (27) moves in the arrow direction. As the ARS link assembly moves, the ARS slide plate assembly (29) moves in the direction indicated by the arrow, switching the slide switch to the PB position.

When the microswitch turns on, the pause solenoid operates and the pressure spring (33) is pulled. As the forward link moves in the arrow direction, the C section of the forward link moves the pinch roller pressure link assembly (31) and the pause solenoid assembly block (34) in the direction shown by the arrow, making the pinch roller assembly (35) contact the capstan flywheel assembly (22). The pinch roller assembly (35) starts rotation and the tape is squeezed between the pinch roller and the capstan flywheel assembly so that it is fed forward at a constant speed.

Since the pause solenoid assembly block moves in the arrow direction, the tape slack detecting lever assembly (37) contacts the tape by the spring (38). Thus the assembly is ready to detect tape slack.

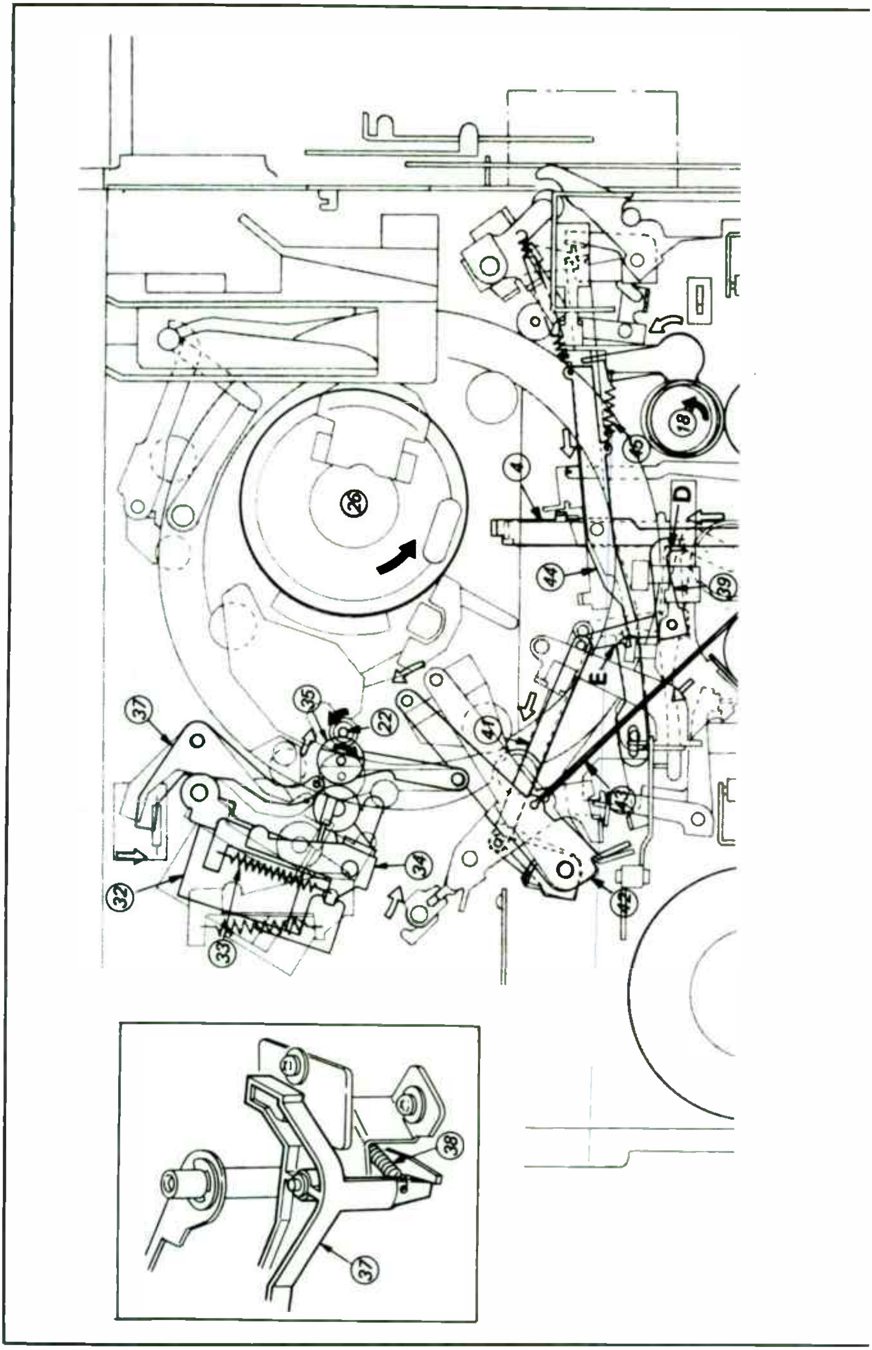
When the forward link (4) is pushed, section F of the forward link moves the play link assembly (39), tension regulator release link assembly (4) and the supply tension regulator arm assembly (42) each in the direction shown by the arrow. The supply tension regulator arm assembly detects tape tension, making the brake band assembly (43) move in the direction indicated by the arrow so as to apply the brake on the supply reel table assembly (7) for a constant tape tension.

Since section E of the play link assembly (39) moves the idler slide plate (44) in the arrow direction when the play link assembly moves in the direction shown by the arrow, the forward assembly is moved by the spring and contacts the take-up reel table assembly. The take-up reel table assembly starts to rotate in the arrow direction and the tape is taken up.

With the rotation of the take-up reel table, the tape counter is turned by the counter belt in the direction shown by the arrow and the count is indicated. Since the ARS link assembly moves when the play button is depressed even if the lever knob of the picture source selector is in the TV position, the antenna auto lever moves in the direction indicated by the arrow, the antenna lock arm and the antenna slide plate are moved by the spring in the direction shown by the arrow, and the antenna slide plate moves in the direction shown by the arrow so as to switch the antenna select switch to the tape position. Thus the antenna select switch is automatically connected to the tape position when the play button is depressed.

PAUSE MODE

Figure 5-14 illustrates the operation of the mechanical parts when the pause mode is set-up with the machine in the play mode. When the pause button is depressed in the play or the record mode, the pause solenoid turns off and the pressure arm assembly (3) moves in the direction indicated by the arrow, making the pinch roller assembly (4) disengage the capstan flywheel assembly. At the same time, the pause brake rubber (6) presses the tape on the pinch roller assembly (4) and the tape movement stops. Note: the play assembly (7) contacts the take-up reel table assembly (8) in this



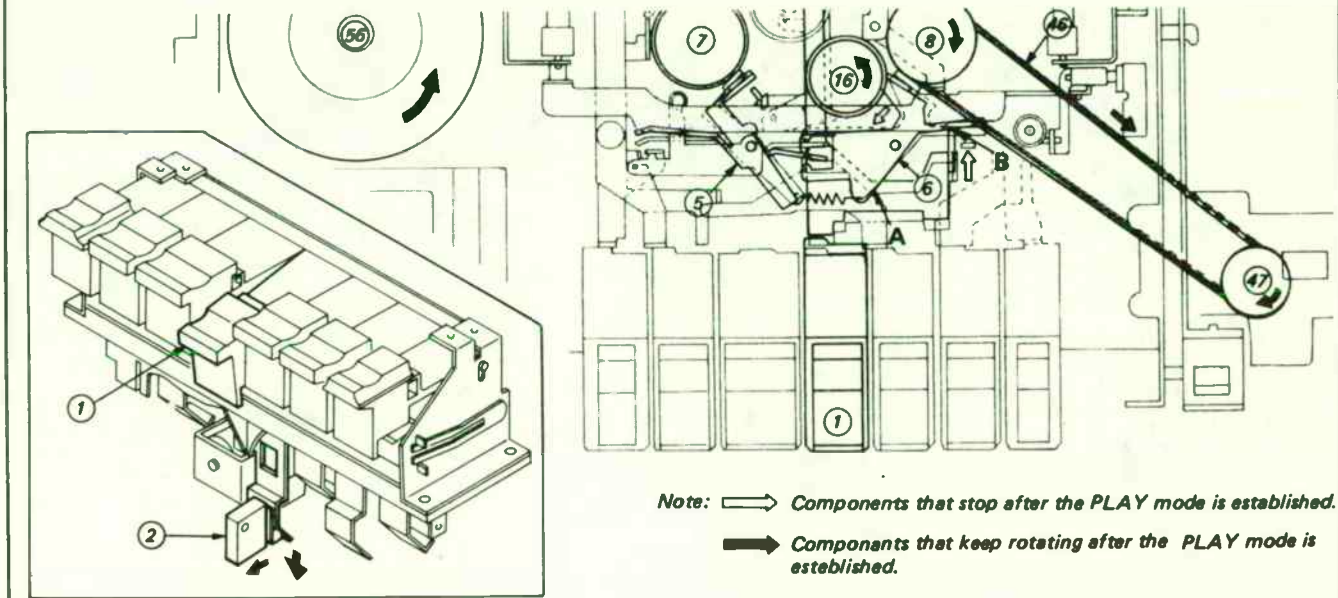
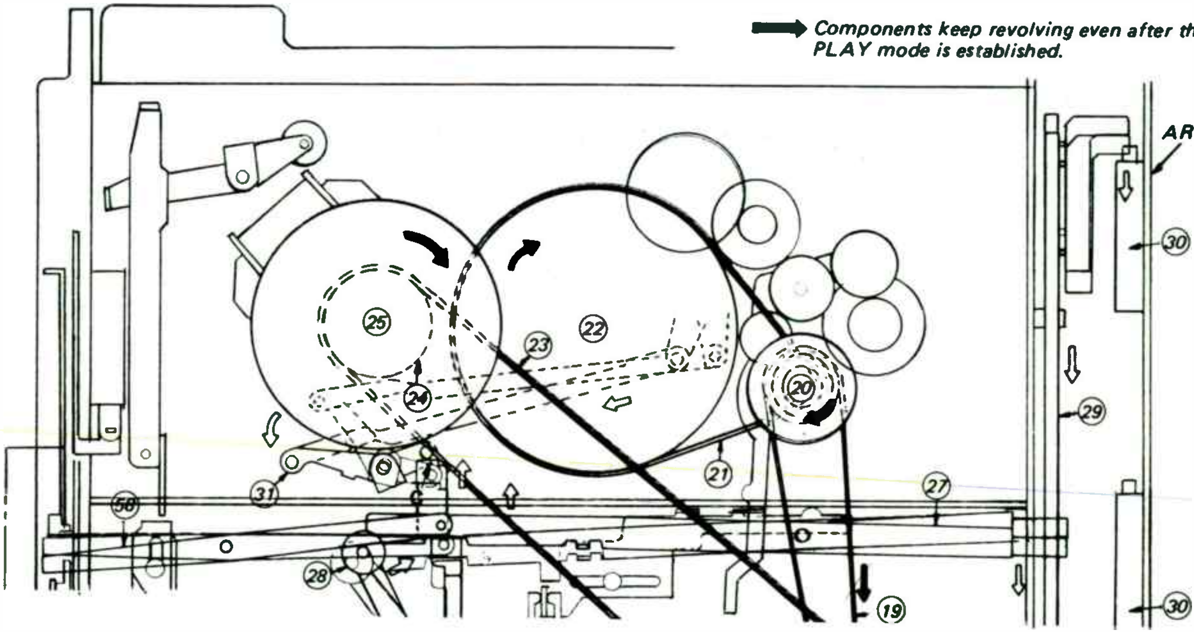


Fig. 5-12. The play operation mode.

Note: ⇨ Components after the PLAY mode is established.

➡ Components keep revolving even after the PLAY mode is established.



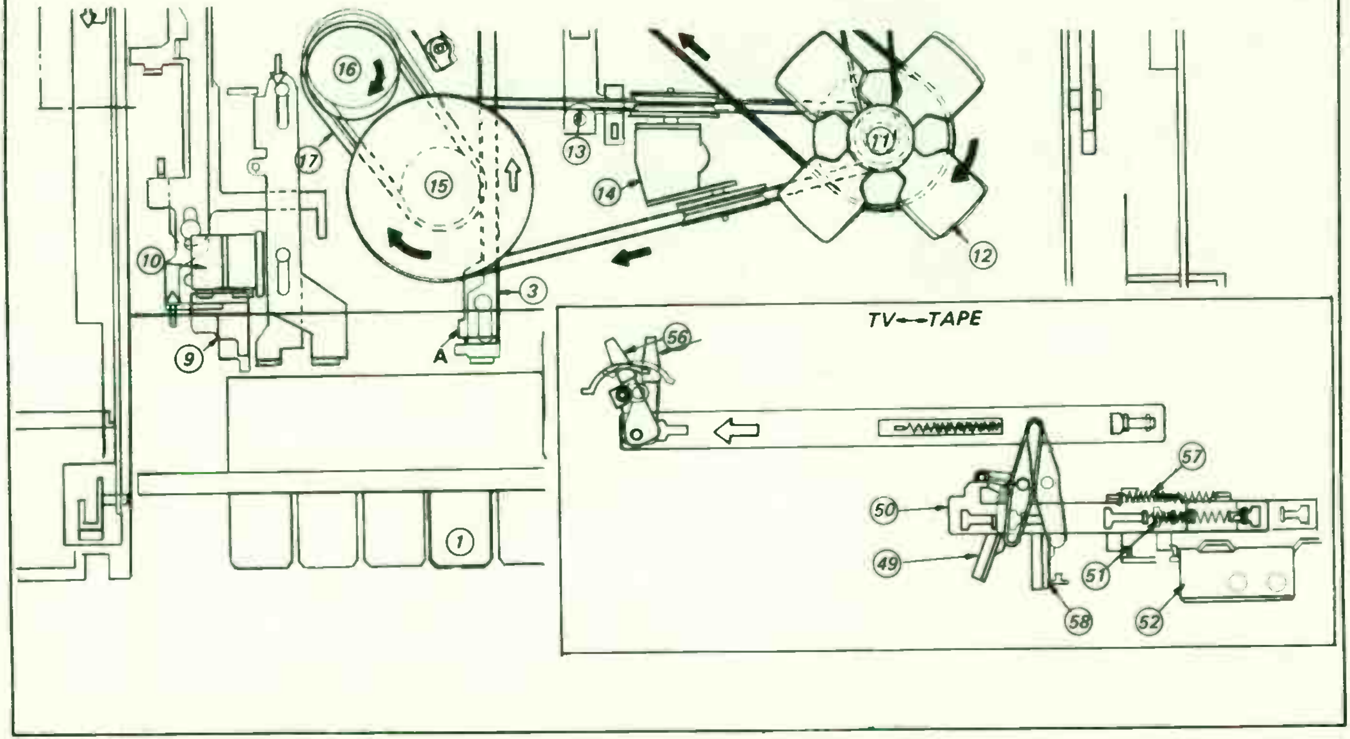
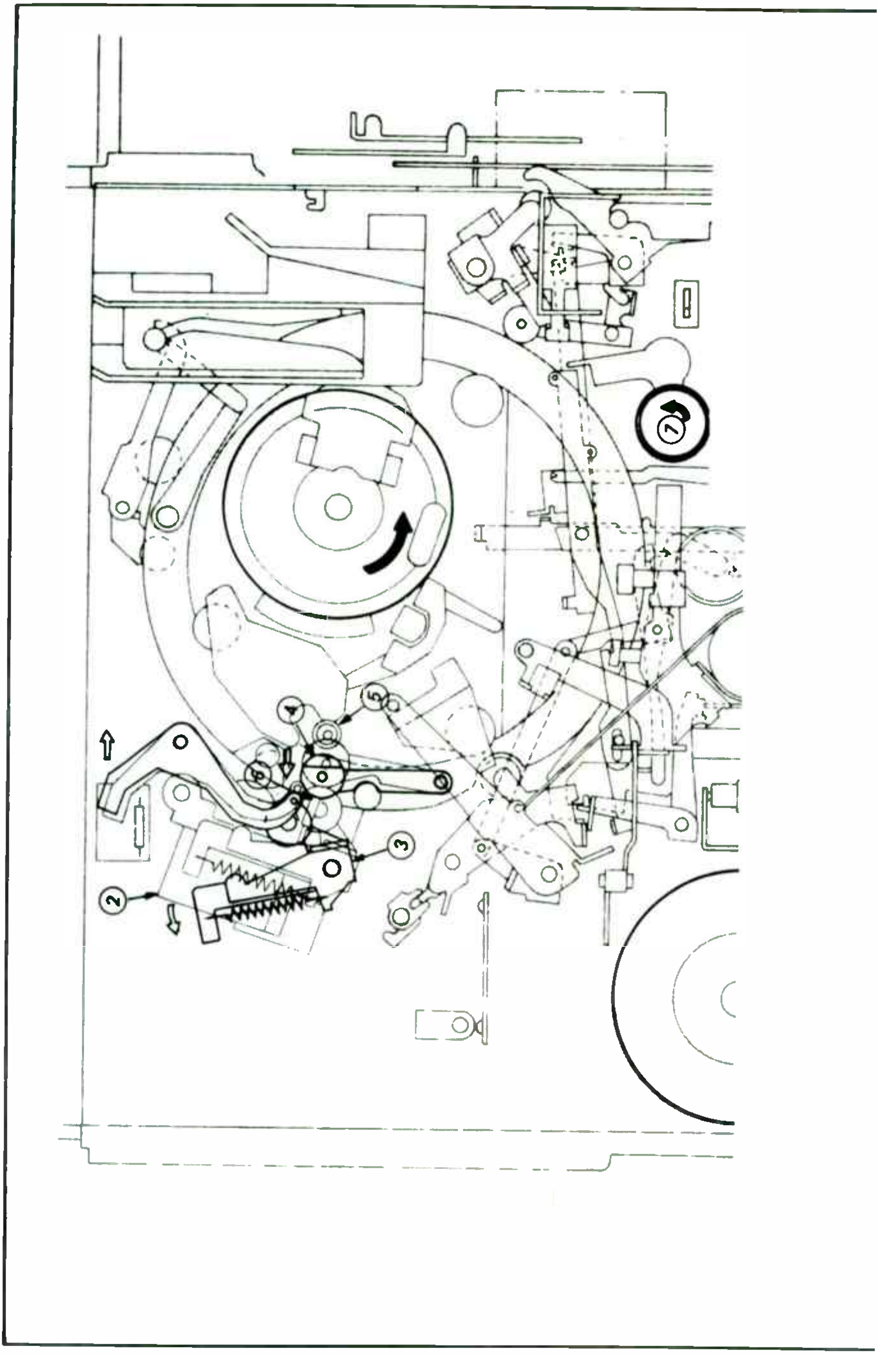


Fig. 5-13. Position of parts in the play mode.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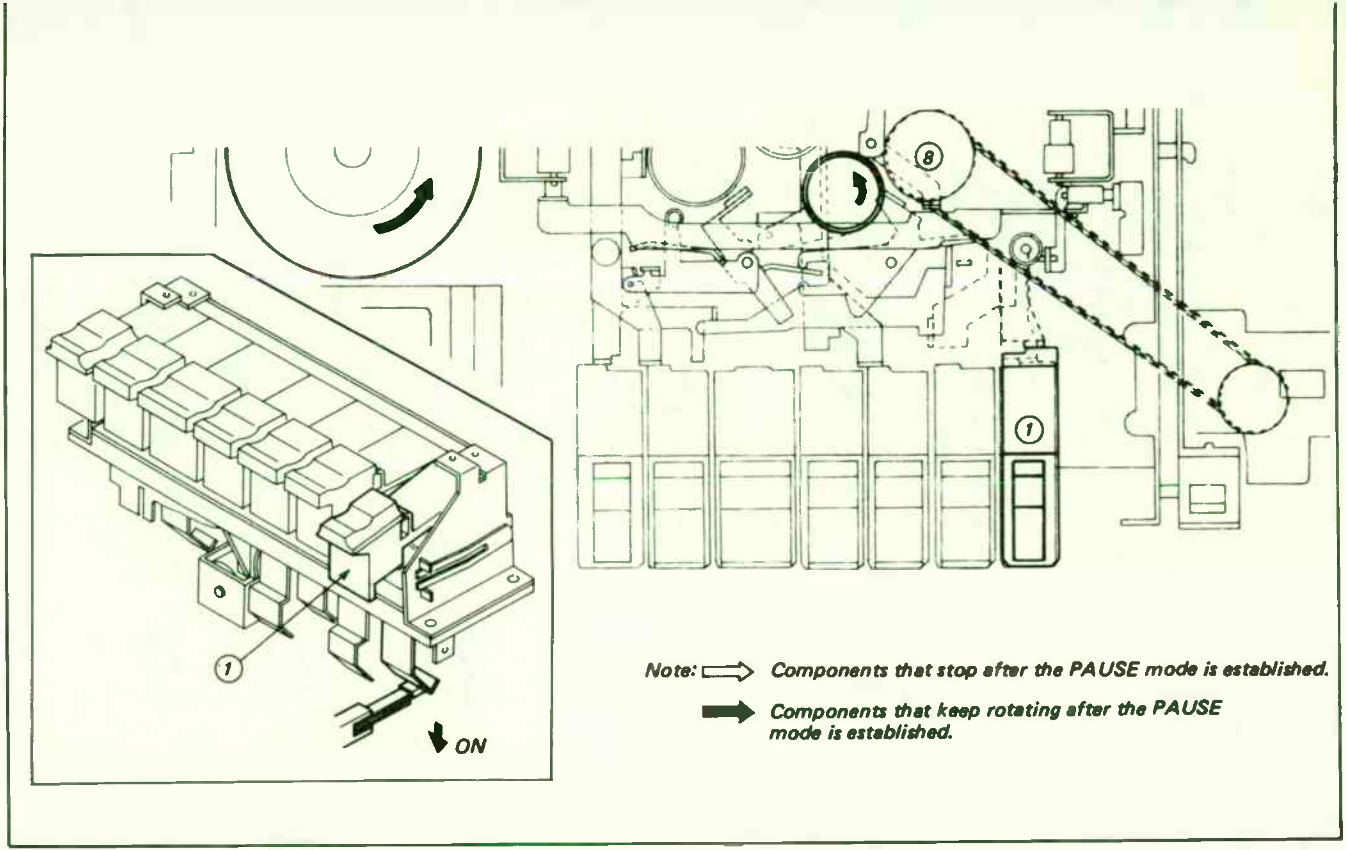


Fig. 5-14. Mechanical parts placement in the pause mode.

state but the take-up reel table assembly (8) is not rotating because the tape does not move and the friction clutch acts.

RECORD MODE

Figure 5-15 shows the operation of the mechanical parts when the record button is depressed. The record button cannot be depressed if the record safety tab in the cassette is broken out, because the cassette cannot push down the probe (3) and section A of the record slide plate (4) contacts the probe. Thus the record button cannot be depressed. If the record safety tab is not removed, the cassette pushes the probe (3), the record slide plate (4) can move, and the record button can be depressed.

When the record button is depressed, the switch lever (5) of the function block moves in the direction shown by the arrow, turning on the microswitch (6). The ac motor then starts its rotation.

As the ac motor starts to rotate, the capstan pulley (8), motor pulley assembly (9), fast forward idler belt (10), intermediate pulley assembly (11), fast forward assembly (12), fast forward idler assembly (13), play belt (14), play assembly (15), relay belt (16), relay pulley assembly (17), capstan belt (18), capstan flywheel assembly (19), drum belt (20), drum pulley (21), drum flywheel (22), and video head disc assembly (23) all move in the direction shown by the arrows.

When the record button is depressed (see Fig. 5-16) and the record slide plate moves, section B of the record slide plate (4) pushes the play link (24) to move in the direction shown by the arrow. Section C of the play link (24) releases the supply brake assembly (44) and take-up brake assembly (45) so that the supply reel table assembly (38) and the take-up reel table assembly (38) and the take-up reel table assembly (41) can now rotate.

With the turning-on of the microswitch (6), the pause solenoid (26) energizes to pull the pressure spring (27). When the play link (24) moves, section F of the play link moves the pinch roller pressure link assembly (25) and the pause solenoid assembly block (28) each in the arrow direction. The pinch roller assembly (29) contacts the capstan flywheel assembly (30), the pinch roller assembly starts its rotation and the tape is squeezed between the pinch roller assembly and the capstan flywheel assembly (30) so that the tape is fed forward at a constant speed.

When the pause solenoid assembly block moves, the tape slack detection lever assembly (32) is moved by its spring. Thus the assembly is ready to detect tape slack.

As the play link is pushed, section E of the play link moves the play link assembly (35) and the supply tension regulator arm assembly (36) each in the direction shown by the arrow. The supply tension regulator arm assembly senses tape tension and makes brake band assembly (37) move in the direction shown by the arrow so as to apply braking on the supply reel table assembly (38) to keep the tape tension constant.

As the play link assembly moves, section F of the play link assembly (34) moves the idler slide plate (39) in the direction shown by the arrow, the pressure spring (40) moves the play assembly (15) in the arrow direction and the play assembly (15) contacts the take-up reel table assembly (41). The take-up reel table assembly (41) starts its rotation in the direction indicated by the arrow so that the tape is taken up. With the rotation of the take-up reel table assembly (41), the counter belt (42) rotates the tape counter (43) and the count is then indicated.

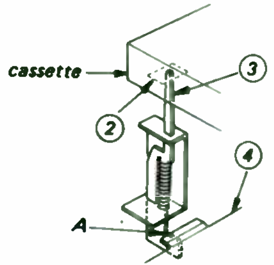
FAST FORWARD MODE

Figures 5-17 and 5-18 show the operation of the fast forward mode. When the fast forward button is depressed, the switch lever of the function block moves in the direction shown by the arrow to turn the microswitch on. Then the ac motor (4) rotates in the arrow direction. The capstan pulley (5), motor pulley assembly (6), fast forward idler belt (7), intermediate pulley assembly (8), fast forward assembly (9), fast forward idler assembly (10), play belt (11), play assembly (12), relay belt (13), relay pulley assembly (14), capstan belt (15), capstan flywheel assembly (16), drum belt (17), drum flywheel (18) and video head disc assembly (19) all move in the directions indicated by the arrows.

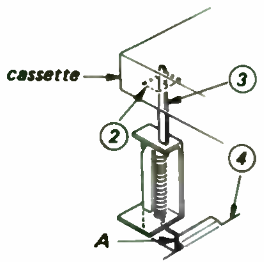
As the fast forward button is depressed, the leaf switch (20) on the SRP board turns on and the sensing head (21) initiates its operation to set up the stop mode when sensing the tape end.

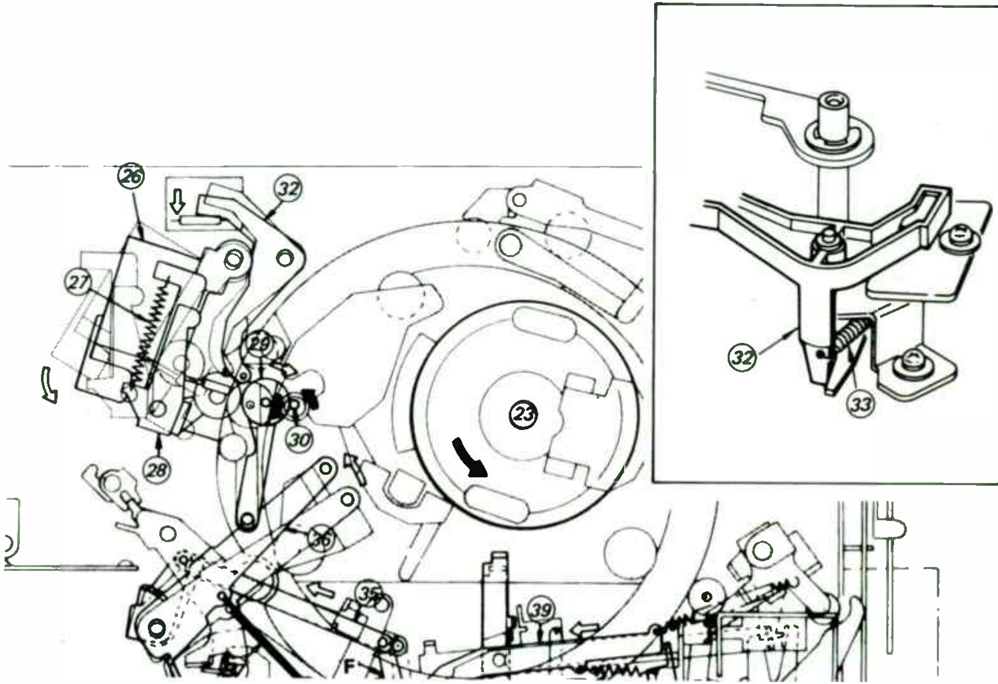
When the fast forward button is depressed, the fast forward slide plate (22) is pushed in the direction shown by the arrow, the fast forward arm assembly (23) is moved by the spring (24) in the direction shown by the arrow, the fast forward idler assembly (10) contacts the take-up reel table assembly (25) and this assembly rotates in the direction shown by the arrow to take-up the tape. With the rotation of the take-up reel table assembly, its rotational force is then transmitted to the counter belt.

As the fast forward slide plate is pushed, section A of the plate moves the rf slide plate (28) in the direction shown by the arrow, *When the record safety tab is not broken*



When the record safety tab is broken





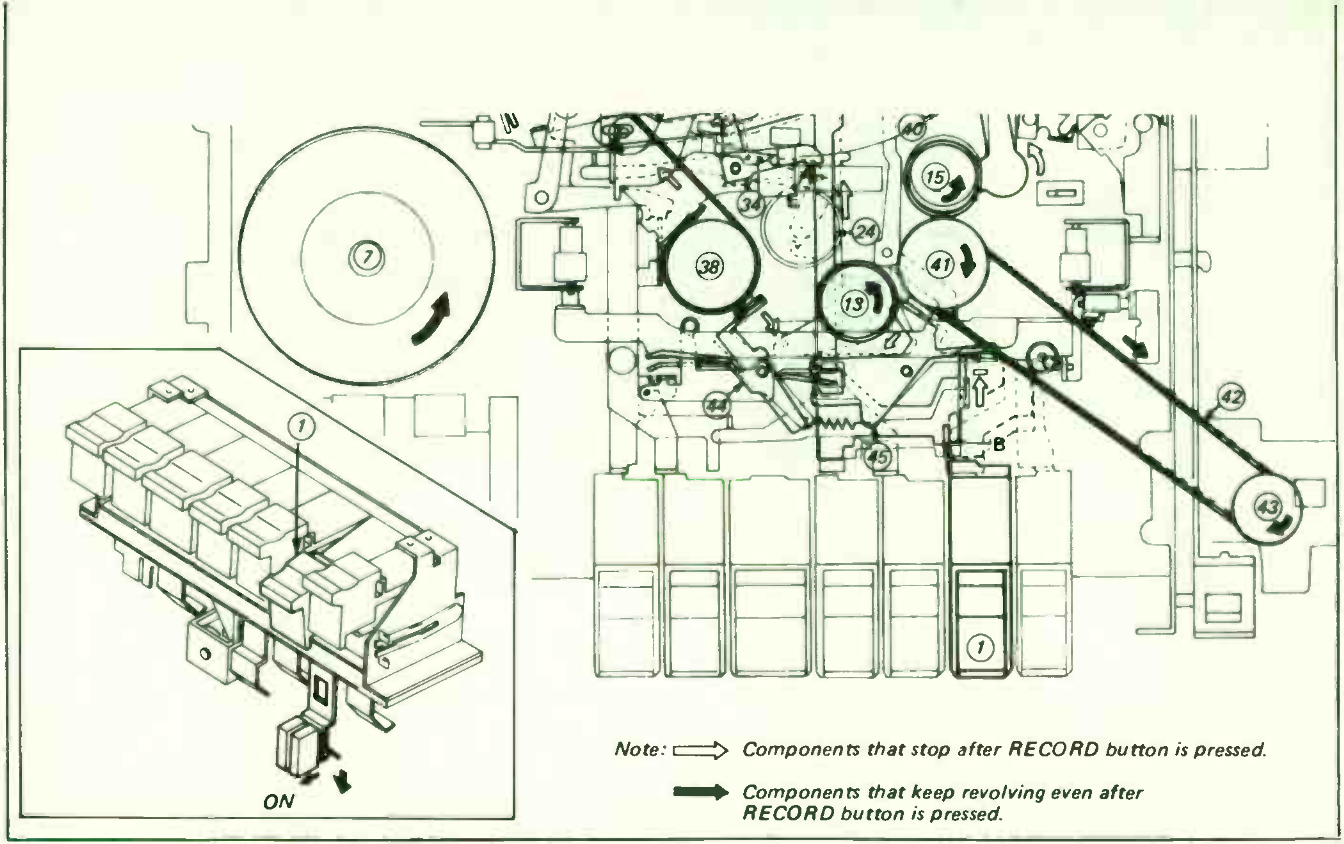
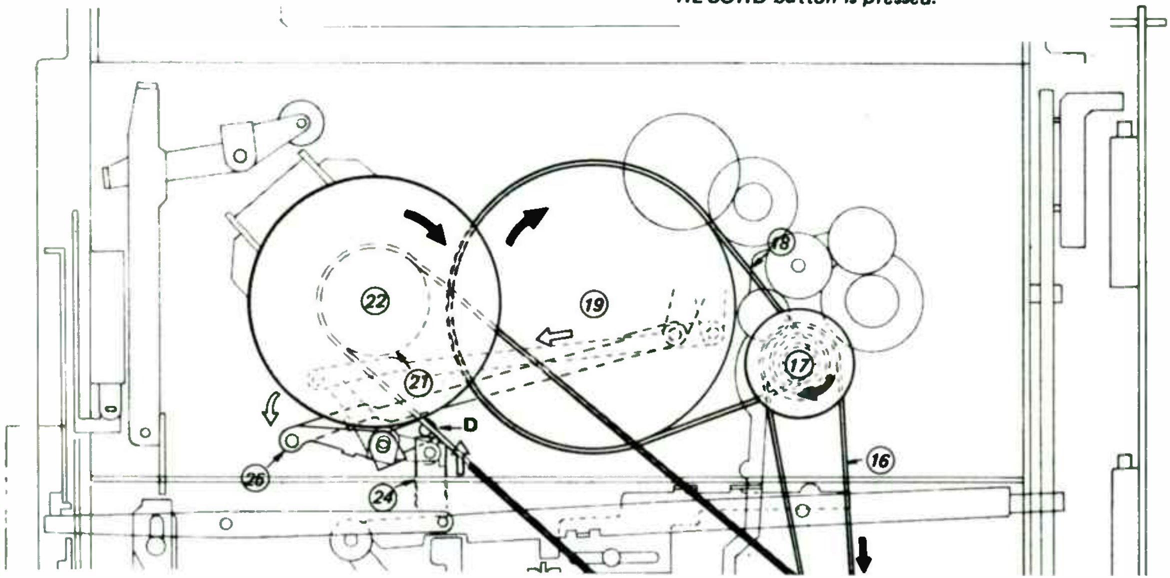


Fig. 5-15. Diagram of the record mode.

Note: ⇨ *Components that stop after RECORD button is pressed.*

➡ *Components that keep revolving even after RECORD button is pressed.*



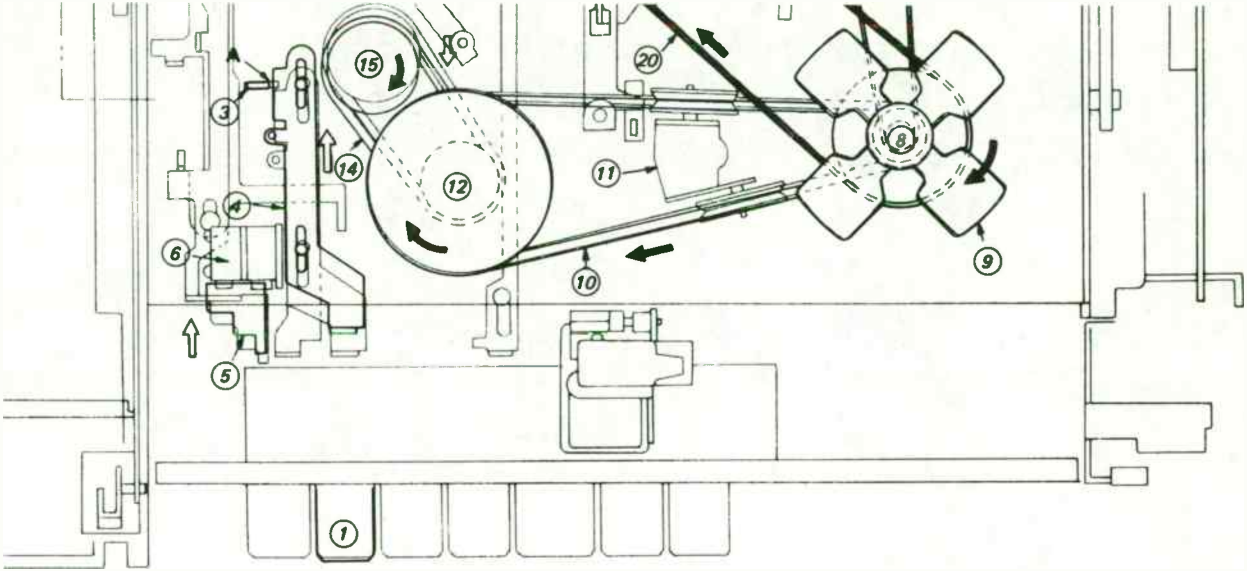
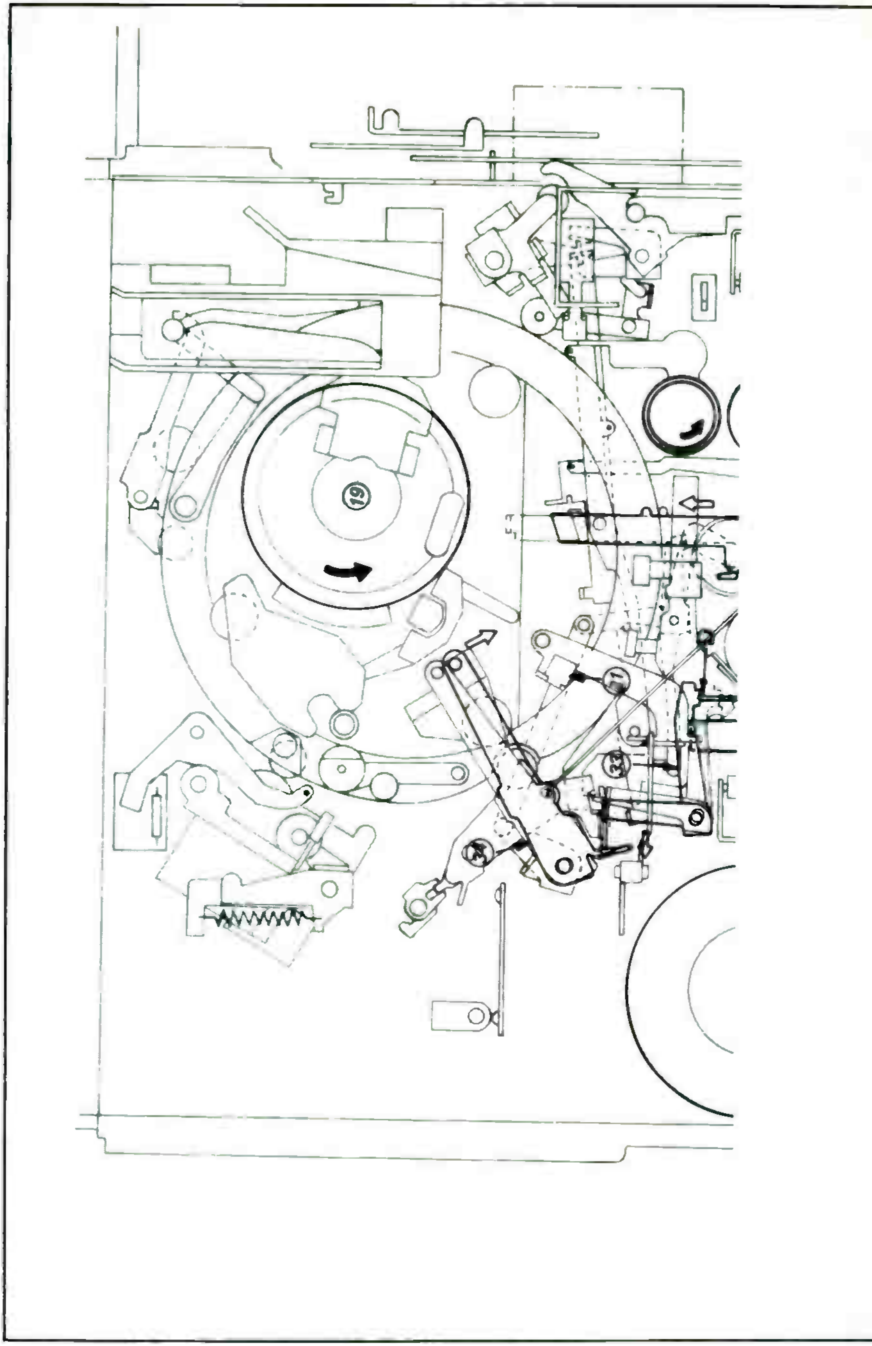


Fig. 5-16. Mechanical parts placement in the record mode.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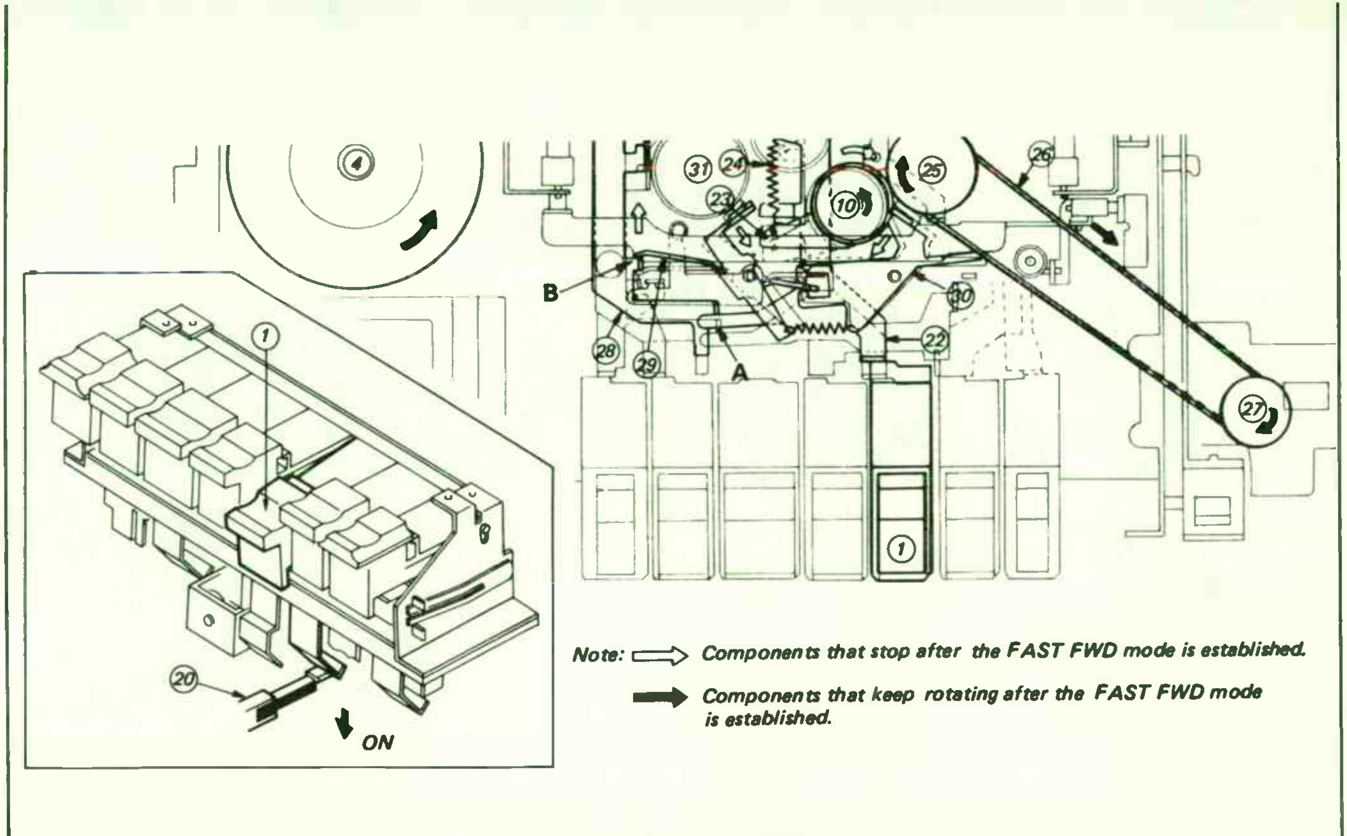
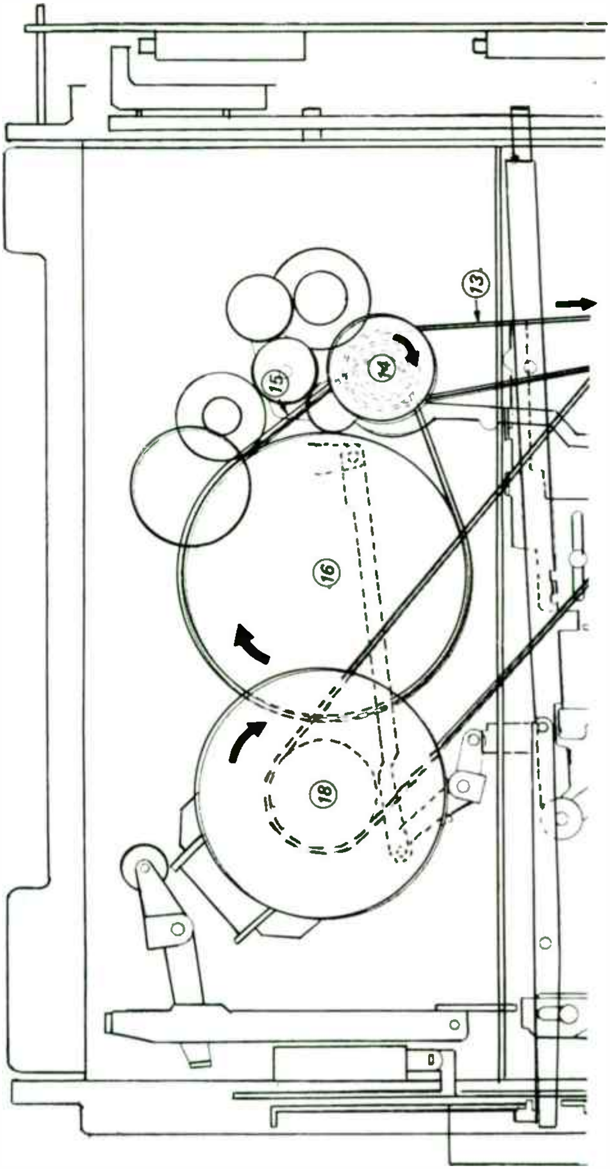


Fig. 5-17. Diagram of parts in fast-forward mode.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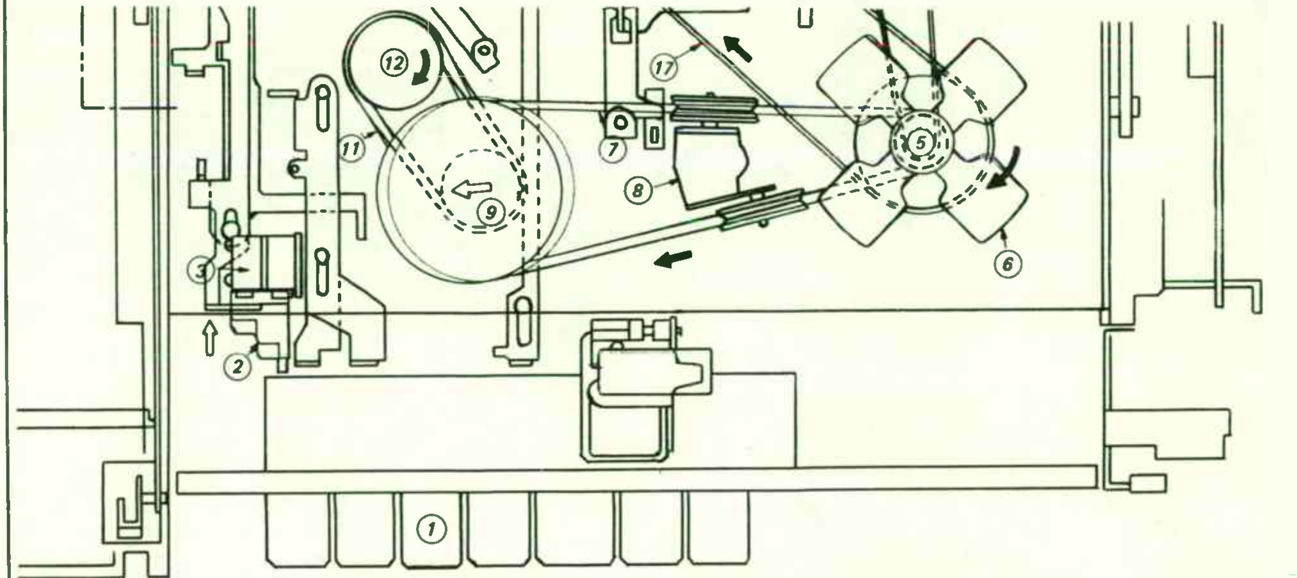


Note: ⇨ *Components that stop after FAST FWD mode is established.*

➡ *Components that keep revolving even after the FAST FWD mode is established.*

Fig. 5-18, Machine at completion of fast-forward mode.

section B of the rf slide plate moves the supply brake assembly (29) and the take-up brake assembly (30) in the direction shown by the arrows, and the brake assemblies disengage from the supply reel and the take-up reel tables. Now the reel tables can rotate freely.

As the rf slide plate moves, section D of the rf slide plate moves the rf link (33) and the supply tension arm assembly (34) in the direction shown by the arrows for decreasing the friction caused by the tape running.

REWIND MODE

Figures 5-19 and 5-20 show the operation of the mechanical components at the completion of the rewind mode. When the rewind button is depressed, the switch lever of the function block moves in the direction indicated by the arrow to turn on the microswitch. The ac motor will then rotate in the direction shown by the arrow. The capstan pulley (5), motor pulley assembly (6), fast forward idler belt, intermediate pulley assembly (8), fast forward assembly (9), fast forward idler assembly (10), play belt (11), play assembly (12), relay belt, relay pulley assembly, capstan belt (15), capstan flywheel assembly (16), drum belt (17), drum flywheel (18) and video head disc assembly (19) all turn in the directions shown by the arrows.

When the rewind button is depressed, the leaf switch on the SRP board turns on and the sensing head (21) actuates to set up the stop mode when sensing the tape end.

The rewind slide plate (22) is pushed in the direction indicated by the arrow when the rewind button is depressed. The rewind link assembly (23) moves by the force of the spring in the direction indicated by the arrow. The rewind idler assembly (25) on the rewind link assembly transmits the force to the fast forward idler assembly (10) to the supply reel table assembly. The supply reel table assembly rotates and the tape is rewound.

The rf slide plate is also pushed in the same direction as the rewind slide plate (22) moves. The supply brake assembly (29) and take-up brake assembly (30) disengage from the supply reel table (27) and the take-up reel table assembly, allowing the reel table assemblies to turn freely. As the rf slide plate moves, the rf link (33) and the supply tension arm assembly (34) move in the directions shown by the arrows so as to decrease the friction caused by the tape running.

STOP MODE OPERATION

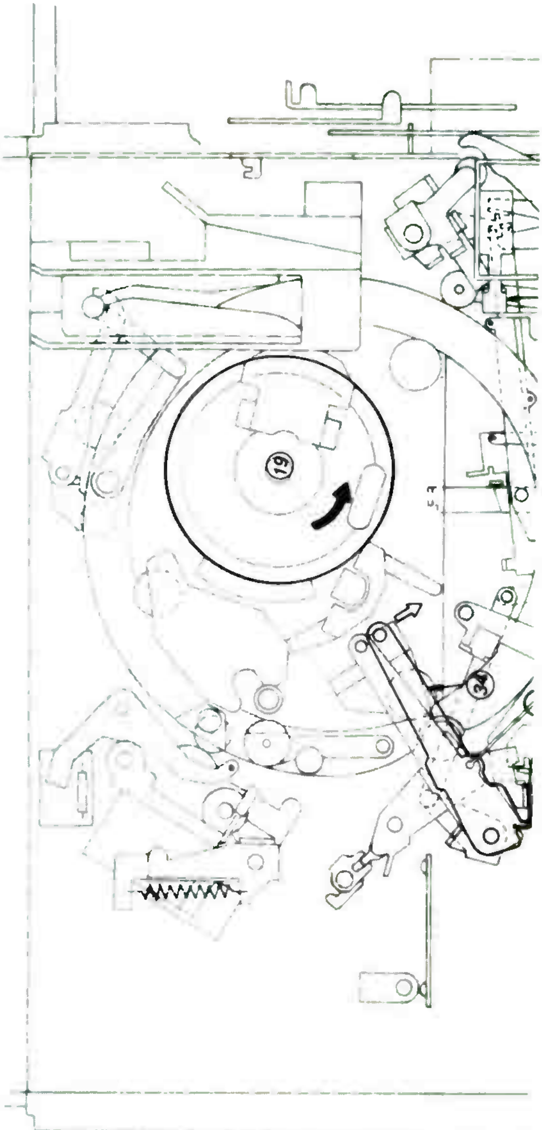
If the stop button is depressed in any mode, all the links are released and the same state as that which occurs when the power is turned on and the cassette is inserted. Since the ac drive motor and the capstan motor are not rotating in this mode, any components such as the reel table assemblies and capstan housing assembly are not moving. Only the ST brake assembly operates, and the brake band assembly and loading brake assembly are off. All the solenoids are in the off-state.

EJECTION MODE

Refer to Figs. 5-21 and 5-22 for the mechanical operation at the completion of the eject mode. When the eject button is depressed, the switch lever of the function block moves in the direction shown by the arrow to turn on microswitch (3). The ac motor then starts. The capstan pulley (5), motor pulley assembly (6), fast forward idler belt (7), intermediate pulley assembly (8), fast forward assembly (9), relay belt (13), relay pulley assembly (14), capstan belt (15), capstan flywheel assembly (16), drum belt (17), drum pulley (18), drum flywheel (19) and video head disc assembly (20) all rotate in the direction indicated by the arrows.

When the eject button is depressed, the eject slide plate (21) is pushed in the direction shown by the arrow. Section A of the eject slide plate (21) moves the supply brake assembly (22) and the take-up brake assembly (23) each in the direction shown by the arrow. The brake assemblies disengage from the supply and take-up reel tables, thus allowing them to rotate freely. As the eject slide plate moves in the direction shown by the arrow, the eject brake assembly (65) moves by the force of the spring in the direction shown by the arrow so as to apply the brake on the supply reel table. Section B of the eject slide plate makes the eject link turn in the arrow direction. Section C of the eject link moves the eject plate B (27) in the direction indicated by the arrow. Section D of the eject slide plate B moves the idler slide plate (28), spring (29) and play assembly (12) each in the direction shown by the arrow. The play assembly contacts the take-up reel assembly, the take-up reel table assembly (25) rotates to take-up the tape. With the rotation of the take-up reel, the counter belt (31) then moves to operate the tape counter.

When the eject slide plate B moves in the direction shown by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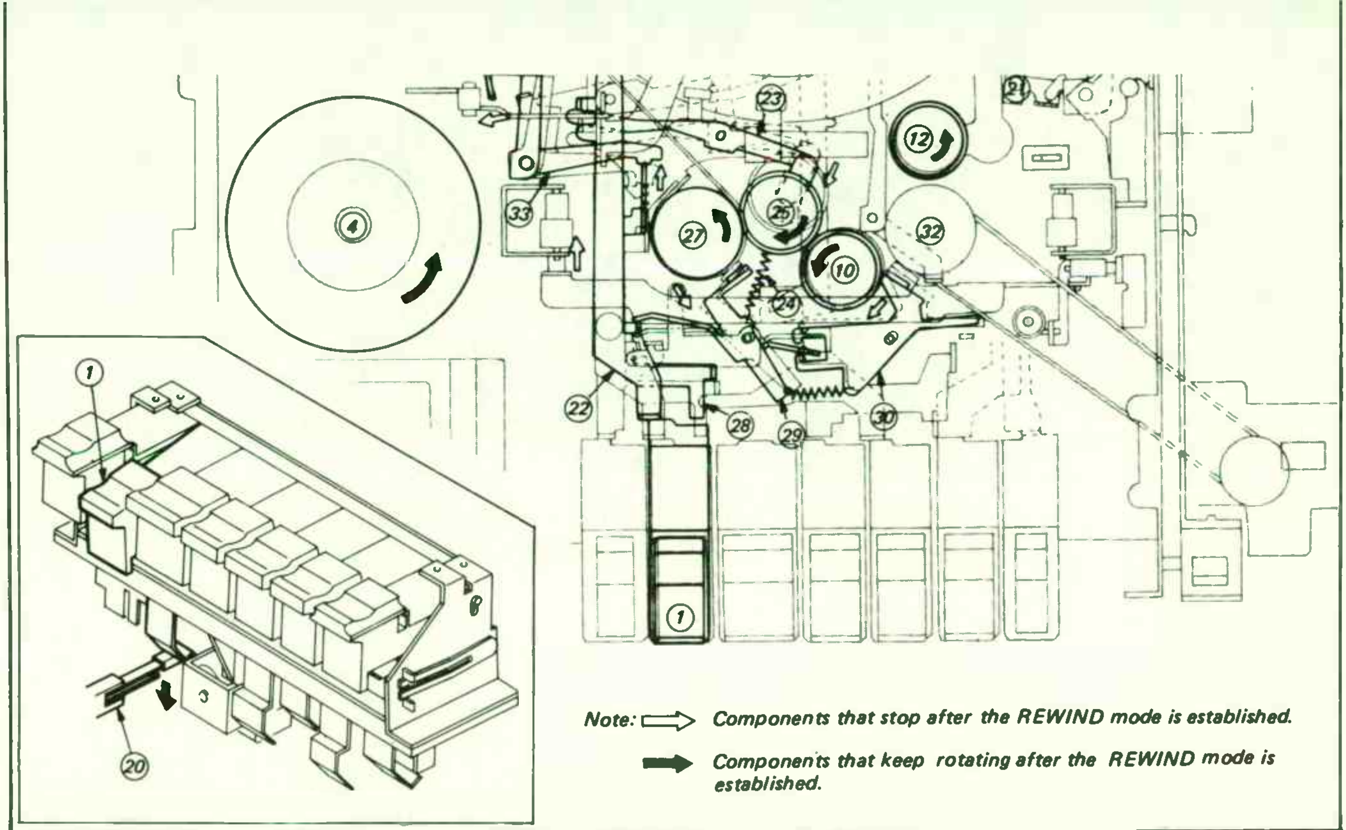
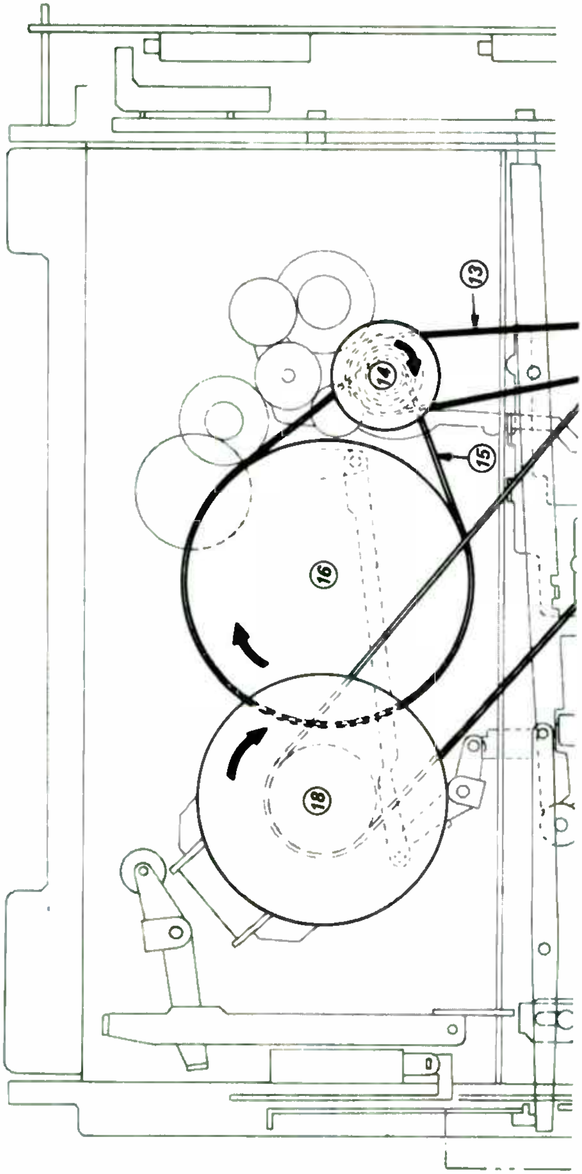


Fig. 5-19. Machine operation in rewind mode.



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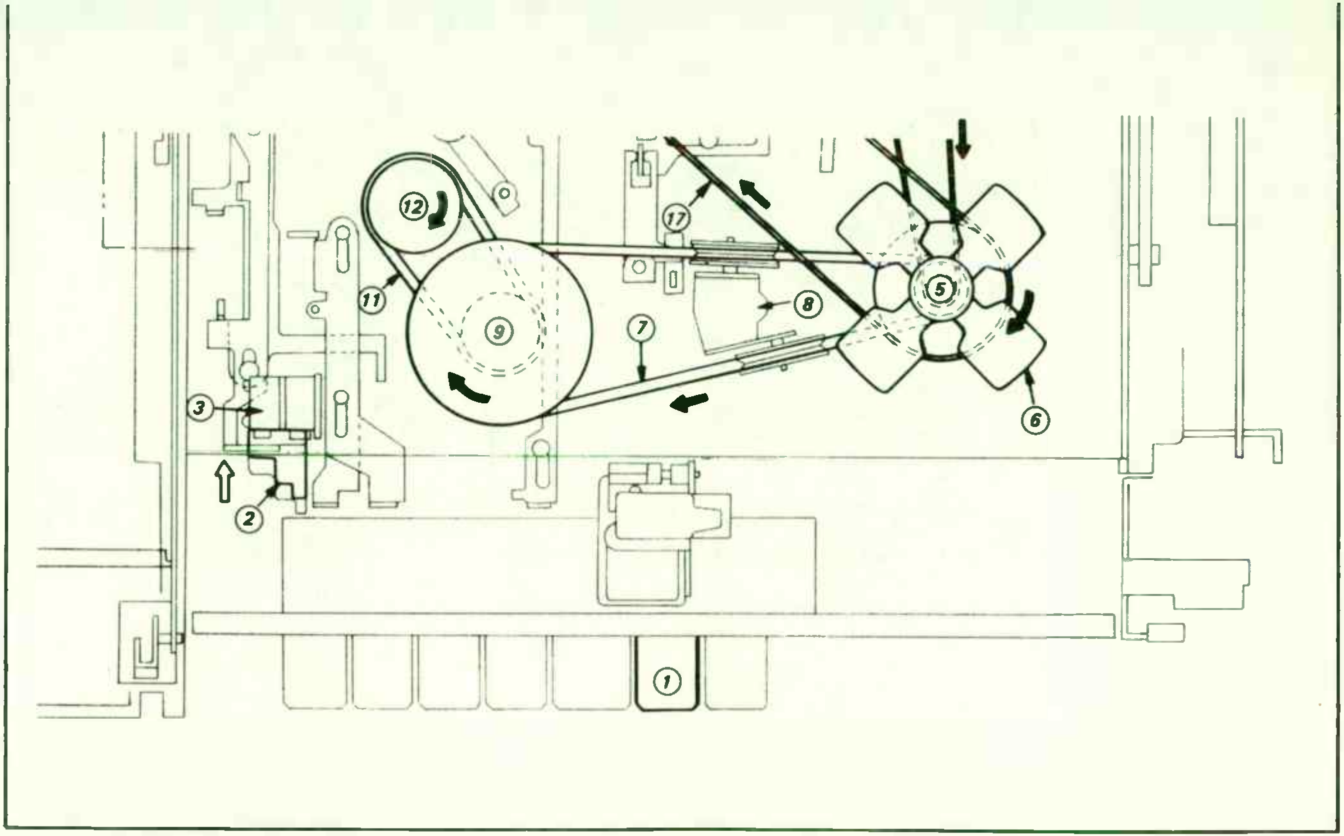
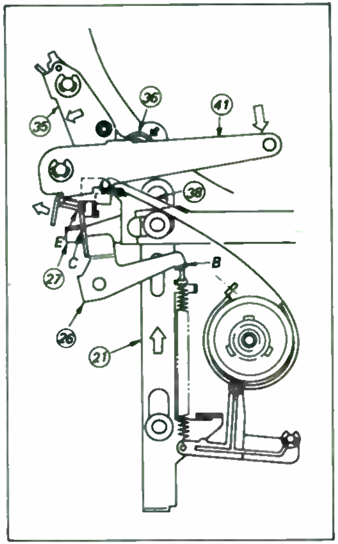
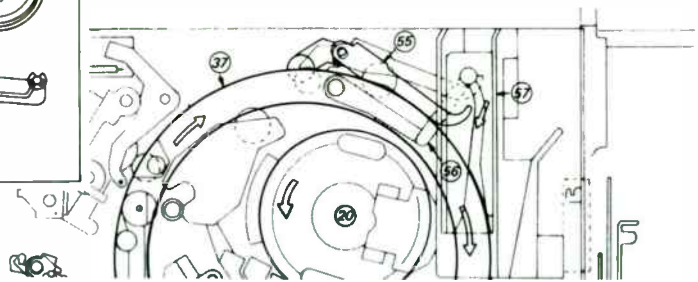


Fig. 5-20. Parts location at completion of rewind mode.



