WE BUILT A HOME VIDEO TAPE RECORDER

First low-cost factory kit shows great promise

By MELVIN H. SHADBOLT

HOME VIDEO RECORDING HAS BEEN ALmost here for several years . . . but until now only as promises. It all started in the summer of '63, when a British company announced plans to manufacture and distribute a revolutionary new $177 home video tape recorder—the *Telcan*.

First releases in the U.S. came as a filmed report shown on NBC's "Today" program. Taped portions of a horse race looked quite impressive. However, live demonstrations in London and later in New York City proved only slightly less than disastrous. One of Telcan's developers announced that it was necessary to demonstrate the recorder prematurely to create the public support needed to persuade some company to purchase Western Hemisphere manufacturing rights. Though Cinerama, Inc. did purchase the rights, apparently there were more problems than originally appeared, since nothing has been heard from either concern for over a year.

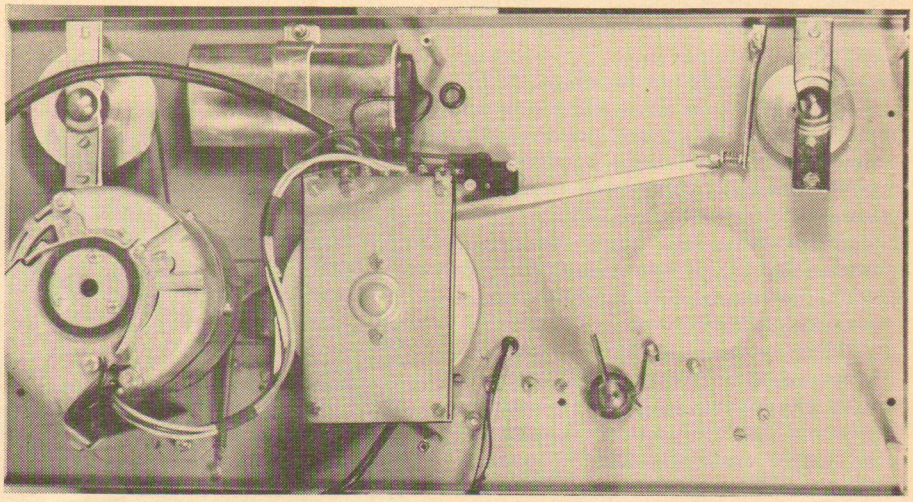
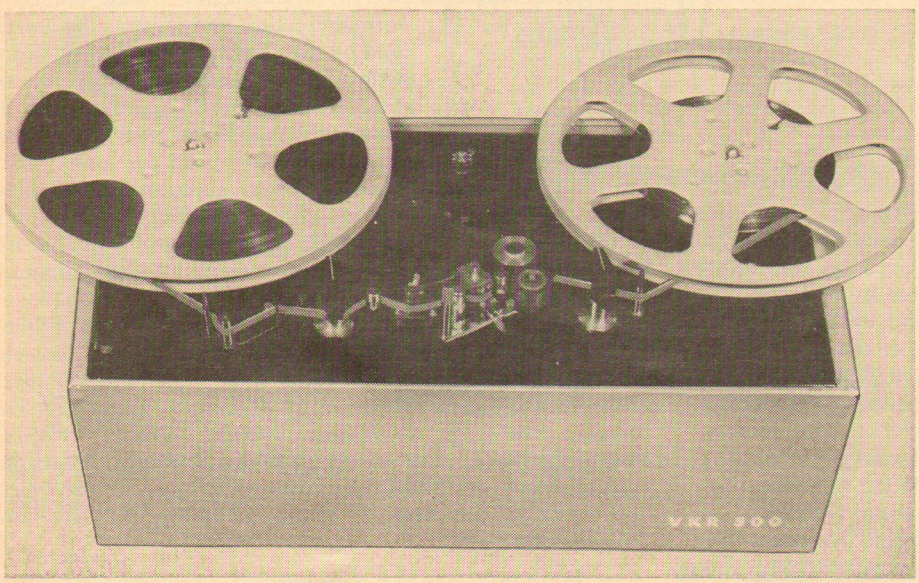


Fig. 1—Underside of VKR 500. At extreme left, motor and takeup reel slip-clutch. Nearer center, motor starting capacitor and capstan flywheel assembly. At extreme right, feedout reel spindle and brake.

At the time of the first releases there was much skepticism among engineers and technicians. The price seemed completely out of reason . . . perhaps $500 would have been more realistic. This at least would have allowed a little more margin for working out remaining bugs, and perhaps would even have made the recorder profitable to market. At any rate, the Telcan announcement did prod a number of companies into greatly accelerating their stagnant development programs—many of which were started over a decade ago!



