

**T**WELVE years ago, BBC Television viewers saw the opening seconds of one of the *Panorama* programmes twice in succession—at first 'live', then followed almost immediately by a re-run. No, it wasn't a mistake in the studio, the date was April 14 1958 and the occasion was the now famous demonstration by the late Richard Dimpleby of a video recording machine, designed and built by the BBC, that used magnetic tape as the recording medium. Not surprisingly, it aroused considerable interest at the time for, although magnetic sound recording had been around for many years, the development of a video recorder had been hindered by the implications of the incredibly high head to tape velocities necessary to accommodate the bandwidth of the television picture.

The BBC's solution was the obvious one: running tape at a very high speed past a static head, but the limitations of this idea were soon apparent, not the least of which was the high tape consumption. It wasn't long, therefore, before the rotating head concept realising head to tape velocities of about 40 m/s, became the accepted solution to the problem and within a year the American Ampex machines employing this technique started to come into service in this country. Readers will probably be familiar with the principle of the quadruplex video recorder: 50.8 mm (two inch) tape running at about 38 cm/s is shaped by a concave guide around a rotating wheel. Four mini record-replay heads mounted at 90° intervals on the periphery of the wheel in turn lay a narrow stripe of video information 0.25 mm wide transversely across the tape where each stripe represents some 18 lines of the scanned 625-line TV picture.

So sound was the design of the original quadruplex machines that this is essentially still the method employed today in broadcast TV recorders, though of course system complexity has increased enormously, particularly since the introduction of colour.

Few people in 1958 can have realised the impact video-tape would have on television production techniques. So complete has the takeover been that today, apart from news and current events programmes, virtually every picture originated by a television camera hits

the screen via the medium of tape. A quick glance at the *Radio Times* shows that, allowing for films and the occasional live programme, some six out of ten programmes of an evening's entertainment are on tape. However, the revolution has been so quiet that, to the general public, anything that isn't live must be a 'film'—a belief that extends to many newspaper TV critics who should know better; it can be very irksome to read a criticism beginning 'Last night's film of the Wednesday Play ...'!

Why then has video-tape taken over from film as the primary recording medium in television broadcasting? For precisely the same reasons that 6.25 mm tape caused the demise of

head with its drive motor sits predominantly at the front and whines alarmingly on its air bearings when running at 15 000 RPM. Below the angled deck is a stack of plug-in printed circuit modules containing an uncountable number of transistors and integrated circuits—some to process the vision on record and playback, servo systems to drive and control the deck, elegant electronic devices to correct deficiencies of the tape-to-head transfer and, of course, the audio chain. Add to this a picture monitor, level meters, and two built-in oscilloscopes for constant monitoring of the circuitry, and you have a machine that will produce a standard colour recording that can be replayed

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original disc sound recording: low cost, high quality and flexibility. Add to this the convenience of instant replay, and video-tape becomes ideal for the ephemeral world of TV.

When talking of low tape cost, this is, of course, low only in proportion to a programme budget—a reel of 50.8 mm tape playing for 60 minutes costs around £100. And the price of a broadcast VT machine is shattering—whereas one has quite a wide choice of closed circuit

on this, or any other similar machine, to give breathtaking colour pictures which can only be distinguished from 'live' by the trained eye of a video-tape engineer—and sometimes even he can be fooled.

Against the complexity of the vision circuitry, it comes as a pleasant surprise to find that the sound system is as conventional as on any audio recorder. In fact, the VT machine has two sound channels, the main one, used for the programme sound, runs along the top edge of the tape and the second, of slightly poorer quality and known as the cue track, lies near the bottom edge. The cue track can be used as a guide track for timing purposes, or might carry a second commentary (say in a different language).