Note: ⇨ *Components that stop after EJECT mode is established.*

➡ *Components that keep revolving even after the EJECT mode is established.*



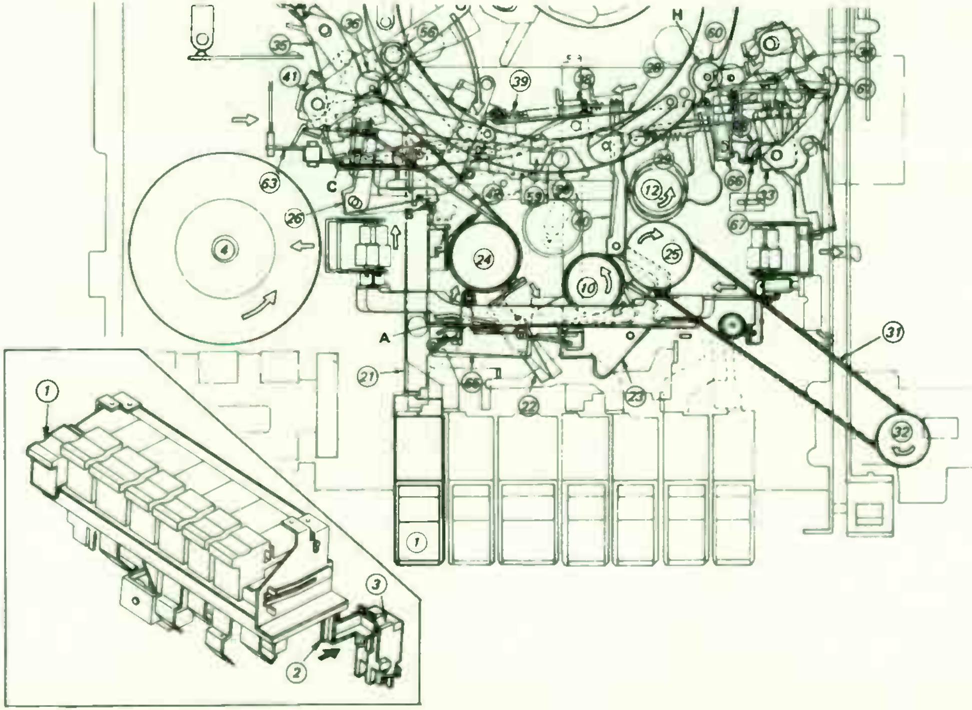
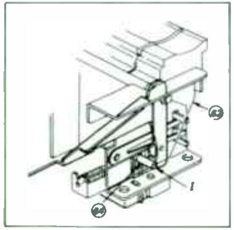
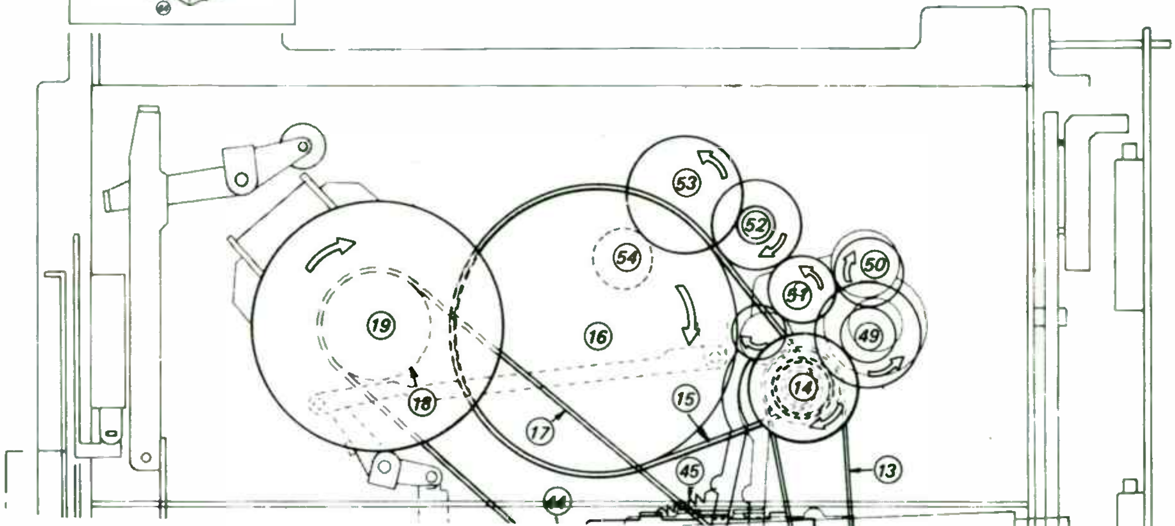


Fig. 5-21. Machine operation in the eject mode.



Note: ⇨ Components that stop after EJECT mode is established.

➡ Components that keep revolving even after the EJECT mode is established.



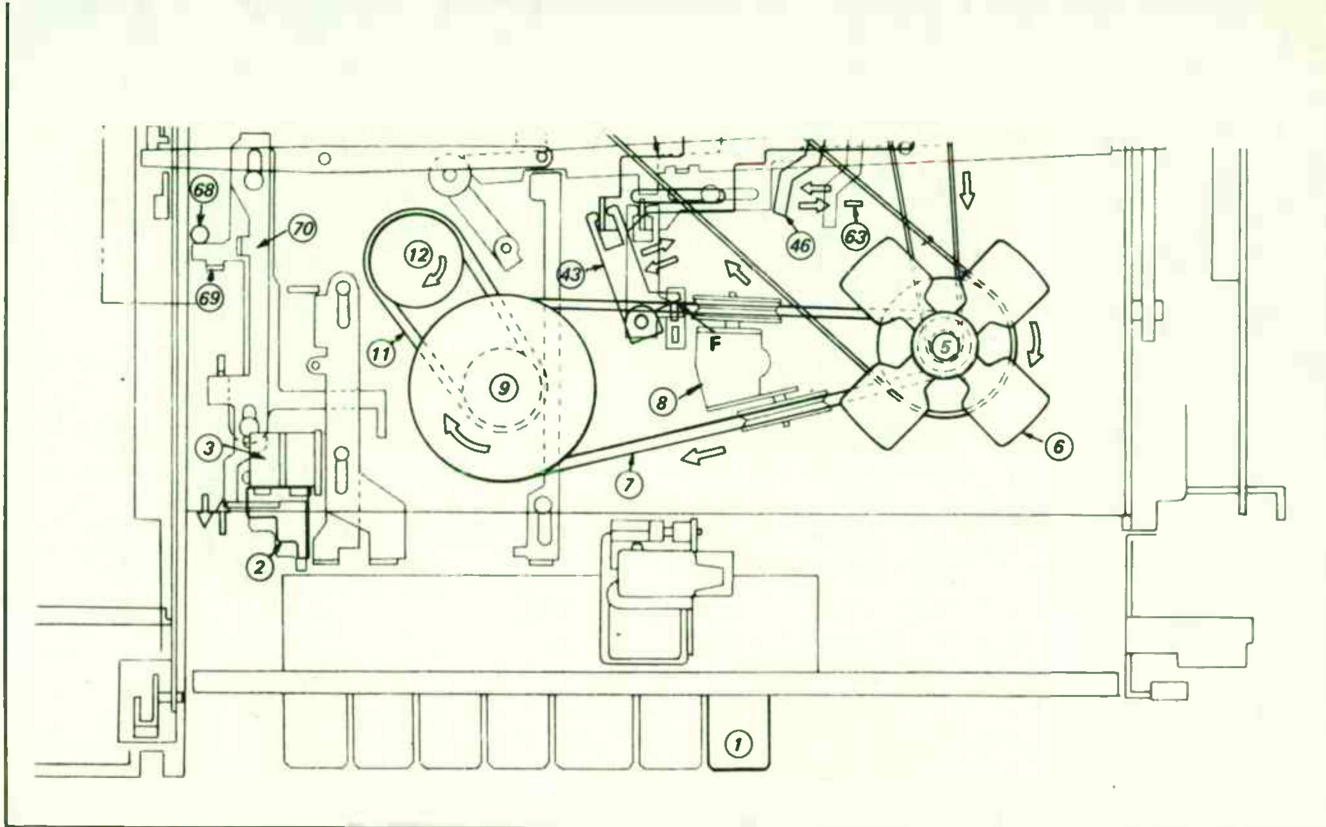


Fig. 5-22. Component parts location at completion of eject mode.

the arrow, the lock release lever (33) at the lock release sub-lever (34) each turn in the direction shown by the arrow. Section E of the eject link moves the left positioning lever (35) turn in the direction of the arrow. The positioning roller (36) disengages from the entire threading ring assembly (37) and a state in which the entire threading ring assembly can turn is set-up. As the positioning lever (35) turns, the eject stopper assembly (38), threading brake spring (39), and threading brake assembly (40) move in the direction indicated by the arrows. The threading brake assembly (40) contacts the take-up reel table assembly. Since the torque of the take-up reel is greater than the braking force of the threading brake assembly (40), the torque of the take-up reel table does not decrease. With the moving of the left positioning lever (35), the supply tension regulator arm assembly (41) and brake band assembly (42) move in the direction indicated by the arrows and the brake band assembly disengages from the supply reel table, releasing the brake.

When the eject button is depressed, the eject slide plate is pushed in the direction shown by the arrow, section F of the eject slide plate moves the threading drive link (43) and the threading switch side plate (44) in the direction shown by the arrows. The spring (45) pulls the threading gear base assembly (46) in the direction shown by the arrow so as to press the threading gear base assembly (46) on the relay pulley assembly (14). The rotation of the relay pulley assembly is transmitted to the entire threading ring assembly (37) via the gear B, gear C, gear D, gear E, gear F, gear G and the entire threading ring assembly turns in the direction indicated by the arrow.

As the entire threading ring assembly rotates, the arm clock assembly (55) is pushed in the direction shown by the arrow because of the cam shape of the entire threading ring assembly (37) so as to release the hold state of the threading arm assembly (56) and the threading arm assembly moves along the threading arm guide (57) in the direction indicated by the arrow. The positioning roller (36) and the left positioning lever (35) are pushed further from the positions to which they were pushed by section F of the eject link (26) when the eject button was depressed. With the moving of the positioning lever (35), the supply tension regulator arm assembly (41) and the eject stopper assembly (38) are pushed further in the directions shown by the arrows from the position to which they were moved when the eject button was depressed.

When the entire threading ring assembly turns and reaches the position of unthreading completion, the guide roller assembly (58) contacts the ring stopper (59), the positioning roller (60) drops into the recess "H" and the limiter assembly D (61) turns in the direction shown by the arrow. The cassette lift assembly (62) is unlatched and moves upward so that the cassette can be taken out.

When the positioning roller (60) drops into the recess "H", the positioning lever (66) moves, the positioning limiter (67) moves in the arrow direction and the brake link (69) is moved by the crank (68) in the arrow direction. With the popping-up of the cassette lift assembly and the movement of the brake link, the switch link (70) moves in the direction shown by the arrow.

When the cassette-lift assembly moves upward, the supply sensor relay lever which having been depressed when the cassette goes upward so that the threading gear assembly (46) disengages the relay pulley assembly (14). When the cassette lift assembly goes up, section I of the cassette-lift assembly moves in the direction indicated by the arrow to push the lock plate (64), releasing the eject button. The switch lever (2) moves in the direction shown by the arrow to turn off the microswitch (3). The ac motor stops rotation and the eject operation is completed.

VIDEO DRUM HEAD DISC REPLACEMENT

1—Remove the upper drum mounting screws shown in Fig. 5-23 with an Allen wrench and remove the upper drum assembly (1) from the drum support (2).

2—Remove the four wires of the video head disc from the solder terminal (3).

3—Remove the two screws and video head disc assembly (4).

4—Clean the bottom and flange surfaces of the replacement video head disc assembly with a piece of alcohol dampened soft cloth.

5—Place the replacement video head disc assembly (4) so that the red lead of the disc assembly is close to the small black mark on the solder terminal (3) and secure the disc assembly temporarily with the two screws.

VIDEO HEAD DISC ECCENTRICITY ADJUSTMENT

■ Remove the threading arm guide (1).

■ Install eccentricity gauge with the thumbscrew (II) so that its probe contacts the head disc circumference about 2 mm below the top edge of the video head disc assembly (3). Refer to Fig. 5-24.

■ Rotate the ac motor slowly counterclockwise. Adjust the video head disc assembly (3) eccentricity so that the gauge reading

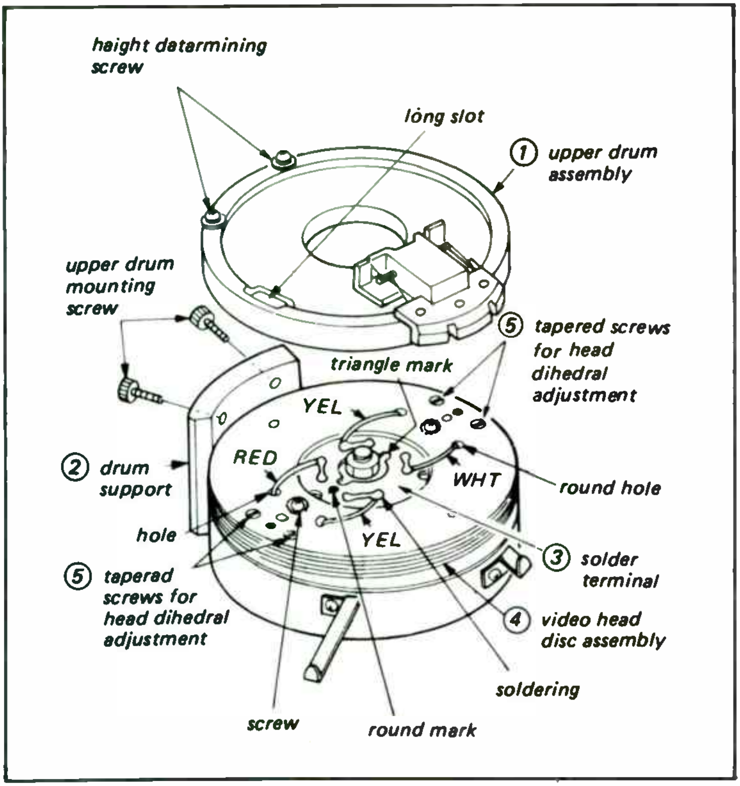


Fig. 5-23. Video head disc assembly.

deflection is within 3 microns, by very gently tapping the inner circle edge of the video head disc assembly (3) with the blade of a screwdriver. Refer to Fig. 5-25.

■ When the eccentricity is less than 3 microns, finger tighten the two mounting screws alternately and finally tighten them fully with a screwdriver. (Tightening torque must be more than 10 kg/cm).

■ Make a final test of eccentricity using the gauge, when the screws are fully tightened. Solder the leads of the video head to solder terminal (3) as shown in Fig. 5-23. Note: Bend the video head leads flat on the top surface of the video head disc assembly (4) so that the slack of the leads does not touch the upper drum assembly (1). Set the upper drum assembly (1) to the drum support. Tighten the mounting screws with an Allen wrench while holding the height determining screws with the fingers. Refer to Fig. 5-23.

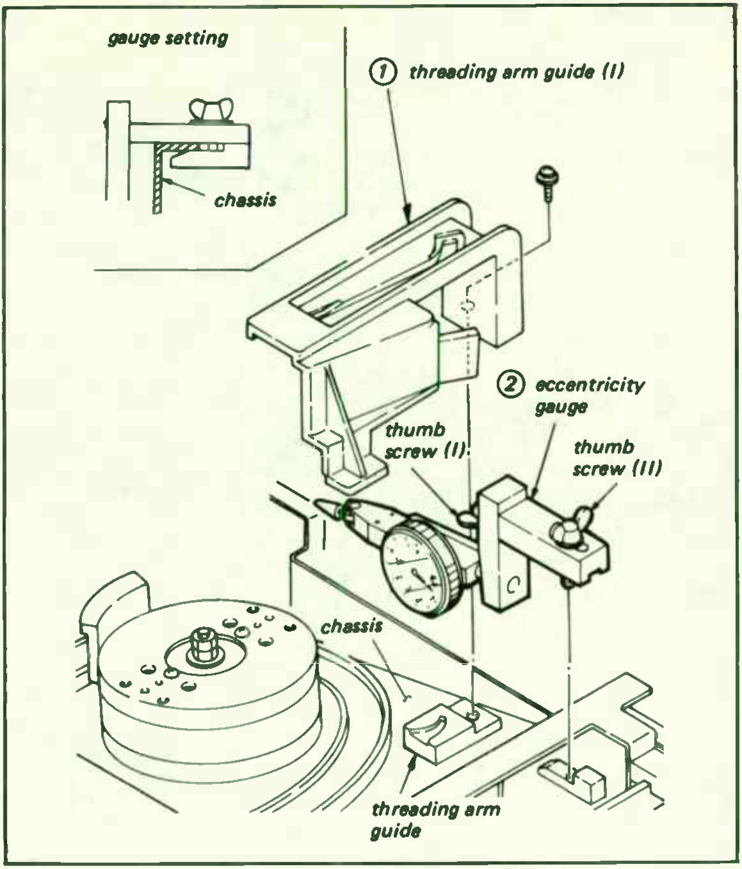


Fig. 5-24. Drum head eccentricity adjustments.

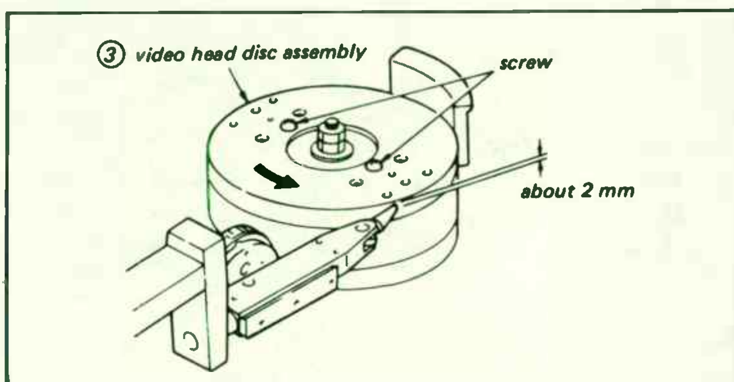


Fig. 5-25. Drum eccentricity measurement.

VIDEO HEAD DIHEDRAL ADJUSTMENT

Note: This adjustment may not be required (Fig. 5-23).

■ Play back the monoscope signal segment of the alignment tape and check for dihedral error at the top of the picture (or at the bottom, at the switching point.)

■ If dehedral error is observed, install four tapered screws (5) in each of the four holes on video head disc assembly (4) through the slots in the upper drum assembly (1).

■ Turn one of the four screws until the screw touches the head base. Give this screw one additional quarter turn.

■ Play back the monoscope signal of the alignment tape and check again for dihedral distortion.

■ If the symptom is worse, unscrew the screw identified in step above, and turn down the screw on the opposite side of the same video head. Repeat, in quarter turn steps, to eliminate dihedral error. Remove all 4 screws after check.

■ Perform electrical adjustment.

AUDIO/CONTROL HEAD ASSEMBLY REPLACEMENT

1—Move harness clamp (3) as shown in Fig. 5-26 in the direction shown by the arrow.

2—Remove exit end adjustment nut (2).

3—Lift audio/control head assembly (1) and unsolder the leads of the head (see Fig. 5-26).

4—Replace audio/control head assembly (1) and solder the lead connections.

5—Perform the tape path (play) adjustment.

TAPE PATH (PLAY) ADJUSTMENT

Note: This adjustment requires high skill. Practice the adjustment fully before performing the actual adjustment.

Tape and Fixtures Required for Tape Path Adjustment

■ Alignment tape—Sony part number KR5-1D.
■ Eccentric screwdriver (for CTL head position adjustment).
■ Inspection mirror (for tape running check).
■ Tension regulator bending fixture.

Guides and Screws to be Adjusted for Tape Path Adjustment

■ Entrance side tape guide nuts (1) and (2).
■ Exit side tape guide nuts (3) and (4).

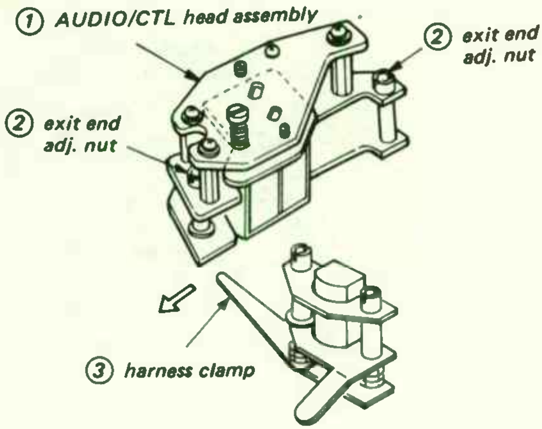


Fig. 5-26. Audio/control head assembly.

- Azimuth adjusting screw (5).
- CTL head position adjusting screws (6).

Tape Path Adjustment

Adjustment sequence (see Fig. 5-27).
1—Coarse adjustment.
2—Rf envelope/tracking adjustment.
3—Audio azimuth adjustment.
4—CTL Head position adjustment.

Coarse Adjustment

Insert a cassette. Press the play button to run the tape in the play mode. Adjust the screws (1), (2), (3) and (4) so that the tape runs smoothly, and any tape curl is removed while observing tape at the entrance tape guide flange and exit tape guide flange. Any fold-out or curl of the tape should be removed at the capstan, and at the entrance and exit of the revolving head disc assembly. The tape should run so that the top edge of the tape maintains stable contact along the upper flange of the tape guides while any tape curl and wrinkles are removed. Use an inspection mirror to observe tape-edge-to-flange guide contact during this adjustment. Refer to Figs. 5-28 and 5-29.

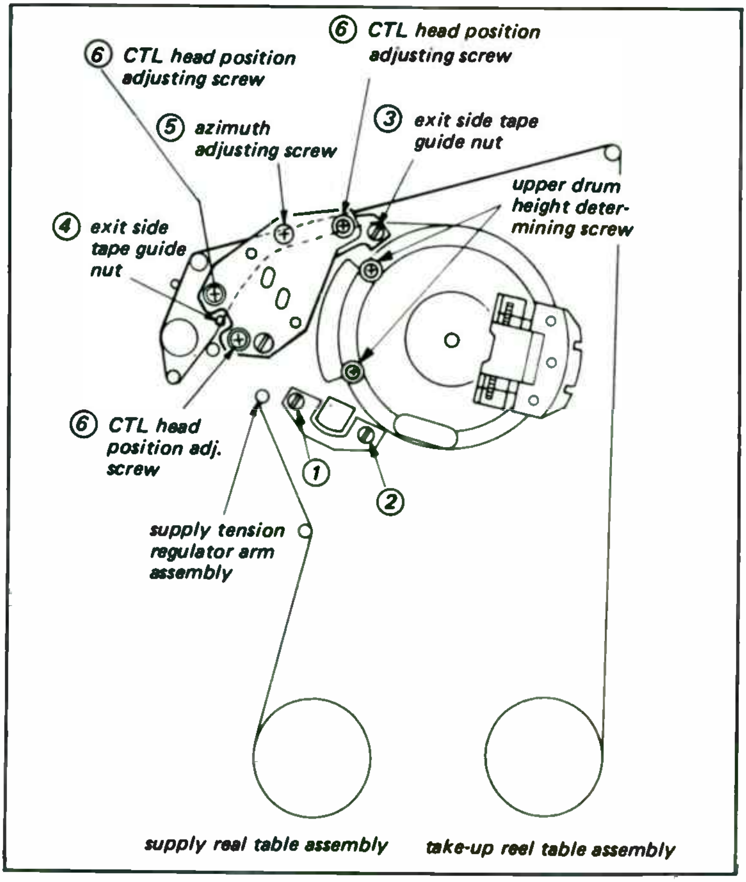


Fig. 5-27. Tape path adjustment.

RF ENVELOPE/TRACKING ADJUSTMENT

Connect the scope to TP 5 on the ARS board. Trigger the scope from TP 501. Play back the monoscope segment of the alignment tape. Refer to Fig. 5-30. While observing the rf envelope on the scope, adjust the tracking control for best results. Connect an ac VTVM to the audio out jack in order to measure the audio signal level fluctuations, as shown in Fig. 5-31.

Adjust tape guide nuts (1), (2), (3) and (4) according to the following adjustment procedures so that the rf envelope displayed on the scope screen meets the specification required. The audio signal level fluctuation should be within 2 dB. See Figs. 5-27 and 5-32.

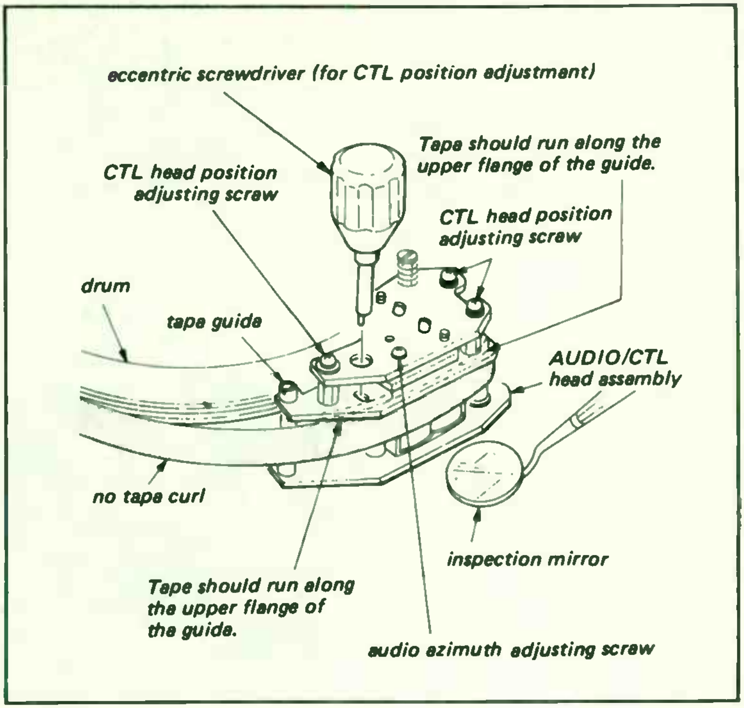


Fig. 5-28. Audio/control head.

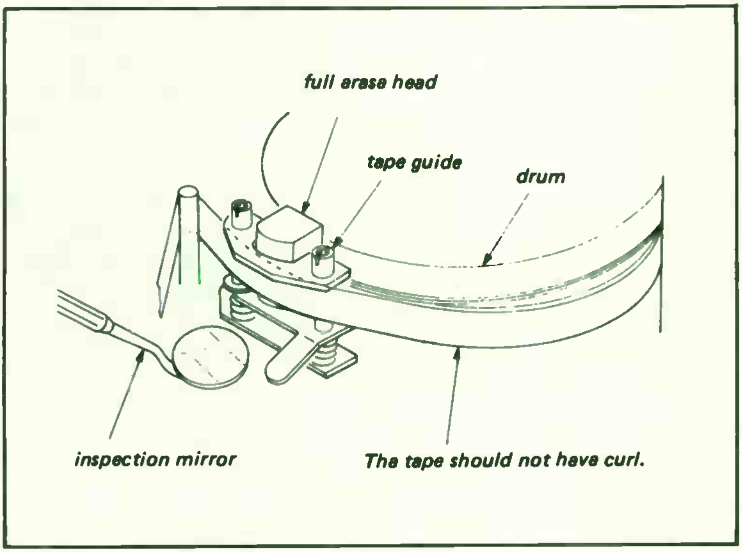


Fig. 5-29. Tape guide running check.

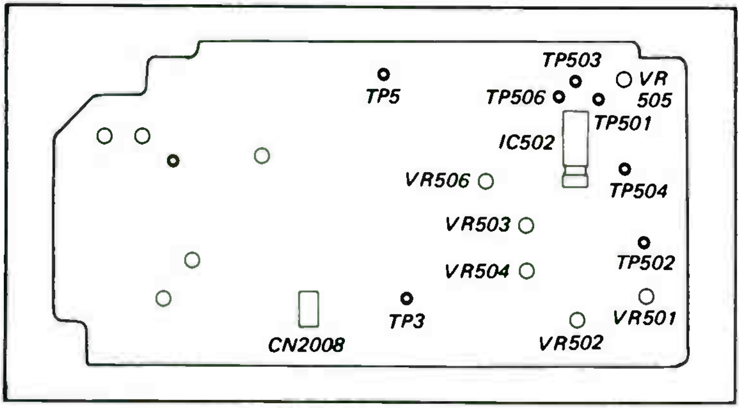


Fig. 5-30. ARS board test point locations.

ADJUSTMENT PROCEDURES

For the entrance side adjustment, play back the monoscope segment of the alignment tape. Make an attempt of either screwing in or out slightly the entrance side tape guide nuts, as shown in Fig. 5-27 as (1) and (2), in order to optimize the center and right half portion of the rf waveshape.

It is allowable that the tape edge contacts either the upper or lower flange of the entrance side tape guide, but it should only contact the upper flange of the entrance side tape guide nut.

The supply tension regulator arm may be bent slightly, if necessary to remove a curl at the entrance guide, but only after all adjustments have been made for an optimum flat envelope. It is most common that the rf envelope amplitude at the point shown at the right side of Fig. 5-32, the entrance, keeps fluctuating a little.

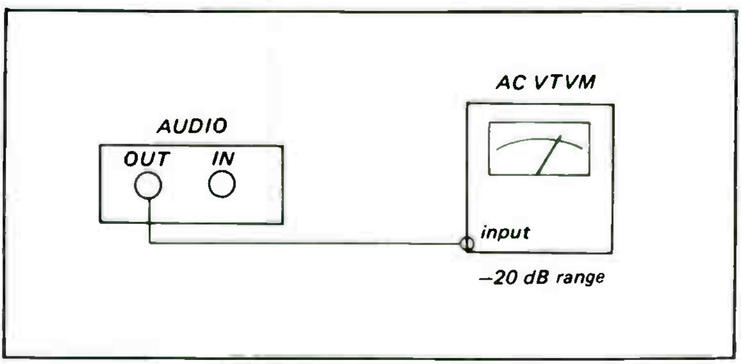


Fig. 5-31. Audio output level check.

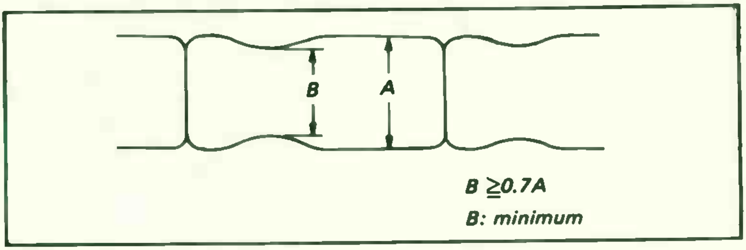


Fig. 5-32. Rf envelop waveform.

EXIT SIDE ADJUSTMENT

Play back the monoscope segment of the alignment tape. Make an attempt of either screwing in or out the exit side tape guide nuts in order to obtain the most flat envelope at the left half of the waveshape. Adjust first the exit side tape guide nuts so that the upper edge of the tape runs along the upper flange of the audio/control head assembly. This adjustment should be done while observing the tape-to-guide contact using an inspection mirror.

Screw in the exit side tape guide nuts gradually so that the envelope of the waveform becomes flat while tape curl is kept at a minimum. Check that audio level variation is within 2 dB. If level variation is great, check for curls on the tape, again using the inspection mirror.

AUDIO AZIMUTH ADJUSTMENT

Adjust the audio azimuth adjustment screw for maximum audio level. Refer to Fig. 5-28. Note: the height of the audio head can be set by running the tape along the flanges of the exit side tape guide nuts. It is not necessary to adjust audio head height independently.

CTL HEAD POSITION ADJUSTMENT

Use the following procedure to change shift state to a no shift state.

■ Connect the channel-1 probe of a dual-trace scope to TP501 and the channel-2 probe to TP503. Set the scope to chop and trigger it externally from TP503.

■ Adjust VR505 on ARS board so that the phase of the positive-going portion of channel-1 waveform matches that of the negative-going portion of the channel-2 waveform. Note these two waveforms in Fig. 5-33. Note: set the tracking control knob to its center detent position.

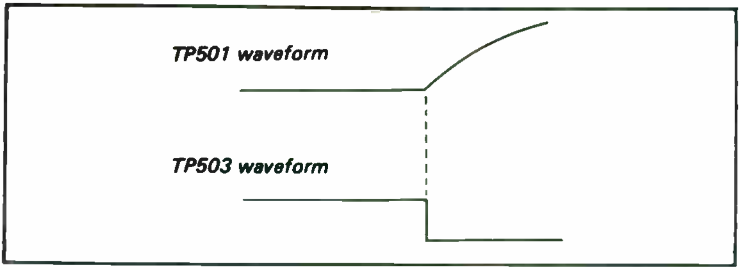


Fig. 5-33. Dual-trace waveform shift adjustment.

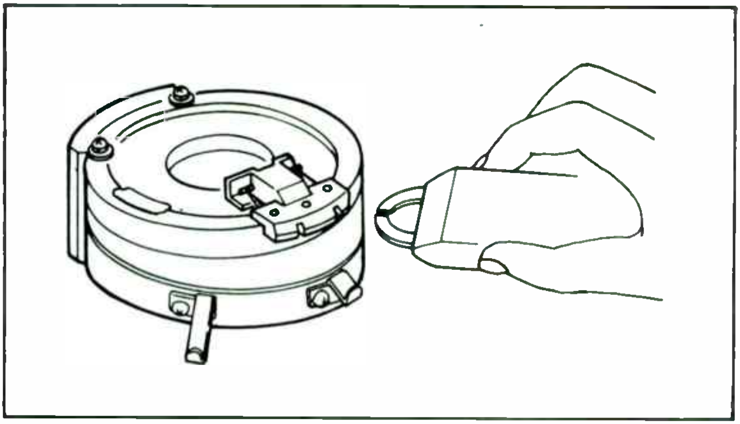


Fig. 5-34. Degaussing the video heads.

■ Play back the monoscope signal of the alignment tape.

■ Loosen the three CTL adjusting screws and adjust the position of the CTL head with an eccentric screwdriver for maximum rf output at TP5 on the ARS board.

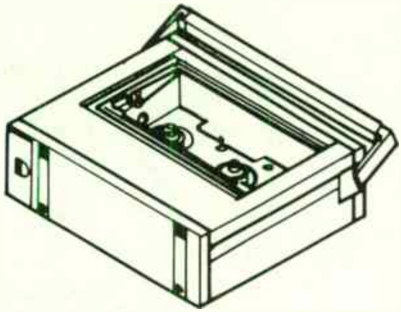
■ Check to see that the audio/control head is positioned in the approximate center of the cut-out hole of the guide base plate.

■ Tighten the three CTL adjusting screws.

DEGAUSSING VIDEO HEADS AND OTHER PARTS

If the video head is magnetized, the S/N ratio deteriorates and slant beat and noise appear on the picture. The video head and other parts must then be demagnetized. To degauss, bring the tip of the demagnetizer as close as possible to the head tip without actually contacting the head tip. Withdraw the demagnetizer very slowly and turn off power of the demagnetizer when it is at least 7 feet away from the VCR deck (refer to Fig. 5-34).

Chapter 6



VCR Tuner and I-f Circuits

In this chapter we will cover the tuner and i-f circuit board used in the Zenith/Sony KR9000 VCR machine. This will also include tuner and i-f circuit board alignment data. Next we'll take a brief look at this machines system control circuits. The chapter concludes with information about the built-in clock timer and its circuit description.

RF TUNER

The vhf tuner has a compact turret switching mechanism. Its electrical performance is equal or superior to that of a large-scale vhf tuner. Dual Gate MOSFET that have a high transmission characteristic, are used in the rf amplifier stage as the transistor amplifier. This MOSFET enables the tuner to provide excellent characteristics for cross modulation, noise figure, and automatic gain control.

An IC (CX-097A) is utilized in the mixer stage and local oscillator circuits for improving operational reliability by reduction of the parts required. The mixer stage has been designed to give a good channel 6 chroma beat characteristic. This is important in the reception of the channel 6 station signal. A constant impedance in the output circuitry eliminates the need of adjustment for optimum coupling to the i-f circuitry stages.

I-F CIRCUIT BOARD (I-F-4)

The developed output signals of the i-f board circuitry are the video and audio signals to be recorded by the VCR tape machine. The TV station signal coupled into the tuner terminals of the VCR are fed to each tuner where the selected signal is converted to the i-f signal with 45.75 MHz for the video carrier and 41.25 MHz for the audio carrier. The i-f signal is connected via the input filter group to a trap for the required attenuations of unwanted signals.

The video i-f response of the input stage is adjusted in the circuit consisting of T506, T507, and CV501 trimmers. The signals are amplified, while maintaining the required bandpass, and detected within IC501. Each signal from IC501 is fed to the AFC circuit and audio circuit via Q501 (i-f buffer). The AFC integrated circuit, IC502, amplifies and detects the i-f signal and develops the AFC voltage that controls the local oscillators of the vhf/uhf tuners for stable operation.

The audio circuit in IC503 amplifies and detects the 4.5 MHz audio i-f signal. The AGC output of IC501 gain-controls the i-f amplification and the rf stage of the vhf tuner for stable reception.

TUNER ADJUSTMENTS

The vhf tuner adjustment locations are shown in Fig. 6-1. A photo of the vhf tuner with cover removed is shown in Fig. 6-2. The vhf and uhf wiring information is shown in Fig. 6-3.

Equipment Required For Tuner Alignment

- Sweep generator.
- Marker generator.
- Oscilloscope.

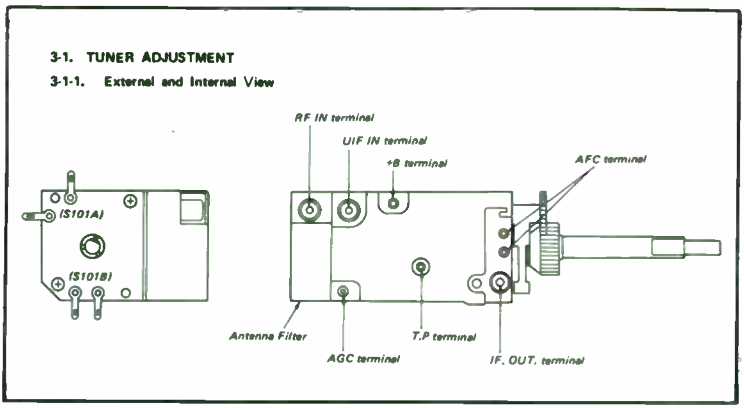


Fig. 6-1. Tuner adjustment locations.

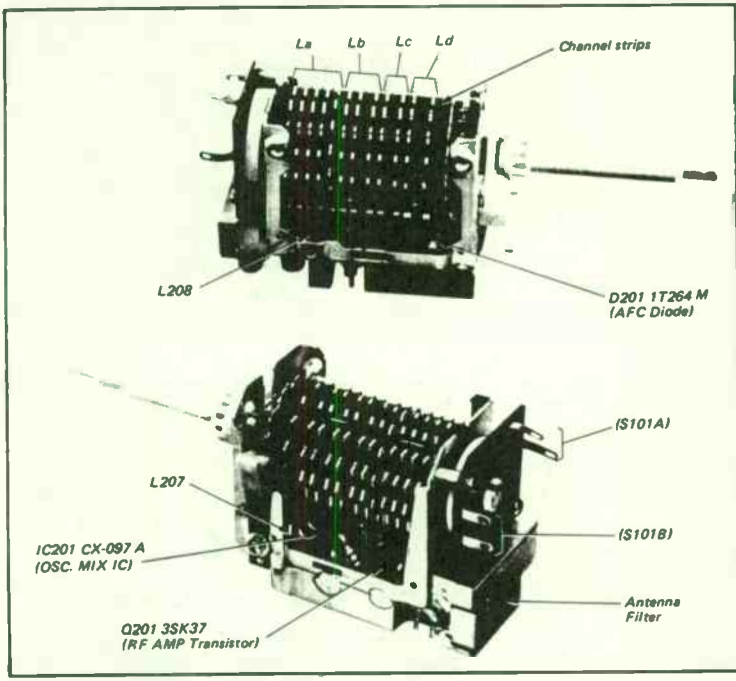


Fig. 6-2. Tuner pictured with covers removed.

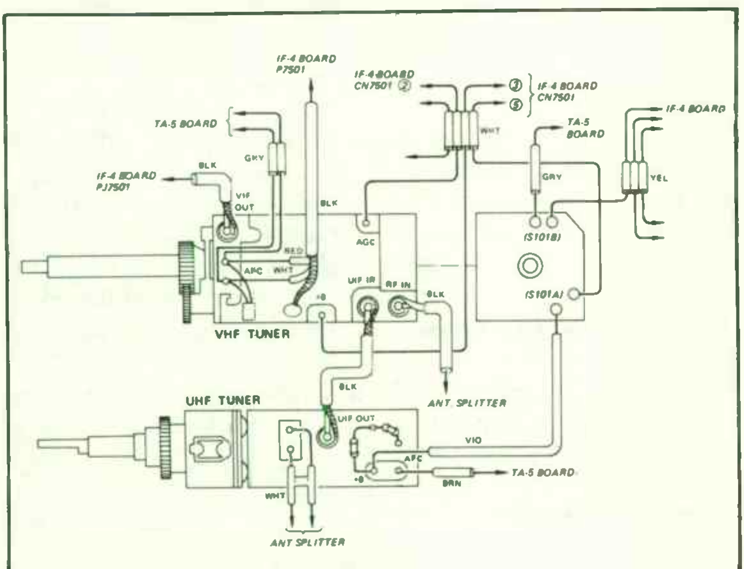


Fig. 6-3. Block diagram of tuner wiring.

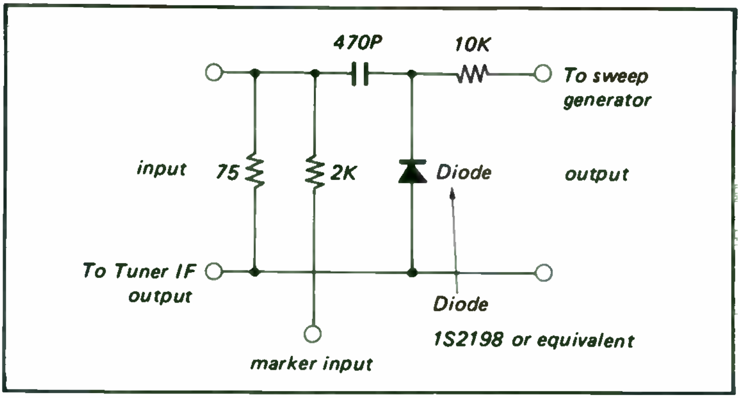


Fig. 6-4. Detector alignment circuit.

- Regulated dc power supply.
- Detector (see Fig. 6-4).

Tuner Adjustment Procedure

Make all the connections for the test equipment set-up. Refer to block drawings in Figs. 6-5 and 6-6.

Scope—set vertical sensitivity range at 1 to 2 mV.

Sweep generator—output level adjusted to produce usable response without distortion. Note: short pins 7 and 8 together of AFC prior to tuner alignment procedure.

Tuner Cover Removal

- Push the tuner cover to release the projection on the cover from the long slot. See Fig. 6-7.
- Turn the tuner upside down and release the protection on the cover from the long slot in the same manner as above.
- Remove the tuner cover as shown in Fig. 6-8.

Note: be sure to remove the cover by following the above procedure sequence. Reverse the removal procedure for the cover attachment.

- To remove and install the tuner channel strips refer to Fig. 6-9. The complete tuner alignment procedure is shown in steps one, two, and three of Fig. 6-10.

I-F BOARD ALIGNMENT

Equipment required for i-f alignment of VCR is as follows:

- VIF sweep generator.

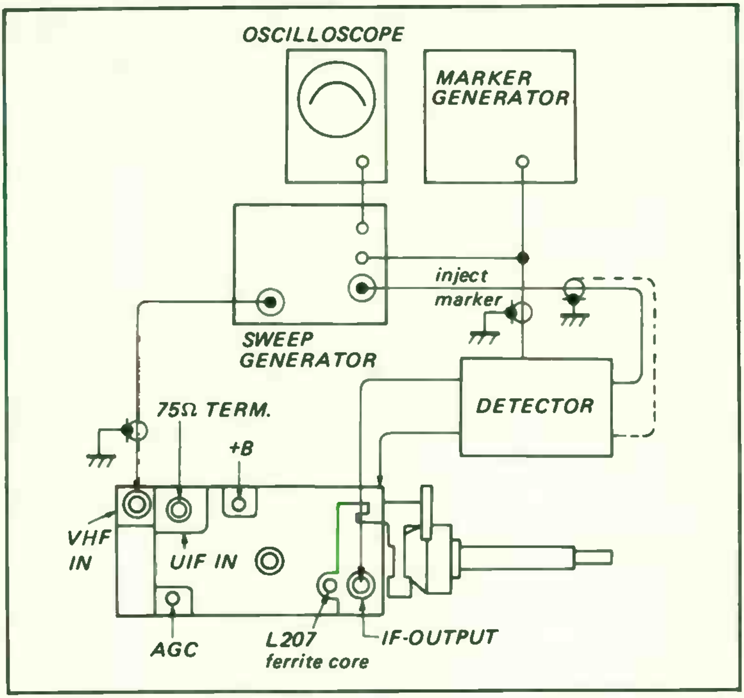


Fig. 6-5. Tuner alignment set-up.

- Standard signal generator.
- Monitor scope.
- Volt/ohm meter.
- Resistor divider pad.
- Insulated alignment tool.
- 50 ohm to 75 ohm converter.
- 3 dB attenuator.

Preset CV501, T501, and T509 as follows, prior to the i-f alignment procedure. CV501 preset: Set CV 501 (trimmer) as shown in Fig. 6-11. Note the position for the maximum capacity of CV501 (the position shown where the MAX mark aligns to the other mark) and then set CV 501 to the required preset position. Trap coil preset: Turn the cores of T501 (VIFT-T1) and T509 (VIFT-T4) about two turns clockwise as viewed from the component side of the tuning coil. Set the VIF sweep generator output to – 22 dBm. Refer to Fig. 6-12.

Maintain the waveform amplitude on the monitorscope at 3 volts peak-to-peak by adjusting the MGC VR (note Fig. 6-13).

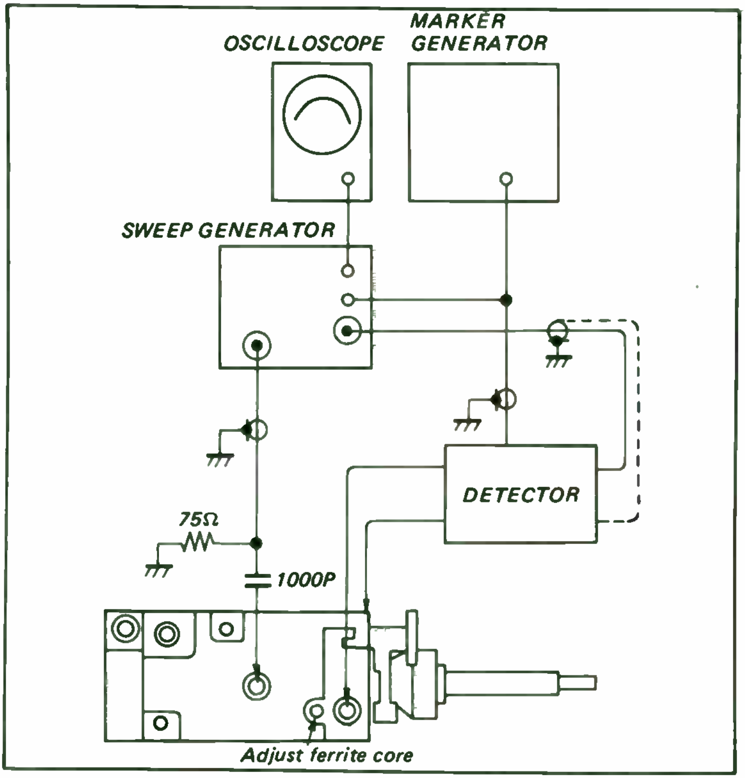


Fig. 6-6. Alignment test equipment set-up.

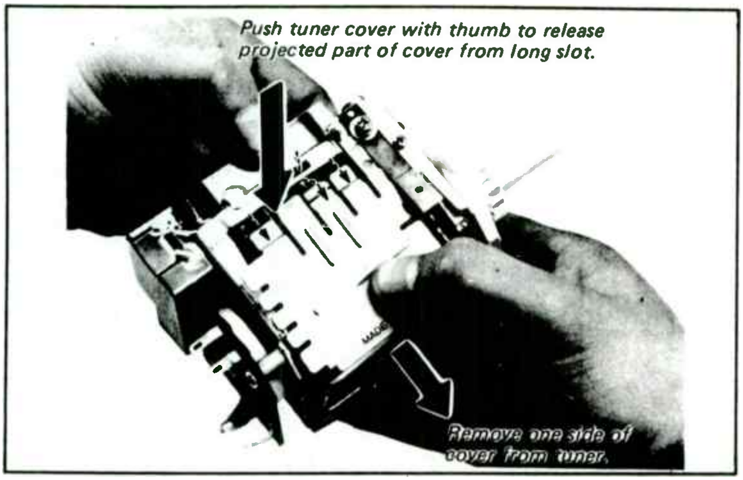


Fig. 6-7. Removing tuner cover.

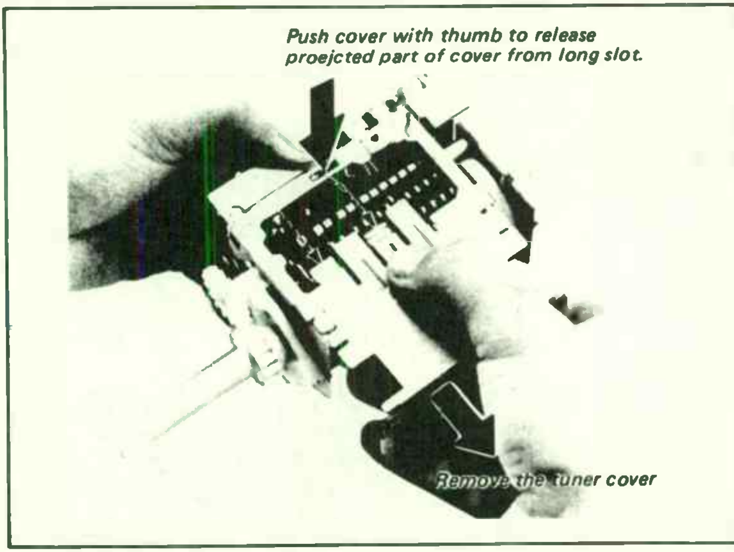


Fig. 6-8. Tuner cover being removed.

Adjust the cores of T508 and T510 for maximum output at 44.00 MHz. See waveform in Fig. 6-14. Adjust the cores of T506 and T507 so that the 45.75 MHz marker (point P) is positioned at the –7 dB point. Refer to Fig. 6-15.

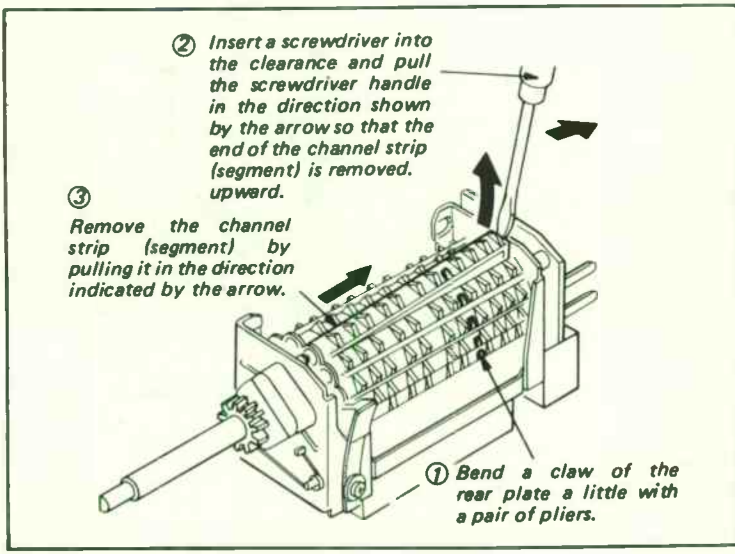
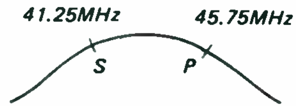


Fig. 6-9. Channel strip removal.

Step	Channel	Adjust	Marker point (MHz)		Adjustment procedure	Equipment setup
			Video	sound		
1	UIF	L207	45.75	41.25	• Adjust L207 (turn ferrite core) so that the peak of response curve is as shown in Fig. 3-10.	See Fig. 3-6.



Step	Channel	Adjust	Marker point (MHz)		Adjustment procedure	Equipment setup
			Video	sound		
2	2-13	Fine tuning shaft			• Turn AFC switch to "OFF". • Turn the fine tuning shaft for correct tuning of each channel.	See Fig. 3-5.
	2	Ld2			If correct tuning is not obtained with above adjustment, adjust as follows. • Adjust Ldn (2-13) for fine tuning of each channel.	
	3	Ld3				
	4	Ld4				
	5	Ld5				
	6	Ld6				
	7	Ld7				

	8	Ld8				
	9	Ld9				
	10	Ld10				
	11	Ld11				
	12	Ld12				
	13	Ld13			• Turn AFC switch to "ON".	

Step 3	Channel	Adjust	Marker point (MHz)		Adjustment procedure	Equipment setup
			Video	sound		
3	2	Lb2 Lc2	55.25	59.75	• Adjust Lbn (2-13,) and Lcn (2-13,) of each channel so that the two markers of each channel are within the peak (75-100%) of the response curve. (See Fig. 3-11.)	See Fig. 3-5.
	3	Lb3 Lc3	61.25	65.75		
	4	Lb4 Lc4	67.25	71.75		
	5	Lb5 Lc5	77.25	81.75		
	6	Lb6 Lc6	83.25	87.75		
	7	Lb7 Lc7	175.25	179.75		
	8	Lb8 Lc8	181.25	185.75		
	9	Lb9 Lc9	187.25	191.75		
	10	Lb10 Lc10	193.25	197.75		
	11	Lb11 Lc11	199.25	203.75		
	12	Lb12 Lc12	205.25	209.75		
	13	Lb13 Lc13	211.25	215.75		

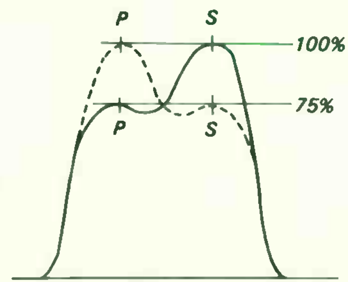


Fig. 6-10. Complete tuner alignment charts.

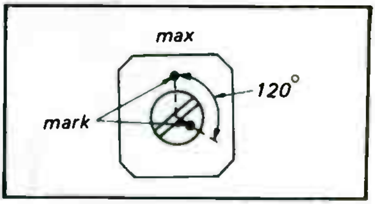


Fig. 6-11. CV501 trimmer adjustment.

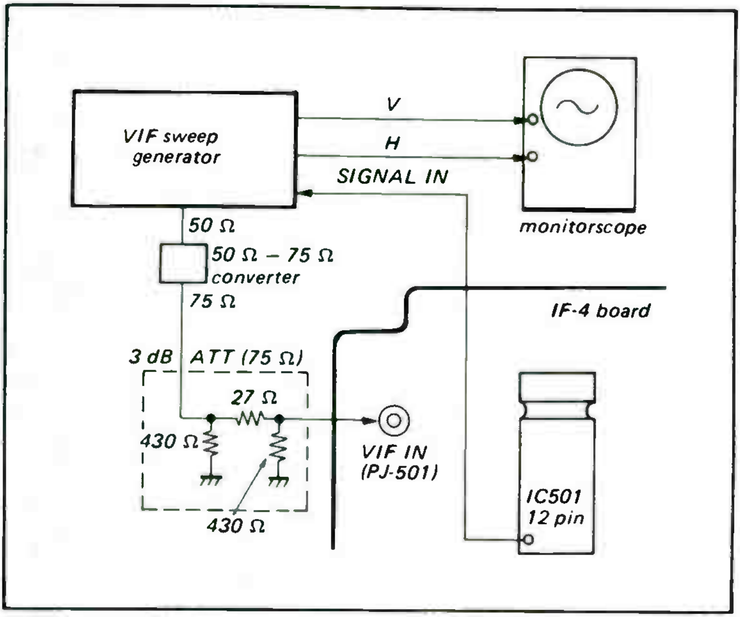
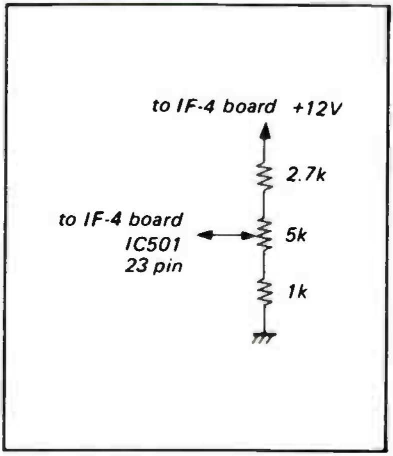


Fig. 6-12. VIF circuit adjustment.

Fig. 6-13. Resistor divider network.



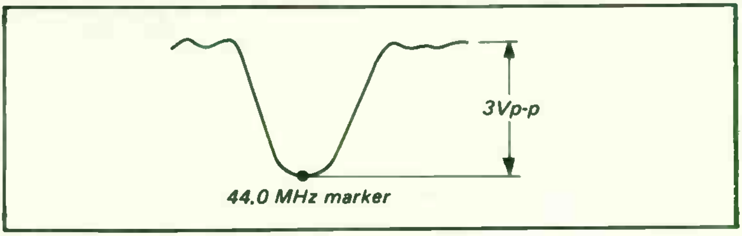


Fig. 6-14. T508 and T501 adjustment.

4.5 MHz Trap Adjustment

Mix the VIF sweep generator output and the 41.25 MHz, −30 dBm output from the SSG and apply the mixed signal to the i-f-4 board. Refer to set-up in Fig. 6-16. Adjust T513 (4.5 MHz trap) to minimize the 4.5 MHz signal leak on the monitor scope screen. Note waveform in Fig. 6-17. Amplitude should be less than 50 mV.

Trap Coil Adjustment

This trap coil adjustment procedure is with the sweep generator.

1—Connect the equipment as shown in Fig. 6-12.

2—Set the generator output to −15 dBm.

3—Adjust the MGR VR (see Fig. 6-13) so that each trap section on the monitor scope screen is easily observed.

4—Adjust T501 so that the 41.25 MHz marker point is positioned at the peak. Refer to Fig. 6-18.

5—Adjust T504 so that the 39.75 MHz marker point is in coincident with the top of the solid line as shown in Fig. 6-19.

6—Adjust T505 so that the 47.25 MHz marker point coincides with the peak of the solid line in Fig. 6-20.

7—Adjust T502 so that the 49 MHz marker point coincides with the top of the solid line shown in Fig. 6-21.

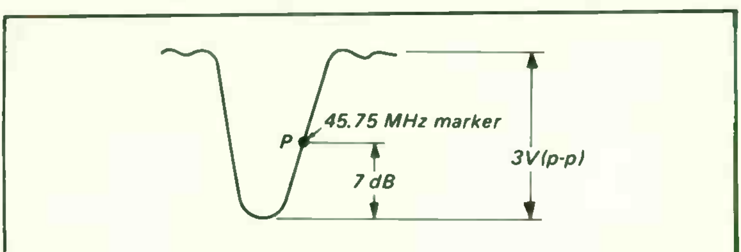


Fig. 6-15. T506 and T507 adjustment.

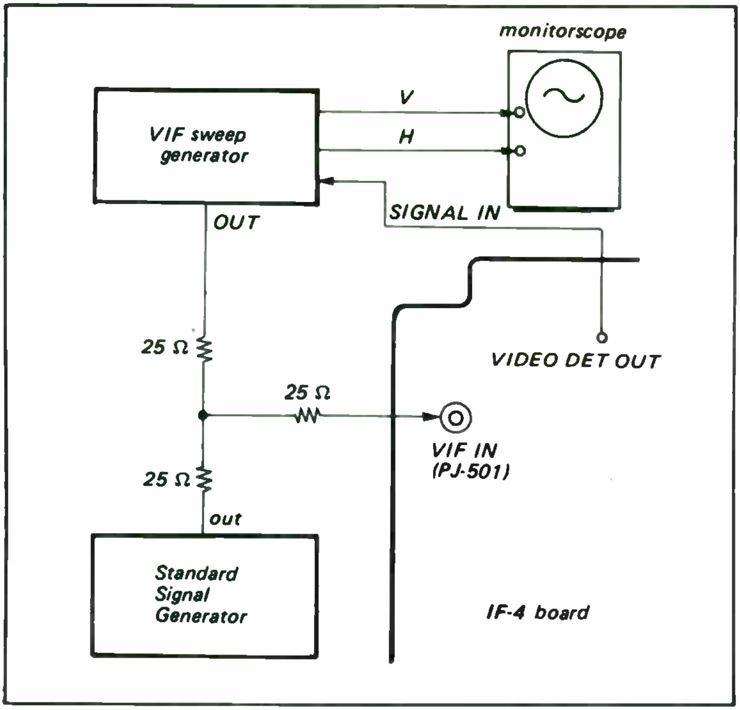


Fig. 6-16. 4.5 MHz trap adjustment.

This is the adjustment procedure when you are using the standard signal generator.

Equipment Setup

1—Amplitude modulate the SSG output with 400 Hz, 40% signal and set its output level for the best observation on the monitor scope. Refer to Fig. 6-22.

2—Adjust each trap coil for minimum amplitude of the trap frequency.

AFC Preadjustment

1—Complete the connections for the equipment as shown in Fig. 6-12.

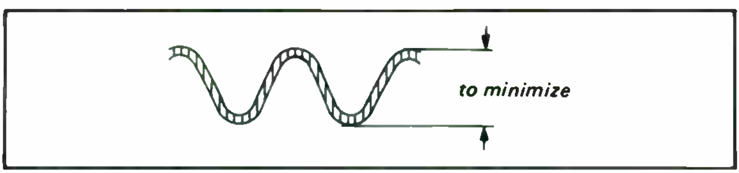


Fig. 6-17. Waveform required for T513 adjustment.

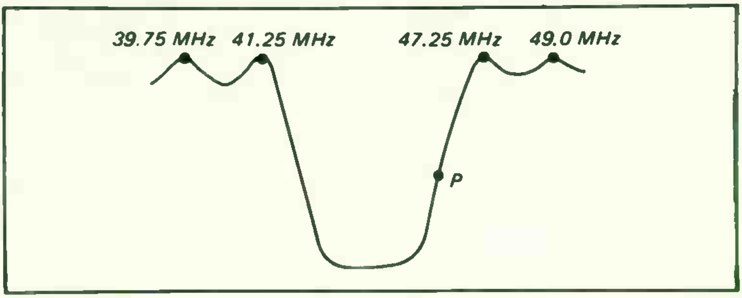


Fig. 6-18. T501 adjustment waveform.

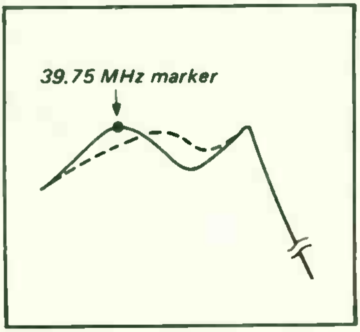


Fig. 6-19. T504 adjustment waveform.

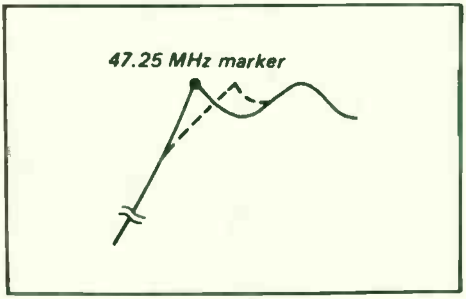


Fig. 6-20. T505 adjustment.

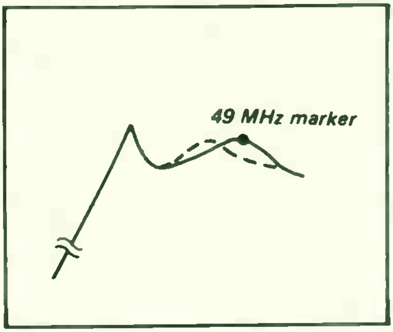


Fig. 6-21. 49 MHz trap adjustment.

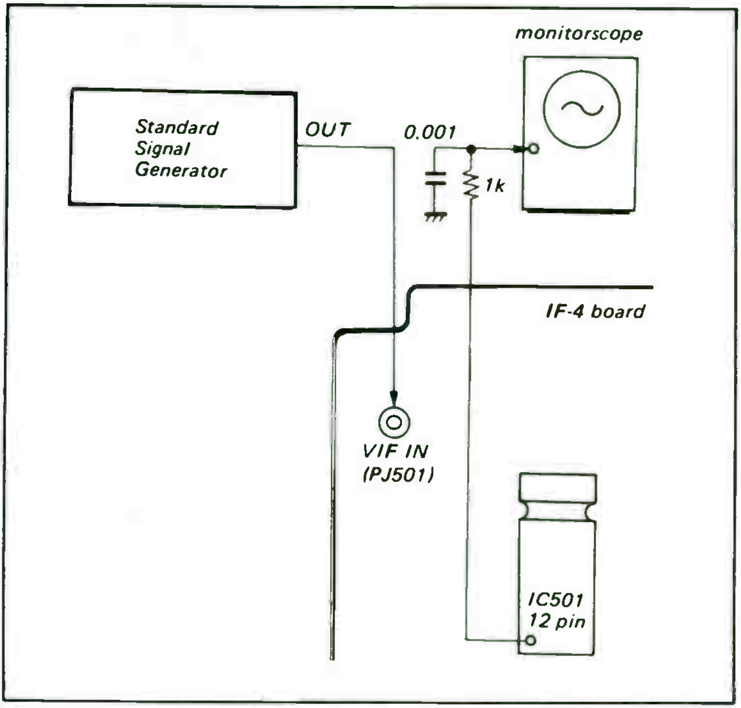


Fig. 6-22. Trap coil adjustment set-up.