VKR 500 uses standard ¼-inch tape at 7.5, 10 or 12.5 feet per second.

Since mid '63, several companies have promised home video recorders in the *very* near future. The race has been won by Wesgrove Electrics Ltd., Nash House, New Street, Worcester, England. Their new VKR 500 is in kit form and being distributed in England and, very recently, in U.S. At least one importer is handling it: P.A.F. Enterprises, 32-34 E. 22 St., Bayonne, N.J. The price, in kit form, is $450; assembled, $650.

The VKR 500, with several pictures recorded off-the-air, is shown in the photos.

Although the new Wesgrove recorder is supposedly an outgrowth of the old Telcan (at least, one of its directors is one of the early developers of the Telcan recorder), comparison of photographs of the Telcan and the VKR 500 indicates that the Wesgrove machine has been completely revamped —at least mechanically.

We had been negotiating with Wesgrove Electrics before public news releases, and fortunately were able to get

Pictures of network TV program, recorded off the air on VKR 500.

one of their early kits flown over in time to conduct a series of tests and experiments prior to general U.S. distribution.

My first impression on opening the kit was that it was nothing more than a glorified audio recorder—stereo, perhaps, because of all the transistors (22). Stripped of all fanciness and housed in a very plain plastic-covered plywood case, the major portion of the recorder's cost is apparently in the mechanical and electrical components—both of high quality. Nothing has been spent to dress up the kit.

Many of the features you would like to see, such as rewind provisions, quick changeability of tape speeds and handy access to all adjustments, just aren't to be found. The VKR 500 was designed primarily to meet the requirements of the less critical lab or educational, industrial or home experimenter, who can get along without such conveniences, particularly when they could have delayed production for perhaps another year and increased cost considerably. The fact remains, the Wesgrove recorder is *actually here*—it *does work*—and best of all, it uses standard ¼-inch audio tape.

General features

Using the 10½-inch reels supplied and standard triple-play audio tape (0.5 mil), you have a choice of three speeds—7.5, 10 or 12.5 *feet* per second. Approximately 9,000 feet of 0.5-mil tape can be accommodated on the 10½-inch reels. Since the VKR 500 is a half-track recorder, a total of 40 minutes of recording time is possible when operating at 7.5 ft/sec (20 minutes per track). The maximum size reel the recorder will accept is 11½ inches, which increases recording time to 1 hour (30 minutes per track).

System frequency response is 1 kc to 2 mc for video and 50 cycles to 10 kc for audio. Input level for both video and audio is 1 volt p-p. The entire unit is only 19¾ x 9¼ x 10½ inches and weighs 28 lb. Total power consumption is 200 watts, the larger part being consumed by the $\frac{1}{10}$-hp motor.

The electronic portion is completely self-contained on a 8⅜ x 9⅞-inch printed-circuit board incorporating 22 transistors and 10 diodes.

Mechanically, the tape transport is as simple and straightforward as possible—no more complicated than that of an average audio recorder. Since there is no rewind, it is even simpler (underside shown in Fig. 1).

Only four operator controls are provided on the tape deck proper: record/playback, stop/start, video azimuth adjust and video playback gain control.

The recorder can be operated on any of three systems: the 405-line, 50-cycle British; the 625-line, 50-cycle European, or the 525-line, 60-cycle American standard. When ordering, you must state which system you are planning to use the recorder with.

Conversion to any system is simple. Primarily it involves changing the diameter of the dual pulley on the motor shaft. This pulley drives the capstan flywheel and the takeup-reel slip-clutch. Since motor speed depends on whether it is used on 50- or 60-cycle power, it is necessary to compensate by altering the pulley diameter. For any country using 120-volt lines, one other modification is necessary—an outboard stepup autotransformer for the British-made 240-volt motor and power transformer.

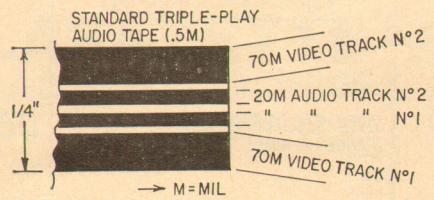


Fig. 2—Width and location of audio and video tracks. Half tape width is used in each direction.

Principles of operation

In the RECORD position, the tape is first erased by a permanent magnet which is rotated into position by the record/playback control. Erasing with dc eliminates possible interference with the wide-band video signal. The tape then passes the audio head, where an FM audio signal is recorded on a 20-mil-wide track just below the center of the tape (Fig. 2). Next it passes the video head, where the video signal is recorded near the bottom of the tape, 70 mils wide. After leaving the video head, the tape passes between the capstan and pinch roller and on to the takeup reel.