The main audio track is 1.77 mm wide and with a tape speed of 39.5 cm/s (15 $\frac{3}{8}$  i/s) the sound quality is, of course, quite good: a typical machine will have a flat record/replay response from 40 Hz to 15 kHz. Unfortunately, with the emphasis on picture quality, quadruplex video-tape is manufactured with the magnetic elements of the oxide coating aligned transversely which gives rise to a higher hiss level than with conventional tape. Wow and flutter presents no problem at all, as the tight

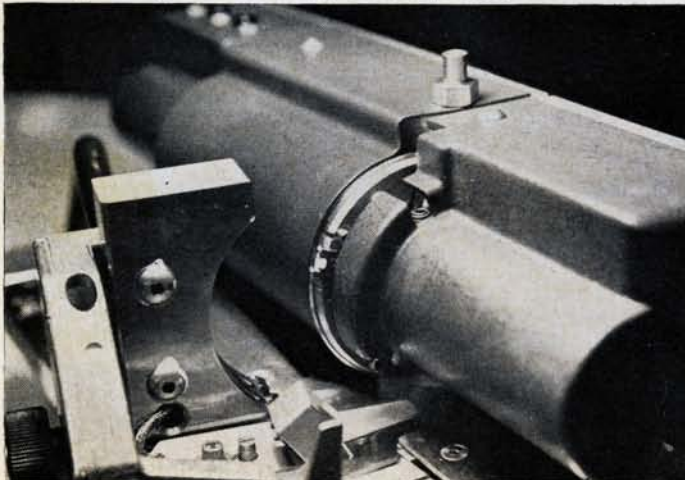
### by Howard Dell

Video-Tape Editor,  
BBC Television

helical scan machines for under £1 000, a fully equipped quadruplex recorder can set the buyer back by about £60 000.

Having spent a small fortune on such a machine, what do you get and how is it used? Well, to start with you get a tape deck of conventional layout that takes reels up to 36 cm diameter (that's 90 minutes playing time) with a normal capstan pinch-wheel arrangement and a recognisable sound head assembly, but there familiarity stops. The rotating vision

Close-up of a video head assembly. The shaped guide has been retracted, revealing the headwheel and one of its pole tips.



The BBC 1 Transmission Suite Control Room. One of the two remotely operated machines can be seen through the glass panel.



servo control of the tape transport demanded by the video department is more than good enough for the sound—the overall record/play wow and flutter can be held down at around 0.02% to 0.03%.

In order to keep the machines running at peak performance, routine maintenance is essential. Apart from a fortnightly major servicing period, maintenance staff keep a continuous watchful eye on all machines, particular attention being paid to the video head. Due to the high speed at which it operates and the fact that the pole tips are impressed slightly into the tape, the wear rate is very high and a head may well be worn out after about 100 hours running time. Rejected head assemblies (that is, head wheel plus drive motor) are returned to the manufacturer for refurbishing for further use.

Once set up, it is no more difficult to record a programme on a quadruplex machine than to make a normal sound recording. The operator has normal play, record, wind and stop buttons at hand and a kaleidoscope of 'fault' lights inform him of any malfunction while the recorder is running. What he cannot do, however, is check the picture off-tape as he is recording (as a three head audio recorder can monitor sound). There is always the danger therefore that the recording will unknowingly be marred by tape dropout, or perhaps a catastrophic loss of recording will occur due to the tape shedding oxide and clogging the heads, although 'clog' detectors are now becoming available.

Because of this uncertainty and the possibility of some other failure, programmes are nearly always recorded on two machines; obviously the chances of both recordings being faulty are pretty remote, but it does happen, though fortunately rarely in a manner that makes a show beyond salvage! Tapes are bulk erased before use, a purely precautionary measure since the machines have an efficient full width erase head. (It might be of interest to relate this to the editorial of the February 1970 issue of *Studio Sound*: the BBC-designed bulk erasers both rotate the tape and increase the magnetic erasing field from zero to a maximum then down again, automatically. Once per revolution 'thumps' just don't exist.)