2—Set the VIF sweep generator output to −22 dBm.

3—Adjust the MGC VR for 3 volts (P-P) waveform on the monitor scope. Refer to Fig. 6-14.

4—Adjust T515 (AFC-3) for maximum displacement of the 45.25 MHz marker point (P) in the direction shown by the arrow in Fig. 6-23.

VIF Overall Adjustment

1—Make the equipment setup as shown in Fig. 6-12.

2—Set the VIF sweep generator output to −22 dBm.

3—Maintain the monitor scope waveform with the MGC VR. Adjust T506, T507, and CV501 so that the VIF response is as shown in Fig. 6-24. The VIF response around 44 MHz should be as flat as possible.

AFC Adjustment

1—Complete the connections shown in Fig. 6-12 and set the VIF sweep generator output to −22 dBm.

2—Ensure that the waveform on the monitor scope is 3 volts (P-P). If not, adjust the MGC VR for 3 volts (P-P).

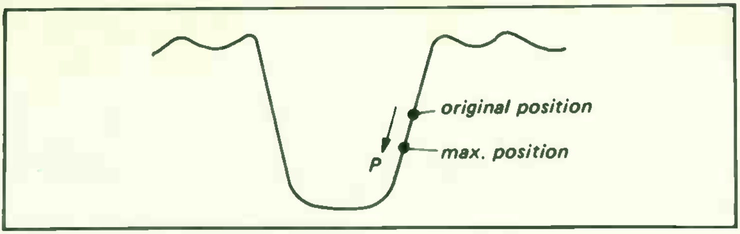


Fig. 6-23. AFC-3 adjustment waveform.

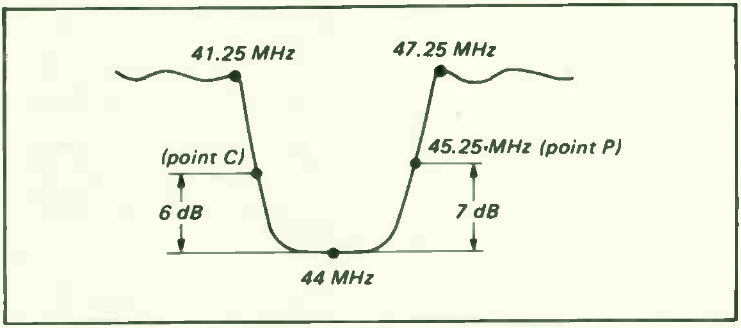


Fig. 6-24. VIF overall adjustment waveform.

3—Change the test setup to the one shown in Fig. 6-25.

4—Adjust VL509 and VL510 to obtain the monitor scope waveform shown in Fig. 6-26.

5—Set the VIF sweep generator output to −26 dBm.

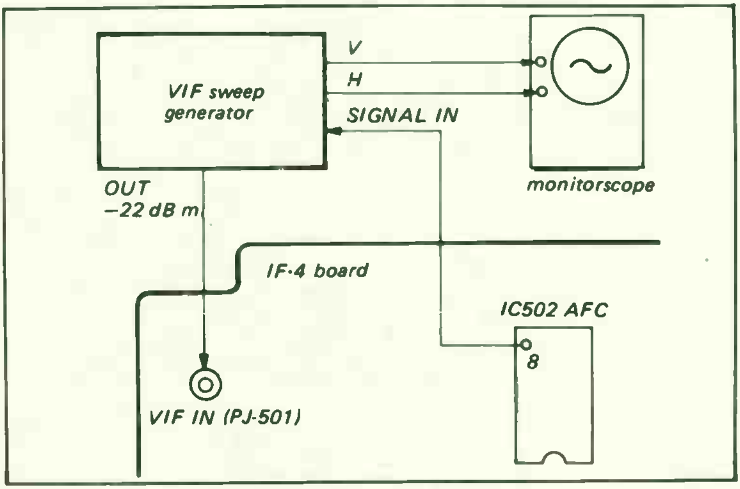


Fig. 6-25. Waveform adjustment for AFC.

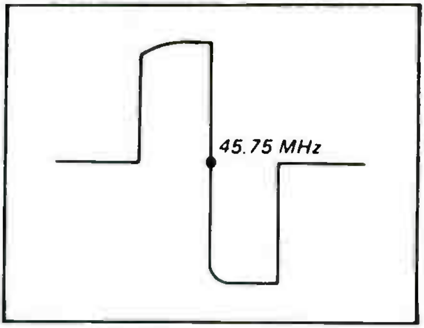


Fig. 6-26. AFC output waveform.

6—Adjust VL510 so that the output waveform becomes as symmetrical as possible. Refer to waveform in Fig. 6-27. If a satisfactory result is not attained, adjust T515. Confirm that the output waveform is effected by the limiter.

7—Adjust VL509 so that the 45.75 MHz marker coincides with the reference line shown in Fig. 6-27.

8—Change the test setup to that shown in Fig. 6-28.

9—Set the SSG output to 45.75 MHz, −25 dBm and adjust the MGC VR for a volt meter reading of 3.8 ±0.3 volts.

10—Connect the volt meter to pins 7 and 8. Adjust VL509 so that the voltmeter reading is less than 0.5 volts dc.

11—Change the test setup to that shown in Fig. 6-25. Set the VIF sweep generator output to −22 dBm.

12—Ensure that the waveform on the monitor scope screen is as shown in Fig. 6-26.

Band Correction Circuit Check

1—Connect the equipment as shown in Fig. 6-12.

2—Set the VIF sweep generator output to −22 dBm.

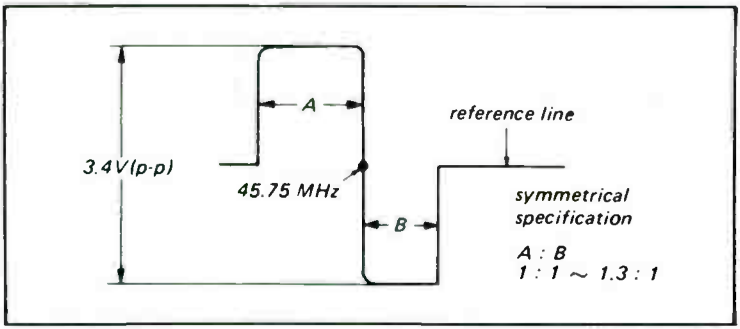


Fig. 6-27. AFC output waveform.

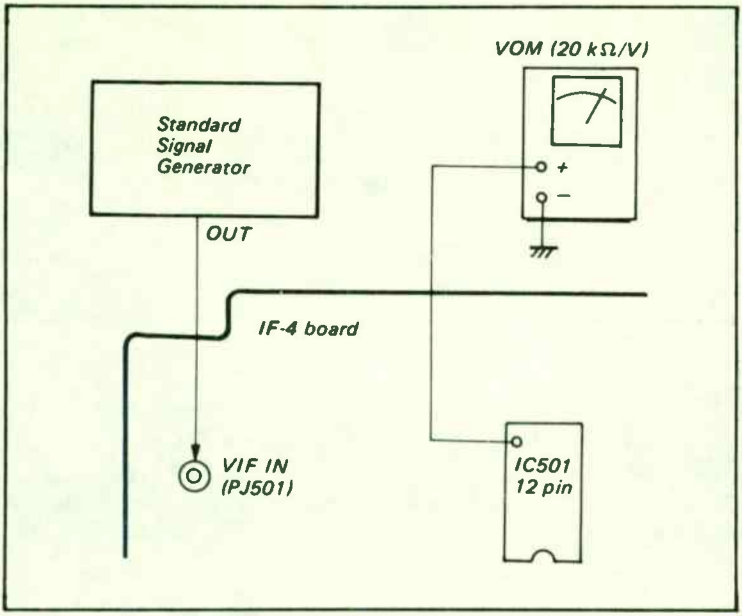


Fig. 6-28. AFC test adjustment set-up.

3—Set the waveform on the monitor scope to 3 volts (P-P) with the MGC VR. Refer to Fig. 6-14.

4—Disconnect the signal in terminal from IC501 pin 12 and connect it to the video out (X) of the i-f-4 board. Refer to Fig. 6-29.

5—Confirm that the waveform on the monitor scope is the same as the one shown in Fig. 6-30.

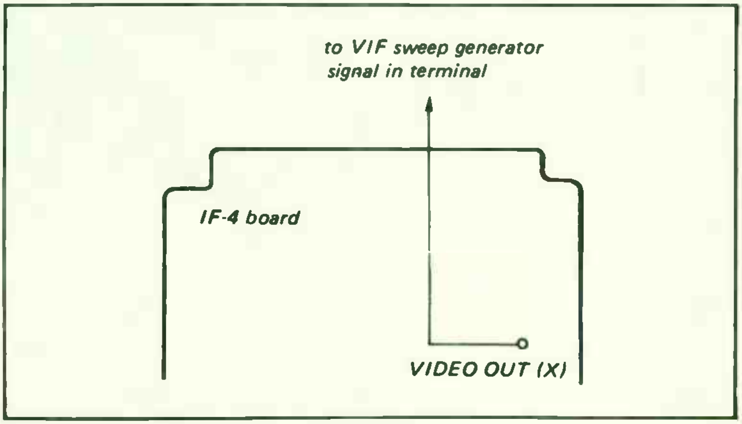


Fig. 6-29. Band correction circuit check.

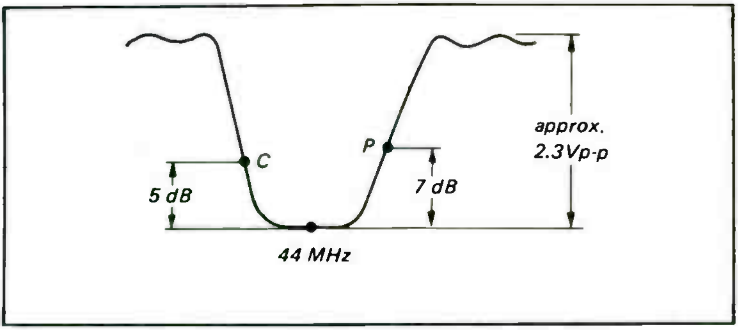


Fig. 6-30. VIF overall waveform characteristic.

Sweep I-f (SIF) Adjustment

1—Set the standard sweep generator output to 5 dBm (4.5 MHz at 25 kHz FM).

2—Adjust T517 for the maximum waveform deflection on the monitor scope screen (see Fig. 6-31).

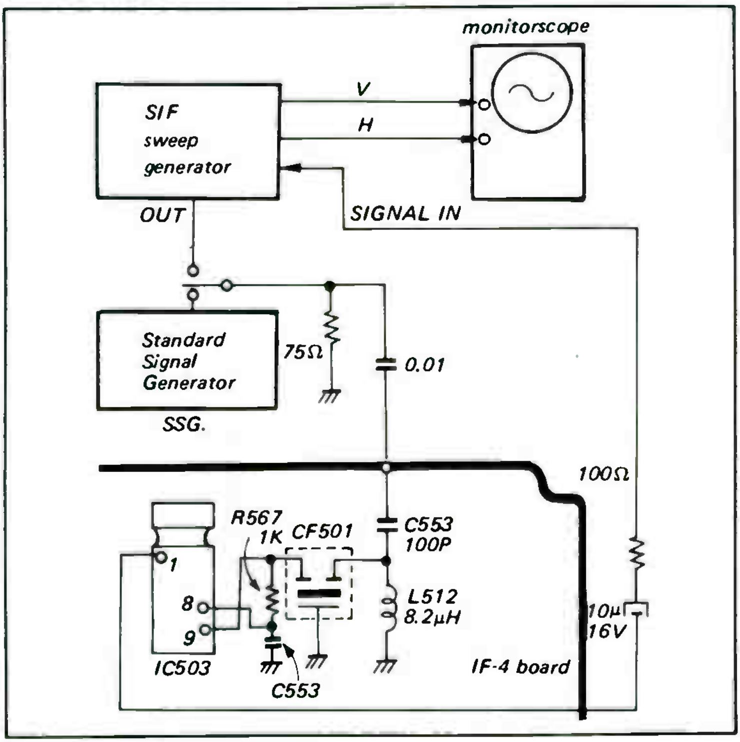


Fig. 6-31. SIF adjustment set-up.

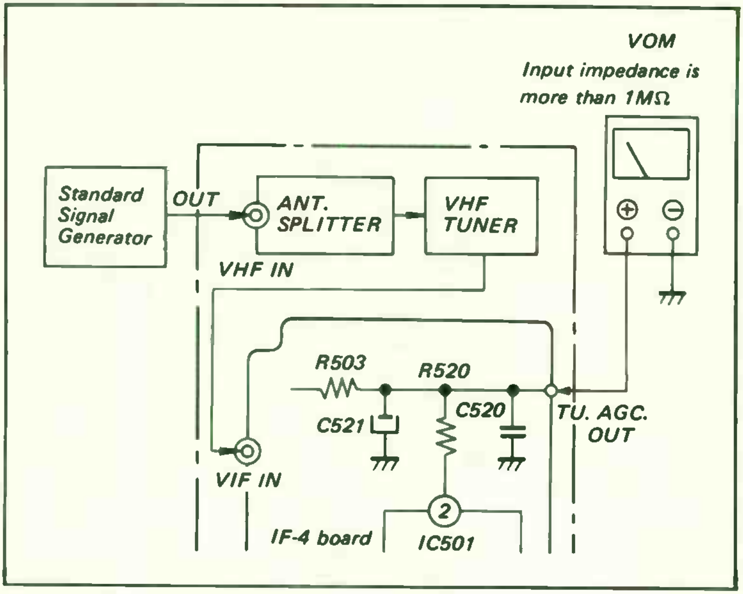


Fig. 6-32. Tuner AGC adjustment.

3—Set the SIF generator output to 5 dBm.

4—Confirm that the linearity of the S-shape waveform is good and the 4.5 MHz marker is on the baseline.

Tuner AGC Adjustment

1—Check that the 18 volts is applied to the B+ terminal of the vhf tuner.

2—Set the tuner control to channel 12 and tune the local adjustment finely.

3—Set the SSG to 205.25 MHz, an available output level of −53 dBm ± 2 dB and 1 kHz 40% AM. Note: the peak level of the waveform is −50 dBm ± dB.

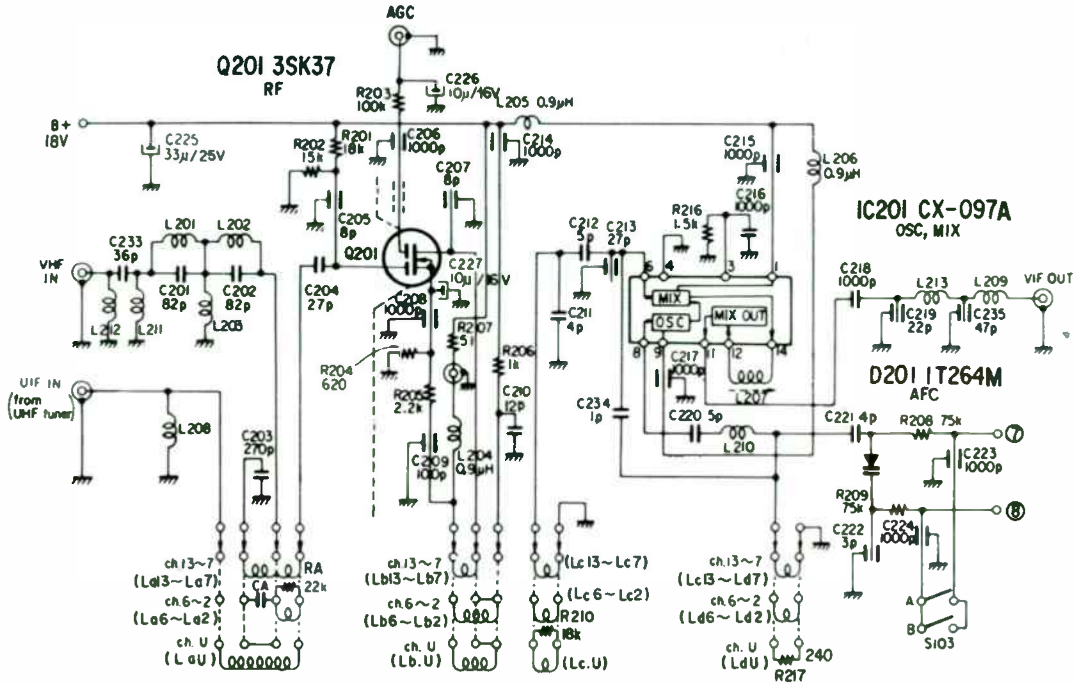
4—Adjust VR501 for a voltmeter reading of approximately 11.5 volts. Refer to Fig. 6-32 for the tuner adjustment setup. The vhf/uhf tuner circuits are shown in Fig. 6-33.

SYSTEM CONTROL AND PAUSE CONTROL CIRCUITS

The main function of the system control circuits is to control the mechanism during tape threading and unthreading periods, together with the subsequent control of the signal systems. In this VCR, the switching between function modes is mainly done by

TUNER SCHEMATIC DIAGRAM

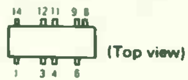
— VHF TUNER BT-752 WU —



NOTE

CH	CA		RA	
	Ref. No.	DESCRI-PTION	Ref. No.	DESCRI-PTION
Ch6	C228	43P	R211	22K
Ch5	C229	39P	R212	22K
Ch4	C230	30P	R213	22K
Ch3	C231	30P	R214	22K
Ch2	C232	30P	R215	22K

CX-097A



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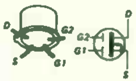


— UHF TUNER BT-262 —

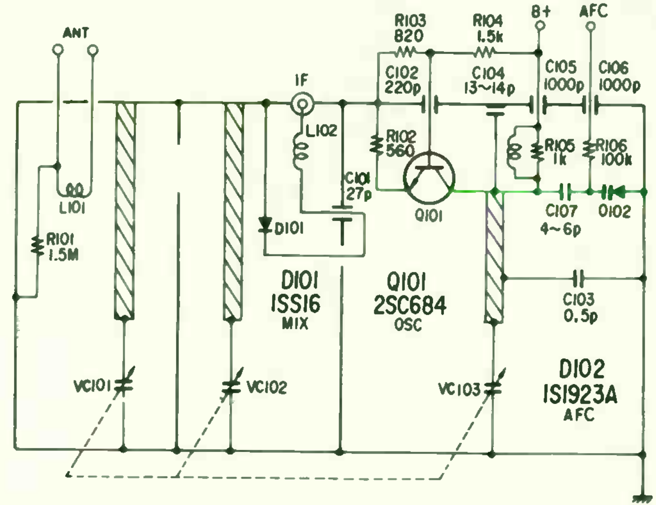


Fig. 6-33. Circuit diagrams for vhf/uhf tuners.

manually depressing the function buttons. Therefore, automatic controls of the mechanism by the system are very few. What is controlled automatically by the system control circuit is the auto-stop solenoid.

There are five major operations provided by the system control circuit.

1—Tape end sensor—the metallic foil attached to both ends are detected. An electrical circuit is closed, driving the auto-stop circuit.

2—Head drum rotation detector—when any of the function buttons are depressed, the system control circuit detects the head drum rotation by detecting the 30 PG pulses. If for any reason the head drum rotation stops, the auto-stop circuit is energized.

3—Tape slack sensor—if tape slack is detected in the play or record mode, the tape must be rewound. When the tape slack is detected by the tape slack sensor element, the auto-stop circuit is energized.

4—Auto stop circuit—auto-stop is initiated by actuation of the devices listed above. When auto-stop is initiated, the system control circuit energizes the stop solenoid to place the function mechanism into the stop mode. The ac motor power is cutoff when the stop solenoid is energized.

5—Muting circuit—this circuit generates audio muting and video blanking signals according to the operation of the mechanical system.

RECORDER MECHANISM COMPONENT LOCATIONS

Location of the switches and solenoids related to the system control is shown in Fig. 6-34. The item numbers in the following description are the reference numbers of the parts in this drawing.

1—Function switch—This switch is located on the opposite side of the chassis as viewed from the top and actuated by the function button mechanism. Function switch (1) is turned on when any one of the mode buttons is pressed. When the switch is on, power is supplied to the ac motor.

2—Function switch—This switch is operated the same way as switch 1. The drum rotation detector protection circuit is operated by this switch. When this switch is on, the protection circuit functions and when it is off, the circuit does not function.

3—Fast forward switch—This is a leaf switch on the SRP board. It is actuated by the fast forward function button and turned on when the button is depressed.

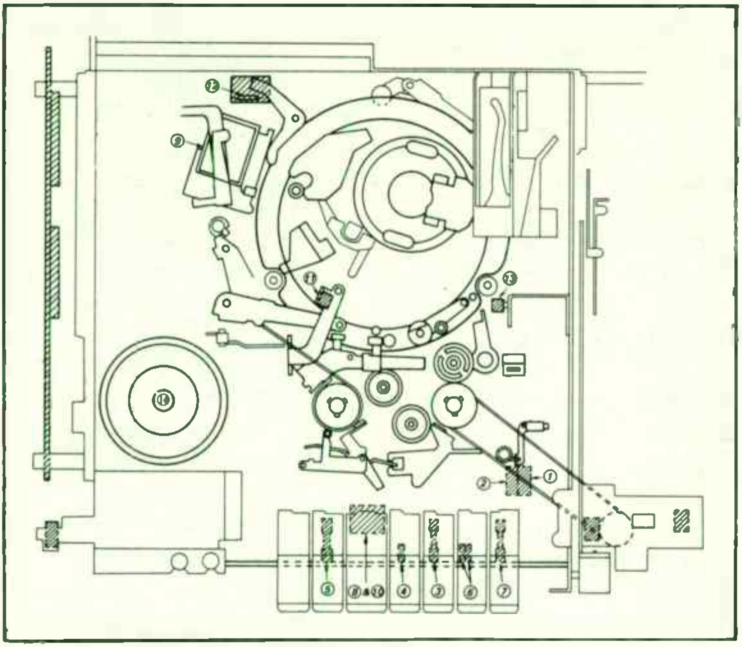


Fig. 6-34. Switch locations on system control circuit.

4—Play switch—This is a microswitch on the SRP board. It is actuated by the play button. It is turned on as the play button is pushed.

5—Rewind switch—This is a leaf switch on the SRP board. It is actuated by the rewind function button and turned on as the button is depressed.

6—Record switch—This is a microswitch on the SRP board. It is actuated by the record function button.

7—Pause switch—This is a leaf switch on the SRP board. It is actuated by the pause function button and turned on when depressed. Note: all the switches described above are released by either pressing the stop function button manually or energizing the stop solenoid electrically.

8—Stop solenoid—The stop solenoid is located beneath the function button block and is energized in the auto-stop mode. All the function buttons and switches are released by the solenoid action. The solenoid action also actuates to turn off the stop solenoid switch.

9—Pause solenoid—The pause solenoid is located on the upper section of the threading chassis and is energized in the play, record, and pause modes. It serves to make the pinch roller press against the capstan pulley tape movement.

10—Stop solenoid switch—This switch is positioned beneath the stop solenoid and is actuated directly by the mechanical action of the stop solenoid. As the stop solenoid is powered on, this switch is actuated to turn off the ac motor power.

11—Supply sensing coil—This coil is positioned on the tension arm, very close to the tape but not in contact with it. This coil senses the tape end during the play, record, and fast forward modes by means of a metallic foil on the tape ends. The sensor energizes the auto-stop function.

12—Tape slack detection switch—This switch is located on the TK board and is actuated magnetically by the tape slack detection lever. This slack detection lever can move in the play and record modes. If tape slack occurs, this switch is turned on, energizing the auto-stop circuit.

13—Take-up sensing coil—This coil is positioned very close to the tape in the cassette tape guide on the take-up side. It senses the tape beginning, in the rewind mode. The sensor energizes the auto-stop function.

14—Ac motor—This is a hysteresis synchronous motor, powered by the ac power line. Its stability is a function of the line frequency stability. When any of the function buttons is depressed, the ac motor is powered and drives the capstan, forward idler, fast forward idler, rewind idler, gear (A), gear (B), and rotary video head disc assembly, via the rubber drive belts.

SYSTEM AND CONTROL CIRCUITS

The system control circuit is located on the SRP board. The block diagram for the system control is shown in Fig. 6-35.

VCR Clock Timer System

The timer clock device has a standard LED readout clock, capable of running on either 50 or 60 Hz frequencies. Note timer system block diagram in Fig. 6-36. This timer circuit can be programmed to start the VCR at a preset time.

Both the clock and the timer can be set by the buttons on top of the machine, above the clock at the left front corner. The clock is set by depressing the clock time and hours buttons and watching the AM/PM light. The minutes can be set by depressing the minute or fast minute button. Note: the hours do not advance as the minutes

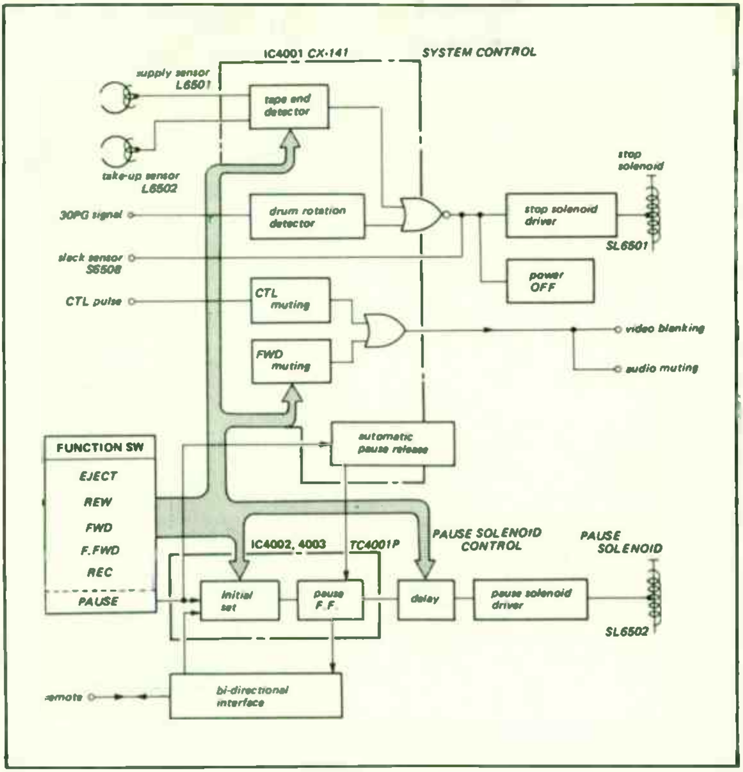


Fig. 6-35. Block diagram for system control.

pass the 60 mark. Each must be set independently. The timer start time can be set by depressing the turn on time button instead of the clock time button and following the above procedure.

The clock also has the ability to reset itself in case of a momentary power interruption (2 seconds or less) and will give a one second display flashing indication in case of a longer power outage. Resetting the clock will return it to normal operation.

Timer Circuit Description

The timer comprises IC801 on the TMC board and functions normally as a 12-hour clock synchronized with a power supply frequency. It is possible to reserve a starting time of the VCR timed by the minute once within 24 hours from the current time.

The clock function must determine whether the power frequency is 50 Hz or 60 Hz, because the timer synchronizes with the power supply. The line frequency is determined at the moment

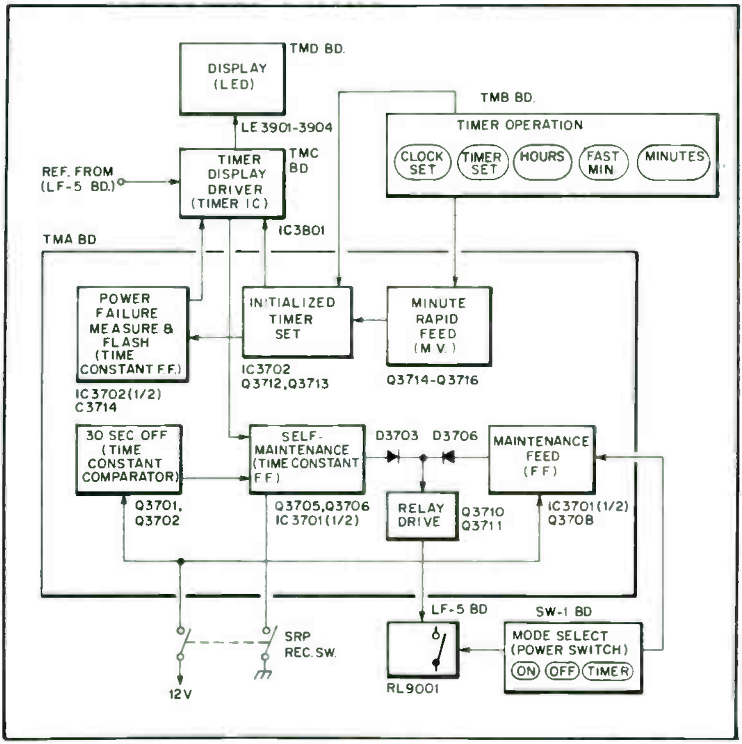


Fig. 6-36. VCR timer block diagram.

when the power is first connected to the IC. A reference signal, supplied from the LF-5 board where an ac 12 volts is wave-shaped, is applied to pin 27. Counting for driving the timer is performed in the IC by comparison of the ac 12 volts with the OSC 1 (pin 26) level.

The timer operates in the following manner. A start time can be reserved in the form of a reservation amendment. When a clock indication matches the reserved time (the second counter is "00"), a signal appears at wake 1 terminal (pin 20). This signal turns on the videocassette recorder only when the recorder is in the timer and the record modes. The start time of the VCR can be reserved on the timer only when its modes are the timer and record modes. The VCR turns off automatically about 30 seconds after the tape is wound to its end and the record button is released automatically or manually.

This timer has a power suspension indicating function. The clock indication advances a little and the reserved time remains unchanged in case of a short power (below 2 seconds). In case of a longer power outage, the current time and the reserved time turn to AM 12:00 at the moment of the power recovery and the clock time advances from AM 12:00. When the AM 12:00 is indicated, the power suspension indicator at the lower right corner of the timer flickers at one second intervals until the clock time and the reserved time are reset.

Clock Operation

The signal, obtained by frequency division of the osc 1 produced in the circuit formed by R803, C803, and the internal circuit in the IC, and the 50/60 input, produced on the LF-5 board as a reference signal, are the inputs to the flip-flop shown in Fig. 6-37. The inputs become the F-Q output and the output enters the counter.

Reservation Function

Starting time can be reserved in the hour and the minute independently as alarm time with the help of the inc control. A real time is counted by the counter and advances. When the real time reaches the reserved hour and the reserved minute, a signal comes out from the comparator as wake 1 logic out. The timer functions as

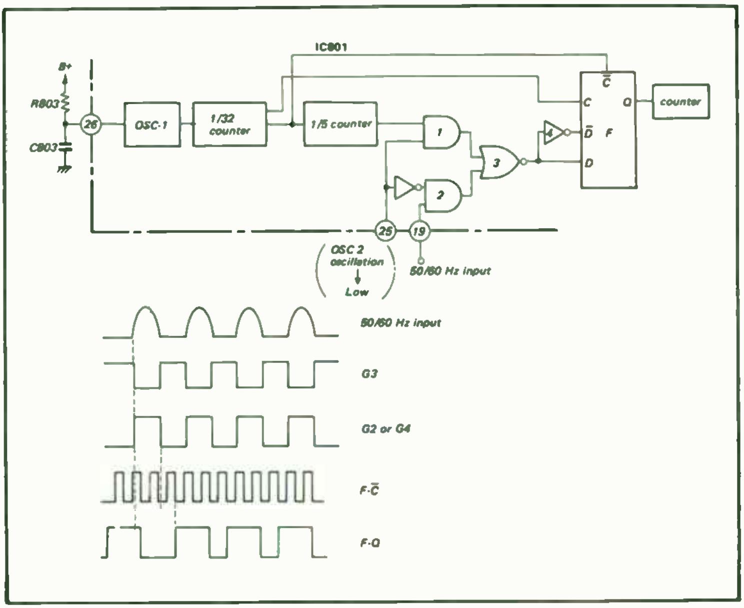


Fig. 6-37. Counter block diagram and waveforms.

the 12-hour clock when ST=1, SA=1, and wake 1 = 1. ST and SA of IC801 open for the time constant (about 2 seconds) determined by R730 and C709 when the power is connected to the ac line.

The wake 1 terminal (pin 20) is plus when the ST and the SA open. The 12 hour/24 hour judgment circuit is the IC functions to perform the 12-hour indication in that condition. The 50 Hz/60 Hz judgment circuit functions as follows. When ST=1 and SA=1, it judges for wake 2 = 1 that the line frequency is 60 Hz and for wake 2 = 0 that the frequency is 50 Hz.

The circuit judges that the frequency is 60 Hz when the wake 2 terminal (pin 19) is pulled by the B+ through R804 in the ST = 1 and SA=1 condition identical with that of the 12 hour 24 judgment circuit. When the wake 2 terminal is connected to ground through R804, the frequency is judged as 50 Hz. The counter is set to count one second for 60 or 50 pulses for the reference signal counting in the IC.

Current Time Amendment

Current time is amended by the inc logic circuit in Fig. 6-38. The time can be amended every 1 step of the hour or the minute in the condition that ST:SA=0:1 and H or M. ST becomes 0 when Q713 is turned on by IC702 and SA becomes 1 when the base of Q712 is turned to 0 by the clock set button when it is pressed.

Reservation Amendment

Reservation can be amended in the reversed condition of the ST and SA condition as noted above.

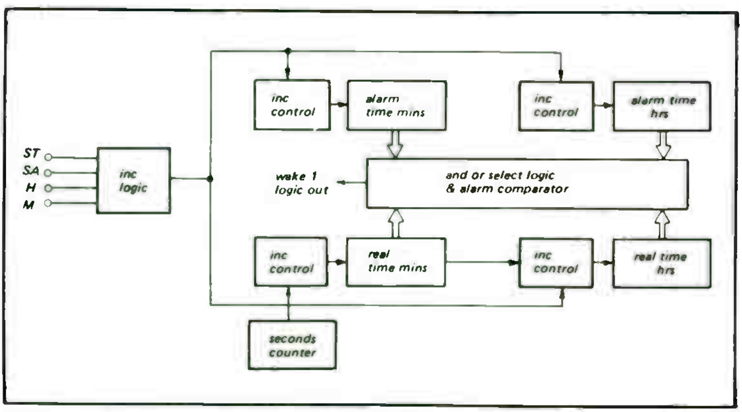


Fig. 6-38. Block diagram of timer control.

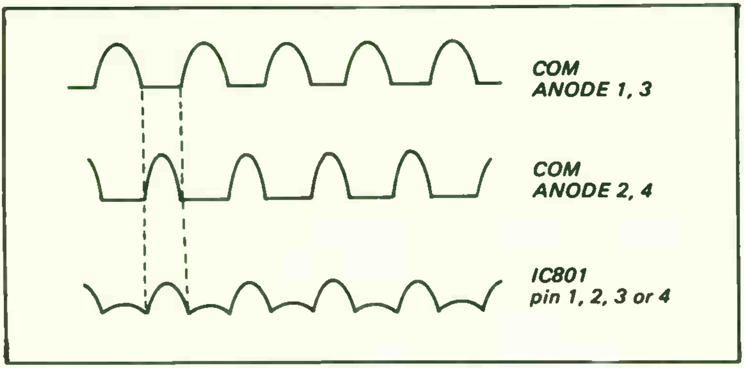


Fig. 6-39. Waveforms to LED drivers.

Driving Indication

The supply of the LEDs is a ripple obtained by the half wave rectification of the ac 3 volts in D711 and D712. See waveforms in Fig. 6-39. The power supply is applied to combinations of LED1, LED3, LED2, and LED4. The cathode side appears as the waveform at the IC terminal. The segments of LEDs 2 and 4 are lighted for forming figures indicating a time.

AM/PM Indication

Pin 3 of the IC is the PM indicator and also the number 4 digit as an IC terminal when it is discriminated from the IC terminal waveform. Since the com anode is number 4 digit, the LED is not driven directly. The signal inverted by Q801 is connected to the E-segment of LED 904 to indicate AM.

Power Suspension Indication

When the power is off for a long time, osc 1 and osc 2 become 0 level. Pin 3 of the IC operates as shown in Fig. 6-40 when the power is restored. The IC side phase corresponding to the anode of Dp of LED 901 becomes open and 0 level alternately every one second. Q, output of the flip-flop formed by IC702 ½ on the TMA board, is tuned to plus by R742 and C713 at the moment when the flip-flop recovers from the power outage and Q802 connected to the output turns on.

The Q802 emitter becomes 0 every other second by pin 3, and the phase of the emitter becomes the same with that of the anode of Dp, and Dp flickers every other second. The flicker of the power outage indicator is stopped by releasing pin 3 or by releasing the

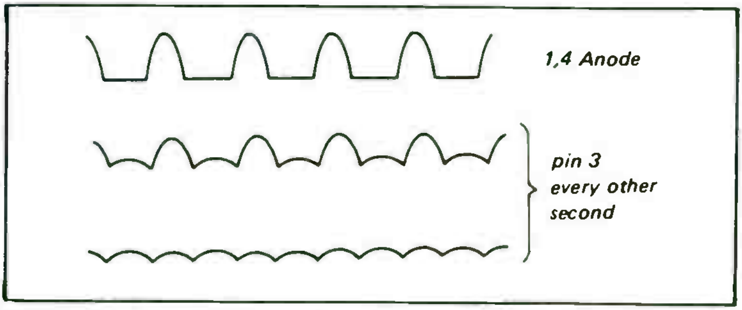


Fig. 6-40. Waveforms for IC clock operation.

flip-flop with the hour and minute buttons, i.e., the indicator is released from flicker by pressing the clock set, time set, hours, or minutes button.

Current and Reserved Time Hold Function

This function holds the time indication and the reserved time occurrence of the power outage until the recovery of the power outage. A voltage stored in the C714 capacitor of 1000 μF is supplied to Vp when the power goes off, which is contrary to the operation of the power suspension indication. The supply voltage for C9005 on the LF-5 board and the osc circuit on the TMC board is stored in C801. The reserved time is maintained and the time indication loses a little when the power suspension recovers while the osc 1 and osc 2 are more than threshold.

Fast Minute Feeding

This function feeds the minute indication rapidly while the fast min button is pressed together with the clock set or the timer set button pressed for amendment of the minute indication of the current time or the reversed time. It is because the one-step amendment of the minute takes much time.

The power supply is fed to the MMV formed by Q714 and Q715 when the fast min button is pressed and the MMV starts oscillating (at about 20 Hz). The MMV output is connected to pin 23, M terminal of the IC. The M terminal (i.e., the fast min button) is tapped automatically instead of tapping the M terminal manually.

On-Off-Timer

The "on-off-timer" is indicated beside the power switch. The collectors of Q710 and Q711 are connected to ground without regarding relay drive transistors Q710 and Q711 on the TMA board in order to turn on the relay on the LF-5 board when the power switch is in the on position. When the switch is in the off position, the bases of the transistors are connected to gnd in order to turn off the relay. The hold circuit described next is reset by connecting pin 8 of IC701(1/2) to ground through D702.

A negative pulse produced by C707 when the power switch is set to "timer" from "off." It is applied to the flip-flop of IC701(1/4) to make the Q output, pin 4, high. Then Q710 and Q711 turn on and the relay turns on. When the record button is depressed in the timer mode, the 12 volts is supplied from the SRP board, Q708 turns on, and the flip-flop is cleared. The wake 1 output is waited for in that state.

Recorder-on Hold Function

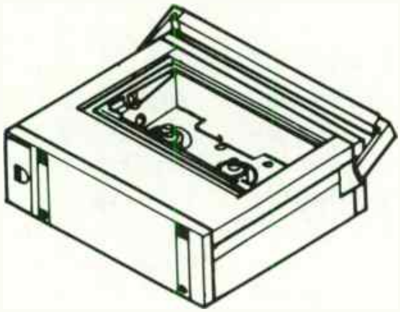
This function holds the VCR in the on state when the time reaches the reserved starting time of the recorder and the recorder turns on in the timer mode. When the time coincides with the reserved time, the 0 level wake 1 described above appears at pin 20 of the IC. Receiving the signal, Q705 turns off. Then the collector of Q705 is pulled by +10 volts and a plus pulse is produced in Q703. Q706 turns on within the width of the pulse and a negative signal is applied to pin 13 of the hold circuit of IC701(1/2).

Since C705 in the hold circuit turns low when the power is turned on and pin 8 turns low, the IC output at pin 10 becomes high and inputted to pin 12. Pin 13 is high while Q706 is off because it is pulled by the power supply. The IC output at pin 11 is low. When the signal from the wake 1 comes in, pin 11 becomes high, pin 8 is high, pin 12 is low and the pin 11 output is kept at a high level even if pin 13 returned to high. The pin 11 output is connected to the bases of Q710 and Q711.

30-Second Off Function

The hold circuit operates without fail when the time coincides with the reserved time in the timer mode and the recorder is turned on. Rec 12 volt is applied from the SRP board to Q701 via D715 on the TMA board and turns on Q701. The rec 12 volt becomes rec when the tape ends or the stop mode is set up. When the rec 12 volts is cut off, Q701 turns off. Q702 is turned on through D716, a pulse produced by Q704 and R713 is applied to the base of Q707, and Q707 is turned on instantaneously. The pin 8 of the hold circuit goes to 0, pin 10 high, pin 13 high, the relay drive output at pin 10 goes low, and the relay is released. This system is named "30 sec. off" because the power of the recorder is turned off about 30 seconds after the setup of the stop (rec) mode of the recorder in the on state in the timer mode.

Chapter 7



Routine VCR Maintenance Tips

In this chapter we will be covering various VCR head cleaning and other routine maintenance procedures. All of these tips can be used by the professional electronics technician or in many cases by the VCR owner. These maintenance points will include how to properly clean the VCR heads and tape guides. The care and feeding of both the Betamax and VHS video tape machines systems will be covered. Other points of VCR service will be degaussing of the video heads and drive belt cleaning and checks. The chapter concludes with tips on video heads that have been worn smooth which then develop "stiction" and a technique for curing this problem.

OVERVIEW

In many ways the VCR is not too much more complicated for routine cleaning than some of the more sophisticated audio tape machines. Of course, some of the electronic and mechanical tape transport devices are considerably more sophisticated.

In an audio machine, the magnetic tape passes over stationary heads to record and reproduce sound. The VCR, by comparison, has *rotating* video heads along with fixed audio, control track, and erase heads. The rotating heads are needed because of the higher frequencies, the tape must travel across the heads at a much faster rate than for audio recording. This is accomplished by rotating the video heads at a very high speed past the slower moving tape.

The original video taping technique was perfected for the professional broadcast industry by Amprex. For home video recorders, the operation has been refined for use of a cassette format, eliminating the need to handle large rolls of tape.

WHY THE NEED FOR VCR CLEANING?

Even with normal operation contamination will cause a VCR to perform poorly. Particles of dust, smoke, loose magnetic tape oxide and oxide binder combine over a period of time to form a hard buildup on the head surfaces. This buildup causes the tape to be physically spaced away from the proper firm contact with the face of the head, which reduces the amount of signal being recorded and played back. Normal spacing between the tape and head face is 0.000020 inch (for comparison, the thickness of a human hair is .004 inch). When this extremely close contact is lost due to dirt buildup on the heads, picture playback performance will be diminished. This signal loss may cause mushy, distorted sound with a noticeable lack of high frequencies. Visually, it appears as a lack of overall picture clarity or as a snowy picture. It is also necessary to clean tape oxide buildup from all the contact points in the tape path, like rollers and guides.

In extreme cases, where tape oxides are allowed to build up over a long period, the accumulation can become large and ragged enough to scratch or tear tapes, or interfere with the precise tape speed required for VCR operation. Regular VCR cleaning is the only way to prevent oxide buildup and other major machine problems. Professional broadcasters and recording studios know this very well and clean all VCR heads on a daily basis. It is recommended that the home model VCRs be cleaned and the heads demagnetized every 100 hours of operation or 2 to 4 times a year.

VCR HEAD MAGNETISM

Every metal part of the VCR which comes into contact with the tape will gradually become slightly magnetized. This especially pertains to the video and audio heads, which should be demagnetized regularly. Residual magnetism affects all types of magnetic heads. Heads and other metal contact points in the tape path will become partially magnetized from such sources as the normal on and off surges from the recorder's electronics. Items such as a faulty bias oscillator, the use of an ohmmeter for VCR troubleshooting, or the use of some magnetized tools near the heads could easily cause magnetism.

A magnetized tape head (and other magnetized metal parts) will erase some of the high frequencies on prerecorded tapes and will cause a hiss or background noise to be seen. Also, magnetization of the video tape from these spurious sources will cause loss of color and partial erasure of the tape. Let's now see how easy it is to remove this residual magnetism from the tape head and other metal machine parts.

You will find it quite simple to perform VCR machine demagnetization. Just plug in the demagnetizing tool, turn it on, and then slowly bring it near the part to be demagnetized. Now move it slowly up and down a few times, and then the tool is slowly retracted to about 3 feet away. Bring the tip of the demagnetizer as close as possible to the head tip without actually contacting the head tip. Should the tool be turned off while close to the head it will have the reverse effect and leave the head magnetized. If you are careful to avoid this, the head and other machine parts will be completely demagnetized. The Nortronics VCR-205 head demagnetizer is shown in action in Fig. 7-1.

Please note that you should only use an approved VCR head demagnetizer for this operation. The video head demagnetizers produce a weaker flux than most of those used for audio tape machines. Using one made for an audio tape player can actually shatter the video head chips.

HOW TO CLEAN THE VCR MACHINE

Let's now take a brief look at some VCR head and guide cleaning tips and procedures. The rotating video heads are the most

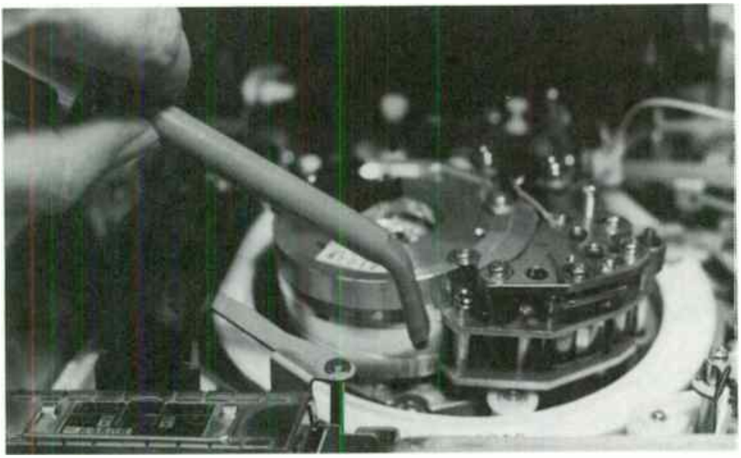


Fig. 7-1. Head demagnetizer in use.

delicate and expensive parts of the VCR cassette machine. They must be treated with the utmost care and respect and, of course, be kept very clean.

The video heads actually penetrate into the tape oxide when recorded and played back, thus there will always be a small amount of oxide shedding from the tape onto the heads and guides in the normal VCR running process. Thus, a good VCR cleaning procedure is required on a regular routine basis.

An oxide buildup on guides and heads will cause very poor record and playback of the video tapes. This will show up as streaks, noise (Fig. 7-2), or if built up enough, no picture at all. You may even suspect a faulty head drum. In fact, dirty heads will show-up first in the playback mode because of the relative weak magnetic field from the tape that must be transferred to the head drum. Another streak condition you may think is due to dirty heads is tape drop-out. This is when a few horizontal lines across the picture are missing (Fig. 7-3) and appear as a line of interference. This drop-out is caused by a streak of oxide missing from the tape or a faulty tape or badly worn tape.

To clean the heads use a special cleaning pad, such as a chamois leather cloth or cellular foam swabs. If these are not available a lintless cloth or muslin can be used. Cotton-tipped swabs *should not be used* for cleaning the video heads (Fig. 7-4). The cotton strands can catch on the edges of the video heads and pull the small ferrite

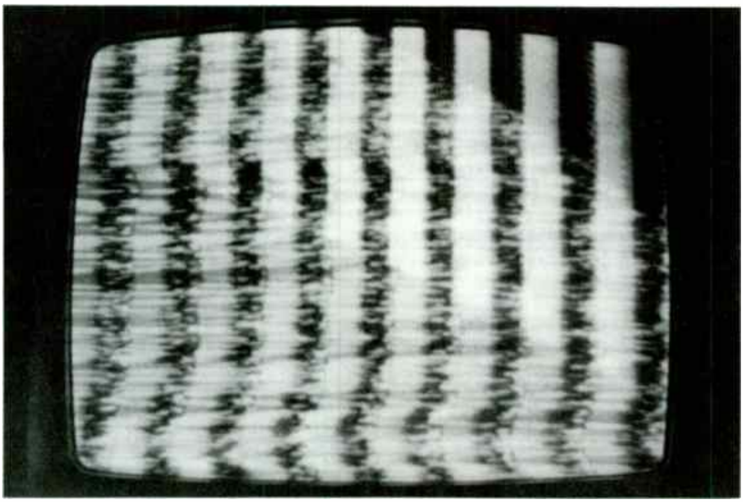


Fig. 7-2. Poor tape playback due to oxide build-up.

Fig. 7-3. Streak due to drop-out.

chip away from its mounting and ruin the head. The cotton swabs, soaked in cleaning fluid can be used to clean tape guides, control track, audio and erase heads. To clean the heads and guides you can use methanol or surgical isopropyl alcohol.

The cleaning pad should be liberally soaked in the cleaning fluid (alcohol) and then gently and firmly rubbed *sideways* across the heads. Never rub it up and down as this may damage the heads. Clean the whole head in this same sideways motion. Make sure you then clean all places that the tape touches. Do not touch these parts

Fig. 7-4. *Do not* use cotton swabs for cleaning heads.

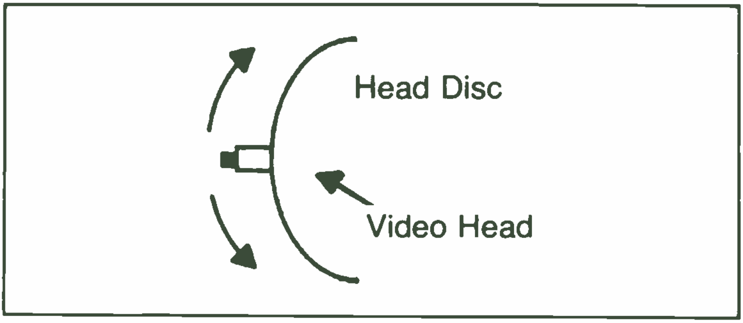


Fig. 7-5. Correct rubbing technique for cleaning heads.

with the fingers as the oil on them will attract dust and dirt. It's a good idea to hold the head so it will not rotate as you rub it clean in the direction of head rotation. This correct cleaning technique is illustrated in Fig. 7-5. The main thing to remember in head cleaning is to be very careful. The more often you perform this task the easier it will become.

Should you find a head that is very dirty and the head chip is all plugged up with oxide you may try the following tip for cleaning. The first thing to do is to soak the area around the head chip with alcohol two or three times. Then, as shown in Fig. 7-6 use an old toothbrush also soaked in alcohol to clean out around the head chip. However, do this very carefully as the head can be damaged. Of course, if it cannot be cleaned the heads will have to be replaced.

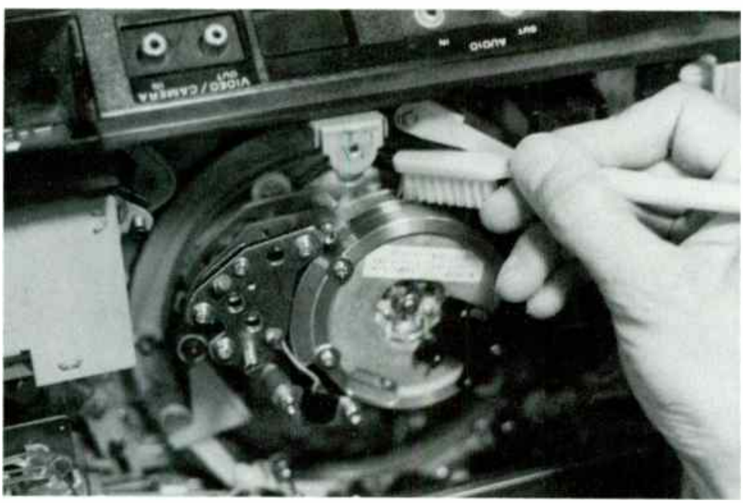


Fig. 7-6. A toothbrush can be used for cleaning clogged heads.

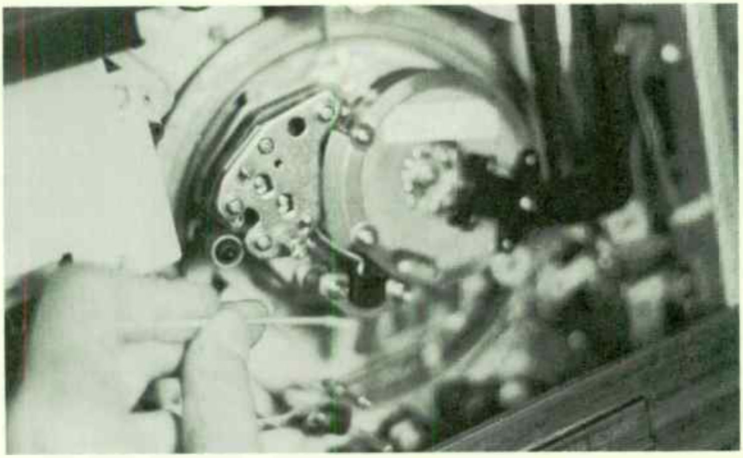


Fig. 7-7. Swab being used to clean the erase head.

You may want to cut the bristles of the toothbrush shorter. A cotton swab is being used to clean the erase head in Fig. 7-7 while a spray-can type video head cleaner is being used in Fig. 7-8.

Cleaning Beta-Format VCRs

Let's now go through the actual steps for cleaning a Beta-format machine. Caution: make sure the ac power cord is disconnected before cleaning the machine.

Step One. Remove the screws that hold the top cover of the VCR in place. These will usually require a Phillips cross-point tool.

Fig. 7-8. Spray type head cleaner being used.

Be careful and don't damage the screw heads. If this is an older model Zenith or Sony Betamax, remove the tracking knob in the lower, left-hand corner by grasping it and pulling it up and off the shaft. Now, press the eject button to raise the cassette carrier platform, lift off the top cover, then push the cassette carrier down again.

Step Two. The two video heads are located within the rotating center ring shown in the lower left corner (arrow) in Fig. 7-9. Now rotate this ring to bring each head (gap) into a convenient position by rotating the black motor fan blower shroud shown (arrow) in the upper right corner. You may also want to use an inspection mirror to get a better look at the heads. *Do not* actually touch the head face with your fingers.

In order to clean these heads, first saturate one of the cellular foam cleaning swabs with a good tape head spray cleaner. Now clean the heads using only a horizontal (side-to-side) motion. To ensure that cleaning is done in a side-to-side fashion, hold the swab stationary against the head and use the fan motor shroud to rotate the head back and forth. *Caution: do not* clean heads with a vertical (up-and-down) motion. This can easily damage the very delicate VCR heads. The proper head cleaning technique is being demonstrated in Fig. 7-10.

Step Three. The control track and audio heads are cleaned next as shown in Fig. 7-11. The control track and audio heads are located near the tip of the swab. Clean these heads in the same way

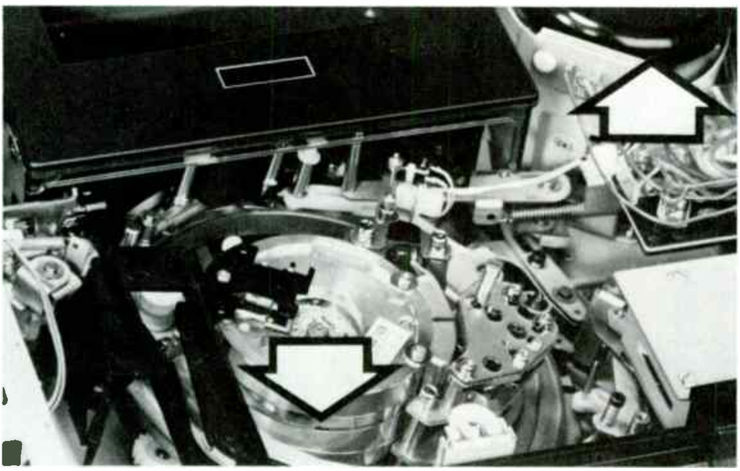


Fig. 7-9. Location of the video heads (courtesy of Nortronics).

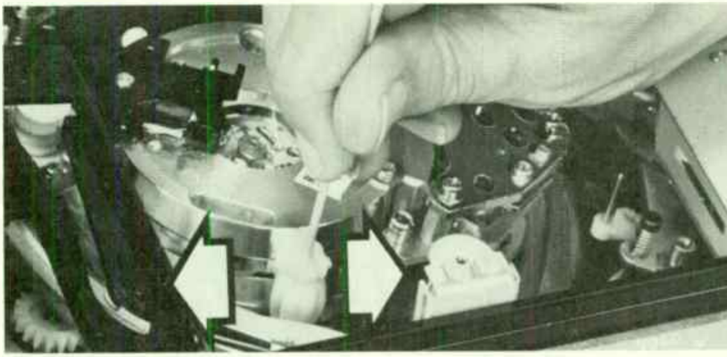


Fig. 7-10. Proper head cleaning technique (courtesy of Nortronics).

you cleaned the video heads (using only a horizontal (side-to-side) scrubbing motion).

Step Four. Now the erase head should be cleaned. The erase head is located by the tip of the swab as shown in Fig. 7-12. Remember, use only a horizontal cleaning motion.

Step Five. After all of the heads have been cleaned, perform the same cleaning function on all contact points (rollers, guides, etc.) that are in the tape path.

Step Six. Now push the eject button to raise the cassette carrier and reassemble the unit by placing the top cover in position. Now install and tighten all cover screws with the cross-point screwdriver. Replace the tracking control if on an older model machine. The VCR machine should now be wiped clean with an anti-static dust cloth.

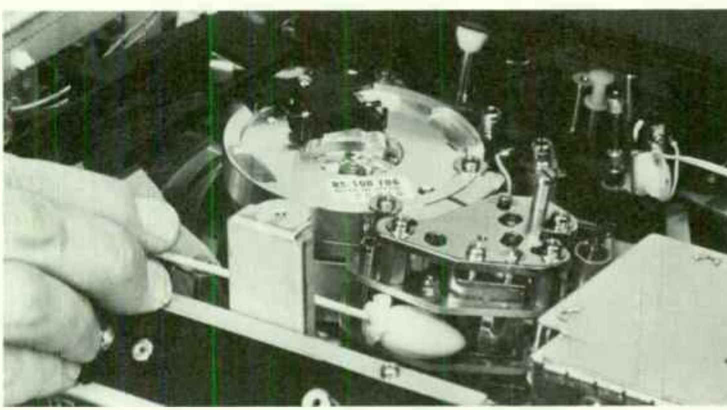


Fig. 7-11. Cleaning the control track head (courtesy of Nortronics).

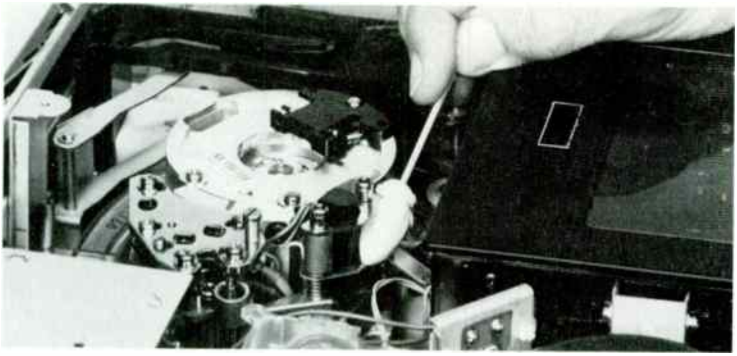


Fig. 7-12. Erase head being cleaned (courtesy of Nortronics).

Cleaning VHS-Format VCRs

Let's go through the actual steps for cleaning a VHS-format machine. *Caution:* make certain that the ac power cord is disconnected from the machine before removing the cover and cleaning.

Step One. First, remove the screws that hold the top cover of the machine in place so that it can be removed. These are usually all cross-point or Phillips-type screws. Be careful and do not damage the screw heads.

Step Two. The two very delicate video heads are located on the rotating head disc as shown by the arrow in Fig. 7-13. Gently rotate this wheel disc to bring each head into a convenient position for cleaning. You may want to use an inspection mirror in order to have a better look at the head faces. *Do not* actually touch the highly polished face of the disc wheel with your fingers. The control track, audio heads and erase head are located on each side of the head cylinder.

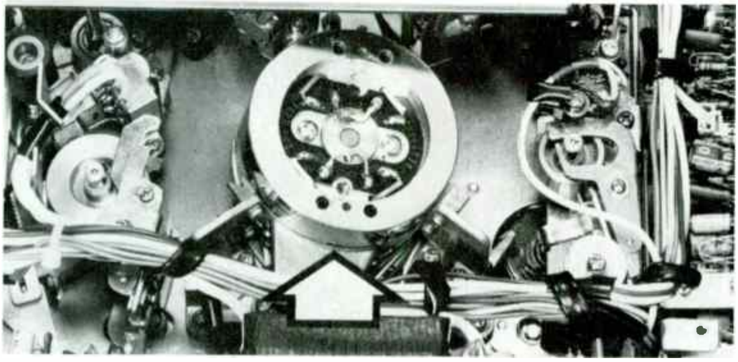


Fig. 7-13. Location of head disc in VHS unit (courtesy of Nortronics).

In order to clean these heads, first saturate one of the cellular foam cleaning swabs with a good tape/head cleaner fluid. Clean the heads using only a horizontal (side-to-side) motion. To ensure that cleaning is done in a side-to-side fashion, hold the swab stationary against the head and use the head wheel to rotate the head back and forth. Refer to Fig. 7-14 for the proper head cleaning action. Caution: *do not* clean with a vertical (up-and-down) motion. This could damage the fragile heads.

Step Three. The control track and audio heads are located near the tip of the swab as can be seen in Fig. 7-15. Clean these in the same way you cleaned the video heads (using only a horizontal (side-to-side) scrubbing motion).

Step Four. After all the heads have been cleaned, perform the same cleaning function on all contact points (rollers, guides, etc.) that are in the tape path.

Step Five. Now replace the top cover, install all screws and tighten. And if you wish to do a class-A job, wipe the machine clean with an anti-static cloth. Caution: you should not use cotton swabs or other lint-producing materials, as the lint may be left during the cleaning process and could damage delicate VCR machine components.

Make sure the tape heads in the VCR unit is totally dry after the

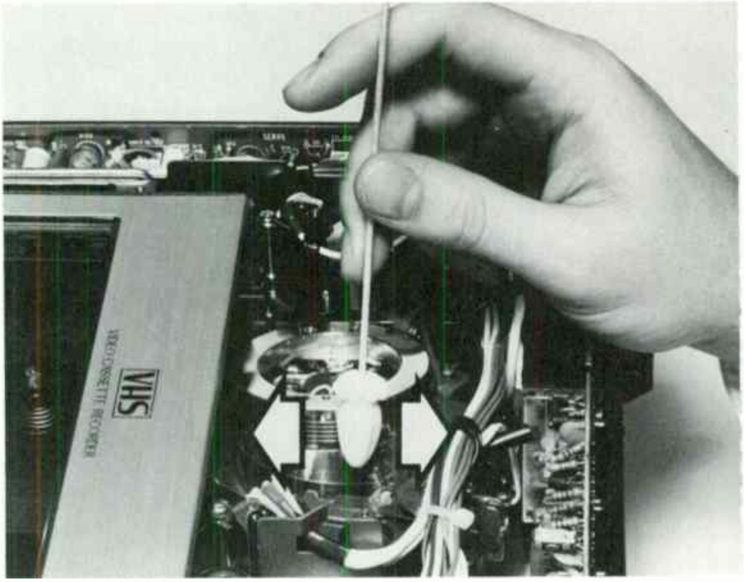


Fig. 7-14. Correct head cleaning technique (courtesy of Nortronics).

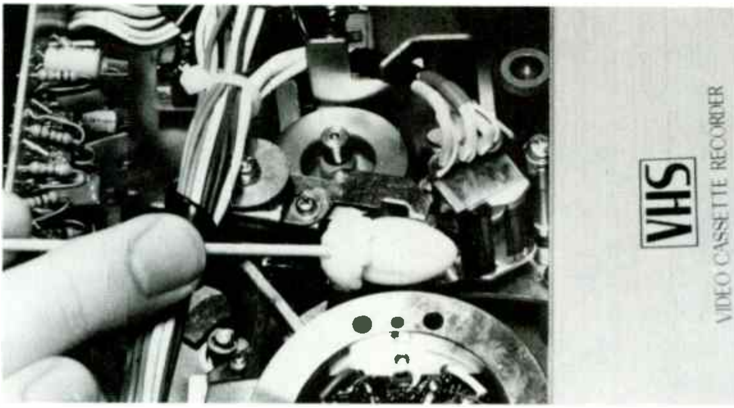


Fig. 7-15. Cleaning of control track and audio heads (courtesy of Nortronics).

cleaning procedure before the machine is put into operation. If you do not do this the tape may not thread properly and jam-up the machine. Nortronics VCR-103 spray tape/head cleaner ensures completely dry heads since this cleaner will evaporate completely leaving no oil or other residues.