The video head is the only unusual item on the tape deck. It is made in two sections. On the oxide side of the tape is the gap. The section the tape passes over is in the form of a "V" (Fig. 3). Although no information is given on the nature of the head, it is probably similar to the design used by the Telcan recorder—probably using a gap on the order of 1 micron (approx. 40 microinches). This is a typical gap on wide-band instrumentation recorders.

The head is heated by feeding it dc through an 820-ohm 1-watt resistor attached to the back of the head by a heat sink. The purpose of this is conveniently overlooked in the manual. However, a few tests indicated at least one possible answer. As the tape passes over the head, more stretch seems to occur on the side opposite the oxide. This could cause a heat transfer away from the head to the opposite side of the tape. Short runs made with the head heater removed showed no deteriora-

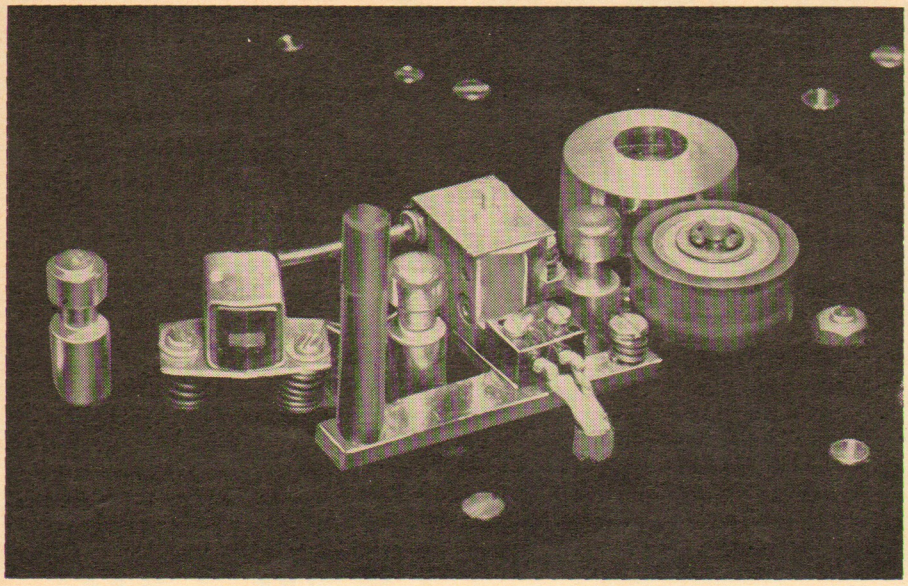


Fig. 3—Head and capstan assembly. Audio head is at left, just right of tape guide post. Video head is in two parts (see text); coil part is in front with its shielded-cable connection going through hole in deck. Gap portion is in back (V-wedge-shaped block). Note end of heater resistor behind gap block. Tall post with knurled end in foreground is video head azimuth adjustment.

tion in the recorded picture. I can only assume that the heater is an attempt to prevent excessive contraction or expansion due to large temperature variations.

The coil portion of the head is on the *opposite* side of the tape. (Again, see Fig. 3.) This coil (used for both recording and playback) measures about 100 μh and has a self-resonant frequency near 2.5 mc. The dc resistance is 2.65 ohms. Although potted and molded in a plastic holder, close investigation under magnification indicates it is wound on a horseshoe-shaped powdered-iron core. The open end of the core, when mounted, virtually touches the back side of the tape and is lined up perfectly with the gap portion of the head on the opposite side of the tape. The reactance of the coil appears to vary from a fraction of an ohm at the low frequencies to well over 1,000 ohms at the top recording frequency of 2 mc. This indicates the tremendous gain vs frequency compensation required in both record and playback amplifiers to record such a wide band of frequencies.

I tried replacing the coil portion of the head with a standard video peaking coil. Although I had some local rf pickup and the output was down, I was pleased to find I could reproduce a picture nearly as good as with the regular coil. This is just one more indication that it is well within possibility for the skilled experimenter to someday design and build his own video recorder—assuming, of course, that he first purchases or somehow makes the narrow gap portion of the head.

The video signal can be taken either from the detector output of any TV receiver or from the output of a CCTV camera. It is important to make certain the level falls between 0.7 and 1 volt p–p, otherwise proper video modulation cannot be obtained within the range of the record-level control. The video signal is first amplified by a conventional two-stage amplifier (Fig. 4). The collector output of the second stage drives the "video driver unit" and also provides a monitoring signal which is fed back to the video amplifier in the TV set. From the emitter of this same stage, a signal of the opposite polarity feeds a sync separator, the output of which drives a separate amplifier to furnish the differentiated sync pulses to the head. It is important that the sync be properly modified to offset the poor low-frequency response of the low-inductance head coil.