NOTES ON TAPE TENSION

Remember, that tape tension is very important in the proper operation of a VCR machine. Too much tension will cause excessive head and tape guide wear. Also, too much tape tension can cause tracking errors due to tape stretch and can even permanently stretch the tape. Too much tension in the threading loop can actually stop the tape from traversing its path and even pull it out of its path. Too little tension will allow the tape to fall out of its true path and not make proper contact with the heads, which causes misalignment with the video tracks and results in picture dropouts. Many tape transport problems are due to the wrong tension on the tape and checks should be performed on a regular basis.

BELTS AND DRIVE WHEELS

All of the drive belts and wheels should also be checked and cleaned when the VCR machine is down for head cleaning. Check for loose drive belts and worn rubber drive wheels. If the rewind and fast forward do operate properly, then suspect worn drive wheels. The drive belts and wheels can be cleaned with isopropyl alcohol or any other cleaner made for this purpose. If new belts are installed make sure they are put on properly and check them for proper tension. Always make a careful check when drive belts, wheels, or other mechanical parts are changed or adjusted.

Much of the VCR machines mechanical alignment and parts replacement requires using special jigs, gauges and fixtures for correct operation. Make sure you are properly trained before attempting these procedures.

VIDEO HEAD STICTION

Videocassette recorders with many hours of use may begin to exhibit a condition which can be described as *stiction*. The word *sticking* and *friction* indicates a condition of the video head drum assembly which causes the tape to stop moving during record or playback. If this occurs and continues unchecked (as in recording with the timer mode) severe clogging of the video heads and tape damage may result.

The apparent cause of stiction is the loss of an air "cushion" between the tape and the record drum head. As the VCR is used, friction from tape travel will polish the drum surface smooth. This prevents the required air buildup and the tape adheres to the drum. Obviously, replacement of the head drum assembly is the ultimate solution, but this is very costly.

The following alternative has been tested and recommended whenever the drum exhibits highly polished areas and as a last resort before the video head disc is changed. This procedure requires the use of a specially designed brush tool (Zenith part no. SD-21179) that can be obtained from your local Zenith distributor. *Caution: do not* use sandpaper, emerycloth or other similar abrasives to perform this repair.

If the head disc is not to be replaced after this procedure, use extreme caution when working around the video heads as they can be easily damaged. Proceed as follows:

1—Remove the cassette lift assembly and threading arm guides. This is for Zenith and Sony machines.

2—Remove the arm lock bracket assembly and the tape retainer spring assembly.

3—Remove the rear panel assembly and perform the threading operation.

4—Fold the narrow side of a calling card (see Fig. 7-16), and insert this between the drum and head bracket assembly.

5—Position the video heads as for dihedral adjustment and lock the head in place with partially inserted dihedral screws, (if dihedral screws are not available, hold the rotating disc firmly with thumb

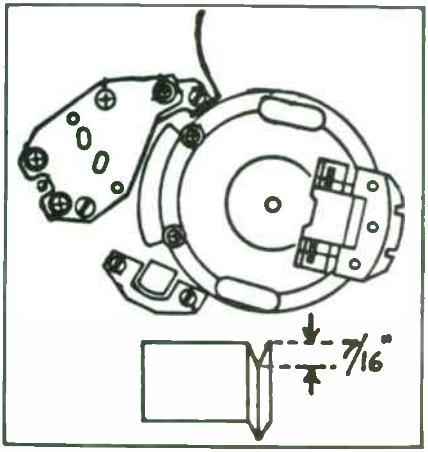


Fig. 7-16. Protective shield made from a calling card.

Fig. 7-17. A VCR service bench.

and forefinger, taking care to not touch the heads).

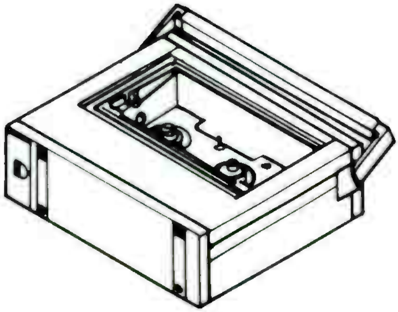
6—Use the brushing tool (part no. SD-21179), with bristles set to approximately ⅛ inch, to brush horizontally across the upper (stationary) head disc, center (rotating) head disc and lower (stationary) head disc. *Do not* come closer than approximately ⅜ inch to the head disc coil.

7—Continue in this way from the front of the head disc assembly to within ⅜ inch of the coil at the rear. Then rotate the video head disc clockwise until the rear coil is on line with the rewind sensing coil.

8—Hold the rotating disc in place and continue brushing toward the rear of the head disc assembly.

9—When the tape path around the drum has been brushed to a dull finish, blow any possible remaining aluminum particles out the rear of the VCR machine with a compressed air gun or use the canned air that may be found in some VCR head cleaning and maintenance kits. This brushing procedure should give many more taping hours without head replacement. A portion of my VCR service bench is shown in Fig. 7-17.

Chapter 8



VHS Videocassette Recorders

This chapter covers the various VHS (Video Home System) videocassette machines. Most of these VHS units are built by the Matsushita and JVC electronic companies in Japan. Many of these VHS machines are very similar and the information presented is applicable to all brands and models of VHS videocassette recorders.

VHS RECORDING

Let's now take a brief look at the principle VHS operation and the basic video tape recording format. To understand the VHS format, it's good to first review the basic principles of video tape recording. Like audio tape recording, video information is stored on magnetic tape by means of a small electromagnet, or head. The two poles of the head are brought very close together but they do not touch. This creates a field of magnetic flux which extends across the separation (gap) as shown in Fig. 8-1.

If an ac signal is applied to the coil of the head, the field of flux will expand and collapse according to the rise and fall of the ac signal. When the ac signal reverses polarity, the field of flux will be oriented in the opposite direction and will also expand and collapse. This changing field of flux is what accomplishes the magnetic recording. If this flux is brought near a material, it will become magnetized according to the intensity and orientation of the field flux. The magnetic material that is used is oxide coated (magnetic) tape. As an example with audio tape, if the tape is not moved across

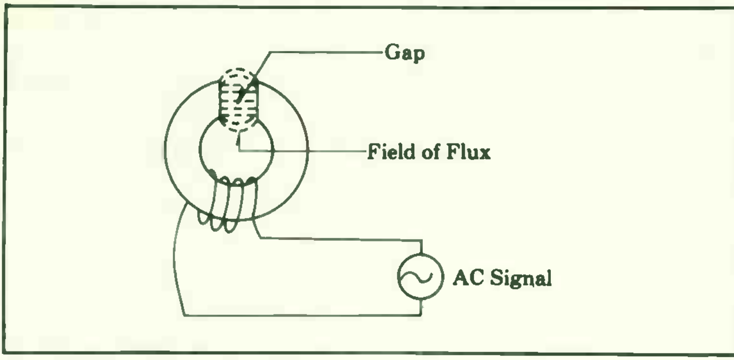


Fig. 8-1. Magnetic flux across head gap.

the head, just one spot on the tape will be magnetized and will be continually remagnetized. If the tape is moved across the head, specific areas of the tape will be magnetized according to the field of flux at any specific moment. A length of recorded tape will therefore have on it areas of magnetization representing the direction and intensity of the field flux.

The tape will have differently magnetized regions, which can be called north (N) and south (S), according to the ac signal. When the polarity of the ac signal changes, so does the direction of magnetization on the tape, as shown by one cycle of the ac signal (Fig. 8-2). If the recorded tape is then moved past a head whose coil is connected to an amplifier, the regions of magnetization on the tape will set up flux across the head gap which will in turn induce a voltage in the coil to be amplified. The output of the amplifier will be the same as the original ac signal. This is essentially what is done in audio recording, with other methods for improvement like bias and equalization.

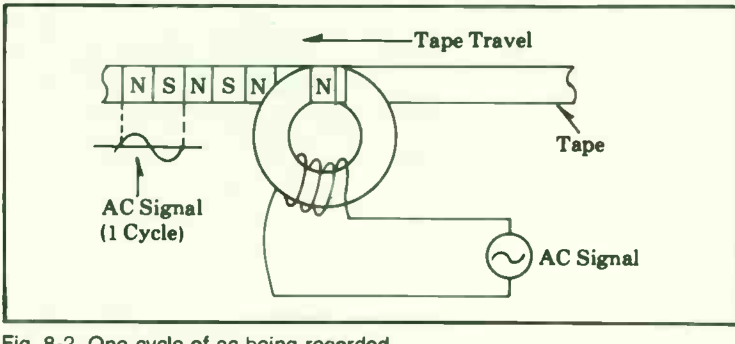


Fig. 8-2. One cycle of ac being recorded.

There are some inherent limitations in the tape recording process which does effect video recording, so let's look at them now. As shown in Fig. 8-2, the tape has north and south magnetic fields which change according to the polarity of the ac signal. Now let's see what occurs if the frequency of the ac signal were greatly increased.

If the speed of the tape past the head (head to tape speed) is kept the same, the changing polarity of the high frequency ac signal would not be faithfully recorded on the tape as shown in Fig. 8-3. As the high frequency ac signal starts to go positive, the tape will start to be magnetized in one direction. But the ac signal will very quickly change its polarity, and this will be recorded on much of the same portion of the tape, so north magnetic regions will be covered by south magnetic regions and vice versa. This results in zero signal on the tape, or self-erasing. To keep the north and south regions separate, the head to tape speed must be increased (refer to Fig. 8-3).

When recording video, frequencies in excess of 4 MHz may be encountered. Through experience, it is found that the head to tape speed must be in the region of 5 meters per second in order to record these video signals. The figure of 5 meters per second was also influenced by the size of the head gap. Clearly, the lower the head to tape speed, the easier it is to control that speed. If changes in head gap size were not made, the necessary head to tape speed would have been considerably higher. How the gap size influences this is explained in Fig. 8-4.

Assume a signal is already recorded on the tape. The distance of the tape required to record one full ac signal cycle is called the *recorded wavelength*. Head A has a gap width equal to one wave-

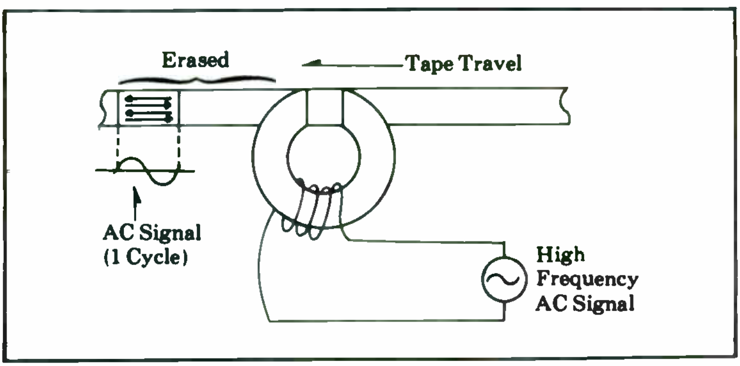


Fig. 8-3. High frequency ac signal recording.

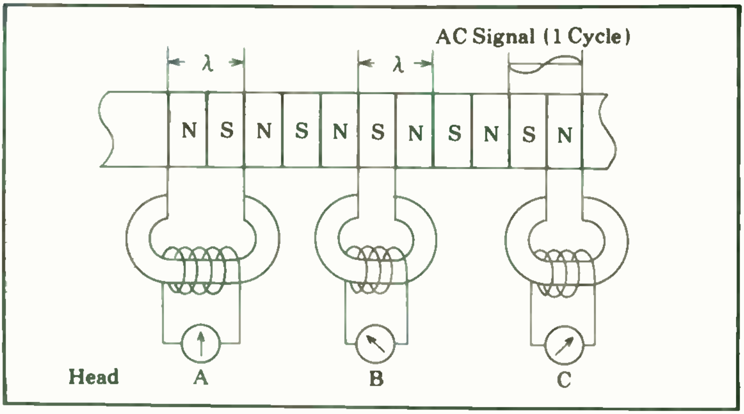


Fig. 8-4. Various tape head gap sizes.

length. Here, there is both north- and south-oriented magnetization across the gap. This produces a net output of zero since north and south cancel. Heads B and C have a maximum output because there is just one magnetic orientation across their gaps. Maximum output occurs in heads B and C therefore, because their gap width is ½ wavelength. Heads B and C would also work if their gap width is less than ½ wavelength. The same is also true for recording.

A head to tape speed of five meters per second is a very high speed, too high in fact to be handled accurately by a reel-to-reel tape machine of reasonable size. Also, tape consumption would be very high. The technique used in video recording is to move the video heads as well as the tape. If the heads are made to move fast, across the tape, the linear tape speed can be kept very low. In 2-head helical video recording, the video heads are mounted in a rotating drum or cylinder, and the tape is wrapped around the cylinder. This way, the heads can scan the tape as it moves. When a head scans the tape, it is said to have made a *track* (see Fig. 8-5).

In a 2-head helical format, each head, as it scans across the tape will record one TV field, or 262.5 horizontal lines. Therefore, each head must scan the tape 30 times per second to give a field rate of 60 fields per second. The tape is shown as a screen wrapped around the head cylinder to make it easy to view the video head. There is a second video head 180 degrees from the head shown in front. Because the tape wraps around the cylinder in the shape of a helix (helical) the video tracks are made as a series of slanted lines. Of course, the tracks are invisible, but it is easier to visualize them as lines. The two heads "A" and "B" make alternate scans of the tape.

An enlarged view of the video tracks is shown in Fig. 8-6. The video tracks are the areas of the tape where video recording actually takes place. The guard bands are blank areas between tracks, preventing the adjacent track's crosstalk from appearing on the track where the video head is tracing.

There is one more point about video recording which will be discussed here. Magnetic heads have the characteristic of increased output level as the frequency increases. In practice, the lower frequency output of the heads is boosted in level to equal the level of the higher frequencies. This process, as also used in audio applications, is called equalization.

Video frequencies span from dc to about 4 MHz. This represents a frequency range of about 18 octaves. Eighteen octaves is too far a spread to be handled in one system. For instance, heads designed for operation at a maximum frequency of 4 MHz will have very low output at low frequencies. Since there is 6 dB/octave attenuation, a 108 dB difference appears ($18 \times 6 = 108$ dB). In practice this difference is too great to be adequately equalized. To get around this, the video signal is applied to an FM modulator during recording. This modulator will change its frequency according to the instantaneous level of the video signal.

The energy of the FM signal lies chiefly in the area from about 1 MHz to 8 MHz, just three octaves. Heads designed for use at 8

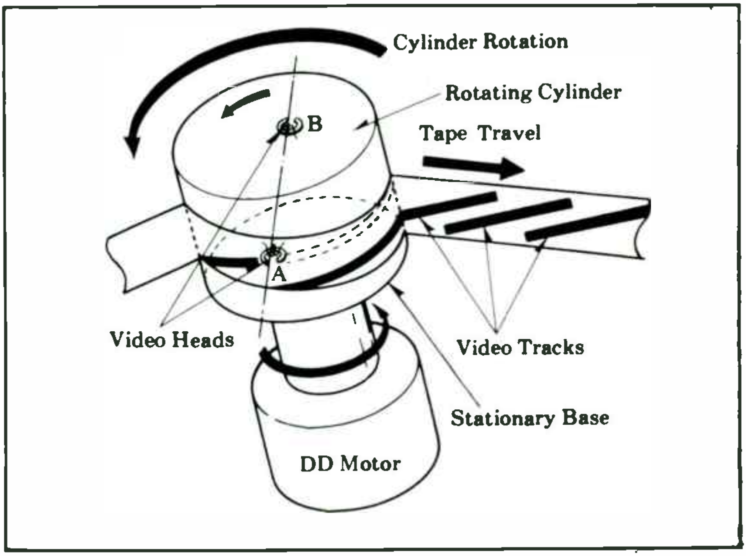


Fig. 8-5. Tape track recorded by video head.

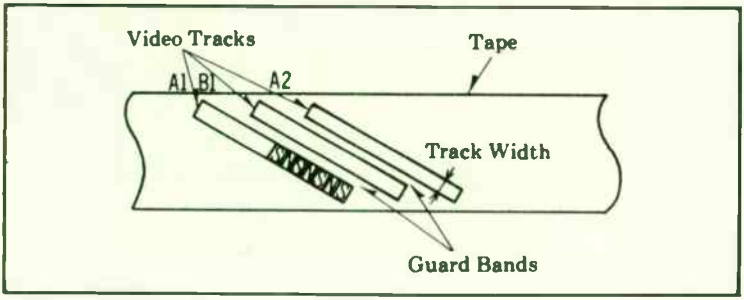


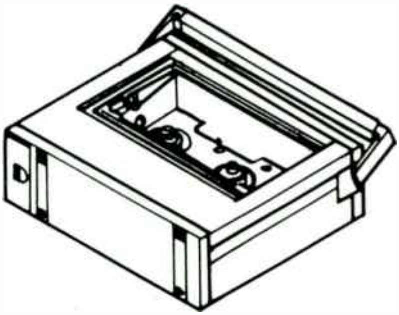
Fig. 8-6. Enlarged view of video tracks on a tape.

MHz can still be used at 1 MHz, because the output signal can be equalized. In actual VCR machines, heads are designed for use up to about 5 MHz. Therefore, some FM energy is lost but it does not affect the operation that much because information included in the high frequency region does not degrade the picture quality. Upon playback, the recovered FM signal must be equalized then demodulated to obtain the video signal.

CONVERTED SUBCARRIER DIRECT RECORDING METHOD

The one method of color video recording that will be discussed here is the converted subcarrier method. In order to avoid visible beats in the picture caused by the interaction of the color (chrominance) and brightness (luminance) signals, the first step in the converted subcarrier method is to separate the chrominance and luminance portions of the video signal to be recorded. The luminance signal, containing frequencies from dc to about 4 MHz, is then FM recorded as previously described. The chrominance portion, containing frequencies in the area of 3.58 MHz is down-converted in frequencies to the area of 629 kHz. Since there is not a large shift from the center frequency of 629 kHz, this converted chrominance signal is able to be recorded directly on the tape. Also note that the frequencies in the area of 629 kHz are still high enough to allow equalized playback. In practice, the converted chrominance signal and the FM signals are mixed and then simultaneously applied to the tape. Upon playback, the FM and converted chrominance signals are separated. The FM is demodulated into a B&W signal again. The converted color signal is reconverted back up in the frequency area of 3.58 MHz.

Chapter 9



General Electric Videocassette Recorders

Figure 9-1 shows a complete General Electric portable VCR system which consists of three units. The model 1VCD2021X is the VCR deck, the model 1CVT600 is the programmable tuner/timer unit, and the model 1CVA400 is the power supply. The specifications for all three units are given in Fig. 9-2. The information in this chapter is courtesy of GE.

DISASSEMBLY OF VCR CABINET

The flowchart in Fig. 9-3 indicates disassembly steps of the cabinet parts and the PC boards in order to find the items required for servicing. When reassembling, perform the steps in the reverse order as those shown in the flowchart. Note: since this model is designed very compactly and uses locking tabs instead of mounting screws, work with extreme care when servicing these units.

DISASSEMBLY OF THE VCR UNIT

Removal of the bottom case

1—Place the deck upside down so the bottom case faces upward.

2—Remove 4 screws (A) as shown in Fig. 9-4. Now remove the bottom case by lifting the rear portion of it. Note: when reinstalling, first insert the locking portion into the slot of the front panel. Final adjustments are required when the cassette guide and the cassette holder unit were replaced and /or removed.

Fig. 9-1. A General Electric portable VCR (courtesy of General Electric).

3—Place a drop cloth or any soft materials under the PC boards or deck for preventing them from being damaged while servicing.

Removal of the cassette cover

1—Turn the deck over again so the cassette cover faces upward. And press the eject button to raise the cassette compartment (Fig. 9-5).

2—Remove 2 screws (B). Then carefully lift and turn the rear portion of it to remove. Pay attention and do not damage the locking portion. Note: when reinstalling, first match the locking portion of the cassette cover to the tab on the cassette holder unit.

Removal of the top case

1—First confirm that the battery is inside the battery compartment or not. If it is, take the battery out.

2—Remove 2 screws (C). Then carefully lift the rear portion and pull toward the rear of the deck to remove (Fig. 9-6). While removing, keep the handle up and hold it with your hand. Note: when reinstalling, first insert the locking portions into the front panel.

Removal of the front panel

1—Stand the VCR deck so the control panel faces upward (Fig. 9-7).

2—Hold both the right and left ends of the front panel and carefully lift and turn the top portion of it to remove. Note: do this step with extreme care so as not to damage the locking portions.

Removal of the cassette guide

Remove 2 screws (D) and the cassette guide. Note: when reinstalling, insert the cassette tape and ensure that the clearance between tape and projections on the cassette guide is more than 1 mm. Then tighten 2 screws (D) as shown in (Fig. 9-8).

SPECIFICATIONS for 1CVD2021X

"SLP" described in this Service Manual means "EP".

Power Source:	12 VDC
	Battery 1CVA100
	Prog. Tuner Unit 1CVT600
	(Not available independently)
	AC Adaptor 1CVA400
Power Consumption:	Approx. 9.4 W at Play mode
Television System:	EIA Standard (525 lines, 60 fields)
	NTSC color signal
Video Recording System:	2 rotary heads helical scanning system
	Luminance: FM azimuth recording
	Chrominance: Converted subcarrier phase shift recording
Audio Track:	1 track
Tape Format:	Tape width 1/2″ (12.7 mm) high density tape
Tape Speed:	SP mode: 1-5/16 i.p.s (33.35 mm/s)
	LP mode: 21/32 i.p.s (16.67 mm/s)
	EP mode: 7/16 i.p.s (11.12 mm/s)
Record/Playback Time:	1 (SP), 2 (LP) or 3 (EP) hours with 1CAS060
	2 (SP), 4 (LP) or 6 (EP) hours with 1CAS120
FF/REW Time:	Less than 6 min with 1CAS120
Heads:	Video: 2 Rotary heads
	Audio/Control: 1 stationary head
	Erase: 1 full track
	1 audio track erase for audio dubbing

Input Level:	Video: VIDEO IN Jack (RCA type) 1.0Vp-p, 75Ω unbalanced
	Audio: MIC IN Jack −70dB, 600Ω unbalanced
	TV Tuner: VHF Input: VHF Ch2-Ch13, 75Ω unbalanced
	(1CVT600) UHF Input: UHF Ch14-Ch83, 300Ω balanced
Output Level:	Video: Video OUT Jack (RCA type) 1.0Vp-p, 75Ω unbalanced
	Audio: Audio OUT Jack (RCA type) −6dB, 600Ω unbalanced
	Earphone Jack: −20dB, 200Ω unbalanced
	RF Modulated: Ch3/Ch4 switchable, 72dBμ (open voltage), 75Ω unbalanced
Video Horizontal Resolution:	More than 230 lines
Audio Frequency Response:	SP mode: 100Hz—8kHz
	LP mode: 100Hz—6kHz
	EP mode: 150Hz—5kHz (10dB down)
Signal-to-Noise Ratio:	Video: SP mode: better than 40dB Audio: SP mode: better than 42dB
	LP mode: better than 40dB LP mode: better than 40dB
	EP mode: better than 40dB EP mode: better than 40dB
	(Rohde & Schwarz noise meter)
Operating Temperature:	32°F—104°F (0°C—40°C)
Operating Humidity:	10%—75%
Weight:	13.5 lbs (6.1kg) (with battery)
Dimensions:	12″(W) × 4-1/2″(H) × 9-11/16″(D)
	(304(W) × 114(H) × 245(D)mm)

Fig. 9-2. Specifications of the model 1CVD2020X (courtesy of General Electric).

SPECIFICATIONS for 1CVT600

Power Source:	120 VAC ± 10%, 60 Hz ± 0.5%
Power Consumption:	Approx. 52 W DC out 12 V 1.6 A
Television System:	EIA Standard (525 lines, 60 field)
Timer:	2 weeks/8 programs programmable timer
Input:	VHF Ch2-Ch13, 75Ω unbalanced UHF Ch14-Ch83, 300Ω balanced RF (Ch3 or Ch4)
Output:	Video: (10P connector) 1.0 Vp-p, 75Ω unbalanced Audio: (10P connector) −6 dB, 600Ω unbalanced AC Outlet: 120 VAC Max 300 W unswitched
Operating Temperature:	32°F—104°F (0°C—40°C)
Operating Humidity:	10%—75%
Weight:	10 lbs. (4.6 kg)
Dimensions:	11-7/16″(W) × 4-3/8″(H) × 9-11/16″(D) (289(W) × 110(H) × 245(D) mm)

SPECIFICATIONS for 1CVA400

Power Source:	120 VAC ± 10%, 60 Hz ± 0.5%
Power Consumption:	Approx. 44 W
Output:	12 VDC Max. 1.6 A for deck operation 15 VDC Max. for battery charge
Operating Temperature:	32°F—104°F (0°C—40°C)
Operating Humidity:	10%—75%
Weight:	5.9 lbs (2.7 kg)
Dimensions:	4-3/16″(W) × 4-5/16″(H) × 9-11/16″(D) (105(W) × 109(H) × 245(D) mm)

Weight and dimensions shown are approximate.
Specifications are subject to change without notice.

Fig. 9-2. Specifications of the model 1CVD2020X (courtesy of General Electric). (Continued from page 281.)

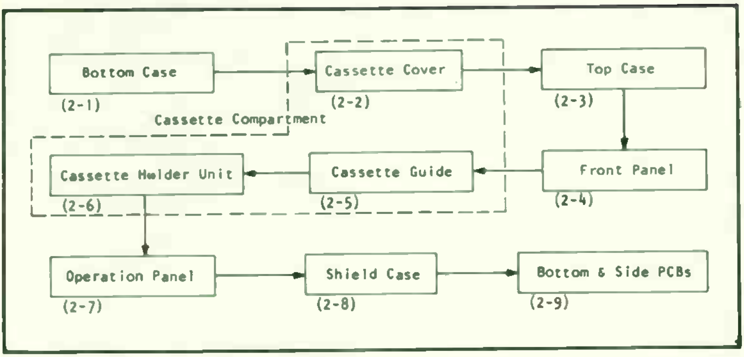


Fig. 9-3. VCR disassembly flowchart (courtesy of General Electric).

Removal of the cassette holder unit

Remove 4 red screws (E) and the cassette holder unit as shown in (Fig. 9-9). Notes: when this part was removed or replaced, the cassette holder adjustment should be performed. When reinstalling, ensure the pin located at lower left portion is engaged with the connecting rod. Refer to Fig. 9-10.

Removal of the operation panel

Note: as the space in this section is very compressed, work with care when doing each step. The operation panel is not required

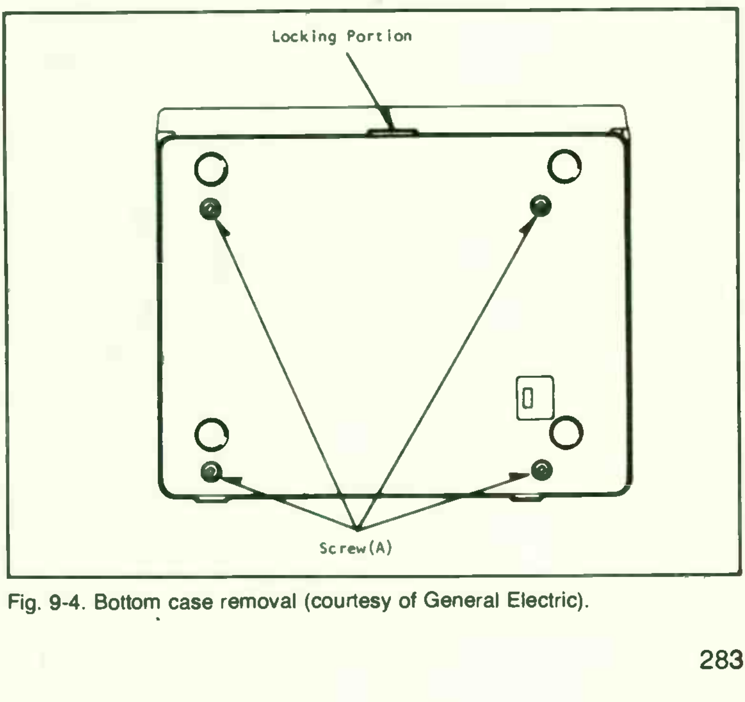


Fig. 9-4. Bottom case removal (courtesy of General Electric).

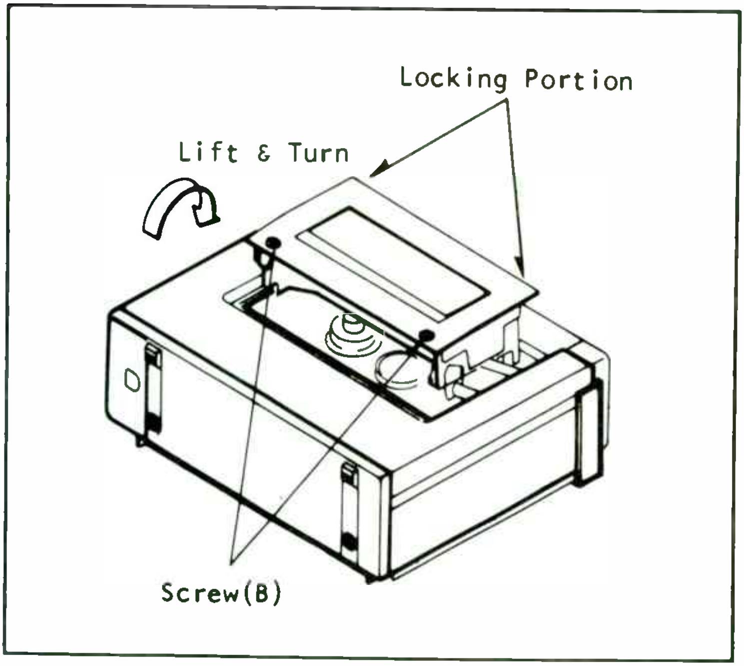


Fig. 9-5. Removing the cassette cover (courtesy of General Electric).

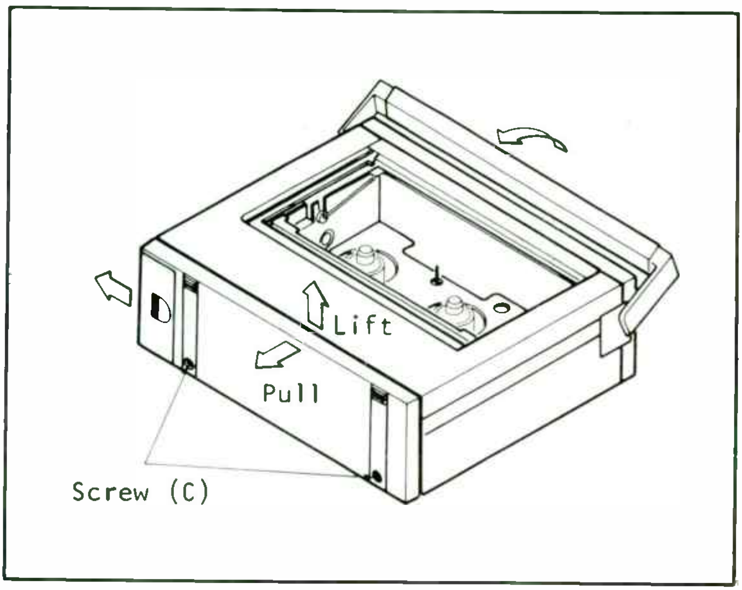


Fig. 9-6. Removal of the top case (courtesy of General Electric).

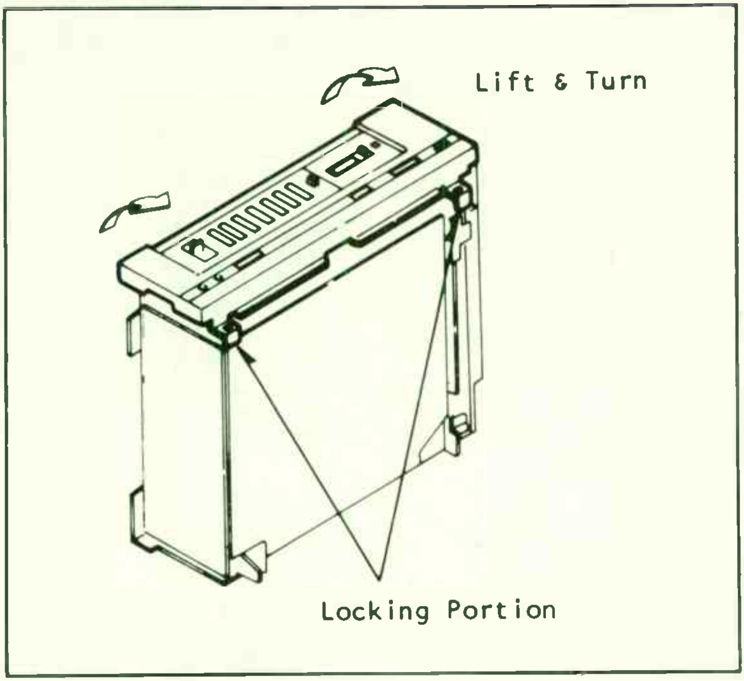


Fig. 9-7. Front panel removal (courtesy of General Electric).

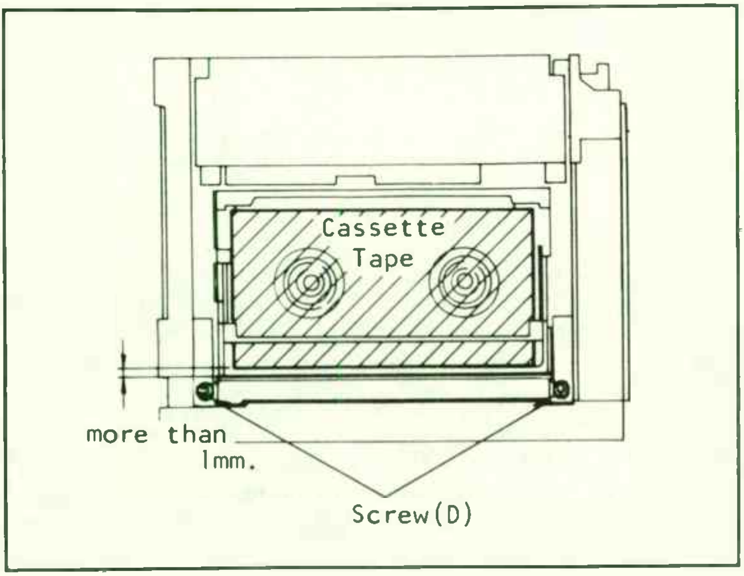


Fig. 9-8. Cassette guide removal (courtesy of General Electric).

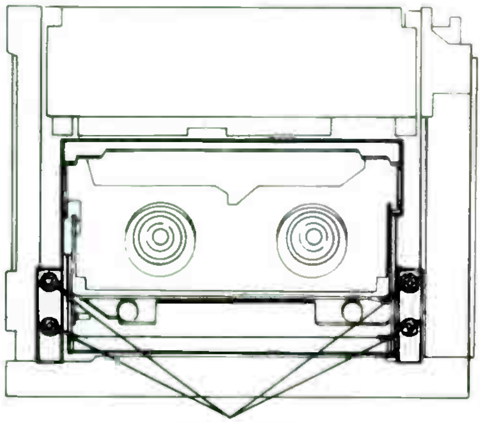


Fig. 9-9. Cassette holder removal (courtesy of General Electric).

to be removed except in cases of replacement of the operation panel or servicing of components mounted on it or on the system control PC boards.

1—Unlock 2 locking portions located on the lower part of each side. Refer to Fig. 9-11.

2—Unlock 2 locking portions located on top of each side.

3—Disconnect 2 connectors which are connected to the ear phone jack and the battery meter.

4—Carefully unlock 8 locking portions which lock the PC board to the operation panel. When reinstalling the operation panel, reconnect the 2 connectors. Make sure you reinstall the operation control buttons and knobs.

Removal of the shield case

Loosen 2 screws (F), remove a screw (G), pull the shield case toward the back of the deck and lift it up to remove (Fig. 9-12). When reinstalling panel, make sure the red lead wire is restored around the dumper correctly.

Circuit Board Swing-out

1—Place a drop or other soft material under the PC boards so as to prevent them from being damaged during machine servicing.

2—This procedure is required when the VCR deck is serviced with the operation panel in place. If this is not the case, first perform steps 1 and 2 of the "Removal of the Operation Panel" section.

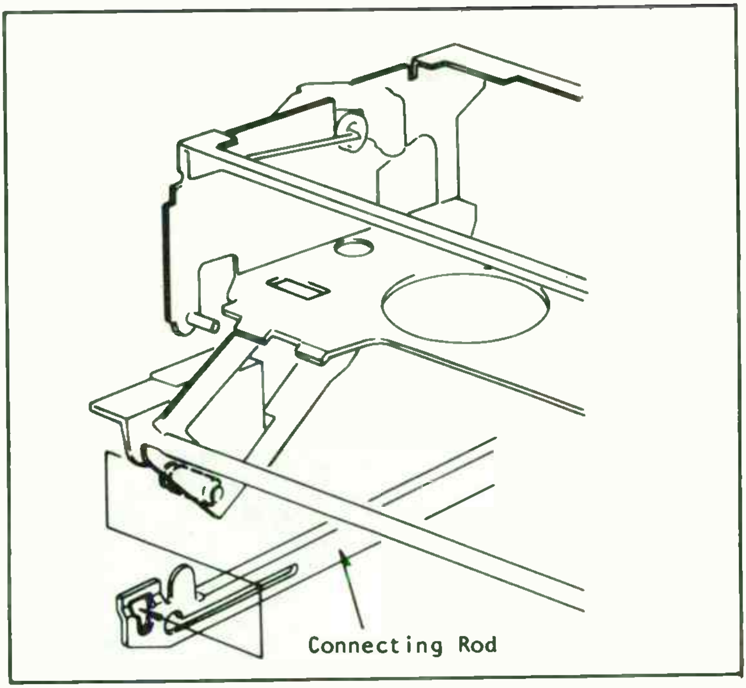


Fig. 9-10. Installation of connecting rod (courtesy of General Electric).

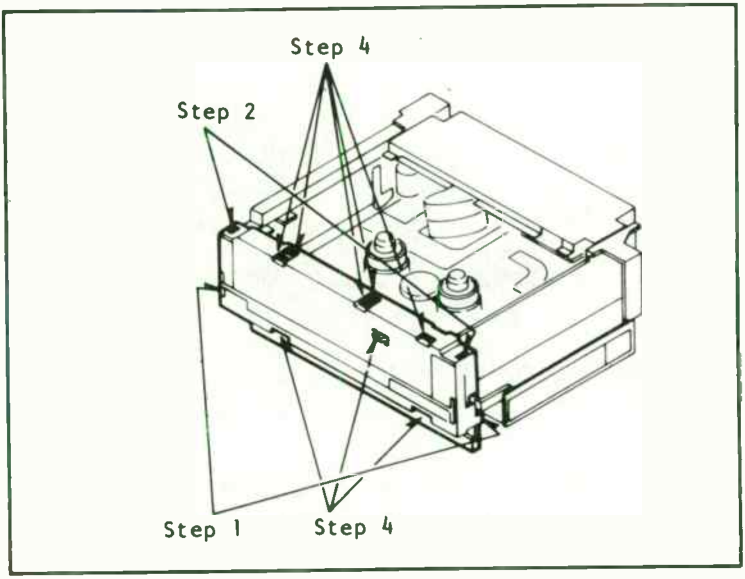


Fig. 9-11. Removal of the operating front panel (courtesy of General Electric).

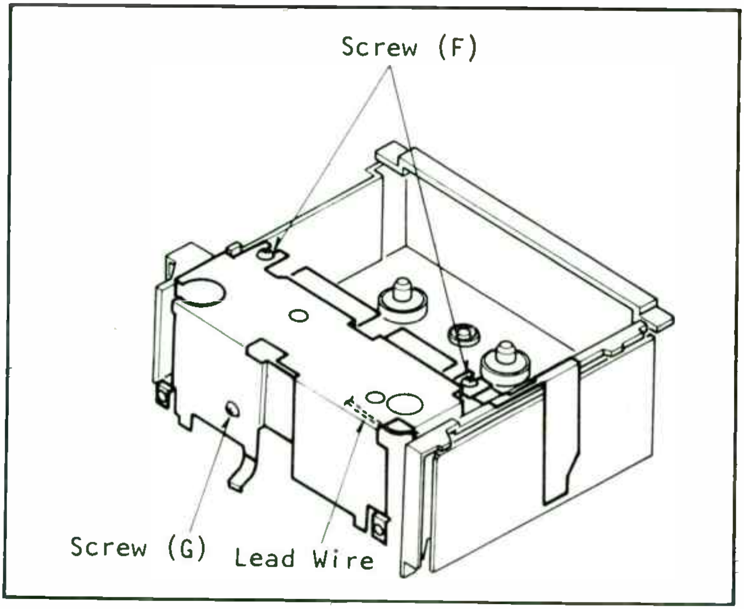


Fig. 9-12. Removal of the case shield (courtesy of General Electric).

3—When reinstalling, make sure the connectors are connected and any electrical components are not damaged.

Procedure for opening PC boards

1—Disconnect the connector (P21) which is connected to the tape counter.

2—Remove (2) screws (H), unlock the (2) locking portions and carefully open the PC board. Support the PC boards with your hand to prevent them from being laid down. Refer to Fig. 9-13.

3—Disconnect the 2 connectors (P17 and P18) on the audio and chrominance board. Now release the leads connecting between the jack panel board and P16 from the cable lead clamp. Now carefully lay down the PC boards.

ELECTRICAL ADJUSTMENT PROCEDURES

The following test equipment is required to make these adjustments:

- DVM (digital volt meter) (voltage range 0.001 V to 50 V).
- Frequency counter (frequency range: 0 to 10 MHz)

Refer to Fig. 9-14 for location of the power supply adjustments and components.

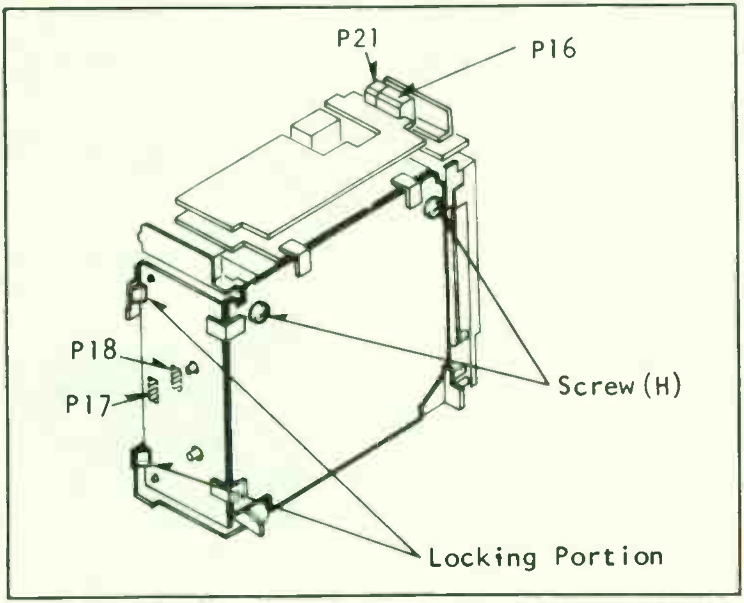
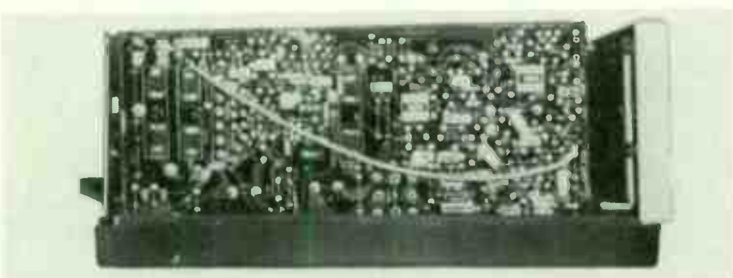


Fig. 9-13. Opening the PC boards for servicing (courtesy of General Electric).



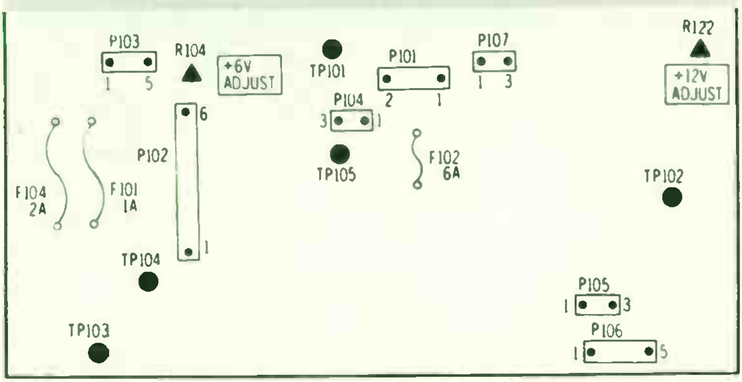


Fig. 9-14. Power supply unit board (courtesy of General Electric).

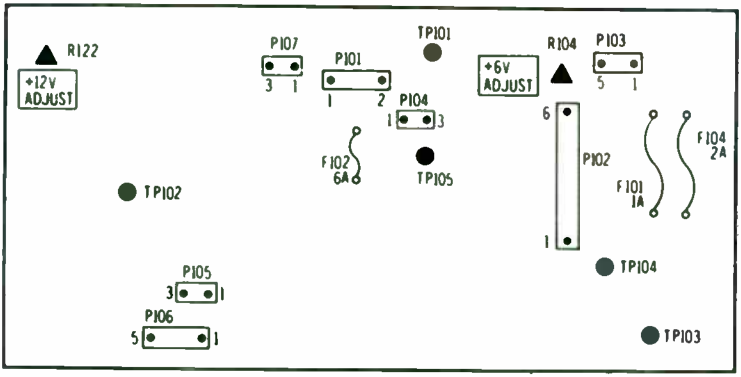


Fig. 9-15. Power supply pc board component side view (courtesy of General Electric).

+12 Volt dc Adjustment

Use test point TP102 as shown in Fig. 9-15 (R122 +12 volt dc Adjustment control).

1—Check the ac input voltage for 120 volt ac and then connect the electronic programmable timer/tuner unit to the deck as shown in Fig. 9-16.

2—Turn on the power switch on the VCR deck.

3—Connect the DVM between TP102 (+) and TP101 (GND) on the power supply board as shown in Fig. 9-17.

4—Adjust the +12 volt dc adjust (R12) for +12 volt +0.05 volt dc.

+6 Volt dc Adjustment.

Use test point TP105 and adjustment control R104.

1—Connect the DVM between TP105 (+) and TP101 (GND) on the power supply board as shown in Fig. 9-18.

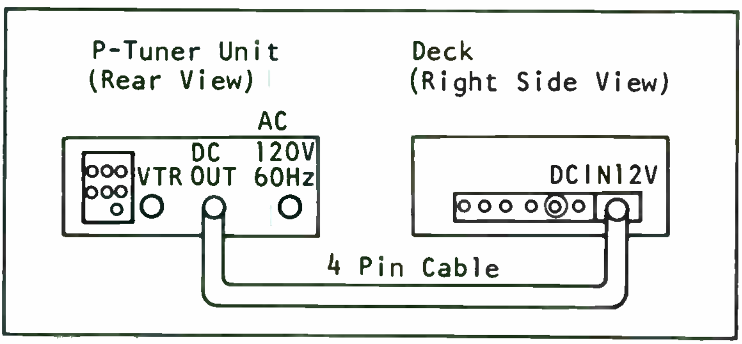


Fig. 9-16. VCR deck and P-Tuner unit connections (courtesy of General Electric).

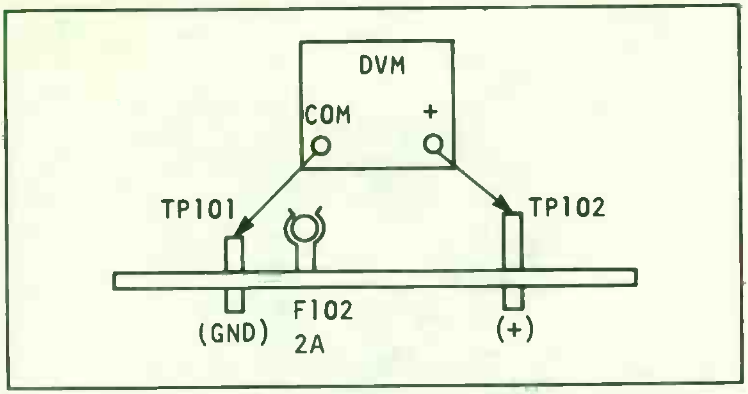


Fig. 9-17. Power supply board connections (courtesy of General Electric).

2—Adjust the +6 volt dc adj (R104) for +5.65 + 0.05 volt dc.

PROGRAMMABLE TIMER SECTION

When this section is adjusted, remove 3 screws (A) the channel select and potentiometer unit as shown in Figs. 9-19 and 9-20.

CLOCK ADJUSTMENT

Test point: pin 40 of IC6705 or IC6706. Adjustment: C6705 (clock adjust). Caution: since the trimmer C6705 (clock adjust) has already been critically adjusted at the factory, do not try to adjust the trimmer except after replacing the crystal (X6701) and trimmer (C6705).

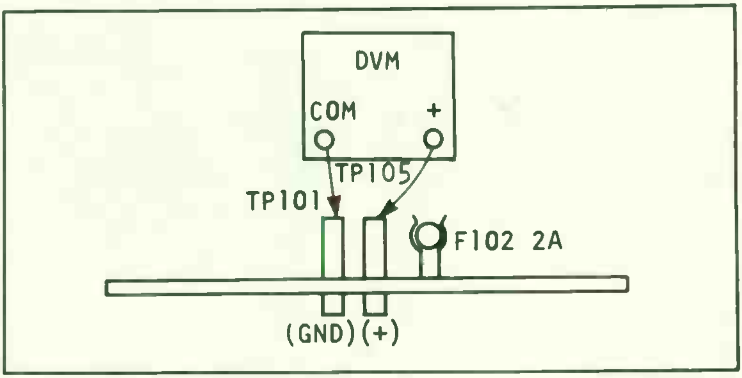


Fig. 9-18. Power supply board voltage check points (courtesy of General Electric).

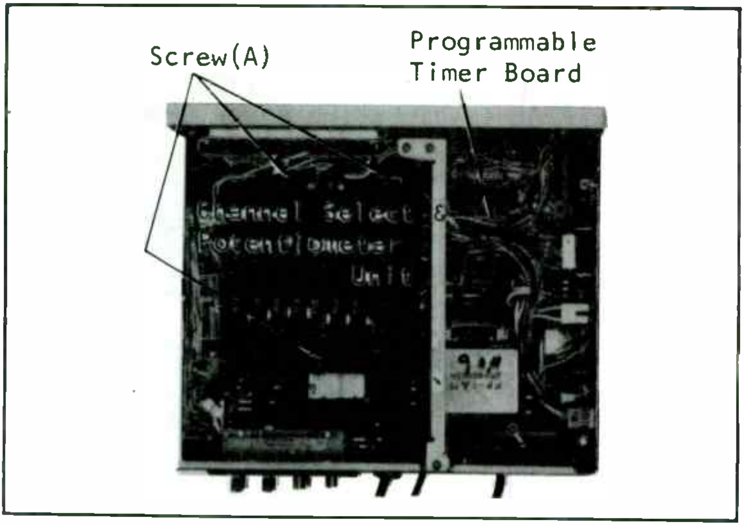


Fig. 9-19. Programmable timer board layout (courtesy of General Electric).

1—Connect the frequency counter to pin 40 of IC6705 or IC6706.

2—Adjust the clock adjustment control (C6705) for 262,144 +5 Hz on the frequency counter. Note: since this frequency is used

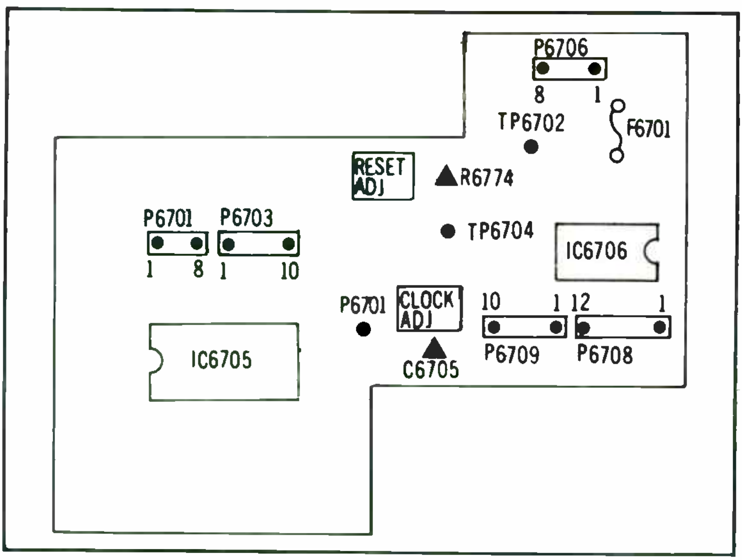


Fig. 9-20. Programmable timer board component side view (courtesy of General Electric).

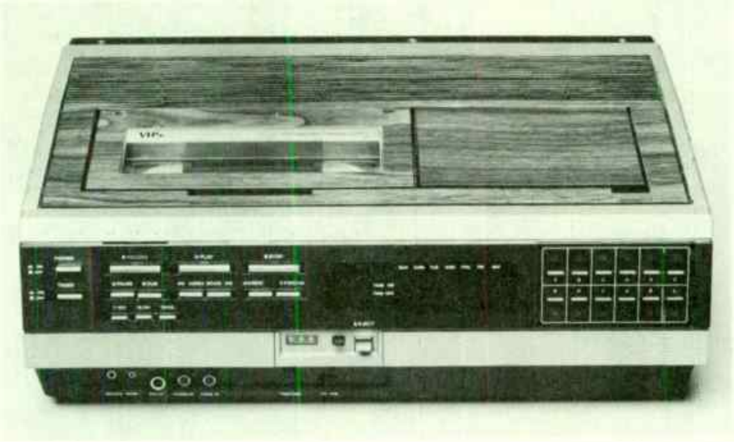


Fig. 9-21. The General Electric model 1VCR1012W VCR (courtesy of General Electric).

for the clock timer, it's required that it be set as precisely as possible.

RESET VOLTAGE ADJUSTMENT

Test points: TP6702 and TP105. Adjustment: R6774 (Reset vol adj).

1—Connect the DVM to TP6702 on the programmable timer board.

2—Adjust the +6 Vdc adj (R104) on the power supply board to 4.0 ±0.05 volts at TP6702 on the programmable timer board.

3—Turn the reset vol adj (R6774) on the same board fully counterclockwise.

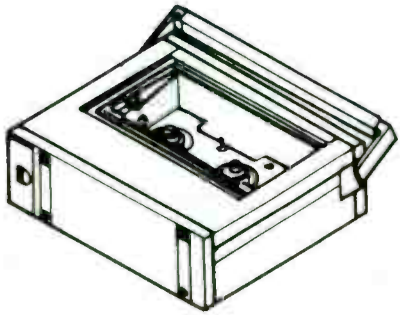
4—Slowly adjust the reset vol adj (R6774) counterclockwise and find the extinguishing point of the timer display tube.

5—Set the +6 volt dc adj (R104) to 5.65 volt dc at TP105 on the power supply board.

OTHER GE VIDEOCASSETTE RECORDERS

Figure 9-21 shows the General Electric model 1VCR1012W.

Chapter 10



Magnavox Videocassette Recorders

This chapter covers the Magnavox models VR8310BK01, VR-8320BK01, VR8330BK01, and VR8340BK01 videocassette recorders. The Magnavox model VR8320BK01 VCR is shown in Fig. 10-1.

MECHANICAL ADJUSTMENT PROCEDURES

These adjustment procedures are for the model VR8310BK01 machine, but this information can also be used for other Magnavox VCRs. Magnavox videocassette recorders use the VHS tape recording format.

Replacement of Upper Cylinder Head Unit

Work with extreme care when removing or replacing the upper cylinder unit. Do not touch the video heads during service or adjustments.

1—Remove screw (A) and discharge brush unit as illustrated in Fig. 10-2.

2—Unsolder the four leads from the head replay board and remove two screws (B). Then carefully and gently lift the upper cylinder to remove it.

3—Before reinstalling the new one, clean the DD cylinder shaft and inside of the new one with soft cloth moistened with freon solvent.

4—Reinstall the new one so the color codes of four leads match the leads on the head relay board and tighten two screws (B).

Fig. 10-1. Model VR8320BK01/BK02 Magnavox VCR (courtesy of Magnavox).

5—Resolder the leads and reinstall the discharge brush unit assembly.

Replacement and Adjustment of DD Cylinder Unit

Be very careful when you are removing or replacing the upper cylinder unit.

1—Disconnect two connectors P301 from head amp circuit on the luminance board and P202 from the servo board. Note: pay close attention to how these wires are routed along the chassis so proper lead dress can be restored when the new one is installed.

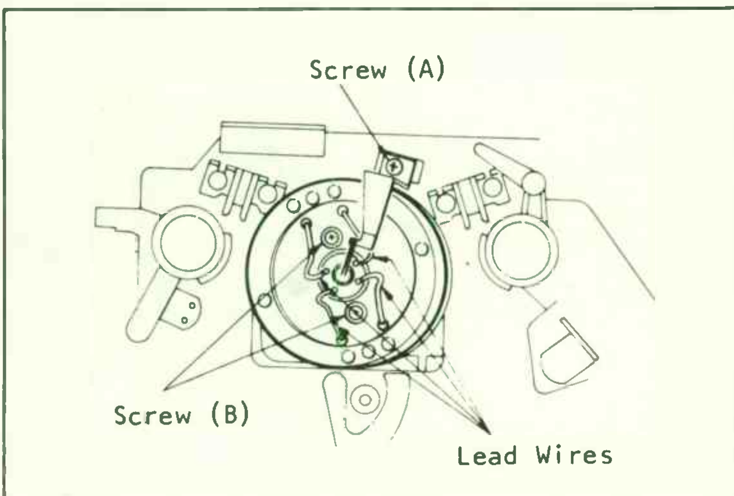


Fig. 10-2. Upper cylinder head unit (courtesy of Magnavox).

2—Remove three screws as shown in Fig. 10-3 which mount the DD cylinder and carefully lift the cylinder out through top of the chassis. Note: since there is very little clearance between the cylinder and chassis, use extreme care when removing or reinstalling to prevent any damage.

3—Remove the upper cylinder from the DD cylinder and reinstall it on the new one.

4—Reinstall the new DD cylinder unit to the chassis and restore the leads. Ensure that the connectors are plugged in properly.

Measurement of Tape Speed and Replacement of Belts

Equipment required for these checks are an alignment tape and a frequency counter.

Measurement Procedure

1—Connect the frequency counter to F.G. terminal (brown wire) on the capstan motor. (Connect one to F.G. head and another one to ground line). Refer to Fig. 10-4.

2—Play back the alignment tape and wait until tape movement comes to a stabilized condition.

3—Read the counter and confirm it is within specs. If it is out of specs than replace the capstan belt. The counter should read 1438.5 ± 7 Hz.

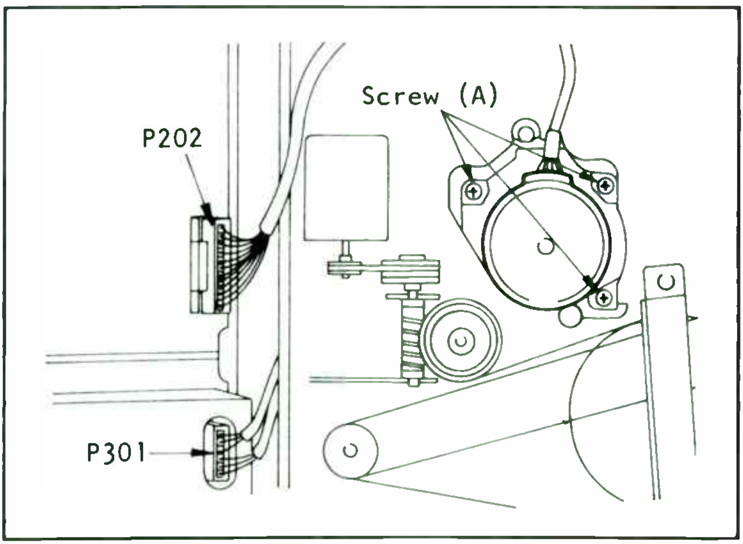


Fig. 10-3. D D cylinder mount (courtesy of Magnavox).

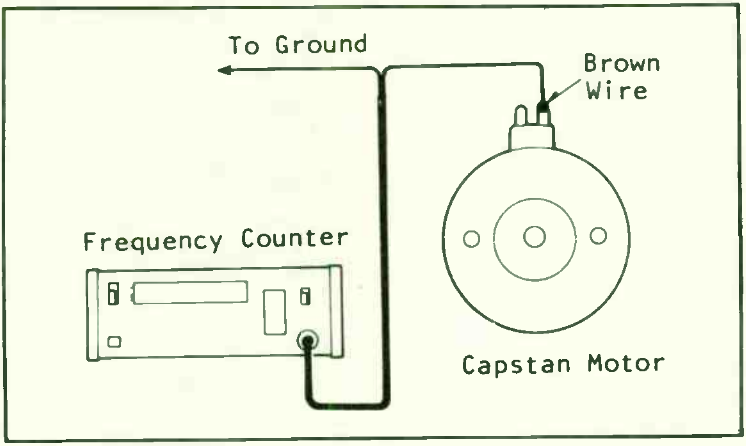


Fig. 10-4. Connection for frequency counter check (courtesy of Magnavox).

Replacement Procedure

1—Remove two screws (A), thrust holder, reel belt B, reel belt A and capstan belt (see Fig. 10-5). If the reel belts are worn, replace them at this time. Note: avoid getting any grease or oil on the drive belts or pulleys.

2—Since three different capstan belts are available, use the appropriate one to obtain the specified tape speed. Note: when installing a new capstan belt, make sure the group of three, four, or five marks are positioned in the direction of rotation of the capstan pulley (see Fig. 10-6).

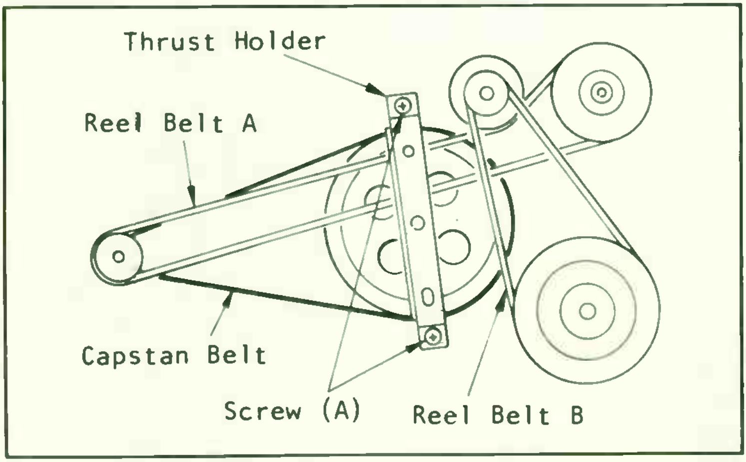


Fig. 10-5. Reel belt drives (courtesy of Magnavox).

Part No. (THICKNESS)	MARK ON BELT (ROTATING DIRECTION)	CASE OF USE
44C001-30B (0.55 mm)		LESS THAN 1431.5 Hz
44C001-30C (0.58 mm)		1438.5 ± 7 Hz
44C001-30D (0.62 mm)		MORE THAN 1445.5 Hz

Fig. 10-6. Drive belt mark identifications (courtesy of Magnavox).

Back Tension Check and Adjustment

Measurement Procedure

Equipment required: back tension meter (Tentelometer model T2-H7-UM). VHS cassette tape (120 minutes in length). Tension specifications (20 to 25 grams).

1—Pull the supply inertia roller in the direction indicated by the arrow and hold it by adhesive tape.

2—Play back the cassette tape from its beginning and wait for it to stabilize. (Approximately 10 to 20 seconds).

3—Insert tension meter in tape path and confirm reading. Caution notes: Make sure that the three probes of the meter are all in good contact with the tape, but out of contact with supply inertia roller while measuring (see Fig. 10-7). It is recommended that three measurements be taken as the tension meter is very sensitive.

Adjustment Procedure

Note: Use a fine adjustment screwdriver.

1—Loosen the screw (A) and insert the fine adjustment screwdriver into the head (B).

2—Move the back tension arm in either direction indicated by the arrow to obtain the specified tension. Turn the driver clockwise to raise tension, counterclockwise to lower it (see Fig. 10-8).

3—Tighten the screw (A). Now verify tension again with the meter. Remove the adhesive tape when the adjustment is completed.

Brake Torque Adjustment Confirmation Procedure

Equipment required: torque gauge and adaptor for gauge (see Fig. 10-9).

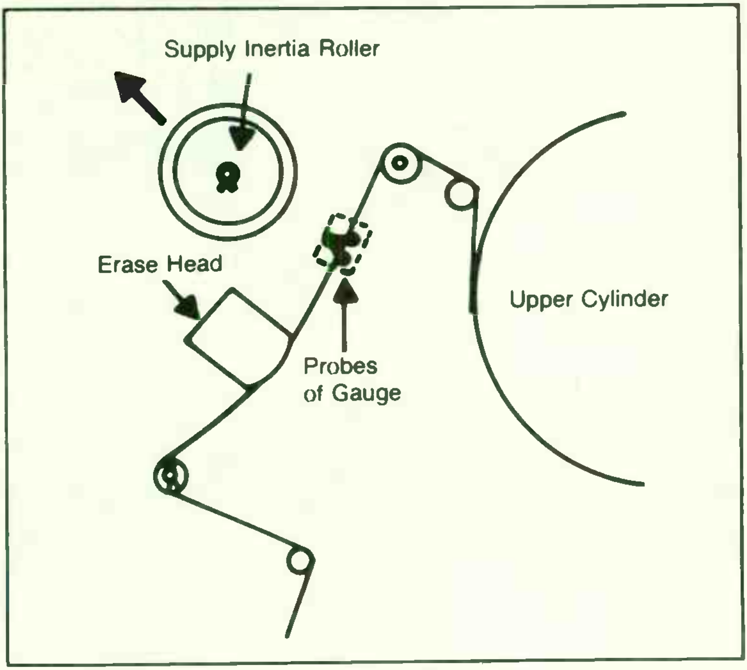


Fig. 10-7. Tape tension check (courtesy of Magnavox).

1—Attach the adaptor to the torque gauge. Now, place the machine in stop mode.

2—Place the torque gauge on the reel table. The weight of gauge should not rest against the reel table.

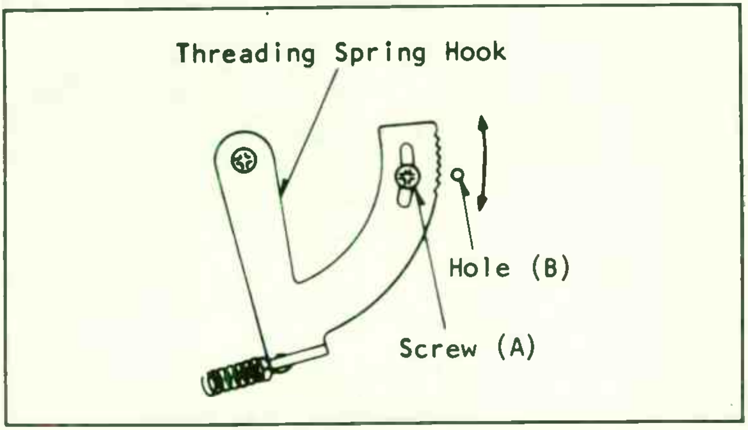


Fig. 10-8. Back tension tape adjustment (courtesy of Magnavox).

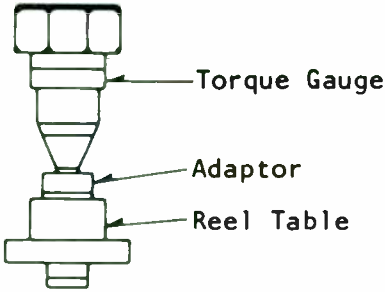


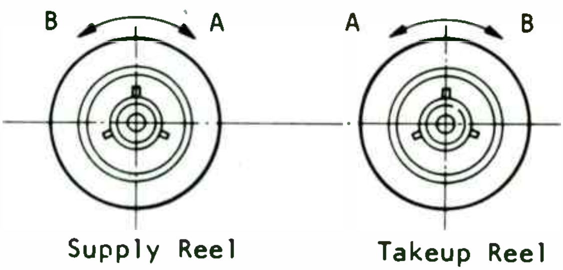
Fig. 10-9. Torque gauge and adaptor (courtesy of Magnavox).

3—Turn torque gauge in the direction indicated in Fig. 10-10 until the brake begins slipping. Read the torque when it begins slipping.

4—Remove two screws (A) and lift the connecting lever so the brake units are visible (see Fig. 10-11).

5—To adjust the brake torque, change the notch setting of the spring.

The spring tension increases by setting on the outer notch and decreases on the inner notch. See Fig. 10-12. Note: if proper brake torque cannot be obtained by changing the spring position, clean the



	A	B
Supply	450 ∿ 650 g-cm	70 ∿ 130 g-cm
Takeup		65 ∿ 135 g-cm

Fig. 10-10. Turn the torque gauge as shown (courtesy of Magnavox).

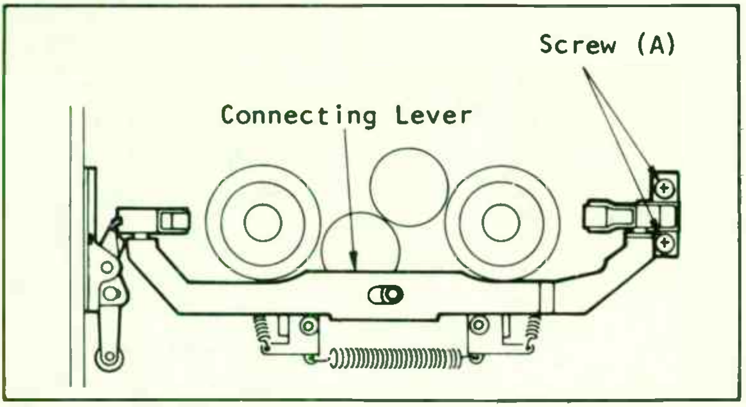


Fig. 10-11. Brake torque adjustment (courtesy of Magnavox).

rotating surface of the reel table with soft cloth and confirm torque before replacing the brake.

Adjustment of Eject Link Clearance

Equipment required: cassette lock arm adjustment fixture. Note: before adjustment, make sure that the eject lever is reset perfectly. Place the fixture, loosen screw (A), and adjust the clearance at indicated point for 0.5 mm to 1 mm. Now tighten screw (A). See Fig. 10-13.

Pressure Roller Unit Replacement and Adjustment

Replacement Procedure

Equipment required: hex wrench (1.5 mm). Loosen hex screw

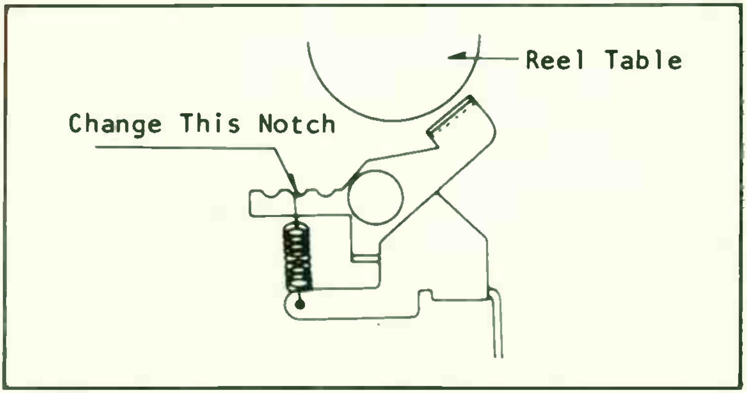


Fig. 10-12. Spring tension torque adjustment (courtesy of Magnavox).

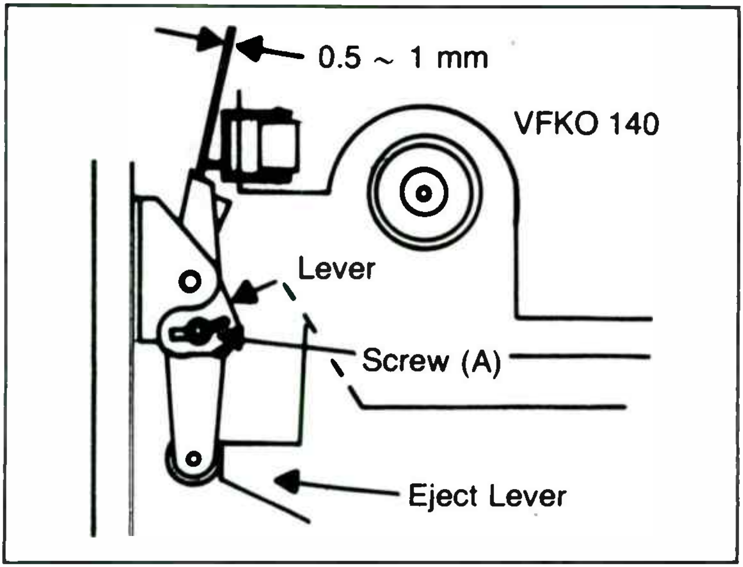


Fig. 10-13. Eject link clearance adjustment (courtesy of Magnavox).

(A) and lift the roller cap and pressure unit off. See Fig. 10-14. Make sure that the washers do not remain at the top and bottom of the removed roller. Reverse steps to reinstall the new part.

Adjustment procedure

1—Play back cassette tape and confirm the condition of tape running at the position where the tape passes between capstan shaft and pressure roller.

2—If the tape runs with waving at the top or lower edge, turn adjusting screw in either direction. Turn screw counterclockwise to maintain top of tape and clockwise for lower portion of the tape. See Fig. 10-15.

Capstan Holder Replacement and Adjustment

A 1.5 mm hex wrench is required.

Replacement Procedure

1—Remove the pressure roller unit.

2—Remove the oil cap, oil pool and three screws. See Fig. 10-16.

Adjustment Procedure

A capstan reference plate is required.

1—Install capstan holder and place three screws (A) but do not tighten up.

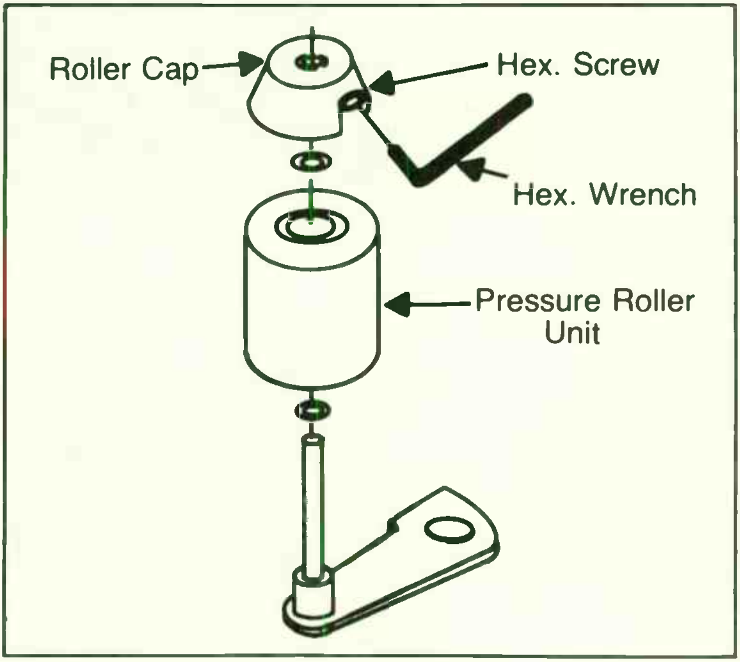


Fig. 10-14. Pressure roller replacement (courtesy of Magnavox).

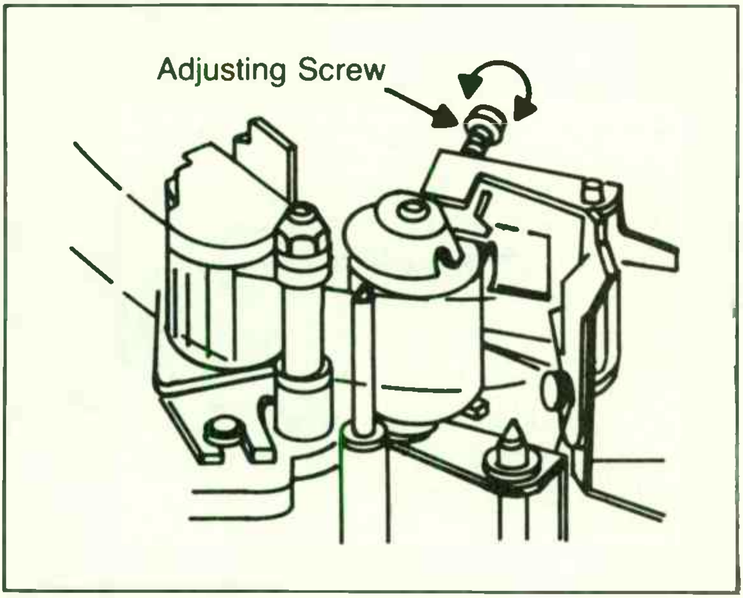


Fig. 10-15. Pressure roller adjustment (courtesy of Magnavox).

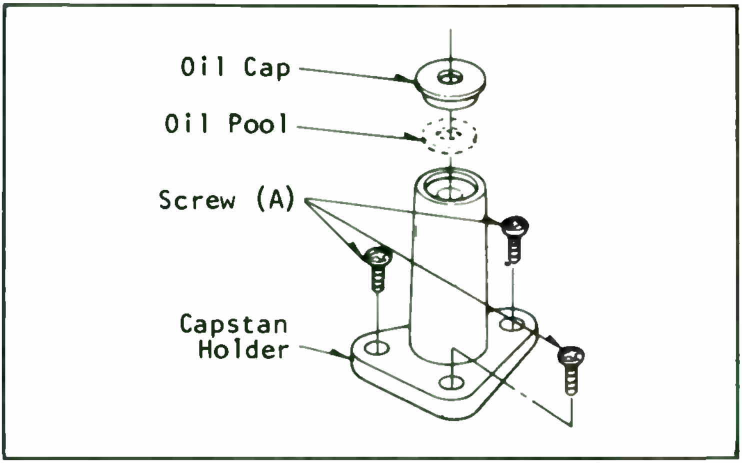


Fig. 10-16. Capstan holder replacement (courtesy of Magnavox).

2—Place the capstan reference plate in its proper position and move capstan holder so that the capstan shaft fits snugly in the notch of the reference plate.

3—Now tighten the three screws (A). Refer to Fig. 10-17.

Pressure Roller/Solenoid Replacement

Retaining ring remover required (4 mm).

Replacement Procedure

1—Remove the lead wires from lead clampers (A), unhook the

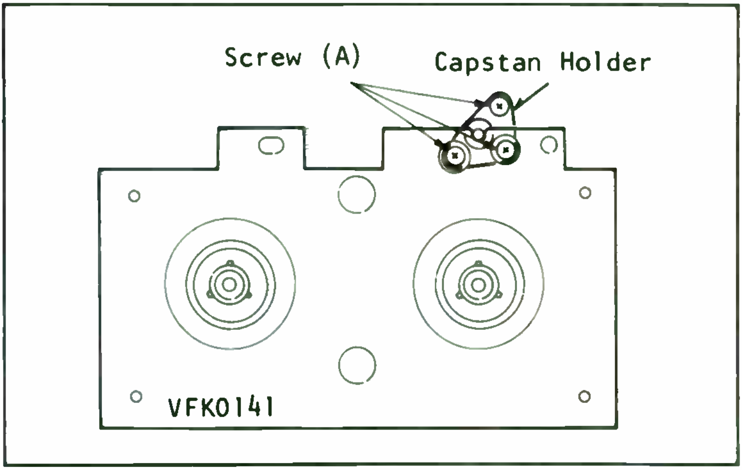


Fig. 10-17. Capstan holder adjustment (courtesy of Magnavox).

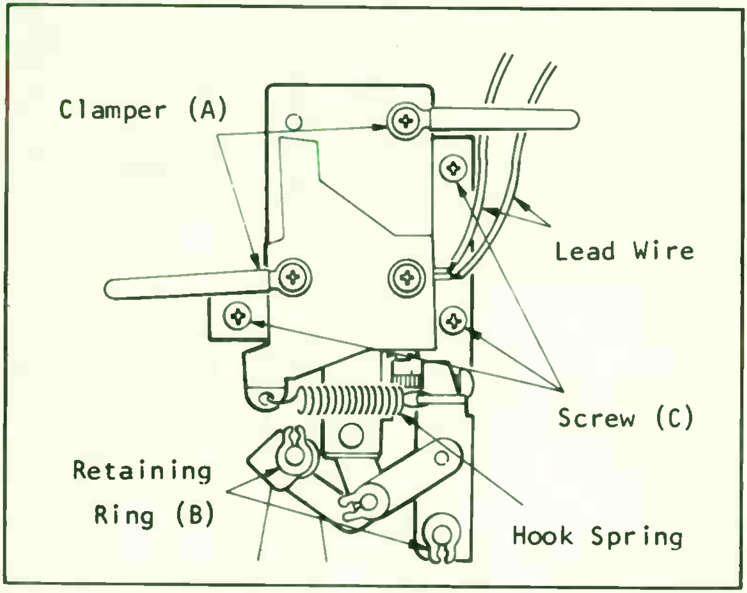


Fig. 10-18. Pressure roller/solenoid replacement (courtesy of Magnavox).

spring on the hook angle. See Fig. 10-18. Next, remove two retaining rings (B) and unsolder two leads on the solenoid.

2—Remove 3 screws (C) which mount the bracket to the chassis and lift the solenoid assembly from the chassis.

3—Then remove several parts mounted on the pressure solenoid.

4—When reinstalling a new one, perform the above steps in reverse order.

Note: upon completion of the installation, perform the following adjustments.

Adjustment Procedure (1)

Press the plunger all the way in with your finger to simulate the play mode and hold it, then adjust for the clearance by turning screw (A). Adjust to 0.2 - 0.5 mm in the play mode. Refer to Fig. 10-19.

Adjustment Procedure (2)

For this adjustment you will need a fan-type tension gauge and a fine adjustment screwdriver.

1—Play back a cassette tape and place the tension gauge to the part (A) of pressure lever. See Fig. 10-20.

2—Slightly loosen two screws (B) and set the adjustment screwdriver into the hole (C). Pull on the tension gauge until tape

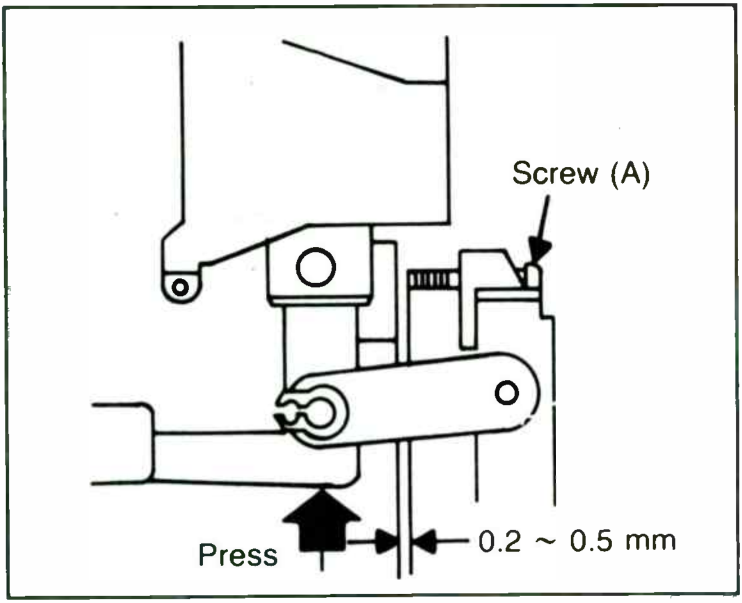


Fig. 10-19. Plunger adjustment (courtesy of Magnavox).

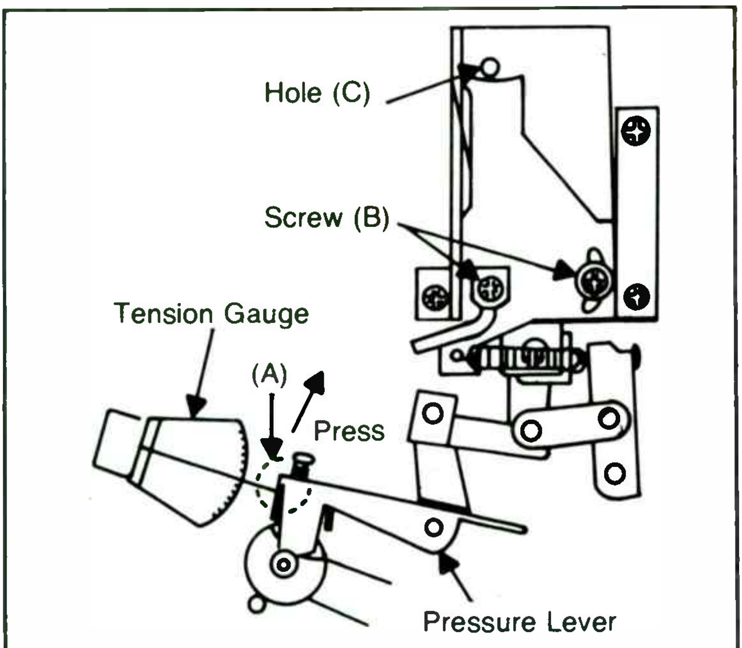


Fig. 10-20. Solenoid plunger adjustment (courtesy of Magnavox).

stops moving and read gauge. The gauge should read 1500 ± 150 grams.

3—If the gauge reading is out of spec, adjust it by rotating the adjustment screwdriver. To increase the tension rotate clockwise, to decrease counterclockwise, then tighten two screws (B).

Position Adjustment of Tension Post and Threading Post

A ruler is required for this adjustment.

Measuring Procedure (see Fig. 10-21).

1—Remove the cassette compartment and turn power switch to on position.

2—Blind the supply photo transistor (Q6302) with your finger and press the play button for loading.

3—As soon as loading is completed, unplug the ac power plug and press the play button again.

4—After the upper cylinder stops completely, measure the length. Specifications are shown in Fig. 10-22 for the tension post and Fig. 10-23 for the threading post.

Adjustment Procedure

For this adjustment you will need a retainer ring remover (4 mm) and a fine adjustment screwdriver.

Tension Post

1—Remove the cassette compartment and refer to Fig. 10-21. Now remove one screw (A), the eject link unit, two screws (B) and lift the connecting lever.

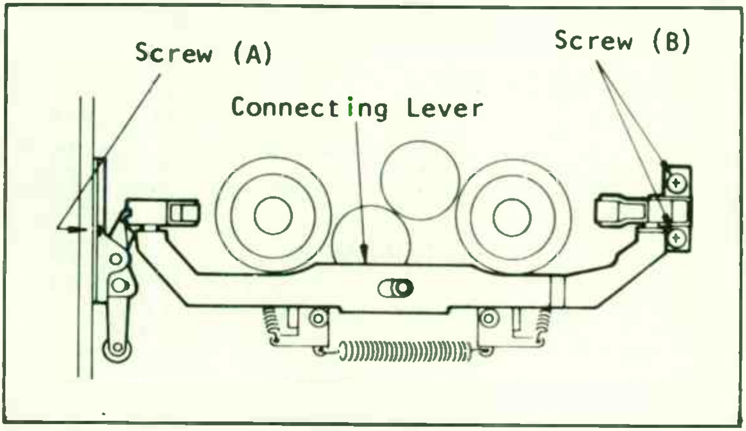


Fig. 10-21. Tension and threading post adjustment (courtesy of Magnavox).

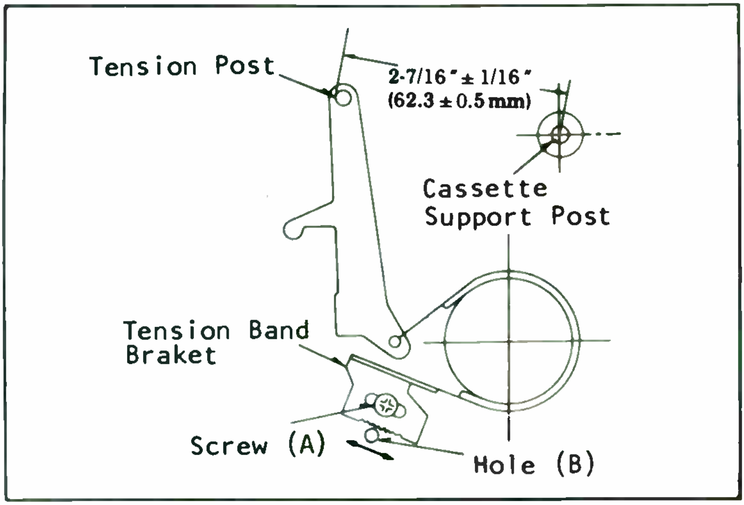


Fig. 10-22. Tension post adjustment (courtesy of Magnavox).

2—Loosen the screw (A), insert the adjustment screwdriver into the hole (B) and move the tension band bracket in either direction indicated by the arrow to obtain the specified length.

Threading Post

1—Remove the retaining ring which secures the tension post and lift up the tension post. Refer to Fig. 10-23.

2—Slighty loosen screw (A), hold the cam lever and move the threading arm in either direction indicated by the arrows to obtain the specified length. Note: upon completion of this adjustment the "fitting adjustment of cassette up holder" should also be checked.

Confirmation of Takeup Torque

A dial torque gauge and an adaptor are required for these checks. Specifications: in play mode, 80 to 160 gram per cm. In fast forward mode, more than 350 gram per cm. In rewind mode, more than 400 gram per cm.

1—Attach the adaptor to the torque gauge.

2—Blind the takeup and supply photo transistors (Q6302 and Q6303) with tape. Then turn power switch on.

3—Set a torque gauge to the take-up reel table, press the play button and read torque on the gauge. Press the fast forward button for the fast-forward mode. When measuring, the weight of the gauge should not rest on the reel tables.

4—Set the gauge to the supply reel table, press the rewind button for measuring the torque in the rewind mode. Remove the tape from photo transistors.

Note: there are no adjustments for the above checks. If the torque readings are off considerably, rollers, idlers, belts, or reel tables, may need replacement or lubrication.

Tape Slack Switch Position Adjustment

This switch should turn on at the moment the play button latches.

Adjustment Procedure

1—Insert the cassette tape, but do not connect the power or press the play button.

2—Have the two screws (A) loosened slightly and push switch bracket slowly in the direction indicated until the switch turns on (clicks). Now tighten the two screws (A). Refer to Fig. 10-24.

Confirmation Procedure

1—Connect the power, cover the supply photo transistor, slowly press the play button until just before it latches and release it just after the loading begins. At this time confirm that the supply reel table rotates counterclockwise.

2—With the power off, slowly press the play button until it latches. Cover the supply photo transistor. Now connect the ac power and confirm that the deck begins loading.

Cassette Up Holder Position Adjustment

A cassette holder fixture (VFK0142) is required for this adjustment.

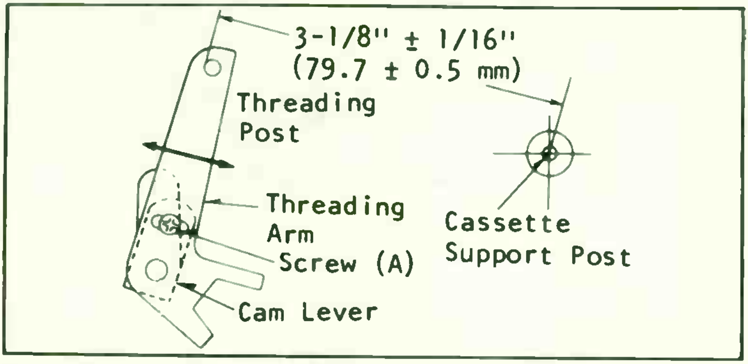


Fig. 10-23. Threading post adjustment (courtesy of Magnavox).

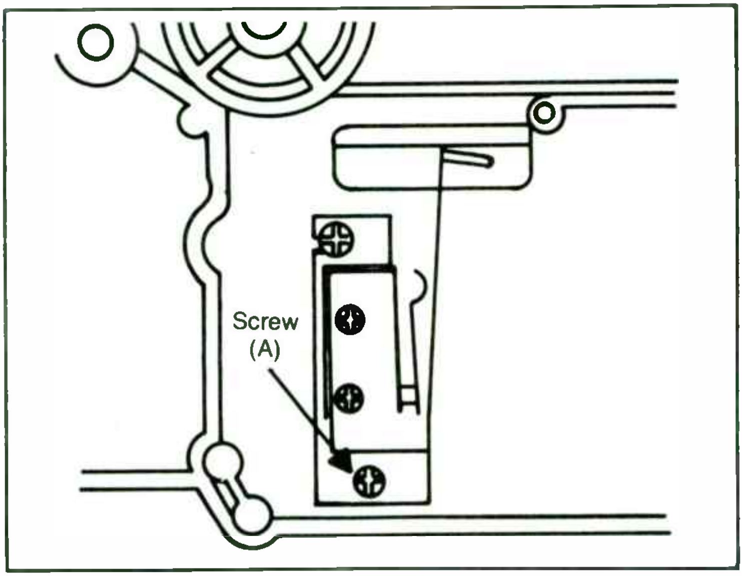


Fig. 10-24. Take-up torque adjustment (courtesy of Magnavox).

1—Install the cassette up holder, set the four screws (A) and turn them a few turns only, but do not tighten. Refer to Fig. 10-25.

2—Place the fixture in the cassette up holder and push the cassette up holder and fixture down slowly. While pushing them down, adjust the pattern so the holes and cut-outs match with the

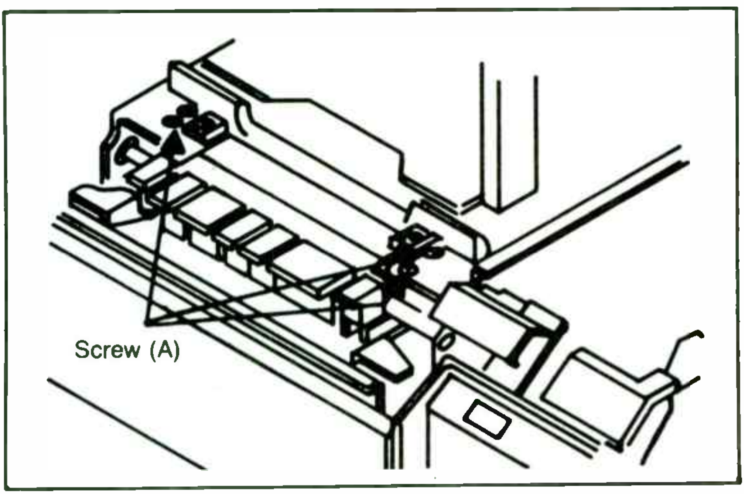


Fig. 10-25. Cassette up holder position adjustment (courtesy of Magnavox).

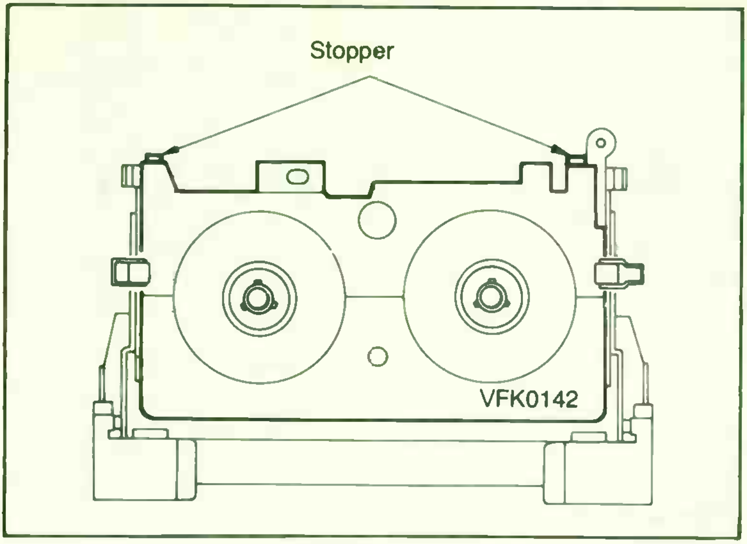


Fig. 10-26. Cassette fixture (courtesy of Magnavox).

parts on the chassis. When they are latched, pull back on the cassette up holder until two stoppers on the cassette up holder touch the fixture. Refer to Fig. 10-26.

3—Then tighten 4 screws (A). And confirm the smooth ejection by pressing the eject button.

4—Again, push the cassette up holder and the fixture down for reconfirmation.

Cassette Arm Units Position Adjustment

A cassette lock arm adjustment fixture (VFK0140) is required for this adjustment. Before you perform this adjustment, remove the eject link unit by removing screw (A). Refer to Fig. 10-27.

1—Install the cassette arm unit and tighten two screws (B). Then set two screws (C) and tighten them slightly, but loose enough so that the base of the cassette arm can be moved.

2—Place the fixture over the reel tables, press and move the left end of connecting lever with your finger (this moves the base of the cassette arm) so the roller on the cassette arm (right side) just touches the fixture or is less than 0.5 mm from the fixture. Now tighten the two screws (C). See Fig. 10-27.

3—Now push the cassette arm (B) (left side) toward the inside until it touches the fixture, and confirm that the cassette arm (A) (right side) also touches the fixture when arm B does.

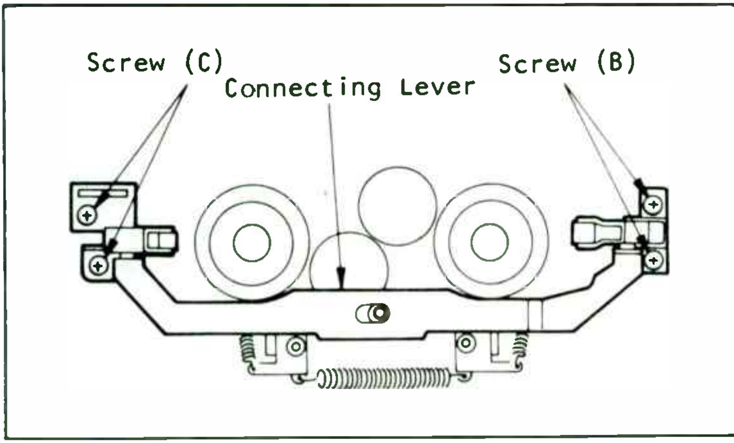


Fig. 10-27. Cassette arm units position adjustment (courtesy of Magnavox).

MAGNAVOX MODEL VR8340BK01

The Magnavox model VR8340BK01, shown in Fig. 10-28, is designed to achieve various special functions. They are noiseless still, frame advance, double speed playback, search (cue, review), and noiseless slow. From a circuitry point of view, the noiseless slow is based on a new technology with regard to the newly developed direct drive capstan motor. In previous models, the noiseless still operation was achieved by detecting the phase difference between a 30 Hz PG (pulse generator) and a DOC (drop out compensator) pulse. But, for the VR8340BK01, slow motion is processed in the same way as applies to the noiseless still operation.

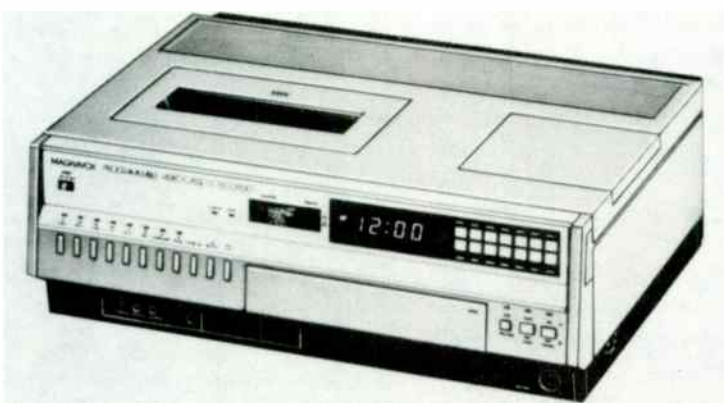


Fig. 10-28. Model VR8340 BK01 Magnavox VCR (courtesy of Magnavox).

Because noiseless slow is basically a periodic repetition of still and play.

Double Speed (×2) Playback

When a recorded tape is played back in the ×2 mode, the picture is almost noiseless as in the still mode. If noise is visible on the TV screen in the ×2 mode, it can be moved out of the visible picture area by turning the tracking control out of its fixed position. In Fig. 10-29 the relationship between the ×2 tape format and the video head output is shown.

Search-forward (Cue) and Search-reverse (Review)

In order to quickly find a particular segment during playback, the capstan motor and the reel tables can be speeded up to nine times faster than the normal speed, either forward or reverse, by pressing the search or reverse button. During cue or review, noise bars appear on the TV screen because each head crosses over several video tracks. In the cue mode (search forward), four noise

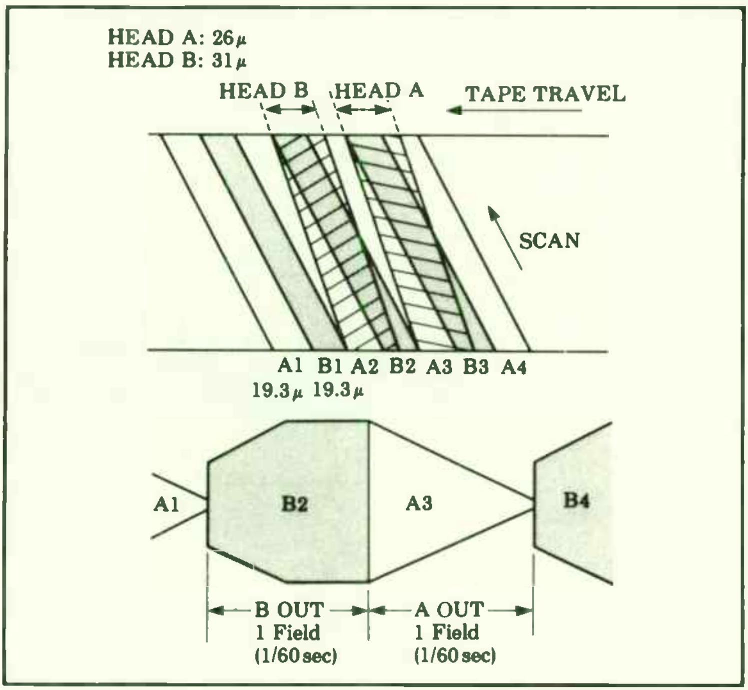


Fig. 10-29. Tape format relationship (courtesy of Magnavox).

bars appear and in the review mode (search-reverse), five noise bars appear, which is inherent to those operations. For more details refer to Figs. 10-30 and 10-31.

Noiseless Slow Tape Movement

To achieve noiseless slow with this machine, a tape moves from a still condition to the next still condition during a certain time period. It means that there are periodic still conditions. The slow speed is adjustable by the slow control on the remote controller.

¼ Slow Speed Movement

As shown in Fig. 10-32, ¼ slow tape movement can be explained as follows:

- Tape stops (2 V period).
- Tape moves from tracks 1,2 to tracks 3,4 (6 V period).
- Tape stops (2 V period).
- Tape moves from tracks 3,4 to tracks 5,6 (6 V period).

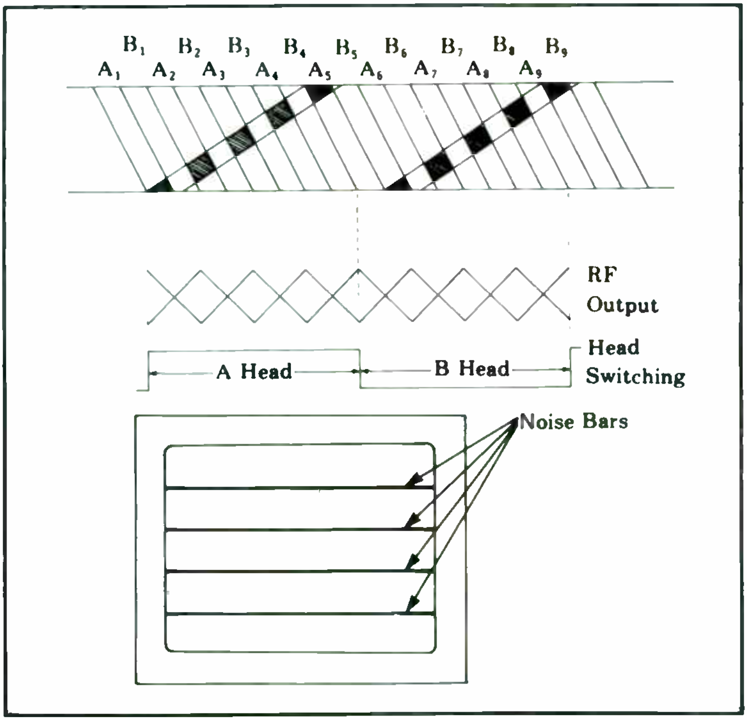


Fig. 10-30. Noise bars in the cue mode (courtesy of Magnavox).

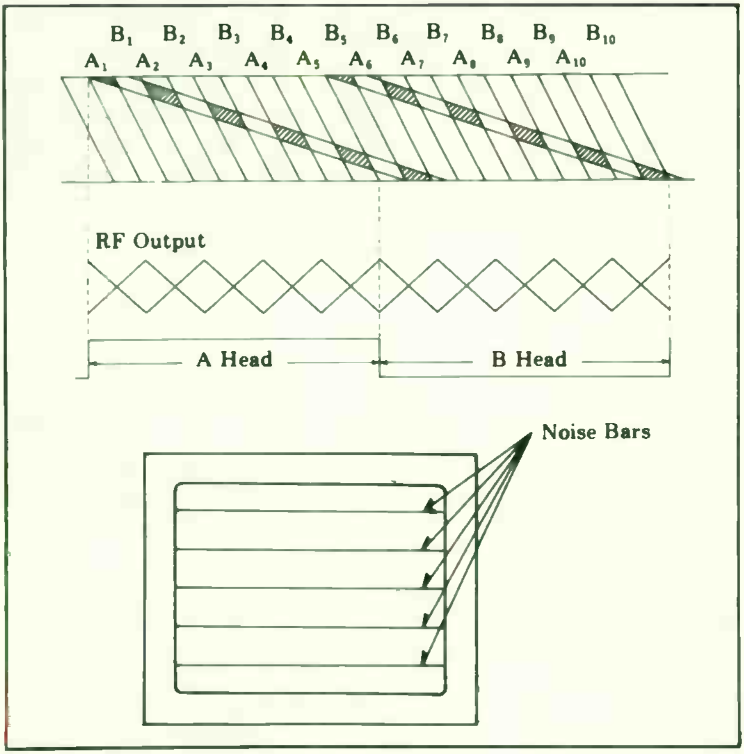


Fig. 10-31. Noise bars in the review mode (courtesy of Magnavox).

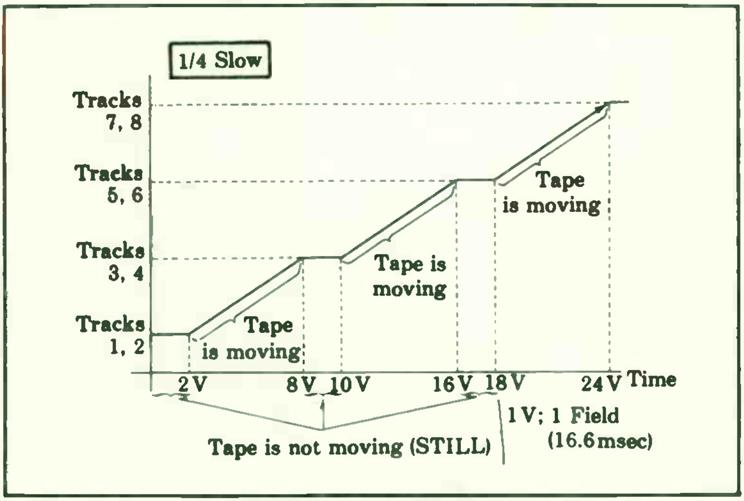


Fig. 10-32. ¼ slow tape speed (courtesy of Magnavox).

Therefore, during 8 V periods, the tape moves 1 frame (2 field). During normal playback for a 2 field movement of tape, 2 V periods are required. In other words, by rotating and stopping the capstan motor periodically, the slow motion operation can be achieved. Figure 10-33 shows the tape movement for 1/5 slow speed. As can be understood by these two cases, the slow speed can be determined by the still period length.

To achieve noiseless slow operation, the following conditions are required:

1—Capstan motor on timing must have a relationship with the head switching signal ×(30 Hz PG).

2—Maximum capstan motor torque must be steady.

3—After initialization of the capstan motor, the speed must be constant (approximately 65% of normal play).

4—By utilizing a control pulse during steady rotation of the capstan motor, the motor must receive reverse braking.

5—When the motor rotation is reduced to stop, the motor current must be shut off immediately.

Noise Position

For the noiseless slow operation, the position where the capstan motor stops is the still position. Thus, the condition when the motor stops must be repeated. For that purpose, the following conditions are required:

1—A control signal must be picked out when the capstan motor is rotating at a steady speed.

2—The motor brake torque must be constant.

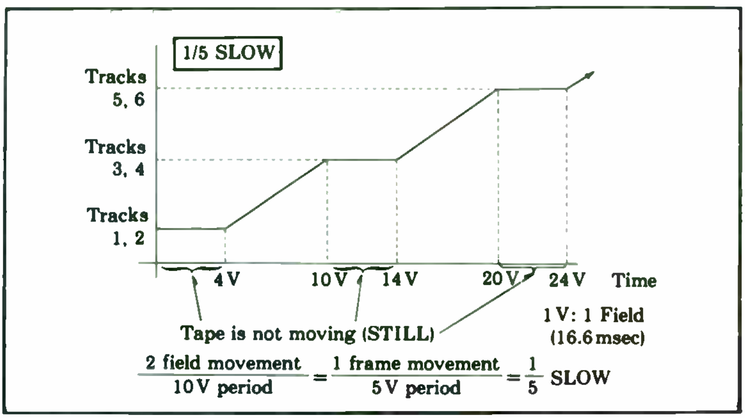


Fig. 10-33. 1/5 slow speed (courtesy of Magnavox).

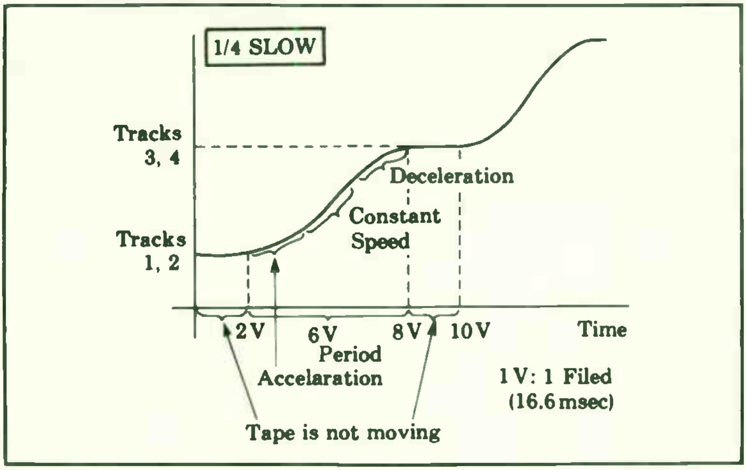


Fig. 10-34. ¼ tape slow motion (courtesy of Magnavox).

Record X-value

In Fig. 10-34 the ¼ slow tape movement is shown. Between 2 V and 8 V the tape moves. But actually, the capstan motor does not rotate at a constant speed in this period. It rotates as follows: during acceleration—if a control pulse is picked out during this period, the position where the capstan motor will stop cannot be fixed. During deceleration—a control pulse cannot be picked out, because after receiving a control pulse, deceleration is performed. Refer to Fig. 10-35.

Under the consideration interchangeability, the center position of a constant motor rotation period is the best point to receive a control signal. Thus, the phase of the control pulse is electrically advanced as follows: 2H (4.5 msec.), 4H (3 msec.), 6H (4.5 msec.).

Infrared FG Method

Within the capstan motor are two round plates on which many slits are engraved. There are three pairs of infrared FGs. Each FG consists of an LED and a photo TR located above and below the round plates. When an infrared ray from the LED is caught by the photo TR through both slits on the rotor and stator plates a certain signal can be picked out. Note the drawing of this technique shown in Fig. 10-36. Phase relationships between FG1, FG3, and FG2 are as follows: FG1 and FG3 are the same phase. FG1 and FG2 have a 90 degree difference. FG1 and FG3—To reduce mechanical difference of slits, two FGs (FG1 and FG3) are used for servo control of a unit.

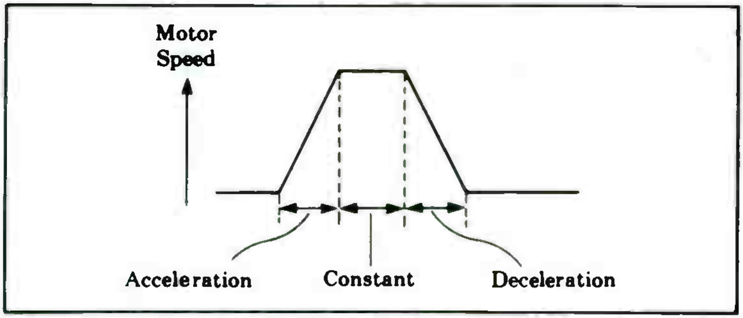


Fig. 10-35. Motor speed for acceleration and deceleration (courtesy of Magnavox).

Actually, summation of these two signals is performed. To detect the capstan motor rotation direction, these two signals (FG1 and FG2) are used.

The detection is required for the noiseless slow operation. Because, for the noiseless slow operation to stop the capstan motor,

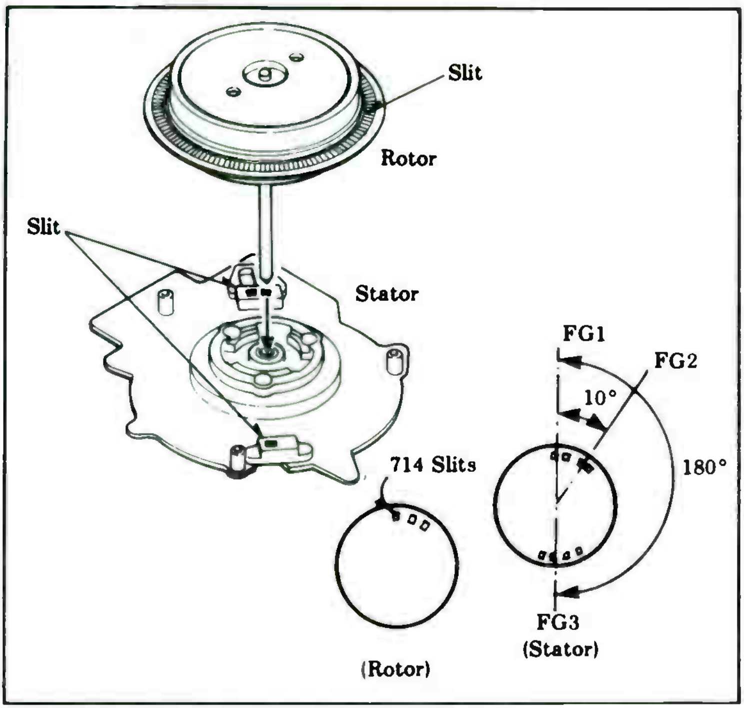


Fig. 10-36. Infrared capstan control (courtesy of Magnavox).

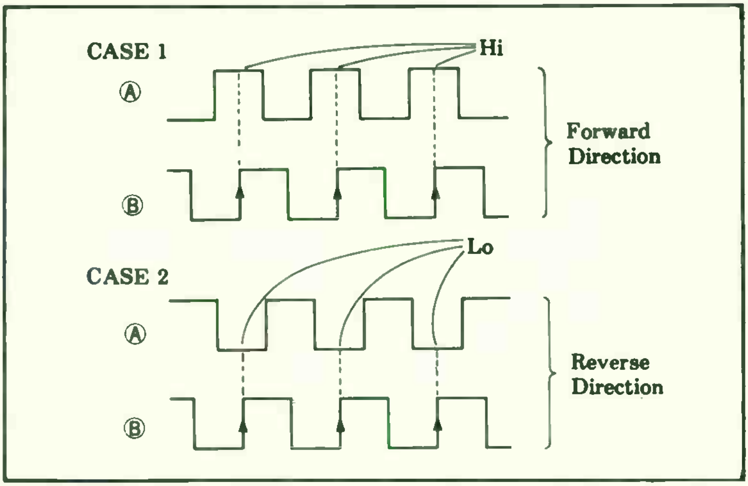


Fig. 10-37. Phase relationship for capstan motor control (courtesy of Magnavox).

the reverse current braking method is used. In Fig. 10-32, the capstan motor rotation is shown. It's the best way to keep the 2 V period after detecting the capstan motor stop. But it's quite difficult to detect the point where the motor stops. Therefore, the following method is applied. When the phase relationship between FG1 and FG2 has changed to case 2, it is judged that the capstan motor has stopped. See waveforms in Fig. 10-37.

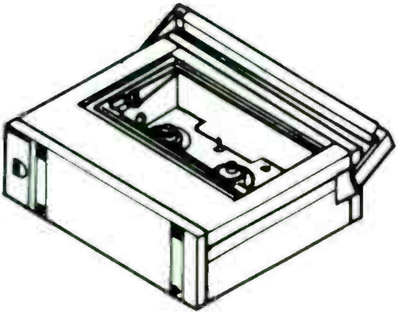
Reel Motor Rotation for Noiseless Slow

In the slow mode, the tape movement period is always 6 V. Between 6 V periods, there is a still period and the length of still period will determine the slow tape speed. In normal playback, the reel motor is always rotating. But in the slow mode, considering smooth tape transport, the reel motor rotates over per 4 cycles of slow operation (6 V ×4=24 V). It means that the capstan motor pulls a tape from the supply reel during 24 V then the reel motor rotates for a short period to take up this portion.

Reduction of Horizontal Sway in the Slow Mode

The mode of slow is the periodic repetition of still and approximately 65% normal play. Therefore, the relative head to tape speed varies, which results in horizontal sync frequency fluctuations. To reduce the H sync fluctuation, the head cylinder is accelerated by a pulse in the slow mode.

Chapter 11



Quasar Videocassette Recorders

This chapter covers the Quasar model VH5000 VHS VCR. A drawing of this machine is shown in Fig. 11-1.

BASIC BLOCK DIAGRAM

From the antenna, station signals are fed to both the VHF/UHF tuners and the TV/VCR switch. Note the block diagram in Fig. 11-2. When the switch is in the TV position, TV signals are applied to both TV receiver and VCR unit.

RF/I-F SECTION

The tuners, i-f, sound and video detector circuits are similar to those found in Quasar color TV sets. Composite video and detected audio from this section are fed to a camera/VCR tuner switch . If the customer connects a microphone and video camera, either station signals or camera/microphone signals may be selected for recording. A microphone may be used with the audio dub feature.

RECORD ELECTRONICS

The video record section processes the video signal, which is then converted to an FM signal. Color signal processing converts the 3.58 MHz chroma frequency to a lower frequency signal. This signal is superimposed upon the FM video signal, and both are magnetically coupled to the video heads. The heads helically record

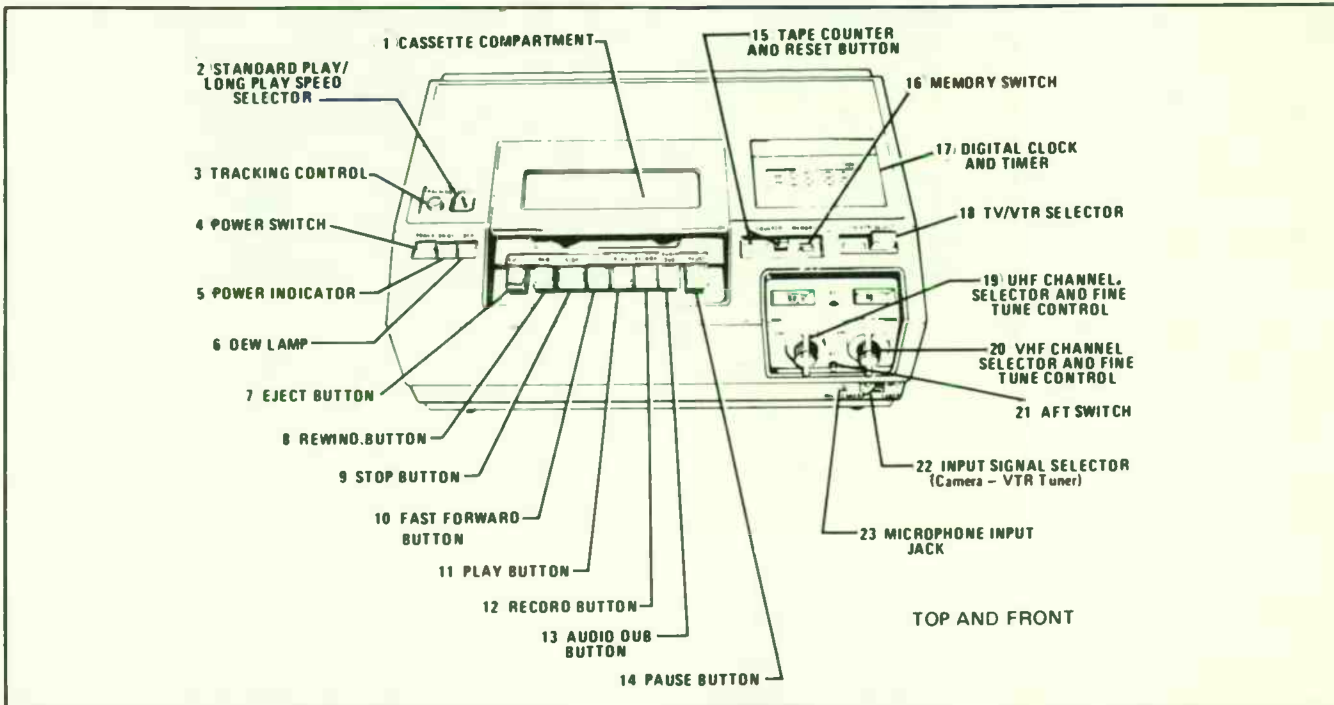


Fig. 11-1. Control locations for the Quasar VH5000 VCR (courtesy of Quasar Company, A Division of Matsushita Electric Corporation of America).

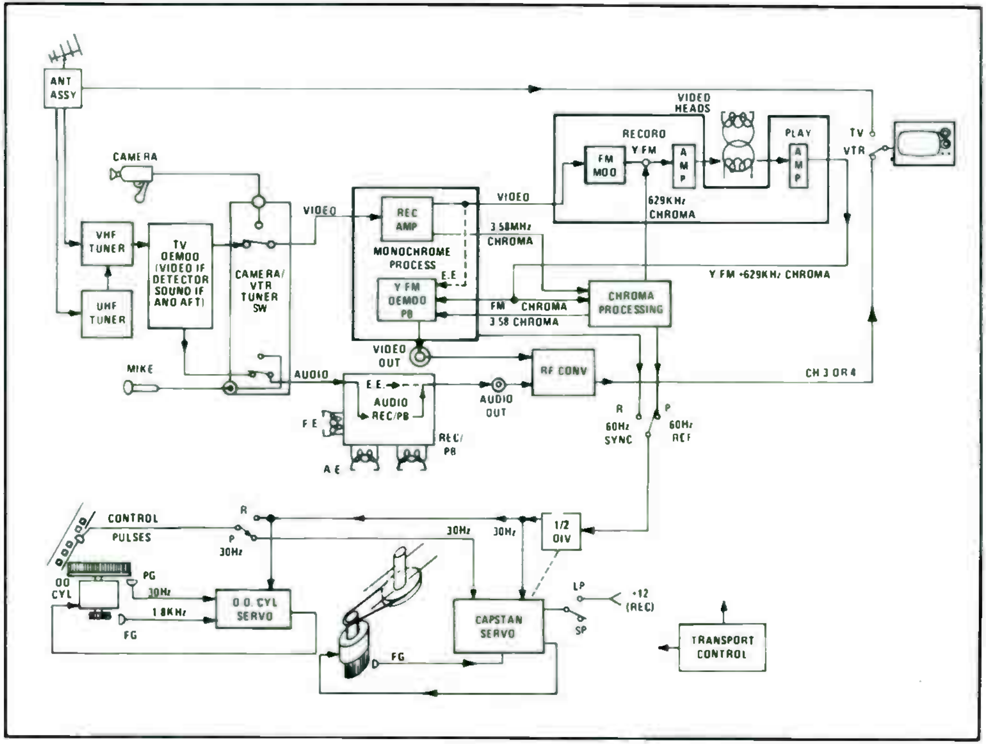


Fig. 11-2. Basic block diagram (courtesy of Quasar Company).

these signals onto the tape. Monitoring is accomplished by bypassing much of the record circuitry and applying the video and sound signals from the record circuits to the play circuits.

Audio recording is accomplished in a conventional manner. This section amplifies the audio, combines it with a 67 kHz bias signal, and the separate audio head records the audio linearly along the top edge of the tape. An audio erase head is used when the audio dub feature is operating. A separate full erase head erases all previous information from the tape, when recording.

PLAYBACK ELECTRONICS

The video and color playback electronics converts the tape signal back to a composite video signal, by performing the following functions:

- Converts the FM video signal back to amplitude variations.
- Converts the low banded color back to 3.58 MHz.
- Controls color signals through use of ACC, APC, and AFC.
- Recombines video and color signals.

The result is a replica of the original NTSC composite video signal.

RF CONVERTER

This section converts the audio to FM and the composite video signal into an AM rf signal, which can be applied to the VHF antenna terminals of any TV set. The rf output is switchable to select either channel 3 or 4.

SERVO SYSTEM

Two servos provide automatic speed and position control of a motor in the direct drive (DD) video head cylinder and the motor that drives the capstan shaft. This assures that each helical recorded track begins at the proper point and that the video heads scan these recordings during playback. Head cylinder rotation produces outputs to indicate head speed and position. These signals are compared with a signal constant to determine any error. During record, the signal constant is vertical sync from the composite video signal, which also times a control pulse recorded along the bottom edge of the tape. During playback the control track pulses provide the signal constant for servo control of the capstan motor.

TRANSPORT CONTROL

This section contains loading motor circuits and control circuits for the various functions. Electronic switching activates functions in the proper sequence and sensing devices provide safeguards in the event of a malfunction.

TV DEMODULATOR SECTION

The rf, i-f signal switching section provides both video and audio signals for the record electronics of the VCR. Refer to the block diagram shown in Fig. 11-3. Appropriate switching permits the operator to select off-the-air TV station signals or outputs from an externally connected video camera and microphone.

ANTENNA ASSEMBLY

TV station signals from the antenna are fed to the antenna assembly. Couplers supply VHF/UHF signals to the VCR tuners. The TV position completes the signal path from either the antenna or VCR (rf out channel 3 or 4) to the TV receiver.

TUNERS

The rf amplifier, mixer, and oscillator stages in the VHF tuner are conventional. The 70 detent UHF tuner has a transistor oscillator and diode mixer. Its i-f output is fed directly to the VHF tuner which operates as a 40-MHz amplifier when it is in the UHF position. A coax cable connects the i-f output from the VHF tuner to the video i-f section on the TV demodulator board. Rf AGC is fed to the VHF tuner, and both tuners receive AFT correction.

VIDEO I-F

Traps in the input circuit shape the overall i-f response. The three video i-f stages amplify the i-f signal from the tuner, and the tuned circuits determine the bandpass. The AFT, sound and video detector circuits receive signals from the third i-f stage. After detection, IC701 amplifies the composite video signal and is applied to TR704 (buffer) which functions as an emitter follower. The video signal leaves the board at P703-2.

AGC SECTION

IC701 also develops i-f and rf AGC voltages, to gain control the 1st and 2nd i-f stages and the rf amplifier in the tuner.

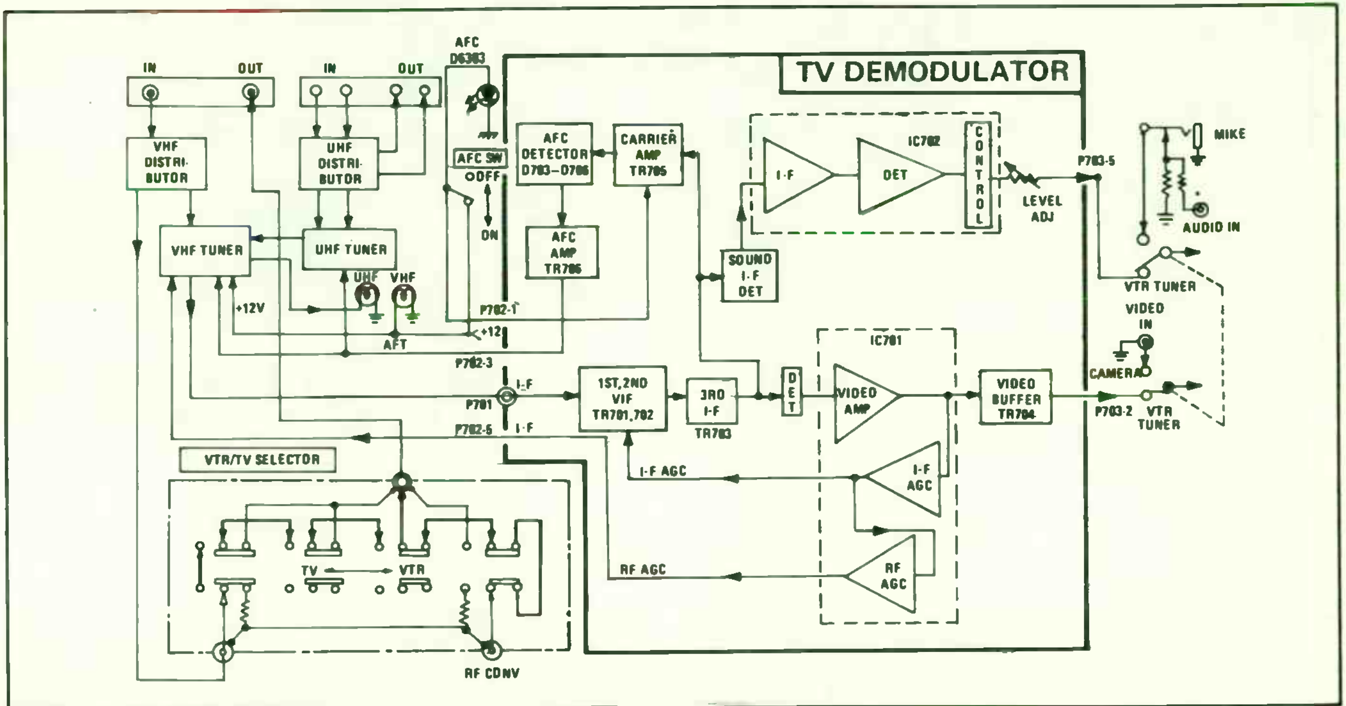


Fig. 11-3. Block diagram of TV demodulator (courtesy of Quasar Company).