The video "head driver unit" is factory potted and sealed. No schematics are shown, nor is there any information about what it is other than that it contains a transistor and certain critical inductances used to predistort the video signal. Its purpose is supposedly to maintain constant gain and frequency response. My guess is that it shouldn't be too hard to duplicate. (Perhaps that's the reason no schematic is given.) Record level is adjusted by varying a 100-ohm pot in series with the dc supply feeding this unit. The dc bias needed to overcome the hysteresis loop of the tape is varied by adjusting a 2,000-ohm pot in series with the bottom end of the head coil.

The VKR 500 has no rewind mechanism. To rewind tape, you must swap reels and restart the recorder. During rewind, the tape does not pass the heads or between the capstan and pinch roller. (This would double the wear on heads and tape.) It rewinds at an average rate of about 2,500 feet per minute.

During playback, two changeover switches, mounted directly on the printed circuit board, are switched to the proper mode and both heads (audio and video) are switched to their appropriate playback amplifiers. For the time being we are concerned only with the video portion of the recorded signal. (See Fig. 5.) The video from the head again passes through one of those "little black boxes," and, as before, no schematic is given. This preamp probably contains one or two transistors and the necessary critical inductances to equalize the video response back to normal. At the output of this stage, the signal divides. No attempt is made to preserve the sync portion through the video amplifiers, since sync is amplified separately by a four-stage sync amplifier/clipper circuit. The horizontal-sync pulses are preserved much better in the recording process than the low-frequency vertical-sync pulses, and therefore require two stages fewer of ampli-

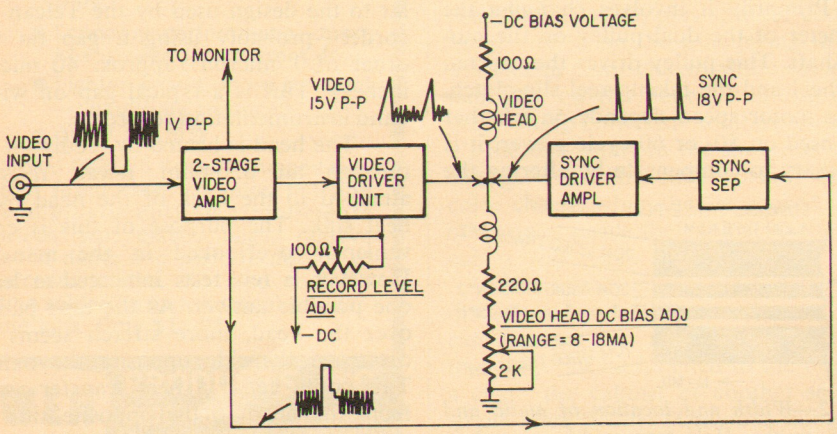


Fig. 4—Block diagram of video record section.

fication. The playback gain control is in the emitter circuit of the video output stage. This adjustment is a "topside" control and can be set for proper contrast when monitoring the playback signal. The video output and vertical and horizontal sync pulses are all mixed, clipped and dc-restored in an R-C/diode video-sync mixer. Its output is then fed to the first video stage of a TV receiver.

If you want to feed conventional CCTV or amateur TV monitors, distribution amplifiers or modulators, you will have to amplify this output with an additional amplifier–cathode-follower combination to increase it to the standard level of 1 volt p–p across 72 ohms.

During the first few playbacks, one further adjustment is necessary; video head azimuth. This can be considered a "focus" control, if you like, since it affects the resolution of the playback picture. If it is misadjusted too far in either direction (causing the head gap to be not perfectly perpendicular to the tape), you will lose all fine detail—the picture will appear fuzzy. Once set, it will need only occasional touching up.

Recording the sound

So far I have neglected the audio portion, since primary concern is with the stranger, more difficult video portion of the VKR 500. The audio circuitry is really rather simple.

Audio is picked up at the speaker terminals of the TV receiver. Recording level is adjusted by the volume control on the receiver. This signal frequency-modulates a multivibrator circuit operating above the audio range. The output of the multivibrator is fed directly to an output amplifier stage, which is connected to a conventional audio head. On playback, the head is switched to a four-stage amplifier/limiter circuit, then demodulated and fed to a frequency-compensating output stage.This signal is then fed back into the TV receiver, preferably before the volume control, since no volume adjustment is provided. Since the audio is applied to the head on an FM carrier, it is not necessary to have a separate bias oscillator.