AFT SECTION

Signal from the 3rd i-f output is applied to the AFT circuits which develop a dc correction voltage, proportional to any change in picture carrier frequency. This correction voltage is fed to the tuners, and corrects oscillator drift or minor fine tuning errors. AFT is switched on by applying voltage to the carrier amp through the AFT switch, which also activates the AFT indicator (an LED).

SOUND SYSTEM

Sound and picture carriers from the 3rd i-f, mix in a diode to produce the 4.5 MHz sound i-f. IC702 amplifiers, limits, and detects the FM sound signal. The resulting audio is amplified within the IC and its output is adjusted for the required level. The audio signal exits the board at P703-5.

SIGNAL SWITCHING

A switch on the front of the machine permits the user to select off the air TV or external camera/microphone signals for recording. Station sound and picture signals are fed through the switch to the record circuitry. In the camera/mic input position, signals from an external video camera and/or microphone couple to the record circuitry for recording video and sound or using the audio dub feature.

SIGNAL PROCESSING

The NTSC video signal enters the luminance board at P32-1 (may be monitored at TP301) and passes essentially unchanged through a buffer stage and low-pass filter (LPF) that has a cut-off frequency above 5 MHz. The signal is amplified and gain controlled by IC301 to maintain a constant video level (Fig. 11-4).

The signal from IC301 is fed to two electronic switching circuits. When recording monochrome only signals, the signal is passed unchanged to P37-5. When recording the monochrome portion of a color signal the switching circuit selects the signal that has passed through a 3.58 MHz trap. Switching is controlled by the automatic color killer voltage (ACK).

The signal enters the FM modulator and head amp circuit board at P55-5 to nonlinear emphasis circuits. Nonlinear emphasis (N.L.) is used along with preemphasis to achieve a high signal-to-noise ratio. The required nonlinear emphasis is different for the SP and LP modes. Therefore switching is provided by a control voltage applied to the SP/LP switching stage. The video signal leaves at P55-1 and re-enters the luminance process board at P37-1. Its amplitude is set by a variable control thus setting the deviation of the FM modulator. The video signal undergoes preemphasis in IC301 and is then fed to a clamp circuit. Its associated control, sets the horizontal pulse level applied from a pulse producer stage to set the horizontal sync dc level. This also sets the FM oscillator frequency of 3.4 MHz at sync time.

Preemphasis produces overshoots in the video signal which would influence the FM oscillator. To prevent this occurrence the signal is passed through adjustable white and dark clip circuits to remove the overshoots. The signal is then fed onto the FM modulator. Output of the modulator is a video FM frequency that varies from 3.4 MHz (horizontal sync) to 4.4 MHz (highlight whites).

In the LP mode, the FM carrier frequency is shifted by an amount equal to half the horizontal frequency, for the channel 1 ("A") head only. Thus FM carrier interleave is accomplished by a switching circuit at the input to the FM modulator that is controlled by the positive half cycle of the 30 Hz wave applied to it.

The video FM signal from the modulator is amplified and limited to remove any amplitude variations and is applied through one or two switched paths, to the record amplifier. Switching is provided by the automatic color killer voltage. When recording monochrome signals only, the FM signal is fed to the record amp unchanged in frequency (broad response). When recording the monochrome portion of color signals the signal path is through a high-pass filter. This permits the higher frequency FM signal to pass but rejects the lower frequency FM sidebands that could combine and interfere with the low banded (629 kHz) chroma signals that are also applied to the record amp, via P52-2.

The FM signal, amplified by the record amp, is applied to both record heads in parallel, to fully saturate the tape at the FM rate. This signal also acts as a bias signal for the low banded chroma which is presented to the heads at a lower level. Switches (on rec) complete the record heads path to ground when recording.

MONOCHROME (B/W) PROCESSING

On playback, the opposite ends of each head are switched to ground. The low level signals from each head, and chroma sidebands (629 kHz), are amplified in separate stages. Each head provides the signal for one vertical field. The output of each head is selected at the appropriate time by the head signal switching circuits, which are

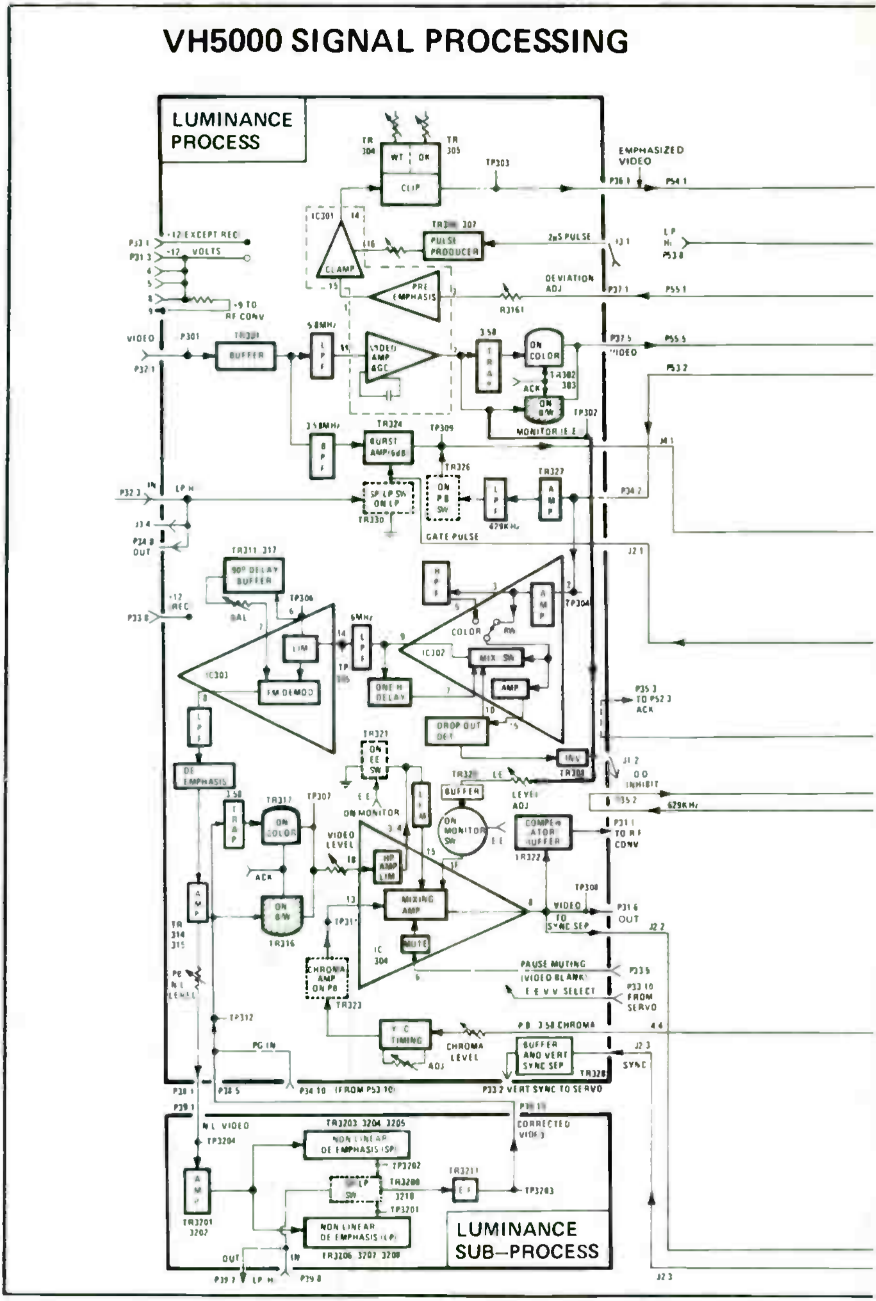
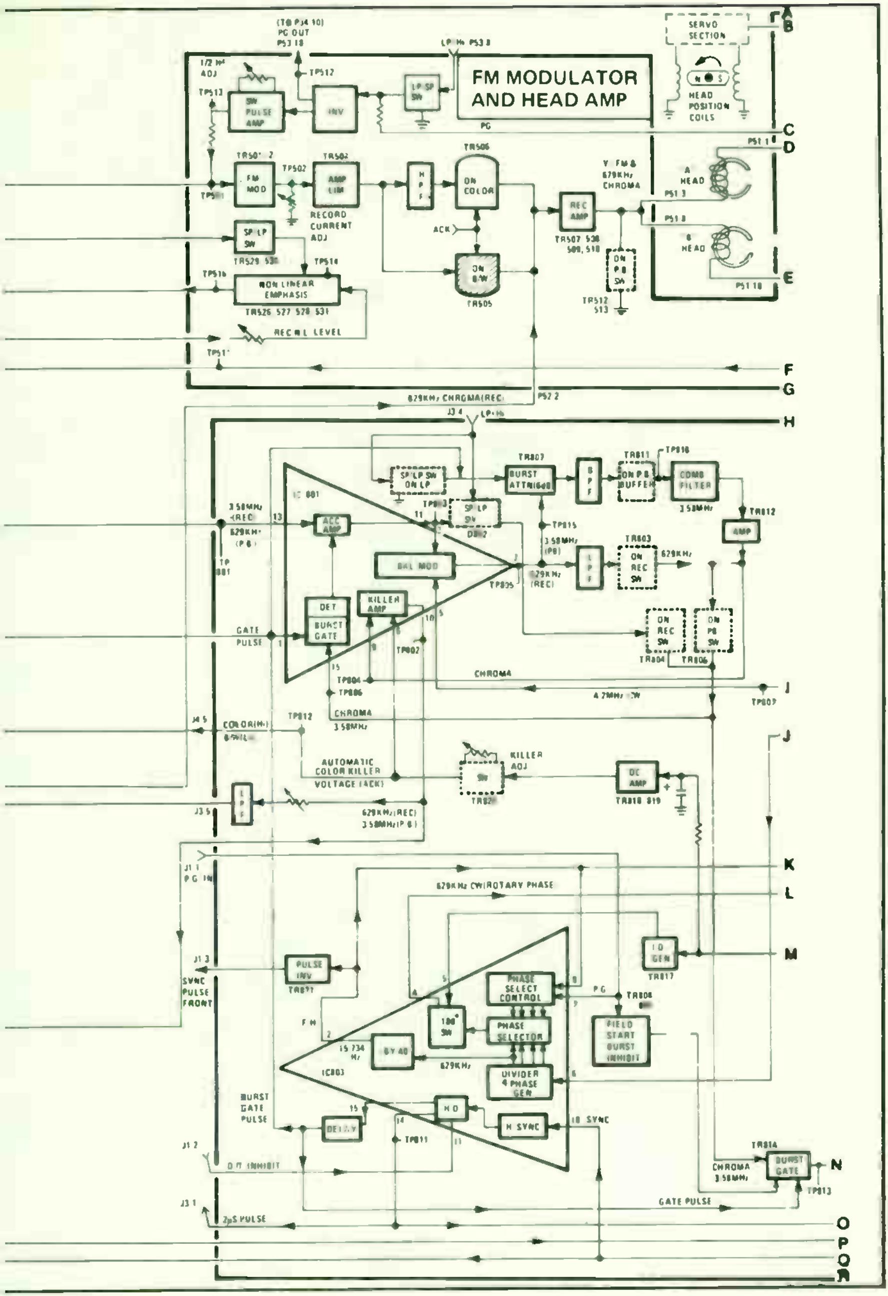


Fig. 11-4. Complete signal processing block diagram (courtesy of Quasar Company).


FM MODULATOR
AND HEAD AMP
SERVO
SECTION
HEAD
POSITION
COILS
A
HEAD
B
HEAD
FM
MOD
AMP
LIM
RECORD
CURRENT
ADJ
ON
COLOR
ON
B/W
REC
AMP
INV
NON LINEAR
EMPHASIS
ACK
629KHz CHROMA(REC)
BURST
ATTN(6dB)
COMB
FILTER
AMP
BAL MOD
DET
KILLER
AMP
GATE
PULSE
CHROMA
3.58MHz
AUTOMATIC
COLOR KILLER
VOLTAGE (ACK)
KILLER
ADJ
DC
AMP
629KHz CW(ROTARY PHASE
PULSE
INV
SYNC
PULSE
FRONT
PHASE
SELECT
CONTROL
PHASE
SELECTOR
DIVIDER
4 PHASE
GEN
FIELD
START
BURST
INHIBIT
BY 40
H SYNC
BURST
GATE
PULSE
DELAY
BURST
GATE
GATE PULSE
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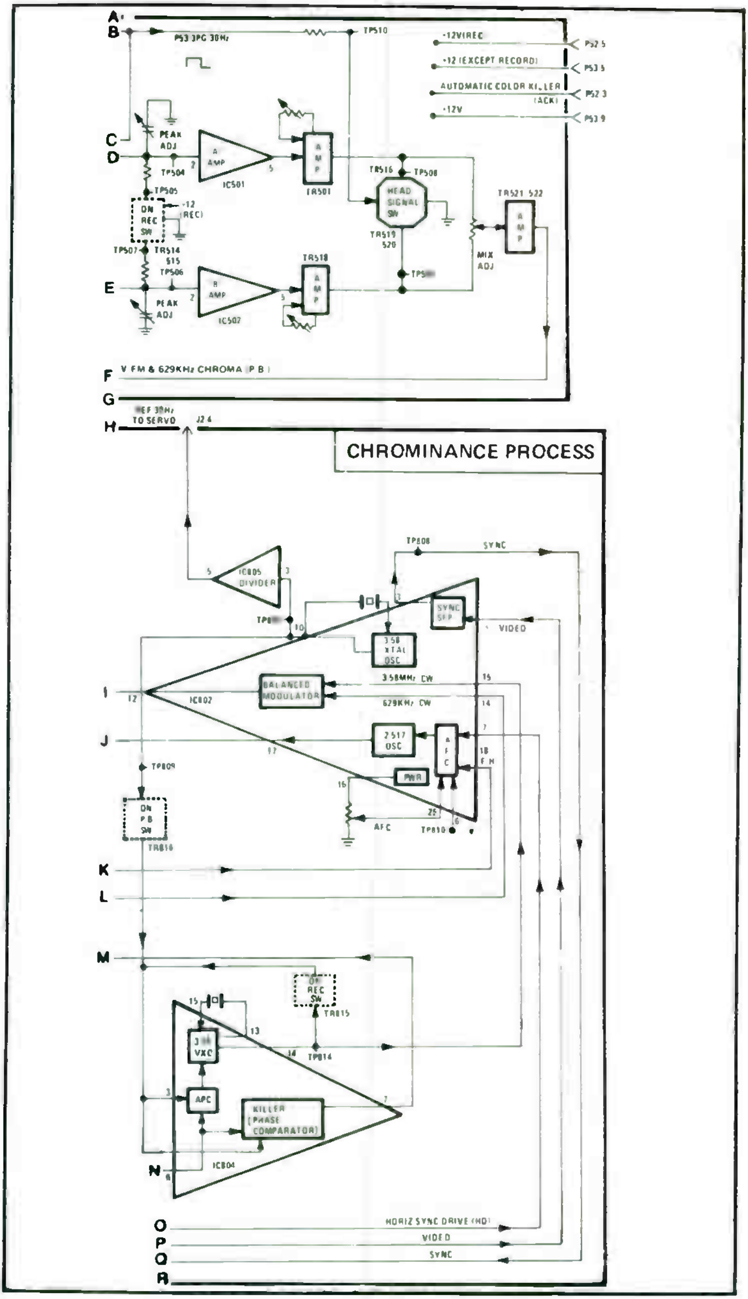


Fig. 11-4. Complete signal processing block diagram (courtesy of Quasar Company). (Continued from page 329.)

activated by voltages produced by head position coils in the head cylinder. The Y-FM and chroma signals are applied to a common amplifier through a control that provides an adjustment to balance the two signals.

The amplified Y-FM and low banded chroma signals are fed to the luminance process board via P53-2 and P34-2, where the two signals are separated. The Y-FM signal is then fed to IC302. This IC provides switching for B/W and color modes and a mixing switch section for dropout compensation.

When playing back a tape that contains only B/W information its amplifier is switched directly to the mixing switch-section. When playing back the monochrome portion of a color recording, IC302 provides switching to accept signals from the high-pass filter (H.F.P.), thus eliminating the lower FM sideband signals.

Normally the Y-FM signal is passed by the mixing switch in the IC to a low-pass filter and to a delay line for storage of one horizontal line. However, should dropout occur it is sensed by the dropout detector which allows introduction of the previous line from the "1H delay", thereby replacing the missing information. With this circuit dropout can occur for several lines without seriously effecting the picture.

The Y-FM is applied through the 6 MHz low-pass filter (LPF) to a limiter in IC303. The L.P.F. reduces second harmonics of the signal for better balancing in the FM demodulator section. The Y-FM signal is fed, via a limiter, to the demodulator. A 90 degree delay and buffer circuit provide the required second input to the demodulator to recover the composite video signal. The low-pass filter at the output attenuates any remaining high frequency components and the deemphasis circuit corrects for the preemphasis that was introduced during the recording process. The video signal is fed through the P.B. level control and is fed from the luminance board to the luminance sub-process board. The circuits in the sub-process board correct for the nonlinear emphasis that was introduced during recording.

The video signal is first fed through a common amplifier to two separate amplifiers. One corrects the nonlinear emphasized signal when playing in the SP mode (the other when playing in the LP mode). The proper amplifier output is used, as determined by the applied voltage to the SP/GP switch-stage. The corrected video signal is fed to an emitter follower which couples it from the board via plugs on the luminance process board.

Switching is provided in the signal path to IC304 so that with a

B/W signal, the video signal is applied directly to the IC. The B/W portion of a color signal is fed through a 3.58 MHz trap to attenuate any signals or noise in the color sideband frequency range. Switching control is provided by the automatic color killer (ACK) voltage.

The playback signal (when in the LP mode) contains a dc level difference due to the ½ horizontal frequency shift of the signal in head ("A") during record. This is corrected by introducing an inverted 30 Hz wave at P34-10 to the signal path. The resulting effect in IC304 reverses the process of frequency shifting that occurred during the record process thereby correcting the playback signal. The signal is then fed to a mixing amp stage in IC304 where the chroma is added. A mute function is also provided to blank the screen during pause, when in play mode, and when changing between LP and SP modes. The video signal leaves the circuit board via three paths; at P31-6 to the video output jack, through a phase-compensator/buffer stage via P31-1 to the rf converter and through J2-2 for sync separation on the chrominance process board.

LP/SP AUTO SELECT OPERATION

Special logic and control circuits allow manual mode selection of tape speed when recording. On playback, logic and timing circuits sample the control track signal and provide electronic switching to play back the tape at the correct speed, for LP (long play) or SP (standard play) mode.

Switching voltage for automatic speed selection is provided by the output of a set/reset flip-flop. It is controlled by properly timed pulses, developed from the control track signal. The control track pulses, after being processed by IC6401, IC6402, and a differential pulse amplifier, set or reset the R/S FF. This circuit produces a switching voltage, high (LP) or low (SP), to establish and maintain the correct mode. This voltage is applied to other circuits on the board to develop control voltages for the signal processing circuits as well as speed control.

A control voltage ("LP high +12 V source in LP-mode) switches the audio record and playback equalization to optimize frequency response in both modes. In the LP record mode, additional video preemphasis is used and the frequency interleave circuitry is activated. In playback, the LP-high voltage switches in appropriate video-frequency deemphasis and an interleave cancellation square wave signal. These functions are performed in the signal processing section of the VCR machine.

Video blanking and audio muting are provided by the circuits on this board for the short interval of time when the speed changes between the LP and SP modes. This is a function of TR6409 in conjunction with the IC6403 and its associated circuits.

REEL ROTATION PULSE PROCESSING

Pulses from the reel rotation sensor are processed by TR6410 and its associated components. These pulses, not used for other functions on the board, are fed to the reel stop detection circuit.

AUTOMATIC SWITCHING (LP/SP PLAYBACK MODES)

On playback, mode switching is accomplished automatically by using the amplified control track pulses (30 Hz) which have different time intervals for the LP and SP modes. The pulse intervals, corresponding to playback speed, are discriminated by comparing the holding time of monostable multivibrators (MM1 and MM2), with the reproduced control track pulses, thus the correct mode is automatically selected and maintained by supplying the developed gate pulses to a set/reset type flip flop (R/S FF).

LP/SP SHIFTER (R/S FF)

Transistors TR6402 and TR6403 (see Fig. 11-5) are connected in a set/reset flip-flop configuration. When either transistor conducts the other cuts off. The switch and inverter, TR6412 provide for switching the flip-flop to either of its two stable states. The simplified diagram (Fig. 11-6) illustrates the circuits that establish the R/S FF state.

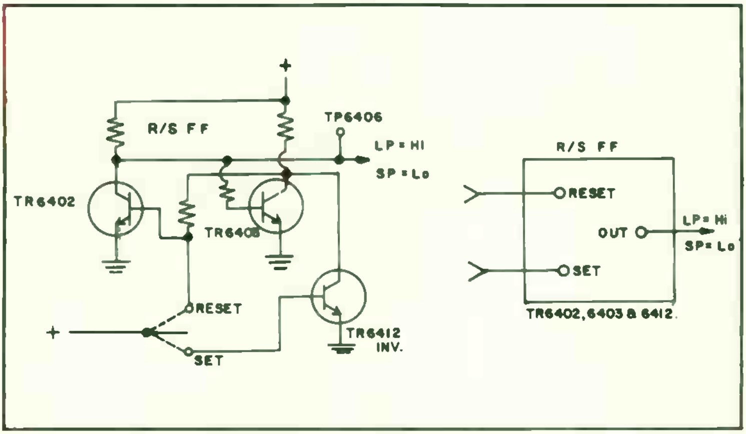


Fig. 11-5. LP/SP shifter circuit (courtesy of Quasar Company).

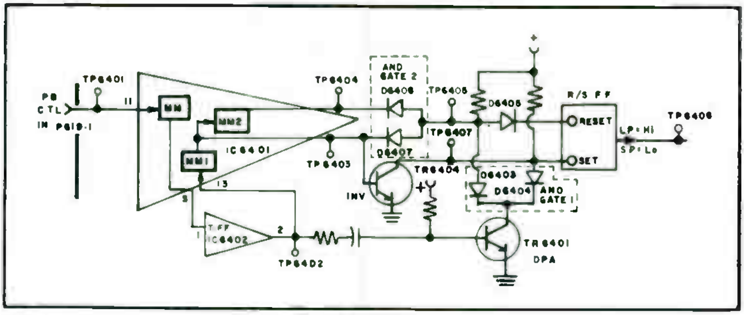


Fig. 11-6. Block diagram of shifter system (courtesy of Quasar Company).

E TO E VOLTAGE

The E to E voltage operates electronic switches on the luminance and audio boards that select the monitor mode (E to E). In absence of E to E voltage the playback circuits operate. See Fig. 11-7.

Transistor TR215 has 12 volts applied to its collector (from plug 65-5 Reg. Transport to P22-2 Servo) and is turned on by forward bias applied via resistor R269. About 10 volts is developed across emitter resistor R270 and is the E to E voltage. This voltage (high) appears at TP219 in all modes of operation except play and play/record.

When the play or record/play buttons are pressed, tape loading begins and 12 volts is applied to the base circuit of transistor TR219. This effectively grounds TR214 emitter through TR219. When the load finish switch closes (after loading tape to the video heads) 12 volts is applied via the switch to TR214 base circuit. Capacitor C248 and resistor R267 provide a short time delay for the circuits to stabilize after loading the tape. When capacitor C248 charges sufficiently, zener diode D213 conducts and drives TR214 into saturation. This turns off transistor TR215 thus defeating the E to E voltage in play or record mode. When the stop function is activated, tape unloading begins and the E to E voltage comes up immediately, because opening of the play and load finish switches results in turning off TR219 and TR214 and instant conduction of TR215.

AUDIO SECTION

A single integrated circuit, IC401 performs the audio functions with very few external devices and components. A multi-section two-position switch (S-401) provides the required switching for record or audio dub (Position R). For all other functions the switch remains as shown (Position P). Refer to audio block diagram (Fig. 11-8). The block diagram illustrates the IC and external functions. All switches shown on the audio board are part of S-401. All sections of S-401 are switched to the opposite position (R), when recording and/or when the audio dub feature is used.

Low level audio signals, from the PB/REC head, must be amplified to a useable level. One side of the head is returned to ground through SW-4. The head output is fed, through SW-5, to an equalization amp in IC401. The output of this section is fed through SW2 and applied to two different paths:

- To the equalization amp.
- To the record and output amps via the tone amp.

Equalization is introduced on playback when playing recordings made in the LP mode, to compensate for the slower speed. The audio signal is fed back into the equalizing amplifier (the amount is determined by the setting of a variable control). Equalization is automatically switched on or off by the voltage applied at P43-6 through SW3 to the SP/LP switch (transistor) stage. When playing back in the "LP" mode a voltage (HI) allows entry of the feedback signal. A voltage (LO) when in "SP" eliminates the equalization function.

Audio level to the tone amp, as determined by the setting of the PB gain control, is fed through SW1. The tone amp output has two paths. One is through the record amp and bias trap but the audio

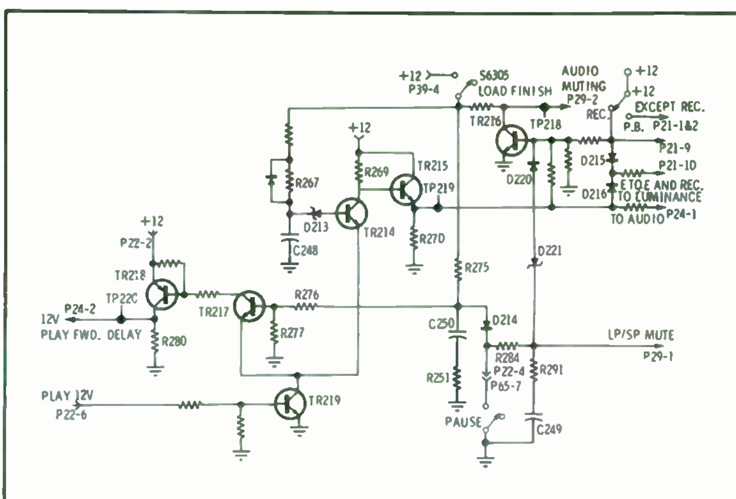


Fig. 11-7. E to E delayed voltage circuit (courtesy of Quasar Company).

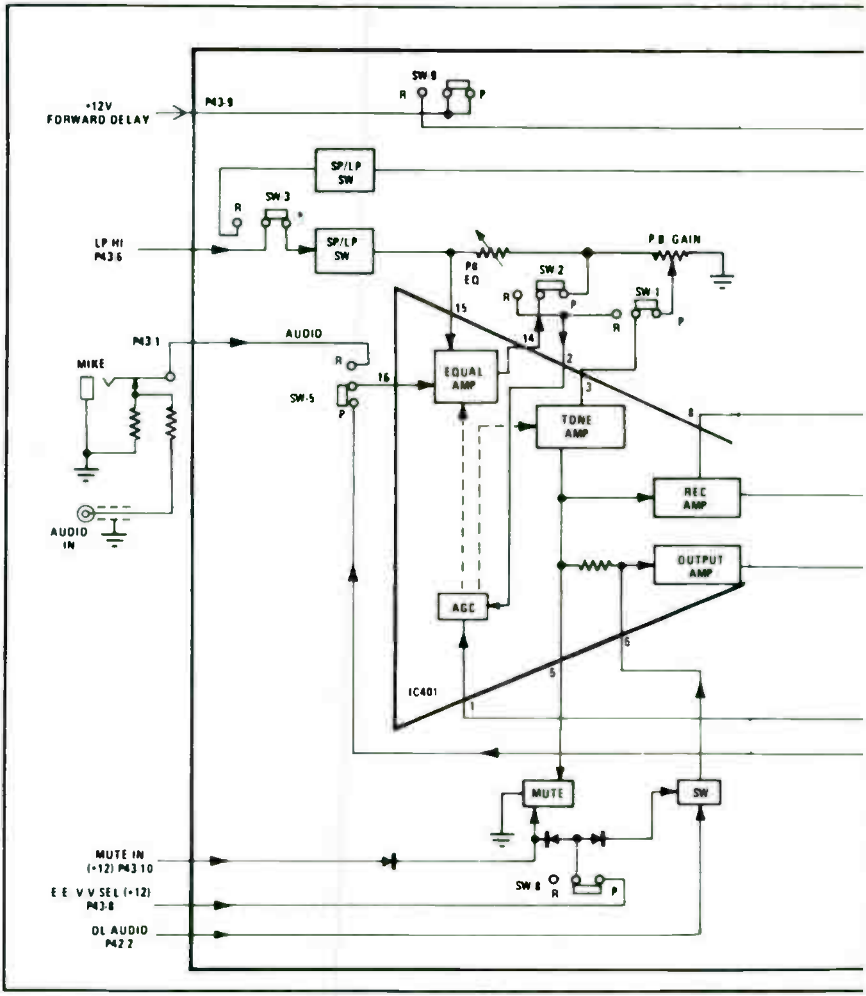
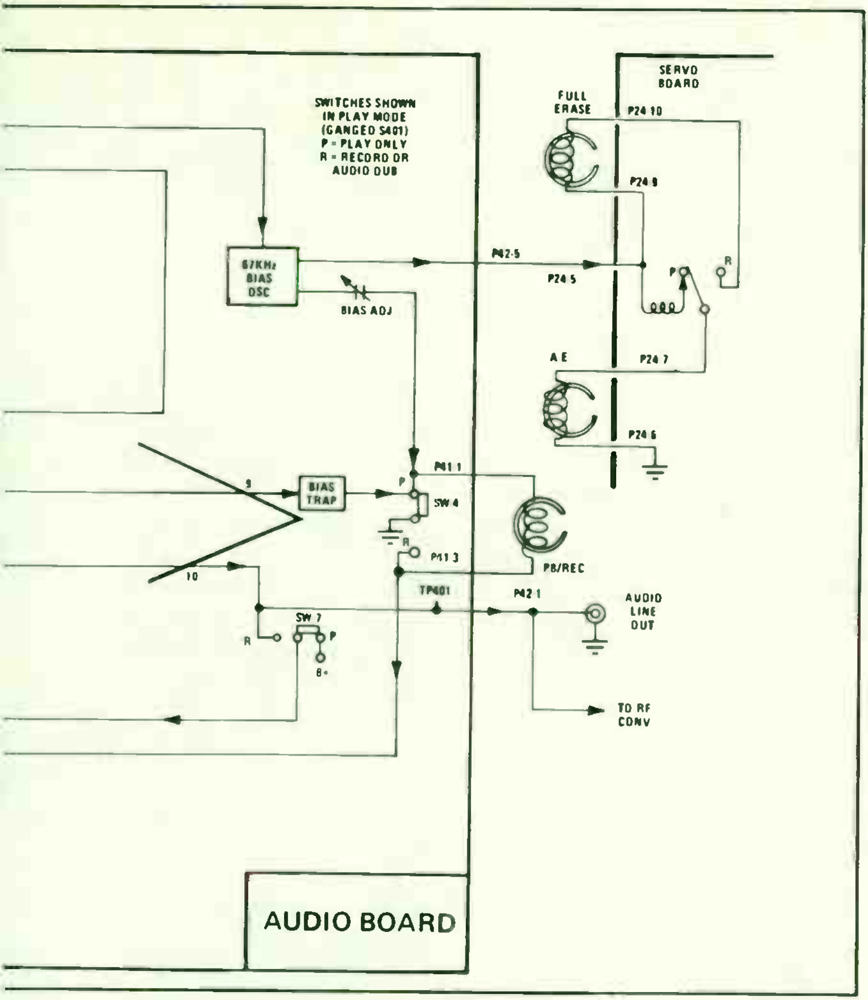


Fig. 11-8. Audio section circuit (courtesy of Quasar Company).

signal is shorted to ground by SW4. Audio to the "output amp" is amplified and becomes the line output of −6 dB at 600 ohms. The output amplifier is always on for monitoring. In play mode the AGC stage is inoperative. The audio is muted during pause (on playback), momentarily when the VCR begins or ends a function and when changing between LP/SP modes. This is done by a positive voltage applied at P43-10 which activates the mute stage and effectively shorts the signal at pin 5 of IC401, to ground.

When the play button is pressed tape loading occurs, but until



loading is complete, audio from the station (if TV is selected) or camera audio will appear in the output. When the tape is loaded, a positive voltage from the servo board appears momentarily to mute the audio, followed by audio from the tape. This is a function of the switching circuit (transistor) at the input of the output amplifier (pin 6 of IC401).

TRANSPORT SECTION

The main function of the transport section is to control the mechanism during tape loading and unloading periods. See complete block diagram in Fig. 11-9. Signals from the transport section controls only three electrical components.

- Loading the dc motor.
- Stop solenoid.
- Pressure roller solenoid

All other mechanisms are controlled by the manual operation of pressing the function buttons such as play, record, fast forward, pause, rewind and stop.

TIMER OPERATION

The timer module is supplied with two ac voltages (3 volt and 16 volt) from the power supply. A fuse located below the transport, protects the timer. The display is a vacuum flourescent tube. Three volts ac is applied to the filaments at pin 32 and returns to ground via pin 1. The 16 volt ac is rectified by diode D6201 and about 20 volts dc (B+) is fed to the control grid pin 18. The color is constantly lighted and is connected to B+. A 40 pin IC (IC6201) performs all clock functions. The drain (pin 29) is grounded, and the source (pin 28) is connected to B+ as is the oscillator pin 23. A small amount of ac is fed to pin 35 (60 Hz) to assure proper clock timing. Refer to Fig. 11-10.

Each of the digits (plates) in the tube display are connected from their appropriate pin connection to the IC. Each digit is made up of seven segments. When the output of the IC is high at term 19 and 22 then digit segments b and c (pins 28 and 30 of the display tube) would also be high and the numeral "1" would be displayed. To display a five (5) the IC output would be high at terminals 16, 17, 18, 21, and 22.

The timer power on indicator LED lights when the timer switch is on by grounding the LED. The anode of the LED connects to unregulated 12 volts in the base circuit of TR629 on the regulator transport board. The clock time or preset time can only be adjusted when the timer is in the off position. With the timer off, B+ is fed through the off switch to the time adjust switch. When the time adjust switch is moved to the FF (Fast) position B+ is applied to pin 34 (fast set input) and the time changes one hour every second. With the time adjust switch in the FWD (Slow) position, positive voltage is applied to pin 33 (slow set input) and the time changes two minutes every second.

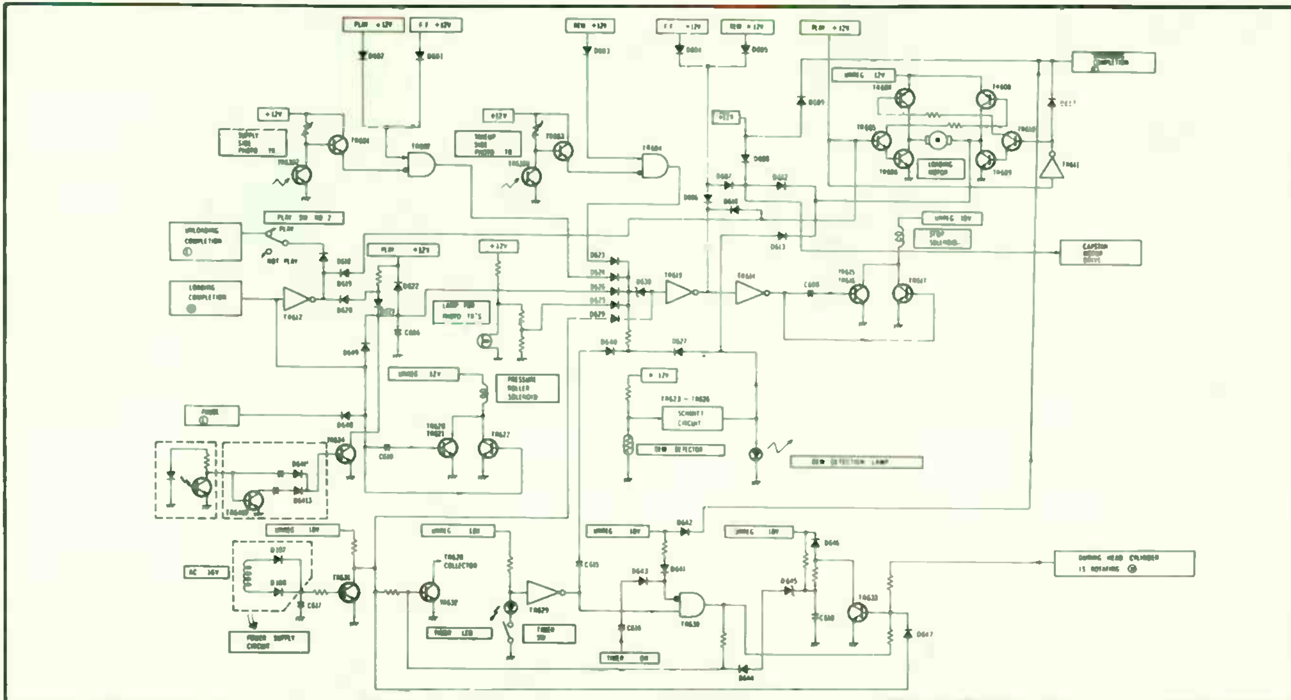


Fig. 11-9. Transport block diagram (courtesy of Quasar Company).

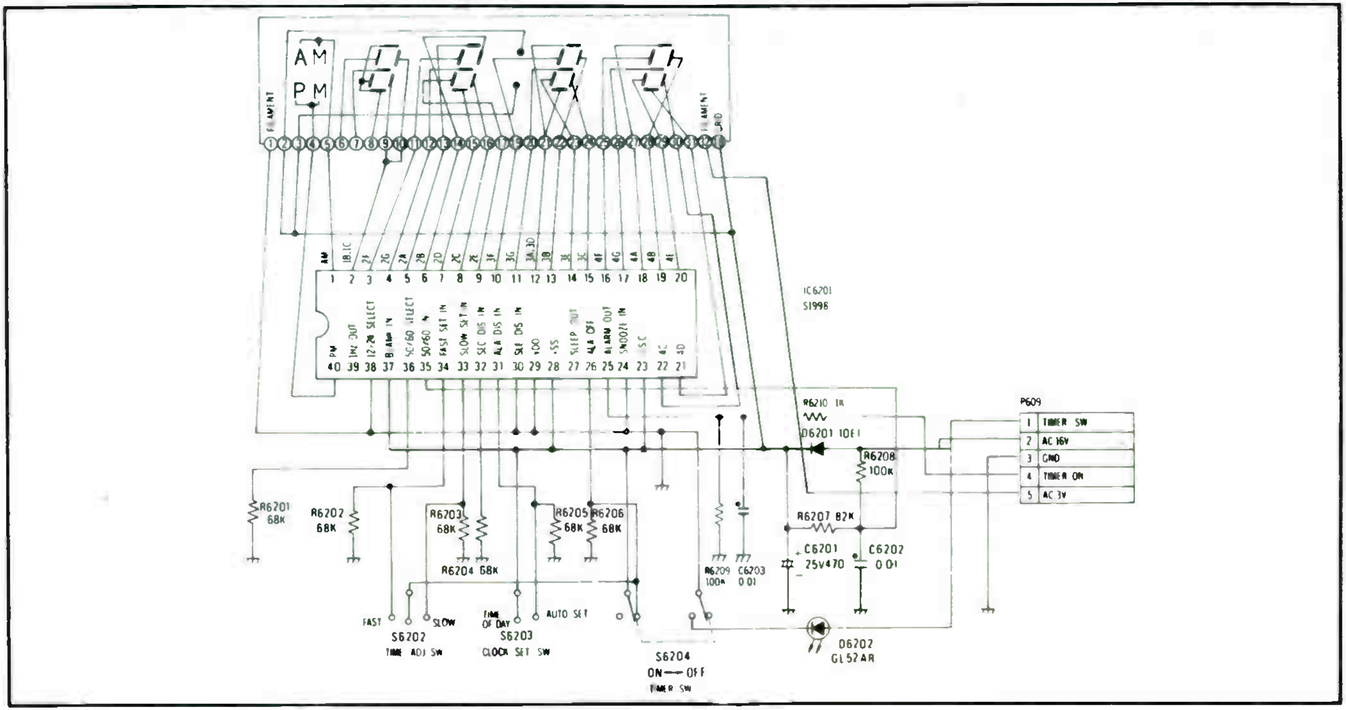


Fig. 11-10. Timer circuit (courtesy of Quasar Company).

SERVO SYSTEMS

The purpose of the servo systems in the VH5000 is to control the video head cylinder and capstan drive motor speed by sensing errors in operation and sending control signals to correct for these errors. There are two servo systems in this VCR. One is the video head cylinder motor servo and the other is the capstan drive motor servo. Each servo has a play and record mode of operation.

CYLINDER HEAD SERVO

Vertical sync from a TV station is the reference for the cylinder servo in the record mode. A head positioning pulse (PG) taken from the head cylinder is wave shaped and used as a feed back signal to the servo. This pulse indicates which head is in contact with the tape and where the video heads are on the tape at any time. The cylinder also generates an FG (frequency generator) signal (1800 Hz) which is counted down and applied to a standard time generator along with the compared output of the PG and vertical sync pulse.The output voltage controls the cylinder motor drive circuits and thus the cylinder speed. See servo reference chart (Fig. 11-11).

CAPSTAN SERVO

The capstan servo system controls the movement of tape in the VCR machine. During record the servo transports the tape through the machine at a constant speed. The reference signal is the cylinder PG pulse. A sample pulse from the capstan motor FG (frequency generator) is divided down to 30 Hz or 15 Hz from 960 Hz (SP mode) or 480 Hz (LP mode). A comparison of the trapezoid wave shaped PG pulse and the FG pulse from the capstan motor develops a control voltage for the motor drive circuit which locks the capstan motor to a constant speed.

When in the playback mode, the reference signal remains the same (trapezoid waveshape derived from the cylinder PG). The feedback signal is now the control track signal which was recorded on the lower edge of the tape. When the tape is recorded the control track signal is put on the tape by a 30 Hz frequency counter which is locked to the TV station sync pulses. Thus the capstan servo senses any deviation in transport speed by timing the arrival of the control track pulses. When in the record mode the position of vertical sync on the tape is accurately determined and the control pulse is coincident with vertical sync on the tape therefore it provides a vernier control of tape speed so that the recorded video tracks on the tape

	Mode	Reference signal	Sample signal
Head (cylinder)	Rec	V—sync	Cylinder P.G.
	Play	Reference signal made from 3.58 MHz (60 Hz)	
Tape speed control (capstan)	Rec	Cylinder P.G.	Capstan F.G. divider output (SP: 30 Hz LP: 15 Hz)
	Play		Recorded control signal

Fig. 11-11. Servo reference and sample signals (courtesy of Quasar Company).

align themselves with the path of the rotating video head cylinder, traveling at a constant speed.

CYLINDER PHASE CONTROL

When in record mode, the video signal from the TV station or camera is fed to a sync separator which separates the vertical sync pulses and may be monitored at test point TP202. The vertical sync is amplified and divided by two (MM located in IC201). This square wave signal follows two paths. One path is via TR213 which amplifies the signal and applies it through the closed record switch to the control head where the 30Hz square wave is recorded on the lower edge of the tape. This control track is used in the playback mode. The other path is through a one shot multivibrator (record shifter). The output signal is a very narrow pulse (reference pulse) and is fed to the sample and hold circuit. Record shifter control (R206) provides for phase adjusting and reference pulse with respect to the other sample and hold input.

The pulse generator (PG) signal from the head cylinder motor indicates which head is on the tape and its position at any instant. After being differentiated and amplified by transistor TR2115 the PG signal is fed to a one shot multivibrator and drives a trapezoid generator (part of IC201). The trapezoid signal (visible at TP205) is fed to the sample and hold circuit. See the block diagram (Fig. 11-12).

The sample and hold now contains the trapezoid-shaped signal (representing head position derived from the PG pulse) and the narrow sampling pulse (derived from the vertical sync). If the video head cylinder speed and phasing is correct, the trailing edge of the trapezoid is sampled near or slightly above its midpoint. Each time a sample is taken it is held as a dc voltage in the sample and hold circuit. This dc voltage is fed to the standard time generator which establishes the width of the pulse applied to the AND gate. By varying the pulse width slightly small changes in cylinder motor current is accomplished to maintain proper phase of the heads when recording.

In the playback mode the internally generated 3.58 MHz crystal oscillator output is counted down to 60 Hz to provide a reference signal. This signal is amplified, divided by two, applied to the record shifter and then to the sample and hold circuit. Only the reference signal has been changed. In record, video sync is the reference, while in playback the locally generated signal is the reference.

The PG pulse from the head cylinder is again applied to the pulse amplifier, PG Shifter (MM), the trapezoid generator and the sample and hold whose output controls the motor to a constant speed.

CAPSTAN SERVO OPERATION

The capstan servo system is similar to that used in the cylinder servo. As in the cylinder servo two control loops are used, a speed control loop and a phasing or head position control loop. In the SP mode the capstan motor runs twice as fast as when in the LP mode see Fig. 11-13.

CAPSTAN SPEED CONTROL

Capstan motor speed is sensed by the capstan frequency generator (FG) which produces a sine wave of 960 Hz in the SP mode and 480 Hz in the LP mode. This signal is divided by two (flip-flop part of IC101) and may be monitored at TP6410 on the LP/SP board. After being amplified and inverted by transistor TR6411 the signal takes two parallel paths. One path is through diode D6418 (when it conducts) and then to the standard time generator and AND Gate (IC201). The other path is through a divide-by-two circuit (IC6403), through diode D6419 (when it conducts) and then to the standard time generator and AND Gate. The inputs to diodes D6418 and

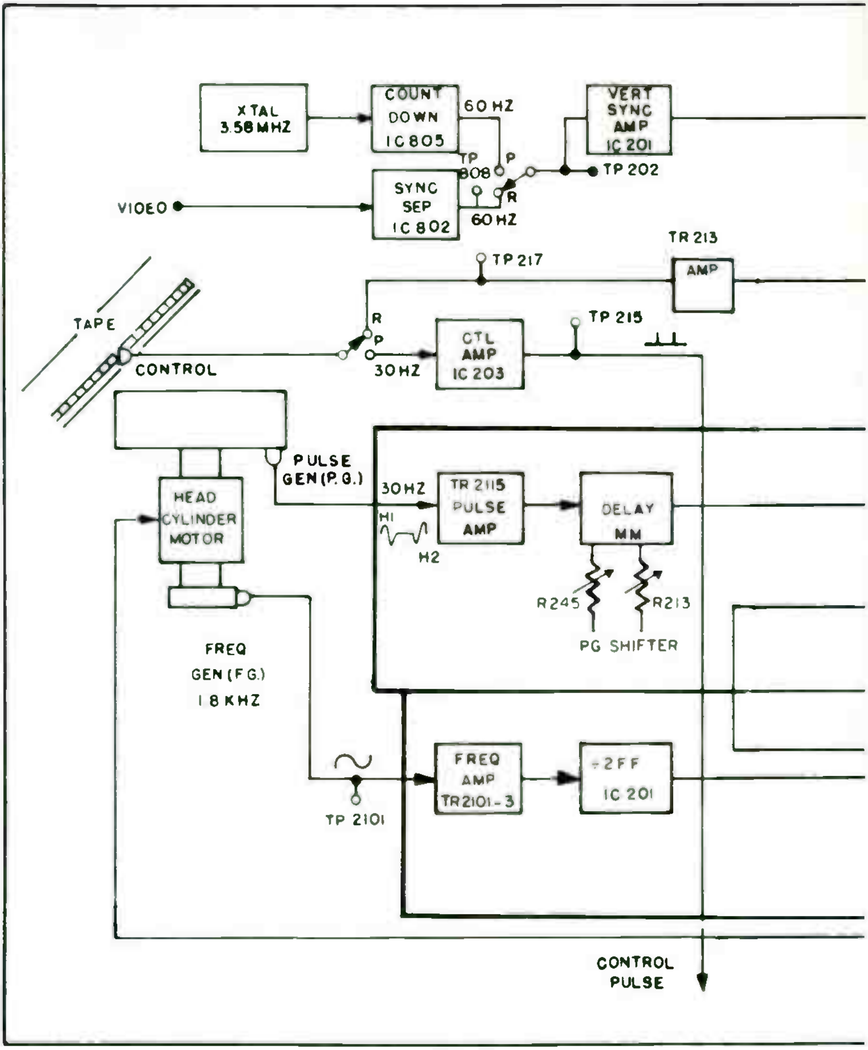
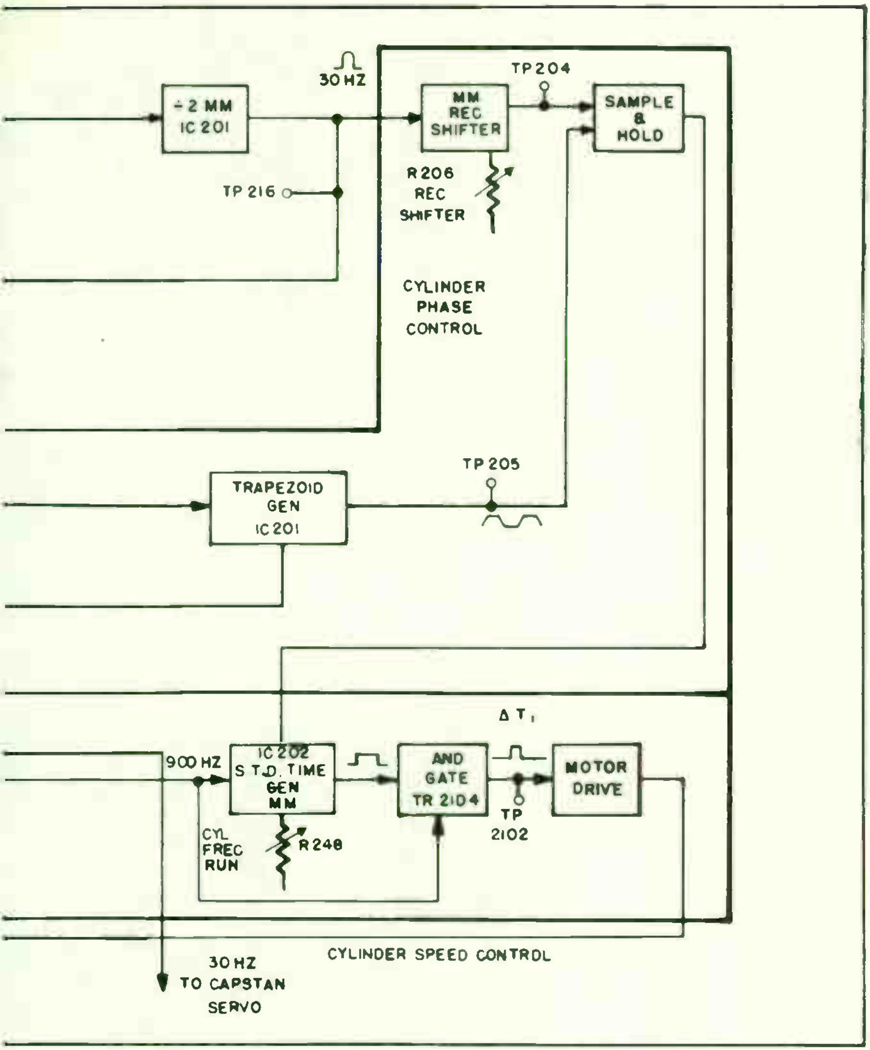


Fig. 11-12. Cylinder servo system block diagram (courtesy of Quasar Company).

D6419 are alternately switched to ground by transistor switches TR6405 or TR6406 for the LP or SP mode. When in LP a logic high is applied to the base of TR6406 and it saturates. This shorts the input signal to diode D6419 to ground. However D6418 is forward biased and passes the 240 Hz FG signal to the standard time generator.

When in the SP mode transistor TR6405 is saturated by a logic



high at its base. This shorts the input signal to diode D6418 to ground. However, D6419 is forward biased and passes the 240 Hz (480/2) FG signal to the standard time generator. Thus, regardless of the mode of operation, the standard time generator always has a control input of 240 Hz. In the SP mode the additional divider in the circuit forces the capstan motor to run at twice the speed as when in LP in order to furnish the required 240 Hz input to the standard time generator and gate circuit.

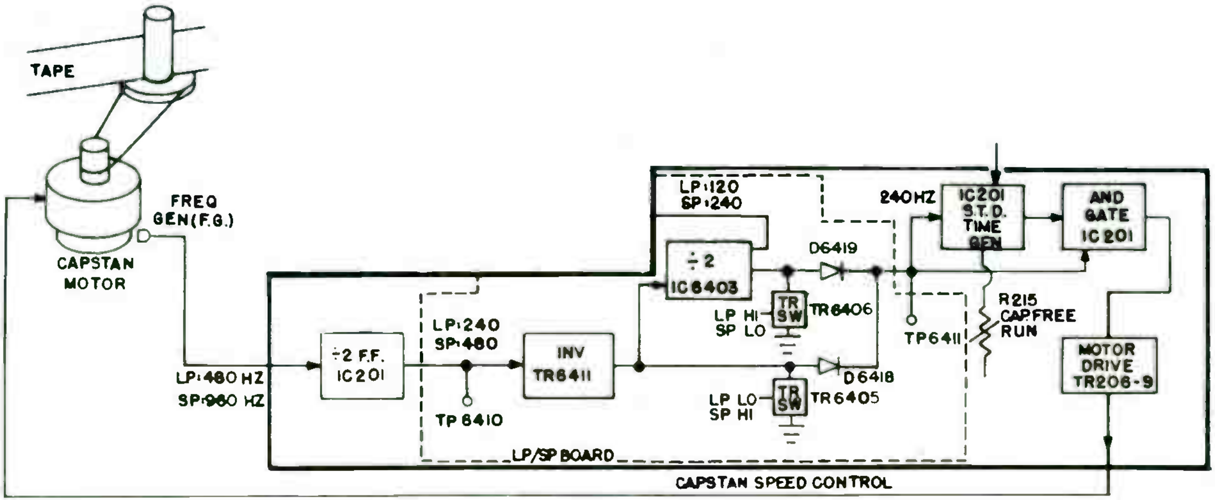


Fig. 11-13. Block diagram of capstan speed control (courtesy of Quasar Company).

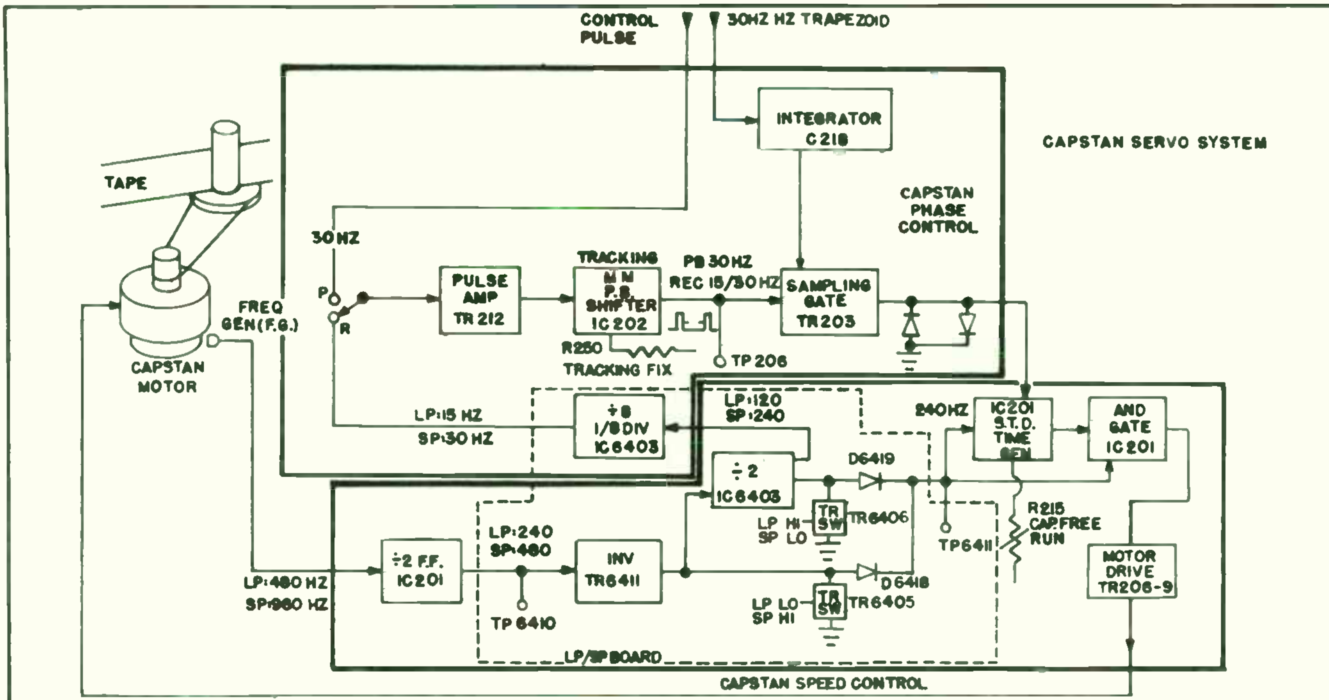


Fig. 11-14. Capstan servo block diagram (courtesy of Quasar Company).

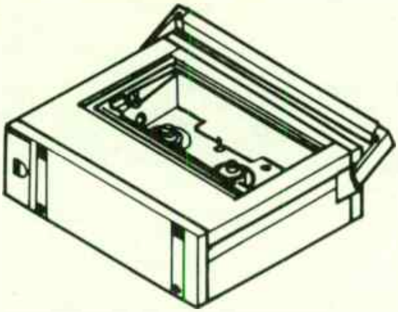
The AND gate pulse output represents the addition of the standard time generator signal and the input square wave relating to motor speed. The pulse is integrated and applied to the motor drive circuit which provides coarse adjustment to obtain the approximate speed. Just as in the cylinder servo, the pulse width from the standard time generator is modified by the phase control loop circuits to accurately control the motor speed.

CAPSTAN PHASE CONTROL

When recording, the capstan servo system maintains a constant tape speed for the selected SP or LP mode of operation. In playback, the servo provides the required speed plus positive control of tape so the video heads will properly track the recorded information. Refer to the servo block diagram (Fig. 11-14).

In the record mode, the output of a one eighth divider (three divide by two counters part of IC6403) is passed to pulse amplifier TR212 and to the shifter stage (MM part of IC202). These pulses (15 Hz = LP −30 Hz = SP) may be monitored at TP 206. The sampling gate circuit (TR203) receives two inputs, one the 30 Hz or 15 Hz signal from the shifter and the other is the 30 Hz trapezoid derived from the head cylinder (PG). The output from the gate is amplitude limited by diodes D203 and D204 and is fed to the standard time generator (IC201 pin 9) which modifies its pulse width. Adjustment of the capstan free run control (R215) sets the basic pulse width. Output from the standard time generator and FG pulses drive an AND gate whose output is integrated by capacitor C222, filtered, and provides bias to transistor TR206. Transistor TR206 receives inputs from the Reg. Transport board indicating that other operations (loading of the tape, etc) are completed before the capstan motor operates and moves the tape. The output of TR206 applies drive to three transistors (motor drive circuit) which apply voltage to the capstan motor.

Chapter 12



RCA Videocassette Recorders

Information in this chapter is courtesy of RCA Consumer Electronics Manual VCR-1-S1 (Copyright 1978).

The RCA Model VBT200 VCR utilizes the VHS (Video Home System) recording format. This machine uses a direct-drive upper cylinder (head wheel) assembly which is powered by a three-phase ac advanced motor. The combination of this motor and a low-mass headwheel unit is the key to the systems stability which is required for color TV recordings of four hours. In addition, a very simple automatic tape threading system minimizes tape handling and insures longer tape life. The mechanical operation of the VCR is controlled by the transport-control electronics system. Other circuits contain the power supply, signal processing, servo control and SP/LP switching.

The block diagram shown in Fig. 12-1 illustrates the various interrelationships among the several sections of the recorder. The video output from either a TV receiver type "front end" (TV tuners and demodulator) or a direct video input are fed to the recording circuitry. This circuitry consists of separate luminance and chroma record sections whose outputs are combined in the record amplifier and fed to the video heads.

During playback, the recorded signal from the tape is fed to separate luminance and chroma playback sections after passing through preamplifier circuitry. The output of these circuits is combined in a video amplifier, whose output is fed to an rf converter.

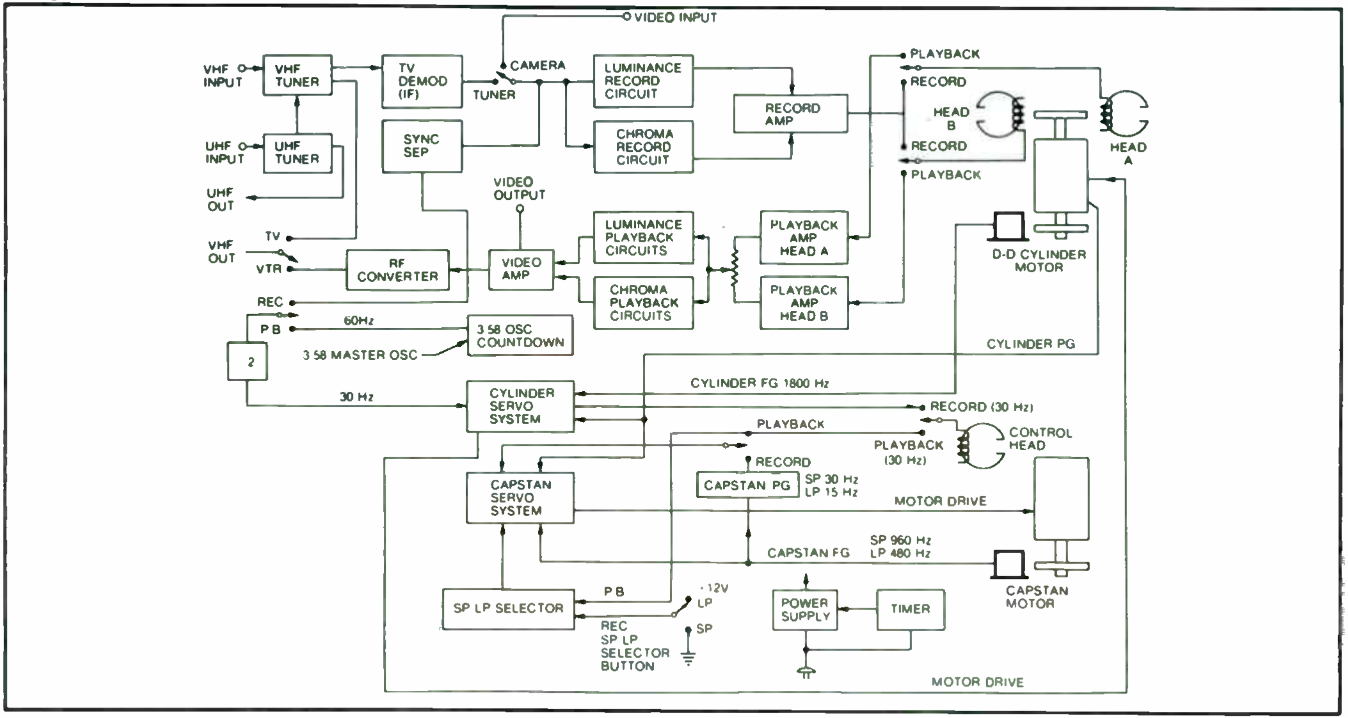


Fig. 12-1. Overall block diagram of the RCA model VBT200 (courtesy of RCA).

This converter remodulates the video information on either channel 3 or 4 for playback on a TV set. A section of the circuit (not shown) samples input video in the record circuit and couples it to the rf converter via part of the playback video amplifier. This set up called the E-E mode (electronics-to-electronics mode), lets the user monitor the video program being recorded.

Cylinder head and tape transport speed control is provided by two separate servo systems called the cylinder head and capstan servo systems. The cylinder servo system receives reference signals from either vertical sync during recording, or from a master 3.58 MHz oscillator (counted down to 60 Hz) during playback. These signals are compared against pulse-generated (PG) samples pulses (which give head position) to maintain the exact cylinder head speed and position phasing required. Also, during recording, pulses which represent vertical sync are recorded by the control head along the bottom edge of the tape. These serve to synchronize the capstan servo system during playback.

The capstan (tape transport) servo system references instantaneous cylinder head position signals against a sample of capstan motor speed frequency generator (FG) signals to maintain constant tape transport speed during recording. During playback, the instantaneous cylinder head position information is referenced against the control track output signals to provide minute adjustments of capstan speed. In this way, the tape transport speed is dynamically adjusted to assure that the rotating heads properly align with the recorded video tracks.

The user selects 2-hour (SP) or 4-hour (LP) recording modes which determines transport speed during recording. The SP/LP selector circuit automatically determines the correct transport playback speed by sampling the control track pulse-rate.

The power supply circuitry converts standard 120 volt ac power line voltage into three dc supplies for use by the recorder. Power consumption for this VCR unit is 45 watts.

POWER SUPPLY CIRCUITS

This VCR power supply uses a power transformer and two bridge-rectifier circuits to develop unregulated 12-volts dc and 18-volts dc. A third unfiltered supply using diodes D107 and D108, produces the "power-off-detector" supply. Refer to power supply circuit in Fig. 12-2. This voltage is applied to the transport and control board logic system to sense a power failure and operate the stop solenoid so that the machine is not left in an operating mode in

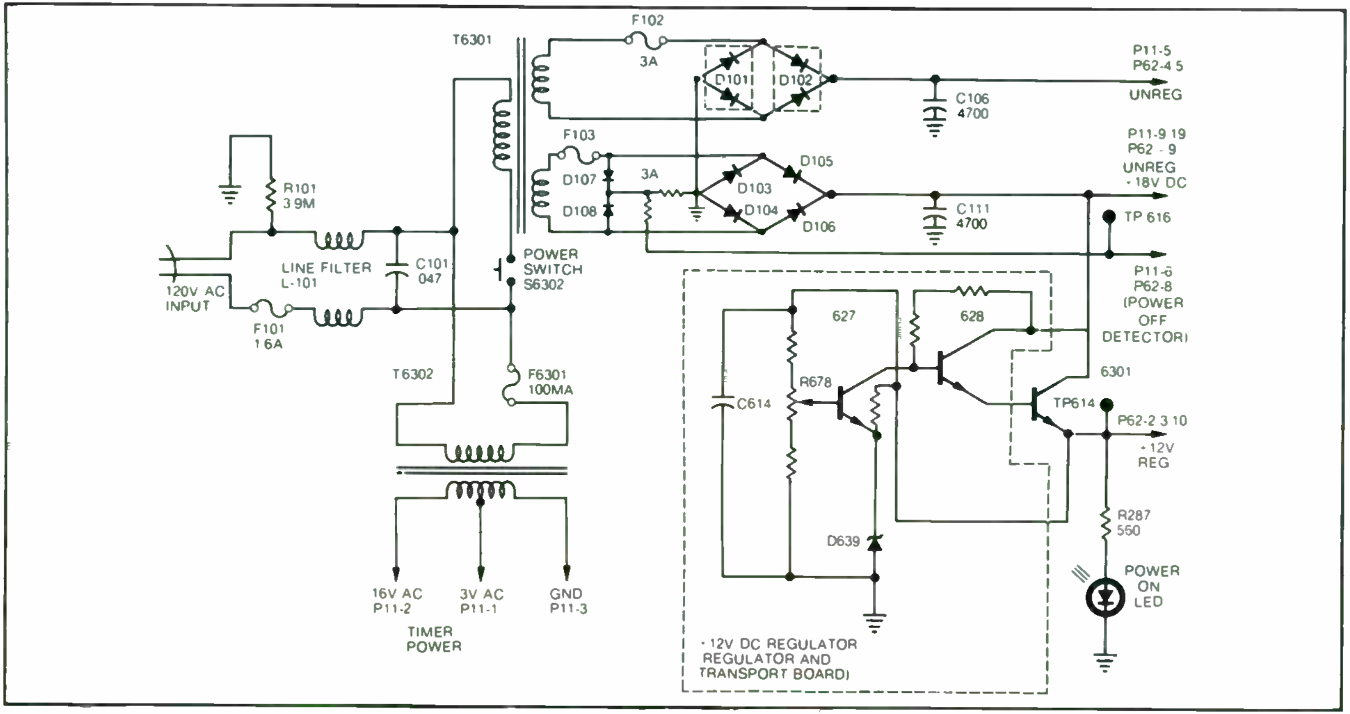


Fig. 12-2. Power supply circuit and 12 volt regulator (courtesy of RCA).

the event of ac power loss. A second power transformer supplies 16-volts ac and 3-volts ac to operate the digital timer.

The B+ distribution in Fig. 12-3 shows that the unregulated 12-volt supply output is applied to the transport and control board where it encounters some switching. This voltage is also supplied to the D-D motor board where it provides input power to operate the three-phase inverter that then drives the D-D cylinder motor.

The unregulated 18-volt supply is also fed to the transport and control board where it provides power to operate much of the logic circuitry contained on this board as well as the stop solenoid. Also derived from the unregulated 18-volts supply is regulated 12-volts dc which is generated by a series-regulator circuit that utilizes low-level driver circuitry on the transport and control board and a power transistor which is chassis mounted. The regulated 12-volts appears at the emitter of the power transistor and can be measured at test point TP 614. Note that the "power on" indicator (an LED) is powered from the regulated 12-volts. Thus, from a servicing standpoint, if stop-solenoid action is heard when the machine is turned on and off, but the power-on indicator does not come "on", would indicate a problem in the regulator circuit because the 18-volts powers the stop solenoid and feeds input voltage to the regulator which then drives the "power-on" LED. You will note that most of the VCR circuitry is powered from the 12-volts regulated source. However, the regulated 12-volts is then divided into several sub-sources via switching and various logic functions.

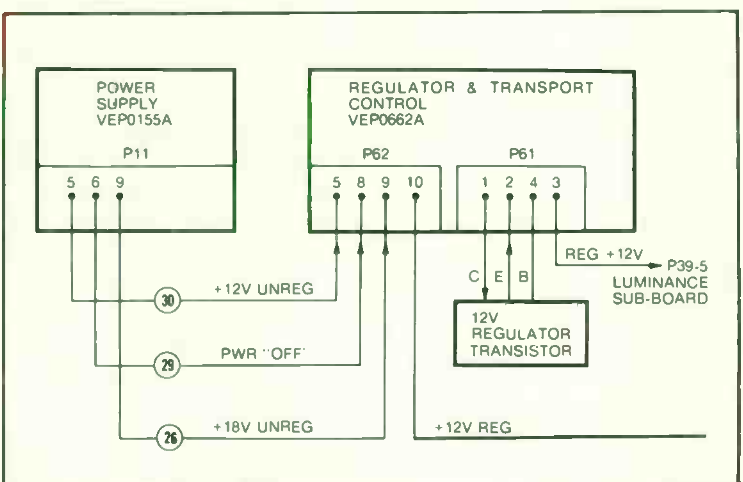


Fig. 12-3. B+ distribution block diagram (courtesy of RCA).

In summation, the power supply circuit provides three voltages to the transport and control board. These voltages are +12 volts unregulated, "power-off" indicator voltage, and +18 volts unregulated. These are all directed to the transport and control board. A driver circuit on this board supplies bias to the 12 volt regulator transistor. Also associated with plug P61 pin 3 is the regulated output of 12 volts from this board which is fed to the luminance subprocess board via the P39-5 plug.

B+ DISTRIBUTION

Referring to the block diagram in Fig. 12-4 you will see that several additional 12 volt supplies are obtained from the regulator and transport control board. These voltages, for the most part, are routed to the servo board. An exception is the P63 plug that feeds unregulated 18 volts to operate the stop solenoid and a source of regulated 12 volts for the audio board of the VCR.

Several B+ sources come from Plug P65 via the servo board. At pin 1 of P65 is a +12 volts loading end source. This voltage becomes available at the end of tape loading in the machine because switch S6305 closes at the completion of loading and provides this voltage to the servo board. Pin 2 output is +12 volts regulated which supplies the majority of the circuitry in the VCR that is common to the record and playback modes. Pin 3 feeds +12 unregulated which supplies power to the D-D cylinder motor three-phase inverter circuit. A source of voltage known as "forward +12 volts" is available at pin 6. This voltage is present when the fwd leaf switch on the transport board is actuated by the play button. This voltage is then processed into several different sources of "play" and "record" voltages. Pin 4 supplies a voltage which is a "fast forward/rewind +12 volt override voltage" that is sent to the SP/LP auto select board. The purpose of this voltage is to inhibit LP motor speed whenever the machine is in "rewind" or "fast forward". Finally, emerging from plug P65 pin 8 is a voltage source known as "capstan-motor-on." This voltage becomes available at the instant the unload-finish switch opens, to signal the capstan motor that the machine has started to load; thus, the capstan motor drive circuitry is enabled so that the motor begins to run.

The B+ Distribution, shown in Fig. 12-5, has a source voltage called "except record +12 volts" and is available at P21 pin 1. This voltage source is present in the "play" or "E-E" modes of operation, but not present in "record". Pin 8 of P21 supplies a voltage source called "delayed record +12 volts". This voltage is supplied a brief

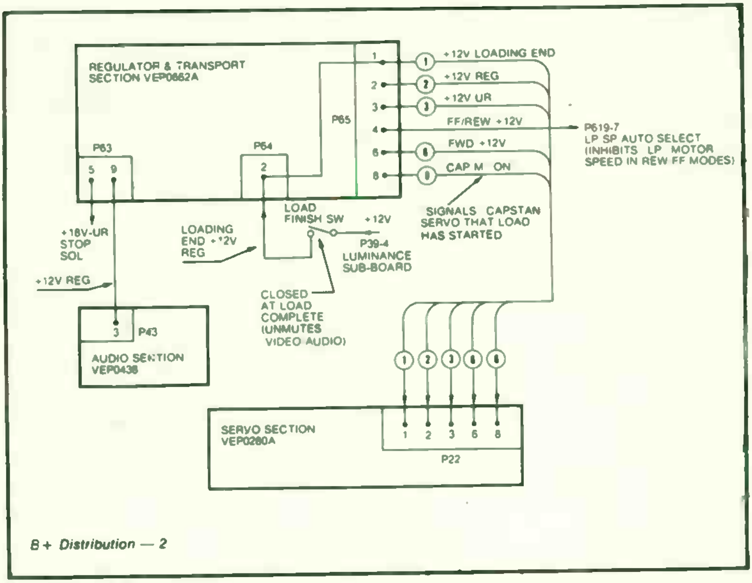


Fig. 12-4. Voltage distribution (courtesy of RCA).

instant after loading is completed as signaled by the load-finish switch. The source of this voltage is logic and time delay circuitry located on the servo board which is triggered by the closure of the load finish switch. The "record" selection function is obtained by passing this voltage through a section of the record/play switch so that the voltage is only present during record.

Another voltage, "delayed forward +12 volts" (supplied to audio board via P24 pin 2) is fed from the same time-delay circuitry. The only difference is that this voltage does not pass through the record/play switch. Thus, the voltage is available any time the play button is depressed. Also, a source of "record" +12 volts is tapped from the regulated B+ source via a section of the record/play switch on the servo board. This voltage is at pin 9 via plug P21.

At pin 10 of P21 is a voltage called the "E-E/V-V select voltage". This voltage is present when the machine is in the E-E mode of operation. Whenever record or play is started, this voltage source is defeated.

Other voltage sources emerging from the Servo board include the "delayed-forward +12 volts" which is fed to the audio section as well as "E-E/V-V select voltage which is also supplied to the audio section. Emerging from plug 25 pin 3 is the dc voltage to operate the capstan motor.

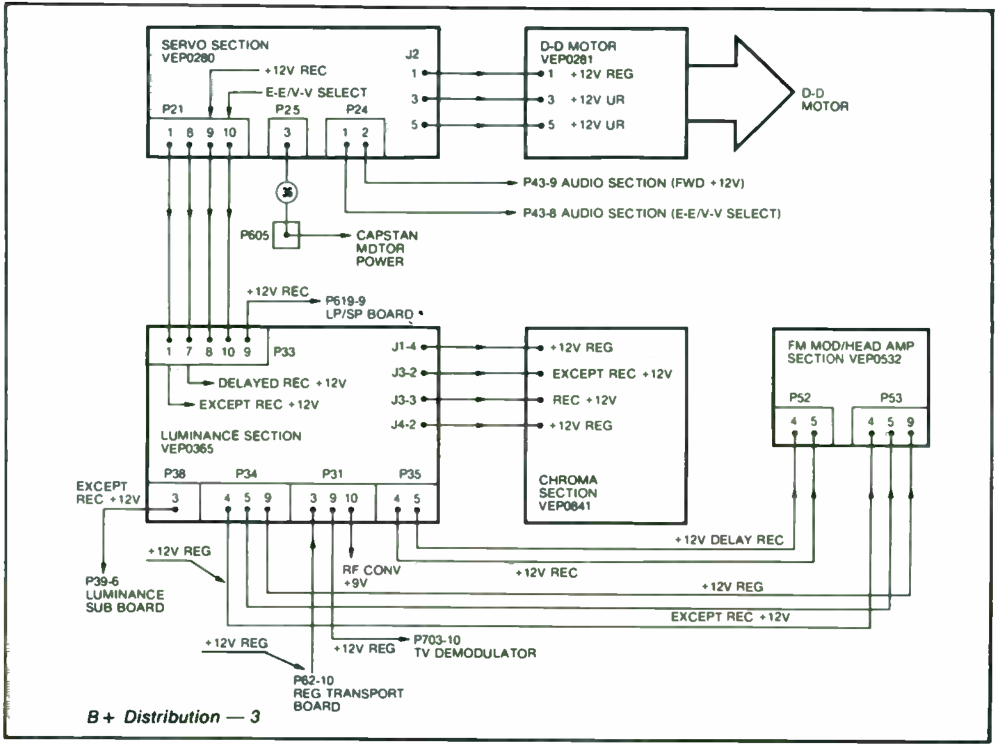


Fig. 12-5. Block diagram of B+ distribution (courtesy of RCA).

The "P21" voltages are fed to the luminance board via plug P33. As seen in Fig. 12-5, the luminance board serves to distribute these various sources of B+ to other circuit boards in the machine. Power is applied to the chroma board via the interconnecting wire jumpers that link the chroma and luminance board. Additionally, "except-record B+ 12 volts' is fed to the luminance subprocess board via P38 pin 3. Plug P34 supplies power to the FM modulator head amplifier section of the machine (also, to P35 pins 4 and 5). The luminance board also supplies +12 volts regulated via P31 pin 9 to power the TV demodulator. Pin 10 of the same plug feeds +9 volts to the rf converter board.

DELAYED B+ SOURCE

This VCR uses two delayed voltages which are provided in order to allow the system to stabilize before record or playback after tape loading. Also associated with the delayed B+ source is an interface with the pause switch. In addition to stopping the transport operation, it also interfaces with the mute circuitry.

E-E/V-V SELECT

The E-E/V-V select (see Fig. 12-6) shows an emitter-follower transistor (TR215) that is powered from the +12 volt regulated supply to provide a switched source of bias to operate electronic switches on the audio and luminance boards that either select the

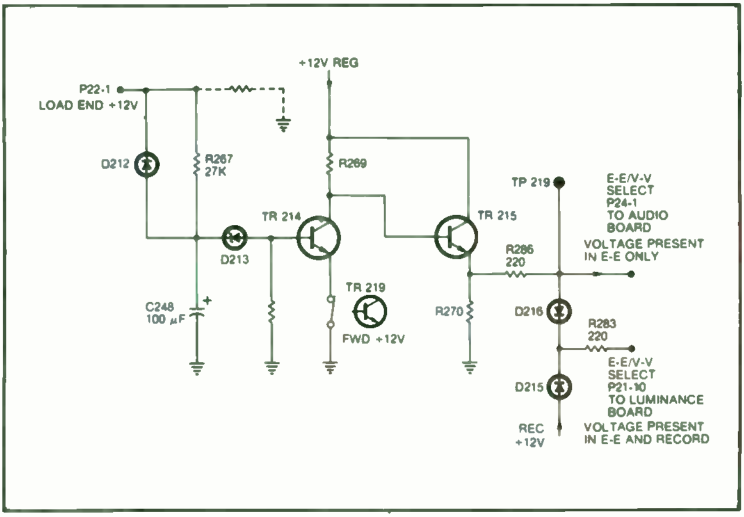


Fig. 12-6. E-E/V-V select circuit (courtesy of RCA).

E-E (monitor) mode of operation or allow the machine to function in playback (V-V). When the VCR is in the monitor mode, transistor TR215 is conducting and thus supplies "E-E Select" bias to the audio boards via plug P24 pin 1, and via diode D216 and P21-10, the voltage is supplied to the luminance board. When the machine goes into the "record" or "playback" mode, the "E-E Select voltage" is turned off, allowing the machine to function in play or record. Note that in the "record" mode, diode D215 supplies record +12 volts to the same circuitry on the luminance board which is active for "E-E" mode operation. This means that this particular circuitry must be deactivated when the machine is in the playback mode. Base bias (control voltage) for emitter-follower transistor TR215 is obtained from another transistor (TR214) which implements an "AND" logic function between the load end +12 volts and the forward +12 volts. Note that base bias for this device is supplied via an RC time-delay network from the load end +12 volt supply and the emitter of the device is grounded via the collector/emitter circuit of TR219 which conducts when forward +12 volts is available. Thus, in actual operation, depressing the play or the record/play buttons immediately causes conduction of transistor TR219 when forward +12 volts is applied from the leaf switch on the transport board. At the completion of loading, capacitor C248 charges through R267 until sufficient voltage is present on the capacitor, at which time zener diode D213 conducts and drives the base of transistor TR214 into saturation, causing the collector of this device to go low, removes base bias from TR215, and turns it "off."

The time-delay action provided by R267 and C248 delays the transition from "E-E" (monitor) mode into the record or play mode for a period long enough to allow tape transportation to stabilize.

VCR PLAY/RECORD SIGNAL CIRCUIT OPERATION

In playback, the VCR's two video heads feed in individual preamps which are turned "on" when the particular head is in contact with the video tape. Preamplifier output is summed together into a continuous rf signal prior to entering separate luminance and chroma circuits. Refer to the block diagram (Fig. 12-7).

SIGNAL CIRCUIT (PLAYBACK MODE)

The B&W signal is 3.4 to 4.4 MHz FM which is fed to limiter stages that remove all amplitude variations including the chroma signal content. Limiter output drives an FM demodulator which

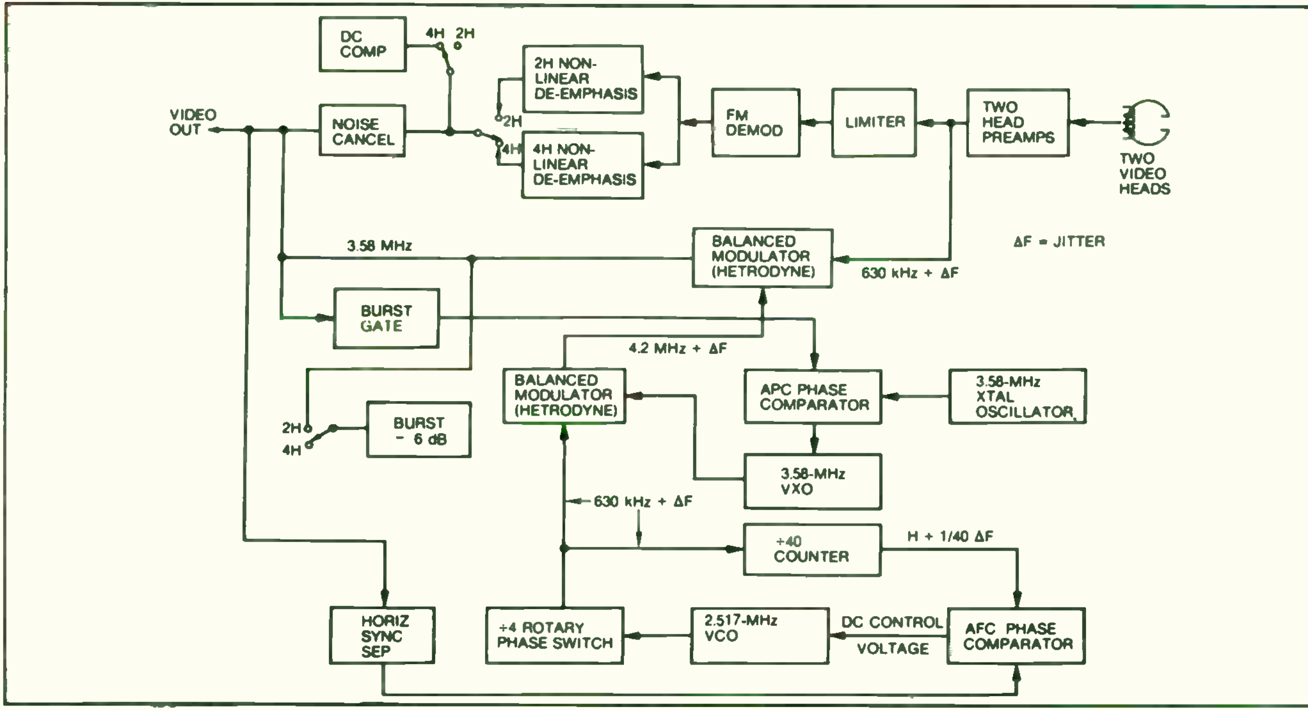


Fig. 12-7. Signal circuit "play" block diagram (courtesy of RCA).

recovers the original B&W video signal complete with the overshoots introduced by the record emphasis. In order to correct frequency response of the video signal the signal is passed through appropriate deemphasis networks which are switchable for 2 or 4 hour operation. After deemphasis, the video signal passes through some noise cancellation circuitry emerges as 1 volt P-P negative sync video to drive the rf converter in the machine to provide channel 3 or 4 output to a TV receiver.

A dc compensation stage is switched in when in the 4 hour mode to remove the dc level shifts that were introduced in "record" to produce the half line offset. This dc compensation is a 30 Hz square wave which corrects the dc component of the video signal in the shifted fields to agree with the dc level of the video in the nonshifted fields.

The chroma signal consists of 629 kHz rf plus a "jitter-frequency" component. Jitter frequency is explained as follows: The video head speed and the tape-transportation speed should be held to a very tight tolerance, and in practice they are. However, an extremely small change in video head velocity, which would produce no noticeable change in a B&W picture, can produce chroma phase errors so severe that the picture is not viewable. Thus, this effect of minute speed variations which are called the jitter component must be removed in order to display proper color. If the 629 kHz down-converted chroma signal containing jitter was beat against a 4.2 MHz signal that contained the same jitter component, the difference would be a constant 3.58 MHz signal without the jitter component. This is accomplished by passing the 629 kHz signal into a balanced modulator where it is beat against 4.2 MHz with jitter to produce an output of 3.58 MHz chroma. In playback, this 4.2 MHz signal plus jitter is produced by the second balanced modulator.

Now, the 3.58 MHz VXO is locked to a locally generated constant 3.58 MHz signal derived from a crystal oscillator. The other input to the balanced modulator is 629 kHz plus the jitter factor. The 629 kHz signal is provided by the same 2.517 MHz VCO that is locked to the horizontal sync. Because in playback, the horizontal sync pulse contains the small time-base errors caused by minute variations in headwheel speed, the playback horizontal sync pulse can be applied to the AFC phase comparator to produce dc control voltage with jitter modulation. Thus, this jitter is introduced into the 2.517 MHz signal whose output is divided to 629 kHz. In this way, the 629 kHz output contains the jitter component and cancels the jitter in the 629 kHz incoming chroma.

E-E OPERATION

Before start of recording, the VCR is in a mode of operation known as "E-E" which couples the input signal from the TV demodulator, via some of the record/play electronics and then to the video output circuitry where it modulates the rf converter for use of the TV receiver. The purpose of "E-E" operation is to allow the operator to view the picture that is to be recorded. For example, it allows the user to determine that the camera picture is adjusted properly, or the tuner is set to the correct channel.

As shown in Fig. 12-8 the video signal from the TV camera switch is routed to the luminance board via P32-1. This 1 volt P-P negative-sync can be scoped at TP 301 which is the input to a buffer amplifier (TR301) that serves as an isolation and gain stage to prevent the following circuitry from loading the VCR video input.

The buffered video signal is fed to a low-pass filter comprised of LC components FL-301 with filter cut-off frequency of about 5.8 MHz. The purpose of the filter is to remove any high-frequency components from the input composite video signal. Output signal from the filter passes into phase- compensator transformer T301 whose purpose is to correct the phase shifts introduced by the low-pass filter. Phase compensated video signal is then fed to pin 11 of IC 301, video processing chip.

Blocks within IC 301 take the composite video signal (including color), feed it to an AGC amplifier whose purpose is to correct for any abnormal input level conditions and thus provide a constant 1-volt video signal to the actual video record circuitry. AGC regulated video is then coupled to a video amplifier in another part of this chip. The video amplifier output comes out of IC 301 at pin 7. This video signal is then fed to video buffer stage (transistor TR320) via "E-E" level control R3169. Buffer output is routed to a second signal-processing chip (IC 304) via electronic switch transistor TR319. This transistor is turned "on" during "E-E" and "record" operation. Switch output (video) is applied to IC 304 through pin 16 of the device.

Video processing IC 304 is primarily part of the playback circuitry. The composite video (including color) is fed to an "E-E" amplifier stage. Output of this stage is fed into a mixing amplifier whose output comes from the chip at pin 8. At this point, the video signal is 2 volt P-P and can be scoped at video test point TP 308. Signal from pin 8 is directed through video-phase-compensator transformer T307. A buffer stage following the phase the compensator makes video signal available to the rf converter via plug P31-1.

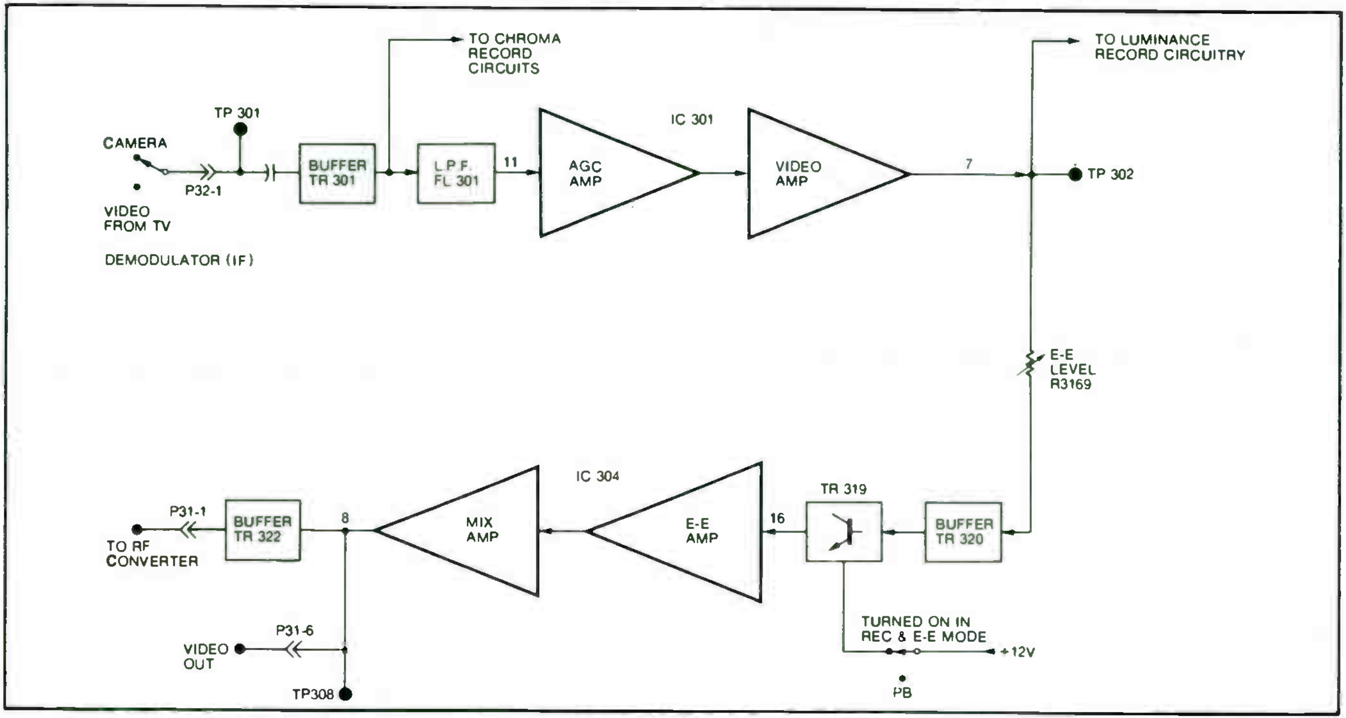


Fig. 12-8. Simplified E-E block diagram (courtesy of RCA).

LUMINANCE RECORD CIRCUITS

The input to the luminance record system closely resembles that of the "E-E" circuitry because the same electronics are used. Briefly, video signal from the input is fed to the buffer and filter circuitry via P32 pin 1 and TP 301. Video signal entering IC 301 pin 11 is fed to the same AGC and video amplifier stages. The output is pin 7 of the IC or TP 301. From this point, the signal takes a different path than it did in the "E-E" mode. Refer to Fig. 12-9.

Pin 7 video is at an amplitude near 1.5 volt P-P (as scoped at TP 302) and passed through a 3.58 MHz trap which removes the chroma signal components. This trap is switched "in" and "out" of the circuitry by the color-killer system. Basically, when the machine is in the "color" mode, additional low-pass filtering is introduced in the video circuitry to prevent chroma/luminance beats.

Luminance video signal is then routed to switchable 2-hour/4-hour nonlinear video emphasis circuitry contained on the head amplifier board via P37-5. This video is then returned to the luminance board where it is fed back into IC 301 via the FM-deviation control. This control is used to regulate the peak-to-peak video level so that the proper signal amplitude is fed to the FM-modulator circuitry on the FM-modulator board.

The video, again processed by IC 301, enters the chip at pin 3 where it encounters additional amplification and preemphasis high frequency boost. Output from the preemphasis circuitry leaves the chip at pin 1 and reenters the chip at pin 15 where it encounters a sync-tip clamper circuit that provides dc restoration of the video signal.

Clamped video (TP 303) is a signal of somewhat over 1 volt P-P that has sizable overshoots (spikes). The purpose of preemphasizing (overshoots) the signal is to improve the high frequency signal-to-noise performance of the machine as well as providing enhancement of picture definition. However, it is important that the overshoots be limited to proper levels to prevent overdeviation of the FM modulator. There are separate white-clip and dark-clip stages that are adjustable which are used to set the clipping level and thus regulate the amount of overshoot. Preemphasized and clipped video output is applied to the FM Modulator board via P36-1.

Input to the FM modulator is emphasized clipped video from the luminance board which enters via P54-1. After passing through an adder stage the video signal is fed to the FM-modulator circuit. When the unit is in the 4-hour mode, a 30 Hz square wave signal is added to the video to produce the alternate field level shifting

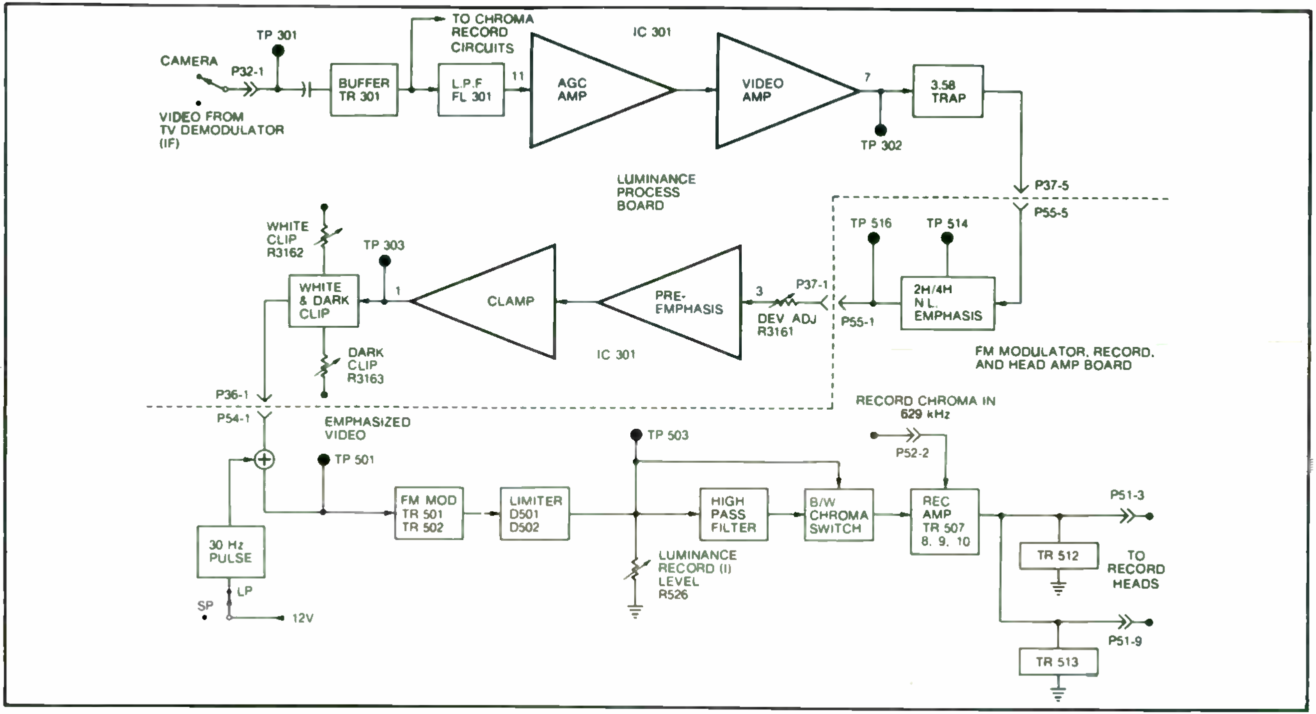


Fig. 12-9. Luminance record block diagram (courtesy of RCA).

necessary for generating the ½ frequency H offset from field-to-field. The FM modulator is just a multivibration (flip-flop)—transistors TR501 and TR502. When the input voltage corresponds to sync-tip level, the FM modulator runs at 3.4 MHz. When video is applied, and the signal is driven towards white, the multivibrator frequency is driven upwards in response to the video signal. The FM modulator output is transformer coupled to a pair of limiter diodes which remove any amplitude variations from the FM signal. Limiter output can be viewed as an FM signal of about 0.6 volt P-P at test point TP 503. This signal, after being level regulated by record-current control R56, is fed to an amplifier stage consisting of TR503 which drives emitter-follower TR504.

Output from the emitter follower is fed through a high-pass filter which is selected by "color-mode" switch TR506 when the unit is operating with a color input signal. When the VCR is operating the B/W mode, switch TR505 routes the signal directly to the video-recorder amplifier. The purpose of the high-pass filter used in color "record" is to prevent FM modulation components from interacting with the 629 kHz chroma signal and producing beats. Thus, this filter has a cut-off frequency of approximately 700 kHz. The video record amplifier then boosts the level of the luminance record signal to provide 12 mA of luminance video record current at the input to the D-D assembly.

Note that the 629 kHz down-converted chroma enters the record amplifier via P52-2 where it is mixed with the luminance component. Thus, the output of the record amplifier is luminance FM with about a 3 mA chroma record current mixed. This signal is then routed to the individual video heads which are driven in parallel.

Note, that in the "record" FM modulator block diagram that the "play/record" head switching is done electronically. When the unit is in "record", the record signal is applied to the heads (via individual transformers) through PS1-3 and -9. The ground ends of the video heads are returned to the circuit board via P51-1 and -10. Note that the heads are grounded through switching transistors TR514 and TR515 which are "on" when the unit is in "record." Notice too, that these switches also ground the input of the playback preamplifiers and peaking capacitors C530 and C545 to prevent them from interacting with the record current. Also evident is that the playback switches TR512 and TR513 are "off" when the VCR is operating in the "Record" mode.

PLAYBACK HEAD AMPLIFIER CIRCUITS

In playback, the video heads must recover the information impressed upon the tape and present it to the luminance and chroma systems to replicate the original video signal. Due to various electrical and physical phenomenon, it is necessary to shape the response of the "record" amplifier, and to compensate for the response of the "record" amplifier and the inherent limitations of the video tape when the signal is played back. Thus, preamplifiers with special response characteristics are used to restore proper frequency relationship to all of the sideband components when the signal is played back. And, due to slight manufacturing tolerances between video heads, not only is it necessary to compensate for the overall video signal, but it is also necessary to match, or equalize, the individual heads so that the field-to-field variation of video signal (rf head signal) is minimal. Referring to head amplifier play block diagram (Fig. 12-10), observe that the two video heads drive individual IC preamplifiers consisting of IC 501 and IC 502. During playback, one side of each head is grounded through electronic switches consisting of transistors TR512 and TR513 which are turned "on." The head signals are applied to terminal 2 or IC 501 and IC 502 respectively.

Associated with the input to these ICs are two trimmer capacitors called "Peak-A" (C530) and "Peak-B" (C545) that set the resonance of the video heads for a peak response at 4.5 MHz. This response peak, and the frequency-response adjustments of the individual preamplifiers, create playback preamplifier frequency characteristics that properly restore the sideband levels to their proper frequency relationships.

Associated with each of the IC preamplifiers is a feedback frequency response control network consisting of RC components and adjustable resistors R553 ("Q-A) and R565("Q-B") which are adjusted for proper playback frequency response characteristics. The outputs of both preamplifiers are fed to additional individual stages of amplification consisting of TR501 and TR518 and then to a summing point consisting of mix control R575.

It is most desirable in video playback to turn "on" only the amplifier that is in contact with the video tape in order to prevent the inactive video head from contributing noise to the input signal. The signal levels at the video heads are incredibly small and any stray noise, after amplification, will degrade performance. Thus, switching transistors TR517 and TR519 are gated "on" and "off" to allow video signal to pass whenever the appropriate head is on the

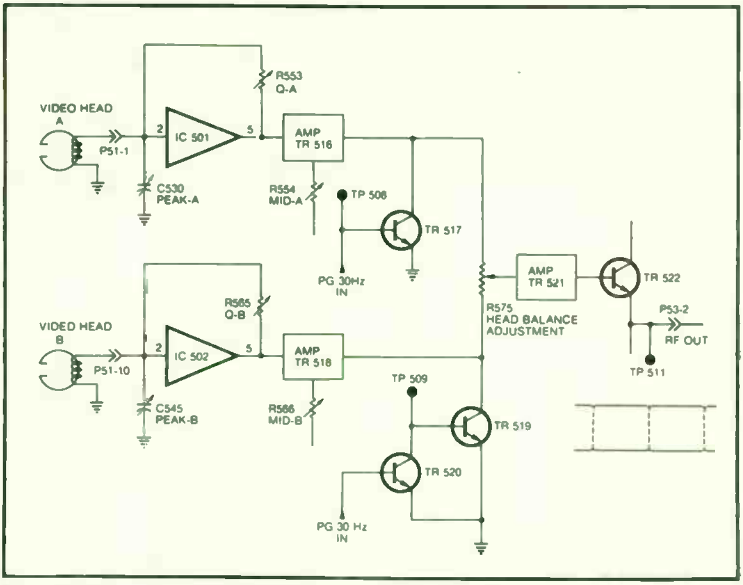


Fig. 12-10. Head amplifier playback block diagram (courtesy of RCA).

tape. The "summed" output of the heads receives additional amplification by transistors TR521 and emitter follower stage TR522. The summed rf head signal (luminance FM and chroma) is routed off the FM modulator/head amplifier board to the luminance and chrominance circuitry via P53-2. This signal can be scoped at test point TP 511.

As shown in the luminance play block diagram (Fig. 12-11), the rf head signal is fed to the luminance processor board at P34-2 for input to the luminance and chroma processing circuitry.

THE COLOR OSCILLATORS

The VBT200 VCR uses three separate oscillators to process the chrominance signal. These are the 3.58 MHz XTAL oscillator (crystal), 3.58 MHz VXO (variable crystal oscillator), and the 2.517 MHz VCO (voltage controlled oscillator). The 3.58 MHz chroma information is down-converted (hetrodyned) to 629 kHz in the "record" mode by beating the signal against a 4.2 MHz CW signal in a balanced modulator (mixer) circuit. Refer to color oscillators block diagram (Fig. 12-12).

Not only is the "record" chroma signal down-converted to 629 kHz, but it is also recorded in a configuration where on the first field (Head-1 pass) the phase of the chroma signal is advanced 90 degrees

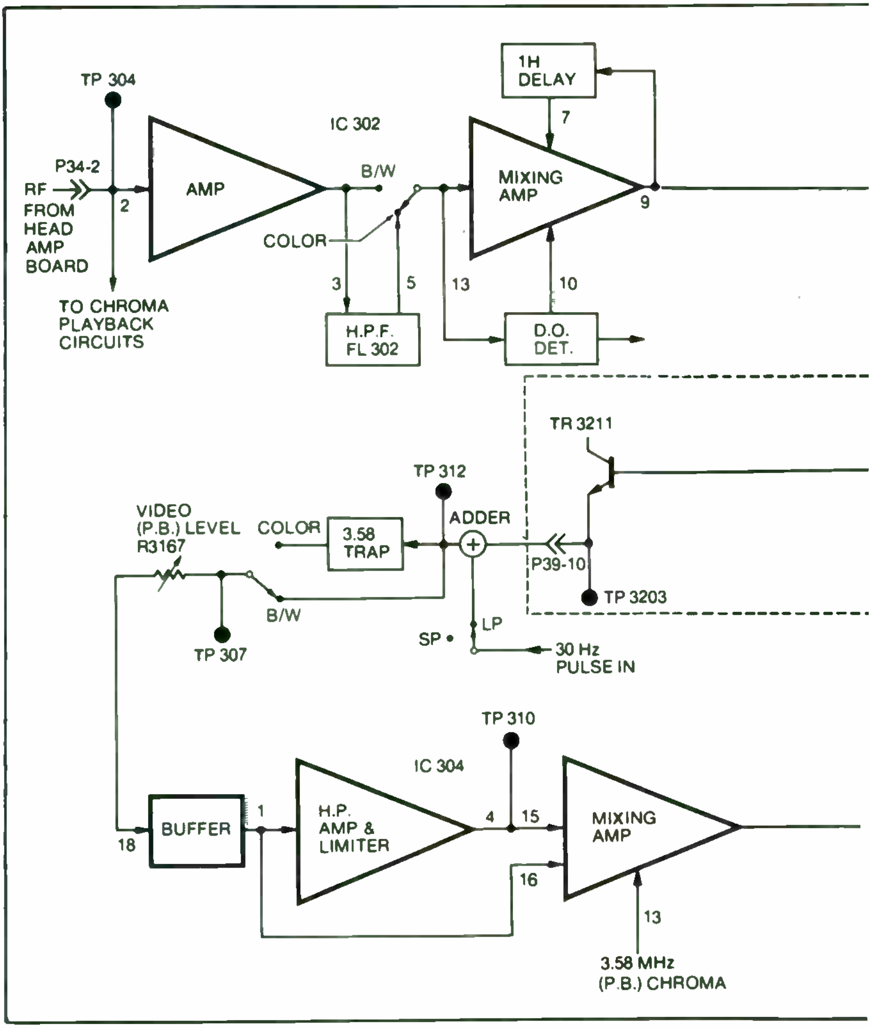
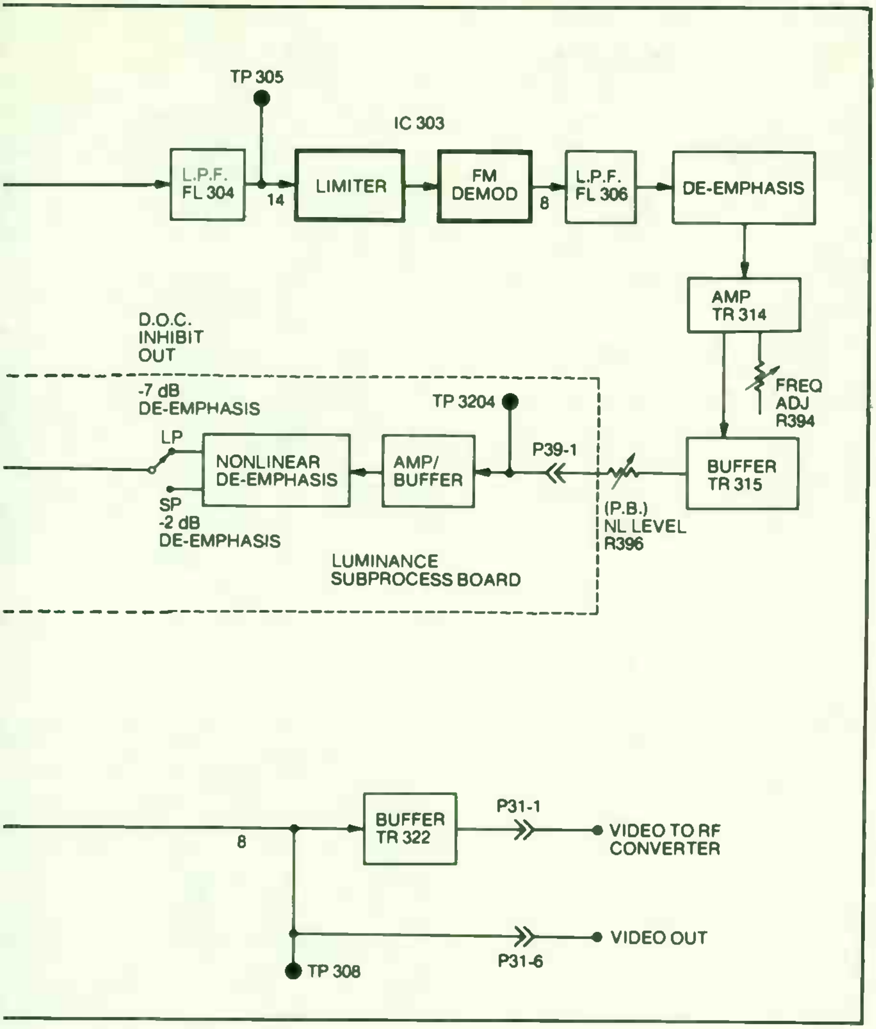


Fig. 12-11. Luminance playback block diagram (courtesy of RCA).

per line. When the second field is recorded (Head-2 pass) the chroma signal is retarded in phase by 90 degrees for each horizontal line. This system of chroma signal recording is called "chroma rotary-phase" recording. This system of chroma recording allows a comb-filter circuit in the playback electronics to effectively cancel chroma crosstalk signal which is present in "LP" recordings because there is a negative guard band in the LP mode.

In order to accomplish the chroma rotary-phase recording



technique, the 4.2 MHz signal used to down-convert the chroma information must change phase by 90 degrees for each horizontal line. Thus, this signal must somehow be keyed by the horizontal sync pulse. The 4.2 MHz CW signal is actually produced by beating together a 3.58 MHz signal obtained from the variable crystal oscillator (VXO) and a phase-rotary 629 kHz signal. These signals are hetrodyned in a second balanced modulator (mixer) and the sum of the two frequencies is the 4.2 MHz CW signal used to down-convert the chroma to 629 kHz. During "Record", the 3.58 MHz VXO is locked to the input signal burst by an APC system as found in some color TV sets. The 629 kHz rotary-phase CW signal is extracted from a divide-by-4 counter clocked by a 2.517 MHz signal produced by the voltage-controlled oscillator (VCO) which is phased-locked to the "record" signal horizontal sync pulse.

In playback, the 629 kHz down-converted chroma signal is up-converted back to the 3.58 MHz frequency by using the same oscillators and balanced modulators in reverse. The incoming 629 kHz signal is fed to the balanced modulator where it is beat against 4.2 MHz phase-rotary CW signal. The difference frequency (3.58 MHz) is the regenerated chroma signal. During playback, the 3.58 VXO (beats against 629 kHz phase-rotary CW to produce 4.2 MHz for up-conversion) is referenced to the 3.58 MHz XTAL (crystal oscillator).

The APC circuit associated with the 3.58 MHz VXO receives output from the 3.58 MHz XTAL oscillator as a reference and the burst component of the up-converted 3.58 MHz color signal is compared against this local generated 3.58 MHz reference signal to generate an error voltage that is used to correct 3.58 MHz VXO phase and frequency so that the output 3.58 MHz chroma signal has a high degree of phase stability. Also, during playback, the 2.517 MHz VCO is locked to playback horizontal sync. Thus, any jitter component present in the playback signal which could affect chroma phase (color hue) can be cancelled by introducing this jitter component "out of phase" into the 629 kHz phase chroma. At the same time, the horizontal sync pulse triggers the gated counter circuit to produce the proper phase of chroma signal required to up-convert the chroma signal.

Referring to the block diagram (Fig. 12-12) again, you will note that four integrated circuits (IC 801 to 804) provide most of the circuitry required for up-conversion and down-conversion of the chroma signal during record and playback. Contained in IC 802 is the 3.58 MHz XTAL (crystal) oscillator whose output can be scoped at TP 807. During "record" this oscillator is switched "off." The other oscillator contained in IC 802 is the 2.517 MHz VCO and its associated phase-comparison circuit. Output from the VCO (IC 802 pin 17) is fed to pin 6 of IC 803, the gated counter circuit which produces the rotary-phase 629 kHz CW signal. One of the 629 kHz signals is fed to a divide-by-40 counter in the chip to produce a horizontal frequency signal which leaves the chip at pin 2 to provide an "FH" (horizontal frequency) feedback signal to the phase-

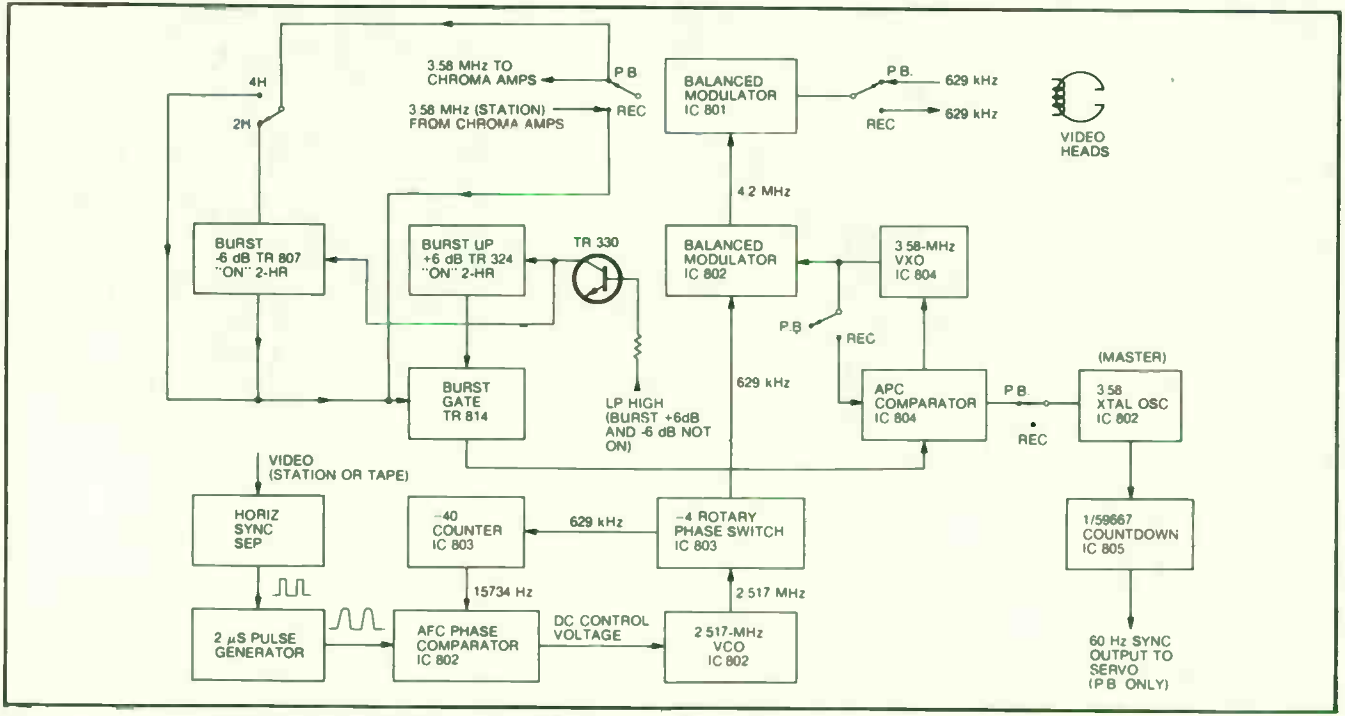


Fig. 12-12. Color oscillators block diagram (courtesy of RCA).

comparator circuitry located in IC 802. This signal enters the chip at pin 18. The other input to the AFC phase comparator is the 2 microsecond pulse which is timed by horizontal sync. This signal is produced by circuitry in IC 803 and comes out of the chip at pin 14. This pulse (TP 811 signal) is sent to the phase-comparator circuitry in IC 802 and enters the chip at pin 7. Thus, this feedback loop locks the 2.517 MHz VCO to a multiple of 160 times the horizontal scan frequency (2.517440 MHz).

This signal is fed to pin 6 of IC 803 where it is counted down to a nominal 629.360 kHz in the chip. Then, gating circuitry selects the proper output from the counter to provide a signal that represents phase zero with respect to the chroma signal phase, depending upon which head is on the tape at a particular time.

The direction of phase rotation, related to which head is on the tape at a given time, can be determined and preset by sensing whether the PG pulse is positive-going or negative going. The cylinder head PG (pulse generator) pulses from J1 pin 1 is fed to pin 7 of IC 803 where it selects the direction of rotation for the four-bit counter. The outputs of the four gates which select the proper counter signal phase are summed together into a single 629 kHz rotary-phase signal which emerges from the chip at pin 4. This output signal is sent back to the balanced modulator stage in IC 802 where it beats with 3.58 MHz CW from the 3.58 MHz VXO contained in IC 804. Output from the balanced modulator IC 802 comes out at pin 12 as a nominal 4.2 MHz signal. This signal is fed to the balanced modulator contained in IC 801 where the actual conversion of chroma information is performed.

The VXO contained in IC 804 is locked to the input chroma-signal burst during "record" by comparing its output to burst in an APC circuit. The 3.58 MHz burst signal enters IC 804 at pin 3 of the chip.

Transistor switches, TR815 and TR816 make the selection of which signals are compared to lock the oscillator during record and playback. During "record", 3.58 MHz VOX output emerges from the chip at pin 14 and is fed back to the APC circuit via transistor switch TR815. The other signal applied to the APC system is burst which is fed via burst-gate transistor TR814 and some limiter circuitry into chip pin 6. This burst signal can be scoped at TP813. During playback switch TR816 is turned "on" to supply reference signal from the 3.58 XTAL oscillator located in the IC 802 chip. This signal (from TR816) is fed into pin 3 of IC 804. The other signal (up-converted playback signal burst) enters the comparator via IC 804 pin 6. Thus in playback, the regenerated chroma signal is phase-locked to the locally generated 3.58 MHz signal provided by the 3.58 MHz crystal oscillator contained in IC 802. The crystal oscillator in IC 802 also drives a frequency counter (IC 805) which counts the 3.58 MHz signal down to 60 Hz to provide a reference signal to lock the head cylinder servo system during playback.

CYLINDER HEAD SERVO SYSTEM

The cylinder head servo system has two basic feedback control loops. The first loop (shown at the bottom of Fig. 12-13) is the speed control loop which maintains the head cylinder rotation at very nearly the nominal 1800 rpm. Cylinder head speed is sensed by sampling output from the D-D motor FG assembly. This is a 1.8 kHz sine wave signal which is fed to a frequency amplifier whose output is shaped into a 900 Hz square wave by a divide-by-2 counter.

The square wave signal is fed to a logic "AND gate" along with the output of a standard-time generator. This generator is a one-shot multivibrator whose pulse width is preset by the cylinder free-running speed control. This constant width pulse is compared with the pulse produced by the cylinder FG in an "AND" gate. The output of the gate is the difference between these two pulses. If the motor tends to run fast, the width of the gate input pulse (motor-speed sample) becomes narrower; thus, the output pulse which represents the difference between the sample pulse and the standard-time generator pulse also becomes narrower. The gate output pulse is integrated (filtered) to provide a dc signal to a motor drive circuit. In case the motor slows down, the pulse width becomes wider, more motor drive is produced, and the motor speeds up. In this way, the motor speed is held close to 1800 rpm.

The top section of the block diagram shows the phasing (position) control part of the servo system. During "record" the video signal is fed to a sync separator which separates out the 60 Hz vertical sync pulse. Vertical sync is fed to an amplifier and through a divide-by-2 counter to produce a 30 Hz square wave signal. This signal follows two paths. One path is an additional amplifier that generates the 30 Hz square wave control-track signal which is recorded along the bottom edge of the tape. The other path is through a time delay circuit which allows the video heads to be phased with respect to vertical sync. The output of this stage, known as the "record shifter", is a narrow sample pulse which is fed to a sample and hold circuit as the reference signal.

The feedback signal (represents speed and position of the

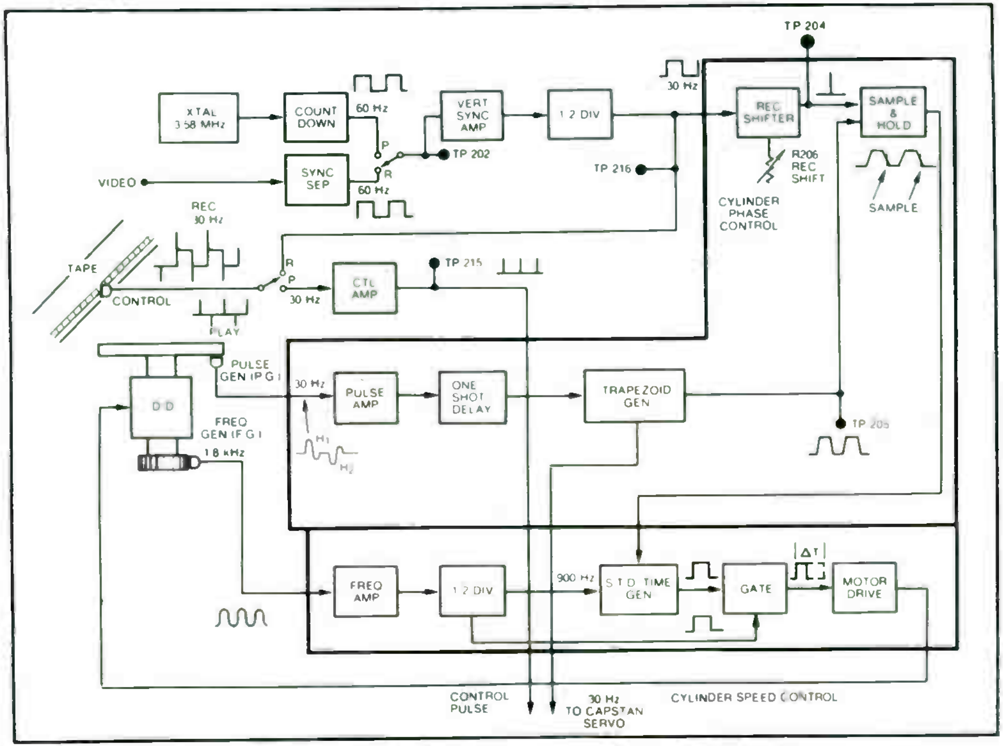


Fig. 12-13. Cylinder servo system block diagram (courtesy of RCA).

cylinder head) is taken from the cylinder motor pulse generator coils (PG). This 30 Hz signal tells two things; which head is on the tape and where the head is on the tape at any particular instant. After passing through a pulse-amplifier circuit and a "one-shot" delay, the signal drives a trapezoid generator. (The trapezoid signal is a waveform that has a definite leading edge rise time and a definite trailing edge fall time.) This signal is also fed to the sampling and hold circuit. When the cylinder head motor speed and phasing are exactly right, the trailing edge of the trapezoid is sampled at its midpoint. Each time a sample is taken, it is held at a dc voltage in the sample and hold circuit. Output of the sample and hold circuit is fed to the standard-time generator and it determines the pulse width of the pulse fed to the AND gate. Thus, by varying the width of this pulse, it is possible to provide a small increment of speed control necessary to accurately position the heads on the tape.

Let's now assume that the cylinder head is running slightly slow. In this instance, the sample will be taken at a higher point on the trapezoid resulting in more dc voltage output from the sample and hold circuit. This is translated into a change in conduction time of the standard-time generator such that the comparison process in the gate provides a signal to speed up the motor. The converse is true if the cylinder head is running slightly fast. In this instance, the sample is taken lower on the ramp and the motor is slowed down.

CAPSTAN SERVO SYSTEM

The capstan servo circuitry is much like that used for the head cylinder servo. Again, two loops are used—a speed control loop and a position or phasing control loop. Capstan motor speed is sensed by the capstan F.G. assembly which produces a sine wave of 480 Hz in the LP mode and 960 Hz in the SP mode. After amplification and processing by a divide-by-2 counter, the 240 Hz (LP mode) or 480 Hz (SP mode) square wave is available as input signal to a standard-time generator/AND gate circuit similar to that of the head cylinder servo. When the capstan motor is running at the correct speed, the input signal to the standard-time generator/gate circuit is 240 Hz. Note that in the LP mode, the 240 Hz signal is available at the output of the first divider. When the machine is operated in the SP mode, an additional frequency divider in the circuit forces the capstan motor to run at twice the speed in order to supply the 240 Hz input to the standard-time generator/gate circuit. A block diagram of the capstan servo system is shown in Fig. 12-14.

Output of the gate is a pulse representing the difference be-

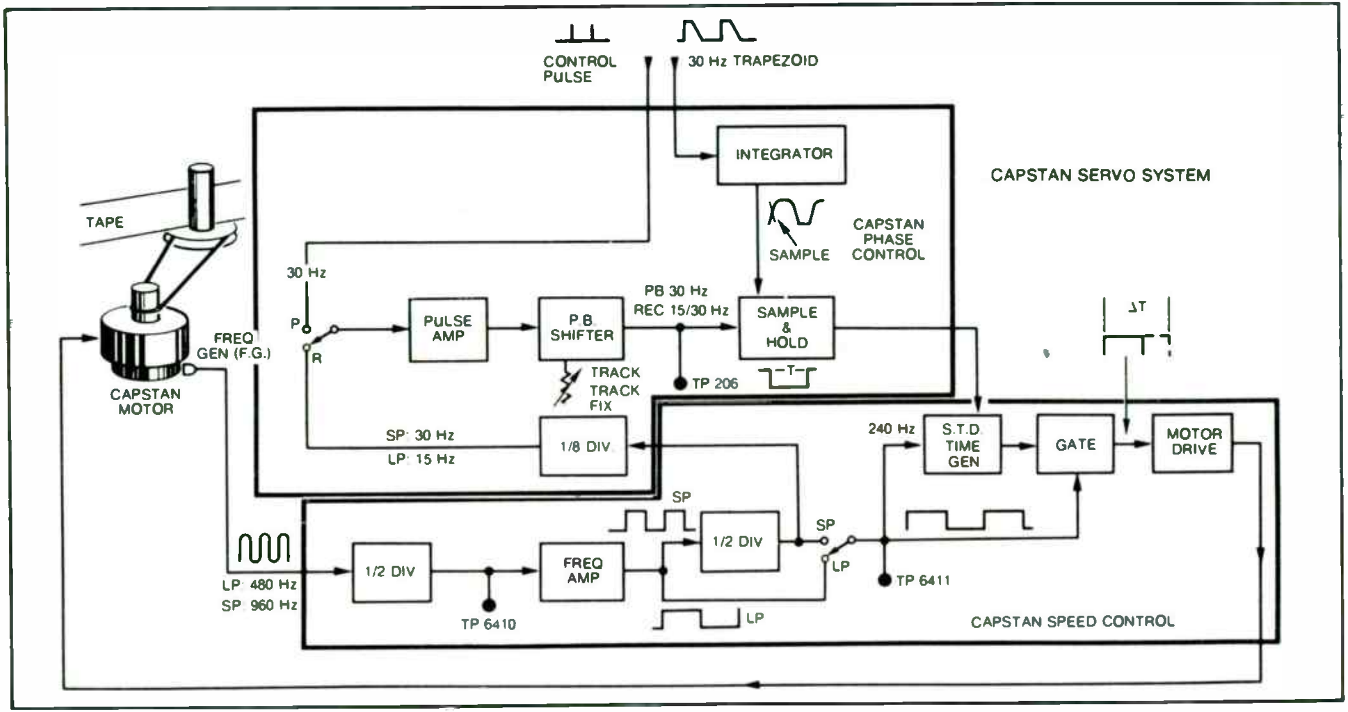


Fig. 12-14. Capstan servo system block diagram (courtesy of RCA).

tween the standard-time generator and the input square wave representing motor speed. This pulse is integrated and fed to the motor drive system so that the entire circuit stabilizes at roughly the correct speed. In a similar way to the cylinder head servo system, the pulse width of the standard time pulse is modified by the second part of the loop which is the phase control circuitry.

In "record" the capstan motor provides constant tape transportation speed. In this mode of operation, the feedback signal representing motor speed is taken from the output of the second frequency divider in the speed control chain. Thus, after passing through a divide-by-8 counter, a square wave signal of 30 Hz (SP) or 15 Hz (LP) is available to represent motor speed. This signal, after processing by a pulse amplifier and some delay circuitry, is a sample pulse which is applied as one input to the sample and hold circuit. The reference signal input to the sample and hold circuit is developed from the 30 Hz trapezoid produced by the head cylinder PG. As with the head cylinder servo, the output of the sample and hold circuit is a dc voltage which represents small increments in speed (phase) changes in the capstan motor operation. This dc voltage is fed to the standard-time generator to modify the pulse width and thus produce a vernier-change in motor speed.

During "playback" the 30 Hz control-track pulse on the video tape is fed to the pulse amplifier in place of the output of the divide-by-8 counter. This signal (after processing) becomes the sample pulse. Thus, any changes in transportation speed are sensed by a change in the sample point so that the changes in output of the sample and hold circuit provides appropriate dc control to the capstan motor to correct the speed/position errors.