Modification to the receiver

Practically all receivers in this country use some form of automatic frequency control (afc) on the horizontal oscillator. Since that uses a slow-acting dc correction signal specifically designed to overcome many manmade disturbances, it will not provide satisfactory operation with the VKR 500. Due to the simple tape transport mechanism, the horizontal sync stability will not remain absolutely constant. Tape stretch, flutter and line-voltage variations all result in minor changes in tape speed and cause the sync to vary, sometimes faster than the afc circuit can react. This causes bending and jitter in the playback picture. Therefore, to insure a stable and jitter-free picture, you must modify the horizontal circuit for a certain amount of "direct" synchronization. This can generally be done by connecting a small capacitor (10 to 50 pf) between the plate of the sync separator and the grid of the horizontal oscillator. The value of the capacitor must be high enough to eliminate the bending, yet low enough to prevent horizontal sync tearing.

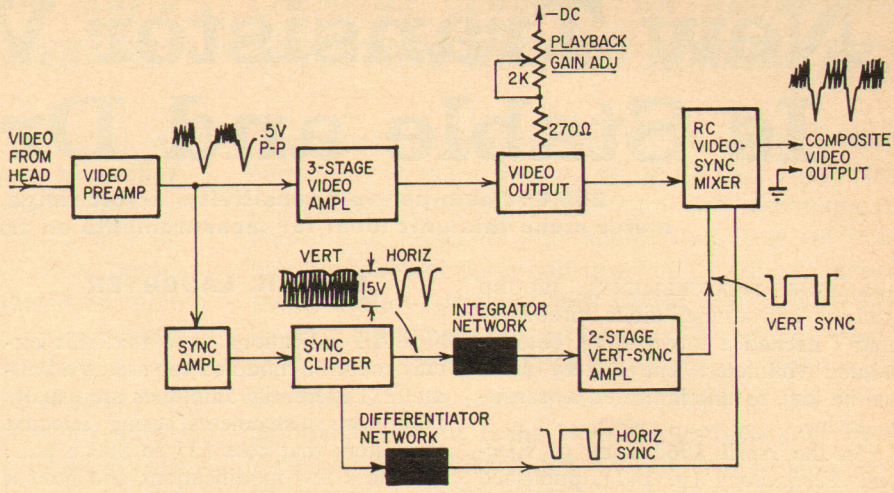


Fig. 5—Block diagram of video playback section.

Weak points

The weak points of the VKR 500 are basically five: no rewind mechanism, critical signal/noise ratio tolerances, inadequate shielding, some negative smearing, and response and sync stability reduced noticeably at slow speed.

The signal-to-noise tolerances demand that the record level be held as high as possible without causing white compression, otherwise the noise level increases very rapidly. If a choice has to be made, the record level should be set so white compression occurs occasionally. Most viewers tolerate occasional white compression more than excessive snow.

If the recorder is to be operated near high-power radio or TV stations, additional shielding will be necessary around the head and the video playback amplifier.

Some low-frequency negative smear will be noted at all times following large contrasty objects. This is undoubtedly due to the excessive loss of low-frequency information and the inability to compensate for it fully, using simple frequency and phase correcting amplifiers.

At slower speeds, response and sync stability are an increasing problem. It's my feeling that the 10- and 12.5-ft/sec speeds will find more acceptance than 7.5 ft/sec, which will be left for less critical applications where added recording time is desired at the sacrifice of quality.

Conclusions

Life of the head and tape, although not mentioned in the instruction manual, can be estimated from what is known about other recorders operating at the same general speed, such as instrumentation recorders. Depending on whether low-friction lubricated tape is used, head life should be between 500 and 1,500 hours. Tape should be good for about 500 to 1,000 passes.

Splices can be made the same as on an audio recorder, and when properly made will have virutally no effect on the picture or the transport mechanism. At these speeds you're bound to have accidents occasionally, so you'd better have some splicing tape ready!

The VKR 500 definitely has limitations. But considering that this is the very *first* home video tape recorder to reach the market for less than $500, and when that price is compared with, say, $10,000 for an industrial recorder or $50,000 for a broadcast recorder, I think it has put us much closer to practical home video tape recording. Although perhaps not yet completely suited for the average consumer, it certainly meets the needs of many technical and experimental users. It offers the opportunity for unlimited experimentation even to the budget-minded lab and industrial organization. It furnishes amateur TV'ers with a heretofore impossible means of exchanging video signals with fellow hams all around the world. It offers educational and technical institutions a cheap and economical research tool. END