VCR CYLINDER HEAD DRIVE CONSIDERATIONS

One of the problems in designing a good video tape recorder for home use is to accurately control the operation of the video scanning process. Most industrial VCRs, as well as many home VCRs, use a belt drive system to operate the head cylinder. The belt drive system drives the head cylinder at a speed slightly faster than the nominal 1800 rpm. Locking-in the cylinder head thus depends upon using a servo controlled braking system that drags the cylinder head down to the required exact 1800 rpm depending upon belt slippage to provide the degree of isolation between the main drive and the servo-controlled cylinder head. This system works well with most TV sets, but on some you may see some horizontal instability (jitter). Also, the cylinder head in some machines can be massive and thus difficult to accurately servo control because of the inertia of the rotating mass.

In the VBT200 VCR, a direct-drive motor system, used in conjunction with a relatively low-mass cylinder head assembly, provides very precise control over cylinder head rotation; thus, assuring very accurate horizontal time-base timing and elimination of most "jitter" problems. To accomplish this technique of providing very close control of the cylinder head motor, an entirely new direct-drive (D-D) assembly is used.

THREE-PHASE FULL-WAVE BILATERAL DRIVE CIRCUIT

Although at first glance, the motor might appear to be a simple 12 volt dc motor, it is far from that. Actually, the motor used to drive the video heads in this machine is a multiple three-phase motor that is driven by a very precisely controlled three-phase ac inverter. The windings, called the main coils of the motor, provide the motive power to drive the motor. Feedback necessary to sustain oscillation of the three-phase inverter is sampled by position indicator coils designed so that the feedback signal always tells the torque instruction circuit which transistor combination should be turned "on" next to sustain rotation of the motor. Refer to the drive circuit block diagram (Fig. 12-15).

The motor speed is modified by control input from the cylinder-servo system which is compared against a standard voltage in the drive instruction logic circuit. The output of the drive instruction logic circuit is then fed to the position indicator, torque direction circuit, and torque instruction circuitry so that the rotation of the motor becomes locked to the cylinder servo system instructions.

DETAILED CYLINDER SERVO SYSTEM ANALYSIS

The cylinder servo system operates differently in "play" and "record" modes. In the "record" mode, the cylinder servo is locked to vertical sync taken from the sync separator located on the chroma board. Input sync is fed to an amplifier stage in IC 201 via plug 21 pin 3 and the record/playback switch. In the playback mode, the cylinder runs at a constant 1800 rpm because it is locked to a 60 Hz signal obtained via a countdown chip clocked by the 3.58 MHz crystal oscillator on the chroma board. In either case, the output of the IC 201 amplifier is fed to a divide-by-2 counter (one-shot multivibrator) which outputs a 30 Hz signal at pin 26 of the chip. This 30 Hz signal supplies the control track signal during "record", as well as

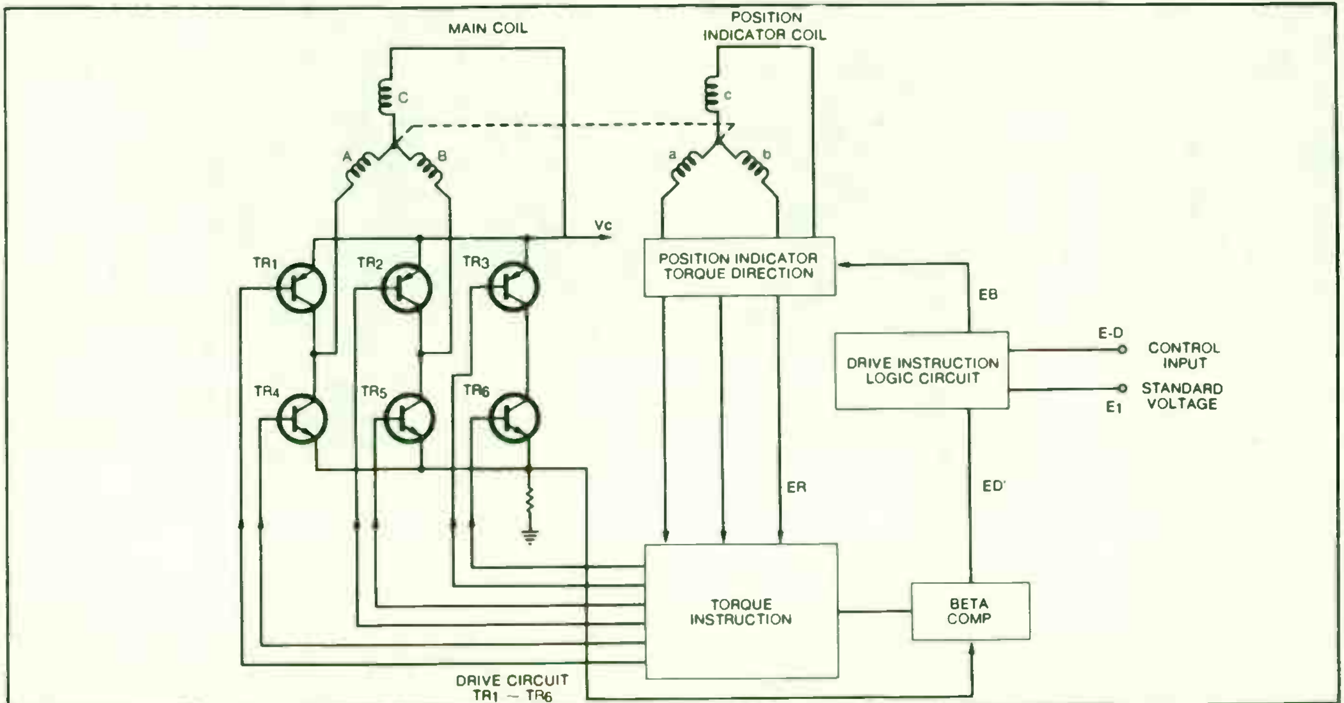


Fig. 12-15 D-D cylinder motor bilateral drive circuit (courtesy of RCA).

furnishing input (via chip pin 21) to the record shifter one-shot-multivibrator. Record shifter output is at pin 18 of the chip. The record shifter is an adjustable time-delay circuit that allows the vertical sync pulse to be physically positioned on the tape.

The other signal used in the sampling process is a 30 Hz trapezoid. This signal is generated by the cylinder PG (pulse generator) circuit. The cylinder PG signal is an alternating positive and negative pulse taken from the PG magnetic pick-up located in the D-D motor assembly. The PG signal enters the servo system through the motor drive board which contains a differentiator circuit and amplifier that receives input via P27-1. Output from transistor TR2115 is a positive pulse signal when head-one contacts the tape and a negative pulse when head two contacts the tape. These pulses are fed to the servo board through wire jumper J2. The input signal is viewable at TP 211. Following TP 211, the positive and the negative pulses are separately processed.

The positive pulse is fed to IC 201 pin 2 (via diode D206) where it triggers one of the two PG shifter one-shot multivibrators. Output of this one-shot multivibrator triggers (sets) a flip-flop (FF) in IC 201. The other PG shifter multivibrator located in IC 202 is triggered by the negative PG pulse which is inverted by transistor TR211. Transistor TR211 signal resets flip-flop "FF" in IC 201.

Output from flip-flop "FF" is a 30 Hz square wave signal in which the duty-cycle of the positive and negative half-cycles are variable via the individual PG shifter controls. This signal (scoped at TP 201) drives a trapezoid generator which is an integral part of IC 201. The 30 Hz PG signal also provides head switching signals to turn "on" the individual head preamplifiers on the FM modulator/head amplifier board.

The PG flip-flop output is fed to the trapezoid generator via IC 201 pin 15. The trapezoid generator generates a 30 Hz trapezoid signal that is timed so that the sample pulse (IC 201 pin 14) samples the center of the trailing edge of the trapezoid signal when the cylinder head (upper cylinder) is running at the correct speed and locked to the system signals. Sample gate action can be viewed with a dual-trace scope by scoping test points TP 204 (sample gate-pulse signal) and TP 205 (trapezoid signal). See Fig. 12-16.

The sample gate output (IC 201 pin 12) is a dc voltage of about +6.5 volts which swings "up" or "down" depending upon where the sample is taken on the trapezoid, as determined by the physical position of the heads on the video tape at the instant of sampling. This voltage, limited by diodes D209 and D210, is fed to pin 10 of IC

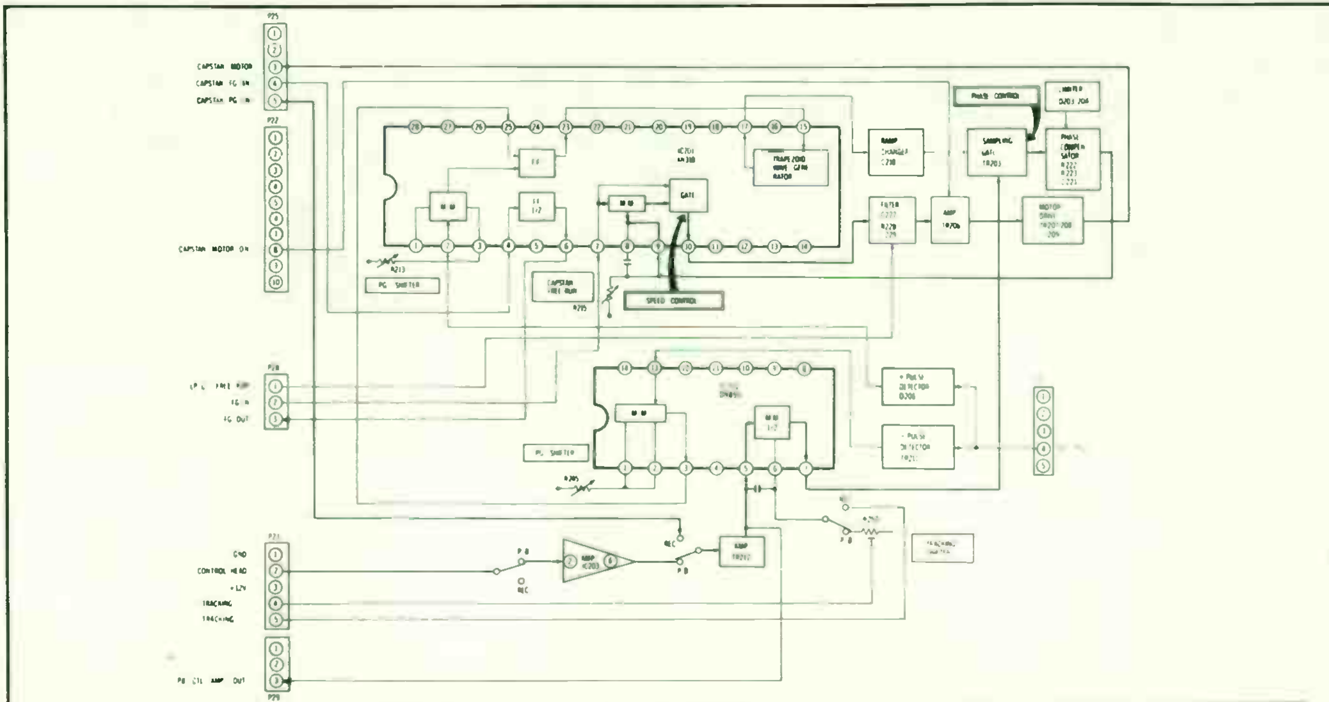


Fig. 12-16. Capstan servo block diagram (courtesy of RCA).

202 where it modifies the pulse width of a one-shot multivibrator which serves as the standard time generator. Associated with this one-shot multivibrator is the cylinder free-run control whose adjustment sets the pulse width of the standard-time generator so that the cylinder head free-running speed is very close to 1800 rpm. Standard-time generator output (IC 202 pin 2) is sent to a logic AND gate located on the motor control board via jumper J1.

Contained on the motor drive board is the motor speed control circuitry associated with the cylinder head motor FG pick-up. The cylinder head FG signal is a 1.8 kHz tone which is fed to the input of a three transistor "FG amplifier" (transistors TR2101, 02, and 03). The input signal can be scope checked at TP 2101. FG amplifier output is counted down to 900 Hz by counter IC 2101. The 900 Hz output is fed to gate transistor TR2104 and also fed back to pin 12 of IC 202 on the servo board where it triggers the standard-time generator (one shot) contained in the IC. Also entering the standard-time generator is the output of the phase-control circuitry of IC 201 (pin 10 of IC 202) along with the cylinder free-run control voltage. The combination of the bias introduced by cylinder free-run control (R245) and the dc phase-control signal sets the output pulse width of the standard-time generator (output is via pin 9 of IC 202). This signal is sent back to the gate transistor (TR2104) on the D-D motor drive board via jumper J1.

The speed control gate (TR2104) compares the counted down (900 Hz) FG pulse and the standard-time generator pulse, producing an output which represents the time difference between the two. Circuit parameters are such that the output of the filter amplifier that drives D-D motor-control IC 2102 pin 5 is a dc voltage of about 4.8 volts when the D-D motor speed is correct and the servo system is locked. The feedback loop conditions are such that if the system is not locked, or the motor tends to run slow, the dc input to pin 5 of IC 2102 will be somewhat greater than the nominal 4.8 volts. If the motor speed tends to be fast, the IC 2102 input will be somewhat lower than the nominal 4.8 volts.

CAPSTAN SERVO OPERATIONS

The capstan servo system is similar in concept to the cylinder servo. As with the cylinder head servo, the capstan servo has two modes of operation. In "record" mode, the capstan servo system maintains constant tape speed for either 2-hour (SP) or 4-hour (LP) operation. In playback, the system maintains constant speed as well as maintaining position control of the tape so that the video heads on the cylinder unit will properly track the recorded information on the video tape. Refer to the capstan servo block diagram (Fig. 12-17).

To maintain constant tape speed in "record," the capstan servo is referenced to the cylinder PG derived trapezoid signal. The trapezoid signal, after some integration by "ramp-changer" capacitor C218, is fed to a sample-gate transistor (TR203) along with the sample-gate signal derived from the capstan PG signal. The sample-gate signal is derived from the counter system on the SP/LP select board (30 Hz in "SP" and 15 Hz in "LP" mode). Output from the sample gate is an amplitude-limited dc voltage (limiter diodes D203 and D204) which modifies the pulse width of the capstan standard-time generator (MM) via IC 201 pin 9. The basic pulse width is set with capstan free-run controls. Output from the standard-time generator drives a logic AND gate, along with the capstan motor FG signal. The output of the speed-control AND gate leaves IC 201 via pin 10. This pulse, after integration in a filter network consisting of capacitor C222 and associated components, is base bias for amplifier transistor TR206. Also associated with amplifier TR206 is a logic input from the transport/control board which indicates that the logical sequences necessary to initiate various modes of operation have been completed before the capstan motor is allowed to operate and move tape. Output from the amplifier TR206 is fed to a three-transistor motor drive circuit that supplies dc voltage to the capstan motor. This voltage leaves the servo board via P25-3.

The rough speed control of the capstan motor is accomplished in basically the same manner as was described for the cylinder servo. In this case, the capstan FG signal (960 Hz or 480 Hz depending upon the mode of operation) is fed to the servo board via P25-4 where it is applied as input to a flip-flop (FF) contained on IC 201. This input signal can be scoped at TP Y203. Output of this flip-flop (half input frequency) comes out at pin 6 as a 480 Hz or 240 Hz signal (SP or LP) which is directed to the SP/LP auto select board via P28-3. An amplifier/inverter stage on the SP/LP board processes the signal to a level sufficient to drive a multivibrator back on the servo board that is part of IC 201. However, more importantly, this serves as a pickoff point where the additional stage of frequency division can be switched "in" to feed a 240 Hz signal to the standard-time generator when in the "SP" mode.

Also on the SP/LP board is the divide-by-8 counter that produces the capstan pulse generator (PG) signal for input to the servo phase-control circuitry when the VCR is in the "record" mode. A

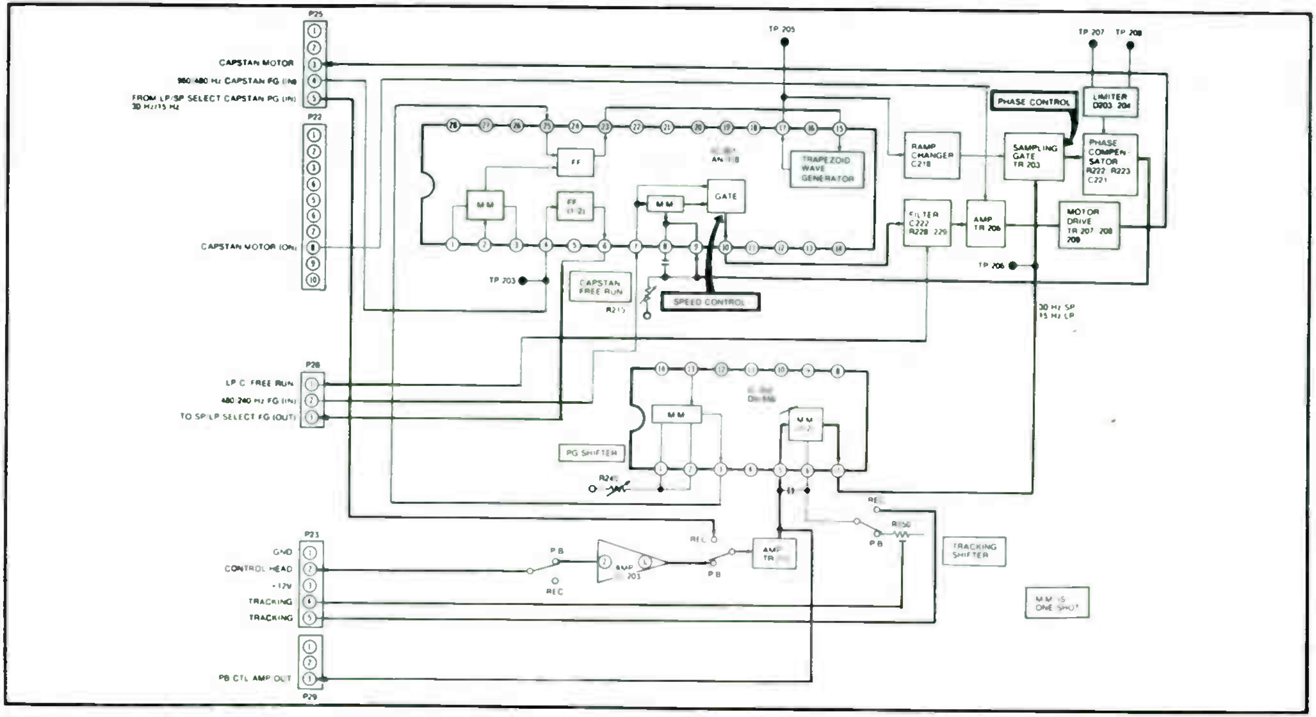


Fig. 12-17. Capstan servo detailed block diagram (courtesy of RCA).

pickoff from this counter supplies the SP mode 240 Hz FG signal.

The 30 Hz or 15 Hz counter output "PG" signal is processed into the sample pulse which samples the trapezoid signal to produce the control voltage necessary to provide correct motor speed. The signal frequency is 30 Hz in the "SP" mode and 15 Hz when the unit is in the "LP" mode.

The capstan PG signal enters the servo board on P25-5 where it is routed to the "record/play" switch. When the VCR is in the "record" mode, the signal is amplified by transistor TR212 and then serves to trigger the tracking shifter one-shot multivibrator part of IC 202. Output of this stage, which interfaces with the tracking control when the machine is in playback, comes out of IC 202 via pin 7. After some additional processing (differentiation), the signal is fed to the sample gate as the sample pulse which is indicative of the motor speed error.

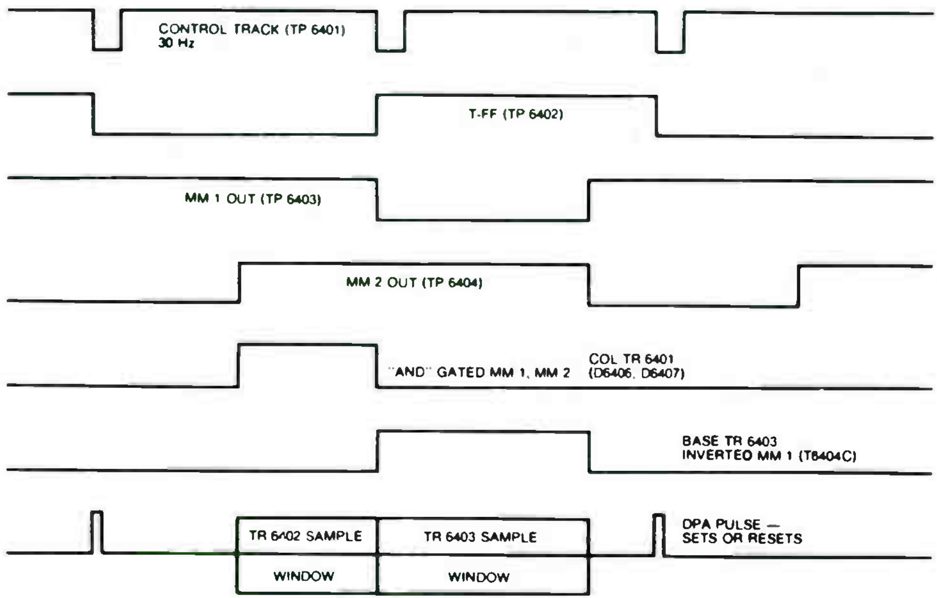
SP/LP AUTO SELECT CIRCUITS

This VCR machine uses special logic and control circuitry to allow the operator to manually select 2-hour or 4-hour operation when recording a tape. During playback, logic and timing circuitry samples the control-track signal and directs electronic switching, causing the machine to play back the tape at the correct speed. Note the auto select timing diagram shown in Fig. 12-18.

In addition to setting the capstan motor speed for SP (Standard Play) or LP (Long Play) operation, the SP/LP auto select circuit controls four additional functions that are necessary for proper SP and LP performance during "record" and "playback". Through use of a control voltage known as "LP high" (+12 volt source in LP mode), the audio record and playback equalization are changed to optimize frequency response in both modes of operation. Also, during the LP record mode, additional video pre-emphasis is introduced and the "½-FH" frequency interleave circuitry is activated. In playback mode, the "LP-high" voltage switches in complementary video-frequency de-emphasis and an "½-FH" interleave cancellation square wave signal.

The SP/LP auto select board also provides a muting voltage which is present when the machine senses erroneous control-track frequency which is indicative of wrong speed operation. For the interval of time necessary for the machine to change speeds and stabilize its operation, the muting voltage is present. Finally, and most important, the SP/LP auto select circuitry electronically

SP REC/SP PLAY OR LP REC/LP PLAY
(Normal Operation)



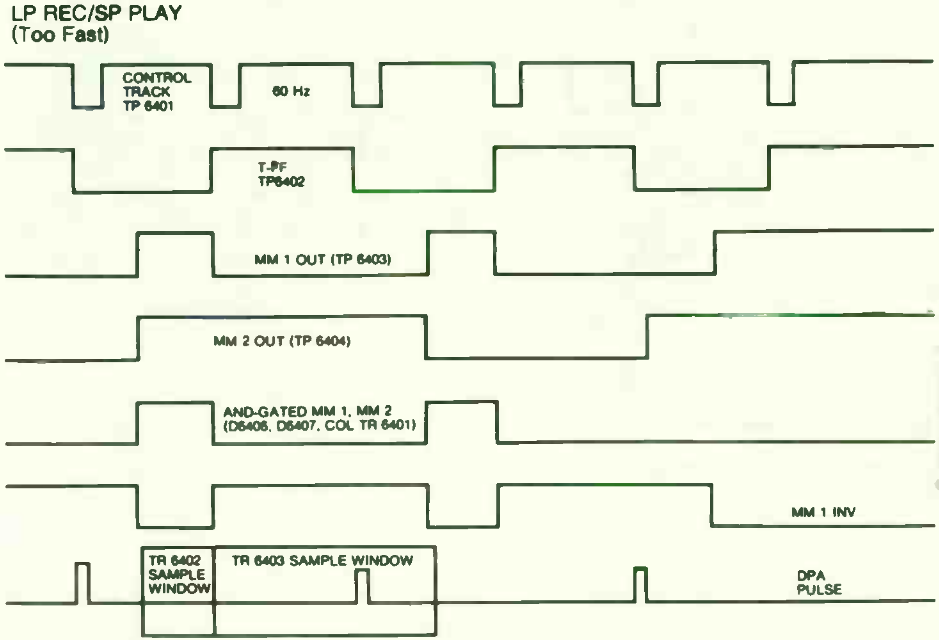


Fig. 12-18. SP/LP auto select timing diagram (courtesy of RCA).

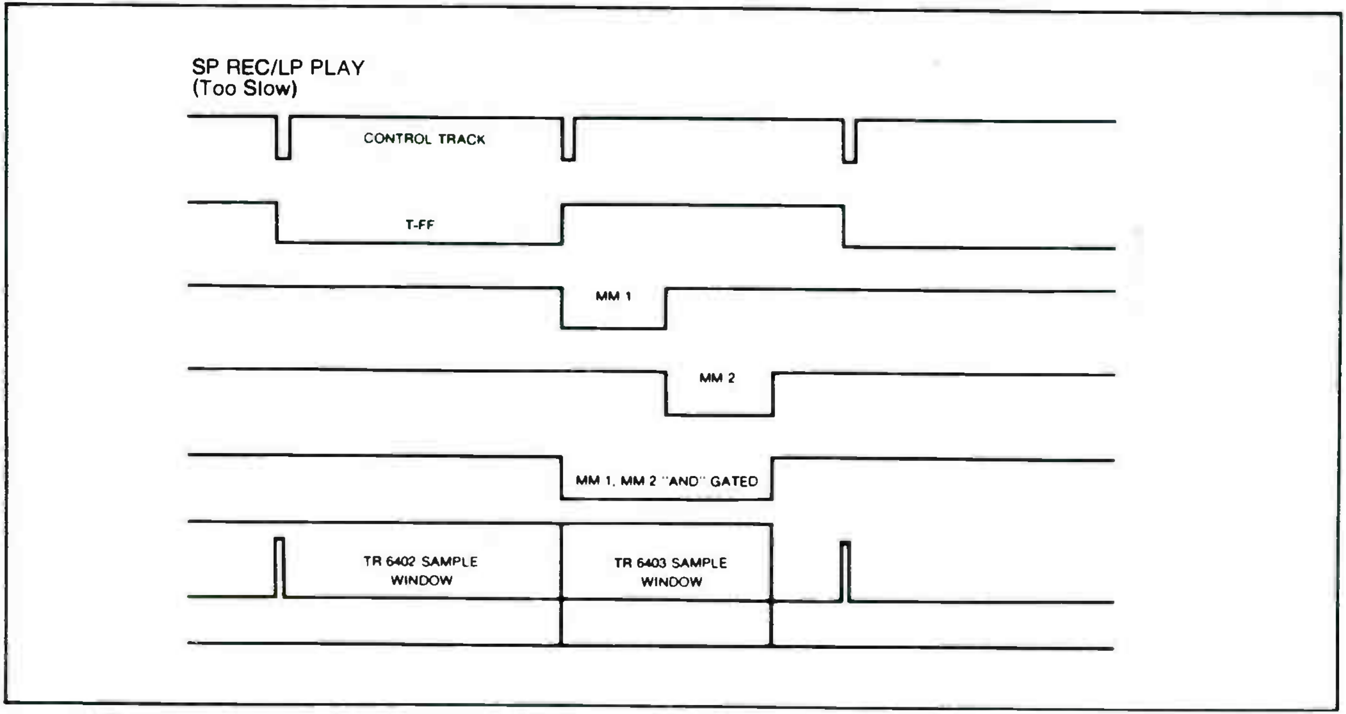


Fig. 12-18 SP/LP auto select timing diagram (courtesy of RCA). (Continued from page 387.)

switches the capstan motor speed from the SP (2 hour) to the LP (4 hour) mode or vice versa.

CAPSTAN MOTOR SPEED SELECTION

The capstan motor SP/LP speed selection is accomplished by switching "in" or "out" an extra stage of frequency division in the capstan FG (frequency generator) circuit. To satisfy the requirements of the capstan servo system, the FG signal input to the standard-time generator and logic AND gate must be a constant 240 Hz. Refer to the block diagram (Fig. 12-19). During "SP Record", base voltage is applied to transistor TR6405, causing it to conduct and load down the signal output of amplifier TR6411. Thus, it can be seen that the signal input to the standard-time generator (signal can be scoped at TP 6411 on the SP/LP select board) must come from the output of IC 6403 pin 3 which is an additional divide-by-2 counter. Under these conditions the capstan motor is forced to run at the SP speed. When LP operation is desired, transistor TR6406 is turned "on" and thus shorts the signal from the pin 3 output of IC 6403. At the same time, the signal from the collector of TR6405 is fed to the standard-time generator via OR gate diode D6418. When the unit is in "play", the appropriate choice of FG input signal from the OR gate is automatically selected by the logic circuit contained on the same board. The action of the circuit in this area being such that either transistor TR6405 is driven into conduction or transistor TR6406 is conducting, making the proper choice of FG signal available to the standard-time generator and logic gate.

SP/LP AUTO SELECT LOGIC

The logic circuit used to sample the control track and control the SP/LP operational modes is somewhat complicated as shown in Fig. 12-20. Basically, two transistors (TR6402) and TR6403) are connected in what is known as a "set/reset flip-flop". This term means that when the FF (flip-flop) is triggered into one mode, it will remain so until it is triggered into the opposite state. Note in the circuit diagram, that the output of this circuit is a line which is designated as "LP high" (TP 6406 voltage). This line is applied to a pair of OR gates consisting of diodes D6408 and D6409, D6410, and D6411 respectively. Outputs from these gates ultimately drive two switching transistors designated TR6405 and TR6409.

During "LP-record" mode, +12 volts applied to the base of transistor TR6406) via logic diode D6409) causes this device to saturate. This action shorts out the FG signal from amplifier transis-

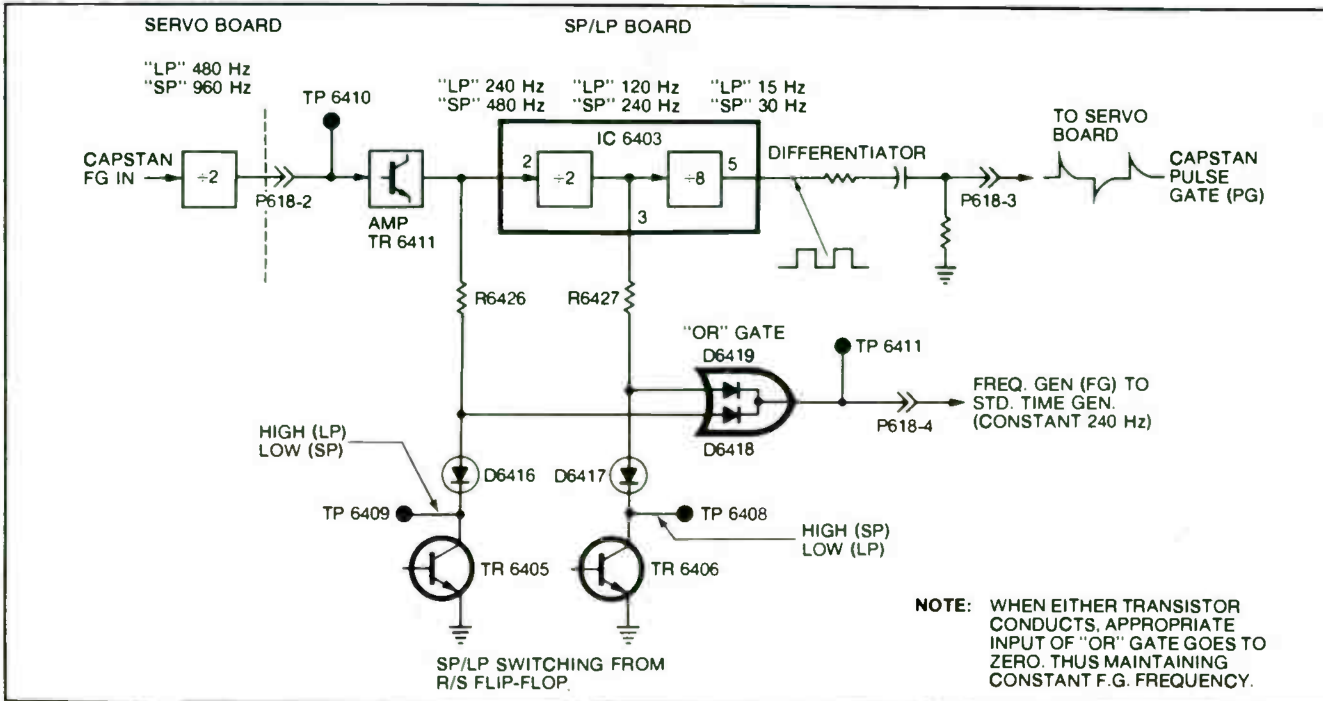


Fig. 12-19. SP/LP capstan speed selector (courtesy of RCA).

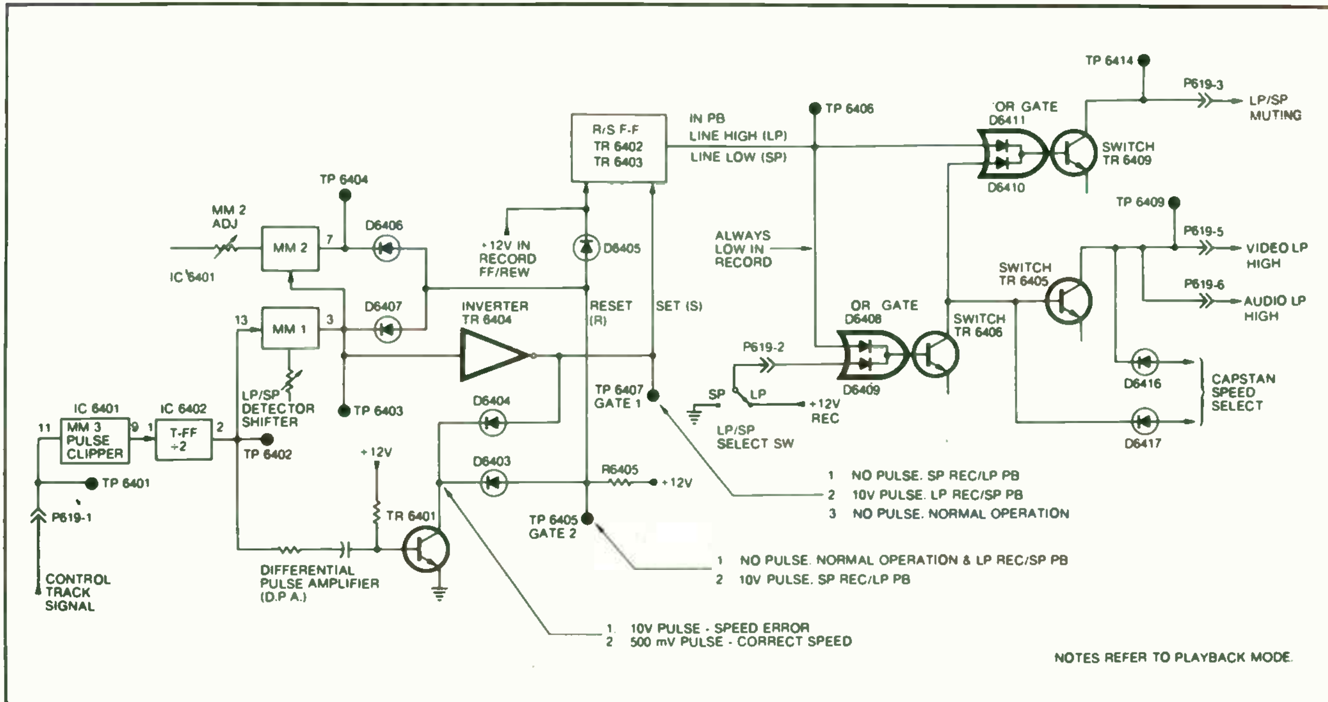


Fig. 12-20. SP/LP auto select logic (courtesy of RCA).

tor TR6411 and forces the FG input to the standard time generator to be that obtained from the extra stage of frequency division in IC 6403. This action also cuts off switch transistor TR6405 causing its collector voltage (TP 6409) to go high (+12 volts) providing sources of voltages designated "video LP high" and "audio LP high" to become available at P619-5 and P619-6. These voltages are routed to the luminance process board and the audio board.

When in the "SP-record" mode, switch transistor TR6406 is turned "off" and switch transistor TR6405 is thus saturated driving the TP 6409 "LP-high" line to the LOW (0V) logic state. At the same time, diode D6416 shorts the signal that comes directly from transistor TR6411 making the FG signal available to the standard time generator that came from the extra stage of frequency division in IC 6403.

In "play," the operating mode is determined by the "PL high" output of the R/S flip-flop (dc voltage at TP 6406). As shown in Fig. 12-20, this voltage is high in the LP mode and low in the SP mode. Whenever the machine is in the LP mode of operation, the output of the R/S FF is high at TP 6406. Under these conditions, bias voltage is fed to the base of switch transistor TR6406 via OR gate diode D6408. Now switch transistor TR6405 is cut off and the proper conditions required for LP operation are set-up. Conversely, when the machine is in the SP mode of operation, the flip-flop output is low at TP6406 and switch transistor TR6406 is cut off.

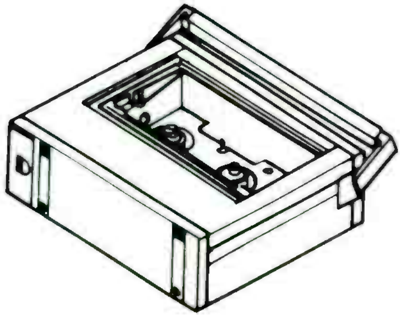
The remainder of the circuitry is dedicated to controlling the state of the R/S flip-flop. Note that two input lines control the flip-flop. These are designated "set" (S) and "reset" (R). When the machine is operating in the correct mode (playing back tape correctly), signals are not present on either of the control lines. In the event of an error condition, a pulse voltage appears on either the (S) or the (R) line which causes the flip-flop to switch to the other state and set up the necessary conditions for the proper playback mode.

For example, if the machine is running too slow (such as if the machine was running in the LP mode, but the tape to be played back was an SP recording), a pulse will appear on the FF (S) line (TP 6407) which will cause the flip-flop to be driven to the opposite state to establish the SP playback mode. The opposite error condition (LP recording with machine in SP speed mode) Q will cause a pulse to appear on the (R) line (TP 6405) which will cause the machine to enter the LP mode. The actual pulse that is used to set or reset the flip-flop is produced by transistor TR6401 (differential pulse amplifier DPA). The base of this device is timed by the control-track signal after it is processed by a pulse clipper stage contained in IC 6401 and a "T-type" flip-flop. The "T type" flip-flop is an IC device (IC 6402) which changes stage every time it is triggered. Thus, the device acts as a divide-by-2 counter.

As can be seen in the timing diagram (normal operation), the 30 Hz control track signal at TP 6401 triggers the "T" flip-flop to change state on the leading edge of the control track signal. Thus, the output of the "T" is a 15 Hz square wave which can be scoped at TP 6402. The leading (rising) edge of the "T" FF (TP 6402 signal) triggers a monostable, or one-shot multivibrator, which has a conduction period of about 25 ms. This multivibrator located in IC 6401, produces a trigger for a second monostable, one-shot designated as "MM 2." Note in the timing diagram (Fig. 12-18) that the second one-shot triggers on the rising edge of the MM-1 signal. The period of this one-shot is also 25 ms. These two signals are combined in a logical AND function by diodes D6406 and D6407. This output is then connected in another logic AND configuration to the collector of TR6401 (DPA). Thus, the DPA pulse is prevented from triggering the R/S flip-flop except in intervals of time when both diodes D6406 and D6407 are reverse biased due to both one-shot multivibrator outputs being in the logic-high stages. This condition only occurs in the event of a speed error which is causing the machine to slow.

The logic necessary to control the "set" (S) line of the R/S flip-flop is provided by taking output signal from MM1 and inverting it in transistor TR6404. The output of inverter transistor TR6404 is used in a logical AND configuration with the DPA signal via diode D6404. As can be seen in the timing diagrams a pulse at TP 6407 is only available under conditions when the capstan motor is running to fast. Application of this pulse then changes the state of the flip-flop and causes the machine to enter the LP mode of operation which is necessary to restore correct frequency to the control track signal.

Chapter 13



JVC Videocassette Recorders

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The JVC HR 7300U shown in Fig. 13-1 uses the VHS format and achieves a very low tape consumption. Recording time in the standard mode is two hours. Increased recording time results from the narrow gap video heads, high sensitivity video tape and the slant azimuth recording head configuration which eliminates the need for a guard band between recorded tracks. Also, the VHS format takes into consideration special operating modes such as still picture, slow motion, and speed playback.

The VHS format presents several technical challenges. First among these were obtaining high picture quality and high resolution despite the slow relative speed between the tape and video heads, improving signal to noise ratio (S/N), and preventing black to white reversal phenomena to the short recording wavelength of 1.2 μm. Also the ± 6 degree azimuth angle of the video heads alone is not sufficient to eliminate crosstalk from the lowband converted color signal.

Steps for solving these difficulties included adoption of a non-linear emphasis circuit and selecting the emphasis amount for optimum S/N. The reversal problem was overcome by using a double limiter circuit, while a phase shift system has been designed for eliminating color crosstalk. By using a four head upper drum, the HR-7300U can record and play back in both two hour standard VHS

Fig. 13-1. The HR-7300U JVC VCR machine (courtesy of US JVC Corp.).

and six hour extended modes. The design also permits playback of prerecorded tapes in the 4 hour mode.

This machine features "feather touch" operation. Just a light touch of the machine buttons or remote control unit keys supplies mode command signals to the various circuits, motors, switches, and solenoids to set up the selected mode. In order to protect the set and the tape, various internal sensors are provided. By continuously monitoring these, the decision is made to continue or stop the mode in progress, or shift to another mode.

A built-in microprocessor assists in detection and control of the operating modes. The microcomputer is preprogrammed and the program can be altered. While a basic understanding of the principles of a microcomputer would be helpful, for practical purposes in servicing, an understanding of which input signals result in which specific output signals is more important. In the following circuit description, "mechanism control" is shortened to "mechacon".

BLOCK DIAGRAM DESCRIPTION

As we go through this circuit description refer to Fig. 13-2. The mechacon circuit receives mode command signals from the operation keys and mode detect signals from the various sensors and produces signals for driving the motors and solenoids to set up the required modes. Mode control signals are also sent to the appropriate circuit boards. These control functions are performed by the central processing unit (CPU) of IC2, which is a one-chip four-bit microcomputer. In the block diagram, the input signal generators from the function keys and sensors are shown at the left of the CPU,

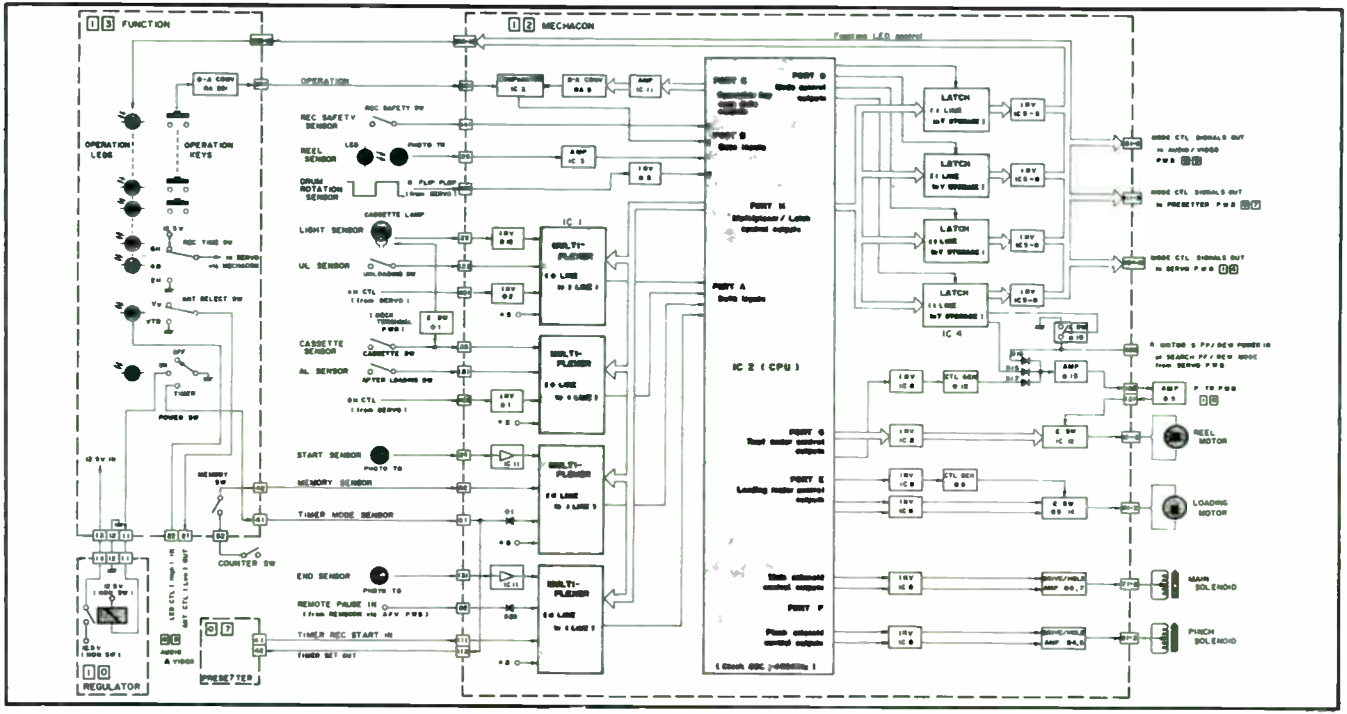


Fig. 13-2. Mechacon (mechanism) block diagram (courtesy of US JVC Corp.).

while the motors and solenoids controlled by the CPU output signals are located at the right, together with the circuit board connectors supplied by CPU signals.

Note that the CPU has only two sets of input ports, (A and B) totalling 8 bits, while a total of 14 inputs are obtained from the operation keys and sensors. For this reason, IC1 multiplexer is provided as an input expander. Using the three-bit bus select signal from CPU port H (strobe data irrelevant), one output is selected from among four inputs and sent to the CPU input ports.

Thus, the four 4 to 1 multiplexer circuits of IC1 supply four-bit outputs to the CPU input A ports from 16 inputs and the remaining operation and sensor signals go directly to the input B ports. At the same time, the four seven-bit latches of IC4 function as output expanders. The four-bit outputs of the CPU D ports are expanded to 28 latched outputs. Latch positions are determined by the three-bit bus select from the CPU H ports and the strobe data.

IC4 outputs are supplied through open collector inverters as either low or open (high when connected to other boards) outputs to the other circuit boards. Drive signals for motors and solenoids are obtained directly through inverters from CPU output ports E, F, and G.

OVERALL SIGNAL FLOW

During a selected mode, high from IC3 comparator goes to CPU input port B to signify that the mode is being held. At this time, the four-bit operation key scan data are obtained from CPU port C in cycle of 7.5 msec (133 Hz) for the binary range of 0000 to 1111. The digital sequence goes through IC11 buffer and RA6 digital to analog converter (DAC) to become a sequential voltage in 16 steps from 0 volts to about 9.5 volts, which is fed to the comparator at 133 Hz.

When an operation key is pressed, a fixed dc voltage, determined by the resistance combination of function board RA1 (DAC) goes to the non-invert input of the comparator. At the same time, the 16-step scan data is applied to the invert terminal. The comparator produces either a high or a low output.

If the scan data is higher than the fixed input from the operation key, low output from the comparator goes to CPU port B. The CPU interprets this as pressing of an operation key, resets port C and sends a new four-bit output sequence of 0000, 0001, etc. As a result, the comparator output again becomes high. When one of the 16 steps from the operation key to the comparator becomes low, a low comparator output goes to CPU port B. By detecting this low together with the output status of port C, the CPU can detect which specific operation key has been pressed. This process will be covered in more detail later.

The CPU also detects other input port data. These include timer, cassette switch, cassette lamp, and the various sensors. Data pertaining to the depressed key are checked, such as whether it is the same as the mode in progress or if a shift to a newly selected mode is possible from the present mode. Outputs corresponding to the operation key are then sent to the motors, solenoids and circuit boards.

From port D, the four-bit output goes to IC4 latch, resulting in 28 latched outputs (in practice, 5 are not used) which are sent through open collector inverters to the circuit boards. Control signals also go to the function board for lighting the LEDs corresponding to the depressed operation key control.

Three bits of the four-bit port E output are for loading motor control. These are supplied via inverters to the control generator for determining motor torque and to electronic switches Q9 to Q14 which select motor direction. For example, in the play mode, rotation is in the loading direction. When the loading mechanism begins operation and the unloading (UL) switch is off, the CPU detects the start of loading. At the end of loading, the after loading (AL) comes on, at which time the CPU detects the end of loading and stops the loading motor. The unloading process is the opposite of this.

The four-bit port F output is divided into two bits each. These go via inverters to the solenoid drive and hold amplifiers for switching the main and pinch solenoids on and off according to mode. The pinch solenoid is driven after completion of loading (AL switch on) during play and recording.

Four bits from port G are supplied through an inverter to electronic switch IC12 for controlling forward and reverse rotation of the reel motor. Rotational torque is controlled by drive voltage from the servo board to D16 during search, fast forward, and rewind (S-FF and S-REW). During ordinary FF and REW, supply is from port D with control via an inverter and control generator (Q15) at D17. IC3 latch provides control via D15 during unloading, at short rewind, at the start of FF/REW and in the idler mode (during which the reel idler shifts toward the supply or take-up reel disk).

During play/rec, take-up is driven mechanically by the capstan motor. The select bus form port C selects the sensor state data required for the particular mode and supplies them to the CPU as auto stop input data.

OPERATION KEY-IN CIRCUIT

Note: the mechacon circuit is completely controlled by the CPU, eliminating the need for complex drive and other circuits. Thus, only the operation key-in, DAC and comparator functions will now be outlined.

Referring to Fig. 13-3, when the sub-power switch is set from off to on, a "high" pulse of approximately 60 msec duration from IC3 pin 2 goes to the reset terminals of the CPU, resetting the CPU and producing the stop mode. All port outputs are at stop mode at this time.

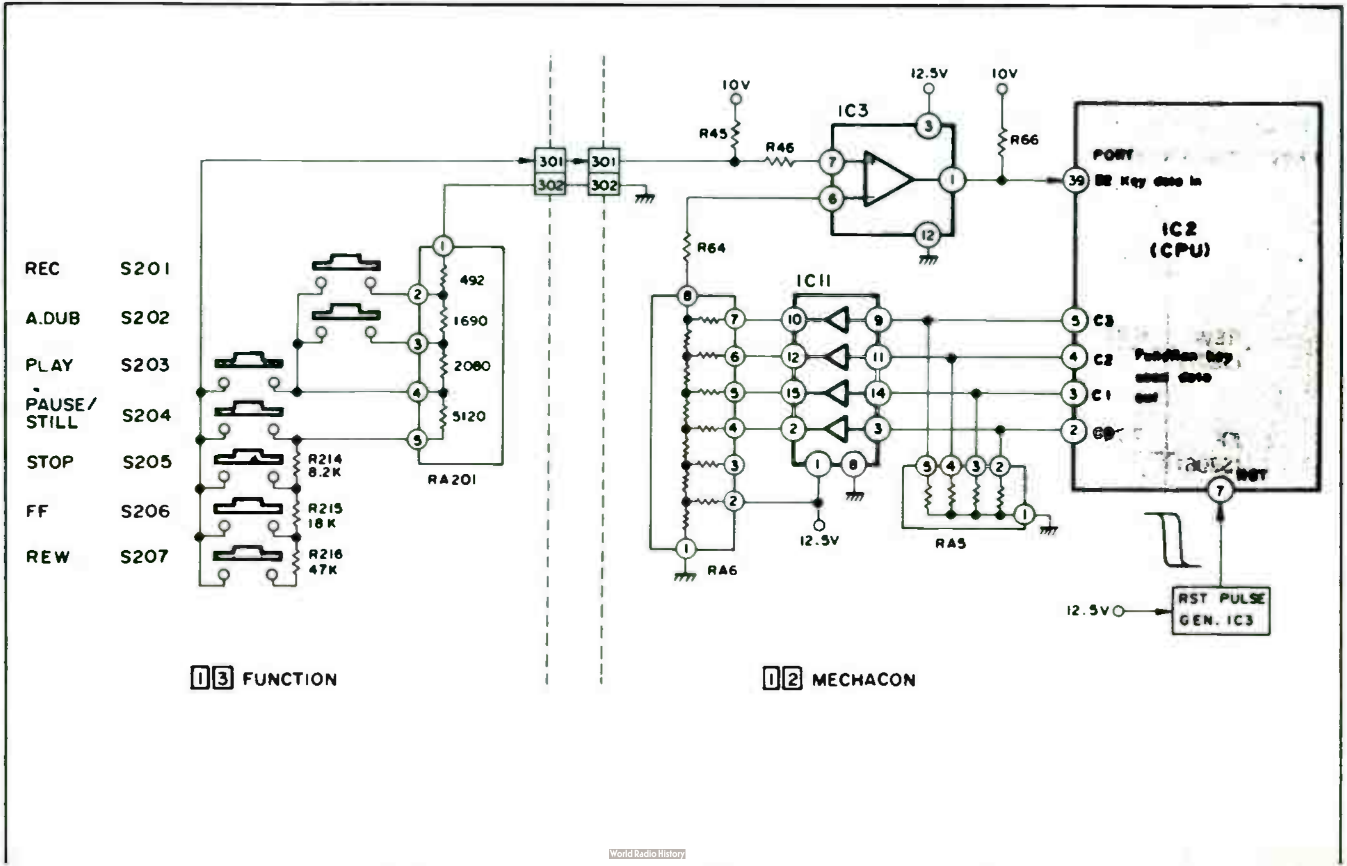
The four-bit operation key scan data output from port C covers the binary digits from 0000 to 1111 in 0.16 msec increments, then produces 1111 for about 5 msec. Each cycle is about 7.5 msec (133 Hz) in duration.

Via IC11 buffer converter, the four-bit output goes to RA6. The RA6 DAC converts the data to a 16 step output from 0.15625 V to 9.63125 V, which goes to the invert pin 6 of IC3 comparator. At the non-invert input, so long as an operation key is not pressed, 10 volt is fed via R45 and R46. The normally high comparator output goes to CPU port B, instructing the CPU that an operation key is not pressed. Pressing an operation key sends a fixed voltage corresponding to the particular key to the noninvert input for the comparator, where it is compared with the key scan data.

As you will note, the voltage obtained by pressing each operation key is limited to one of the 16 steps according to the four-bit key scan data. As an example, assume the play key is pressed, as is indicated in Fig. 13-4. This applies 2.99 volts to the comparator noninvert input. At this time, when the voltage at the invert input from the key scan data rises beyond 2.99 V (as when the four-bit data exceed five), the comparator low output goes to CPU port B, indicating to the CPU that an operation key has been pressed. The key scan counter is reset and the four-bit scan data from port C increment sequentially from 0000, 0001, etc.

Since the play key is pressed, the comparator output becomes high at the 0000 data poll, supplying the equivalent of a "no" response to port B2. After incrementing in sequence, when the poll reaches 0101, the comparator output becomes low, providing a "yes" response to port B2. The CPU thus recognizes that the play key has been pressed and enters the play mode. At the same time, the key scan data stops incrementing and the 0101 output is produced for approximately 5 msec.

The CPU clock operates at 400 kHz and one instruction cycle is



REC S201
A.DUB S202
PLAY S203
PAUSE/ STILL S204
STOP S205
FF S206
REW S207
R214 8.2K
R215 18K
R216 47K
492
1690
2080
5120
RA201
301
302
10V
R45
R46
IC3
12.5V
10V
R66
R64
IC11
RA6
12.5V
RA5
IC2 (CPU)
PORT
Key data in
C3
C2
C1
RST PULSE GEN. IC3
12.5V
13 FUNCTION
12 MECHACON

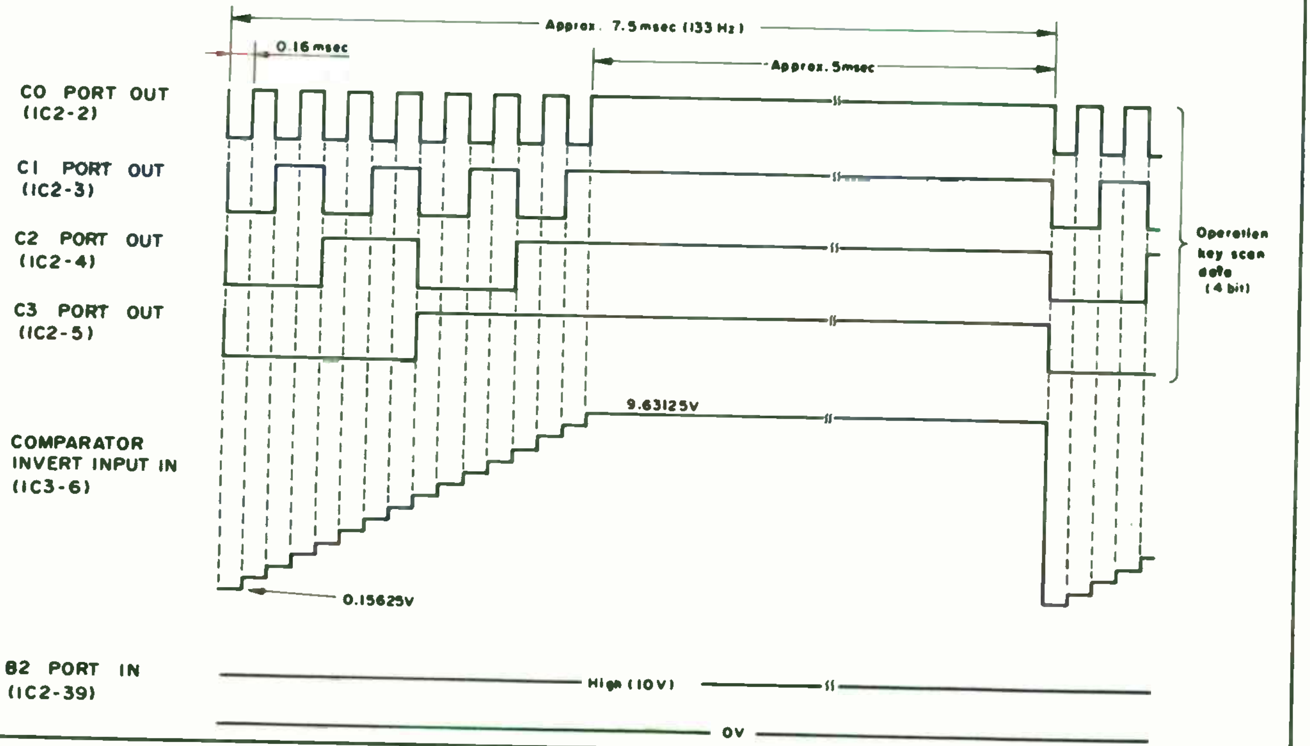


Fig. 13-3. Mechacon functions and DAC comparator outputs (courtesy of US JVC Corp.).

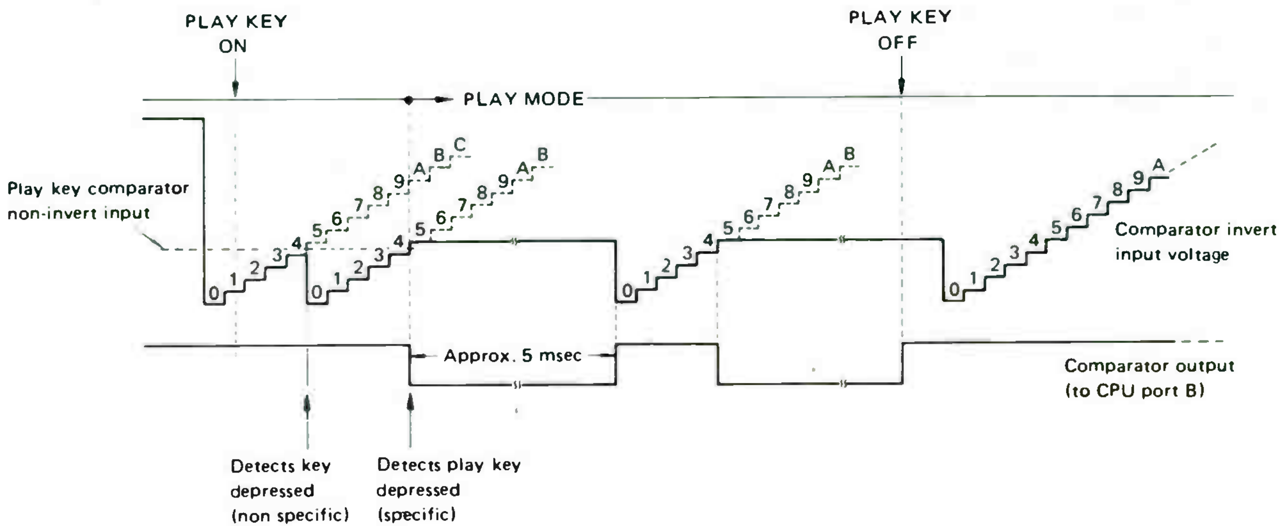


Fig. 13-4. Waveforms with "play" key depressed (courtesy of US JVC Corp.).

10 μsec. Therefore, approximately 500 instructions can be performed in the five msec period. However, in order to avoid errors, the process is repeated an additional time, then implemented. When the play key is off, as indicated in Fig. 13-3, the key scan data remains at stand-by for one cycle of 7.5 msec.

When the channel key of the remote control unit is pressed, the comparator output goes low. With port B low for two polling cycles, the channel up command is then recognized. In the above manner, the CPU is able to determine which key has been pressed and executed the instruction according to mode.

MECHACON OPERATION (OTHER THAN NORMAL)

In addition to setting up the selected operating modes, the mechacon circuit functions to protect the tape and VCR machine. Such functions are indicated as follows:

Sub Power Switch-on Requirements

1—Cassette sensor: completely inoperative unless the cassette switch is on. While a mode is in progress, if the cassette switch changes from on the off, (after unloading) the stop mode is entered.

2—Light sensor: inoperative if cassette lamp fails. If the failure should occur during an operating mode, (after unloading) the stop mode is entered.

3—Record safety sensor: if the record safety switch is not on, recording (including record pause) and audio dub are inoperative. During these modes, if the switch state changes from on to off, unloading is performed and the stop mode is entered.

4—If the unloading switch is off when the sub power is set to on, unloading will not occur.

5—The channel key of the remote control unit is operative only during the stop, unloading REC pause, FF and REW modes.

6—Start sensor: if on during the REW mode, the REW mode becomes inhibited. When the start sensor switches on during rewind or search rewind (after unloading) the stop mode is entered.

7—End sensor: when the end sensor is on, play, recording and FF are inoperative. If these modes are in progress and the end sensor switches on, (after unloading) the stop mode is entered.

8—Reel sensor: with the after loading switch on during play, recording, audio dub, search FF and search REW, if the take-up reel disk rotation stops, after about 3 seconds unloading is performed and the stop mode entered. This limitation does not apply to pause/still. During FF/REW, while the unloading switch is on, if take-up reel disk rotation stops, after about 4.2 seconds the stop mode is entered.

9—The drum motor rotates when the unloading switch is off.

10—Drum rotation sensor: with the unloading switch off, if the drum motor (video heads) rotation stops, after about three seconds, unloading is performed and the stop mode entered.

11—Memory sensor: during rewind with the memory switch of the function board on, when the tape counter indication decrements from 0000 to 9999, the stop mode is entered.

12—The unloading motor rotates in the forward direction when the play LED is lighted and the after loading switch off. When the stop LED is lighted and the unloading switch off, the motor rotates in the reverse direction.

13—AL sensor: During unloading, if the period between unloading switch off and after loading (AL) switch exceeds 10 seconds, unloading is performed and the stop mode entered.

14—UL sensor: during unloading, if the period between after loading switch off and unloading (UL) switch on exceeds 10 seconds, the mechanism stops and the emergency mode is entered.

15—Pause/still overtime sensor: if the pause or still mode continued for more than 5½ to 6 minutes, unloading is performed and the stop mode entered.

16—Auto rewind: during play/rec, audio dub, FF and search FF, when the end sensor functions and auto stop is produced, (after unloading) the rewind mode is entered. However, if the stop key is pressed during unloading, the auto rewind mode is not entered.

17—Short rewind: when the stop mode is produced from FF or REW, short rewind is performed for 240 msec then the stop mode is entered.

18—The capstan motor rotates when the unloading switch is off. However, this limitation does not apply to pause/still.

19—When the remote control unit is connected, control can be performed by either the local or remote operation keys. If both are used, the most recently pressed key instructs the mode. However, when the stop is pressed, the stop mode has priority regardless of the pressing sequence.

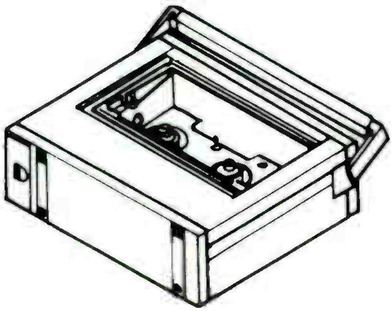
20—During recording, the remote pause mode has priority over the local and remote operation keys. However, this does not apply to the stop mode.

Sub Power Switch to Timer

1—If the record safety switch is off, record start is inhibited and at pre-start, the stop mode is entered.

2—While a mode is in progress with the sub power switch on, if the switch is set to timer, the mechanism stops. However, at the timer start time, record or record pause becomes the record mode.

3—During timer recording, the pre-start (high) signal initiates loading 10 seconds prior to the timer start time, then at record start, the pinch roller engages to yield the recording mode.



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