After a playback of the whole recorded programme to check the technical quality, it is very

likely that the tape will require editing before transmission. Probably 80% of taped programmes seen on the air have been edited to some degree. This may be just one join in a school programme to cover a fluff or a break in the action, or upwards of 150 edits in a large drama where the play will have been shot deliberately in short sequences. Traditionally, video-tape has been edited by cutting and joining the tape at the required points with a special sticky tape, the butt ends being aligned in a microscope-fitted splicing jib. Technically, the cut is made in the field blanking period and with a positional accuracy on the tape of about  $\pm 0.05$  mm; exceed this and the picture as seen on the screen may well flash at the edit point, in extreme cases it could break up altogether and take several seconds to restabilise.

A more elegant method of editing has been taking over slowly in the last few years and with the introduction of colour has really come into its own: a process called electronic dub editing. Here the tape isn't cut at all—the whole programme is re-recorded from the master on to a clean tape using a pair of machines which can be locked together electronically in such a manner that the programme is built up from the required sequences. At the heart of the system lies an electronic editor, which controls picture edits to one frame accuracy at the turn of a knob and can effect speech and music edits that are quite undetectable—all without ever having to touch the tape. Combined with the wealth of television special effects possible these days: dissolve, colour distortions, freeze frames, etc., and as much sound tinkering as one can devise, there is potentially a creative programme editing service that is limited purely by the cost of time. In practice, the time spent editing a programme might be five hours for a thirty minute comedy show to two or three days for an important drama (like one episode of *Henry VIII's Wives*).

A tape costing around £100 when new will have an intrinsic value of perhaps tens of thousands of pounds by the time it is ready for transmission, so great care has to be taken both in its handling and storage. Before loading a programme tape, the VT machine is always cleaned with the solvent *Freon* and special paper tissues, and the heads are demagnetised with an

ordinary hand degausser. Ingenious tape movement sensors on the decks prevent tape stretch by inhibiting selection of different modes (for example, play from rewind) until the tape has stopped, and the mechanical alignment of the tape transport is regularly checked to ensure even winds on the spools. Tapes are stored and transported on their edges in stout fibre or plastic boxes and the tape library has an air conditioning system with temperature and humidity maintained within very close limits.

So much for the predictable dangers—but what about the human element? Well, the machines have a record 'lock-out' switch which will prevent the record mode from being selected by accident, but of course it has to be set. Should someone actually manage to start recording on top of a programme, it is unlikely that much would be lost before the mistake were realised, and in this event a repair could be made from the second (backing) copy still held in reserve.

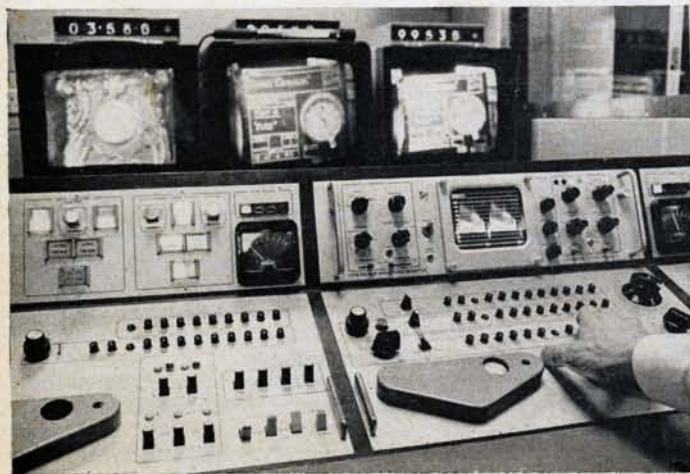
Having edited the tape and stored it safely there comes the time when it is to be transmitted. Although most of the 20 machines at the Television Centre in London are capable of going on the air, in practice transmissions are usually originated from one of the 'Transmission Suites'. There are two installations so designated, one serving the BBC 1 Network and the other BBC 2, each containing two of the latest designs of VT machines in ultra clean surroundings.

The engineer responsible for preparing the tape for transmission lines up the machine controls on the two minutes of test signals recorded before the start of the programme. The most important of these will be the 'colour bars'—vertical stripes of different colours—which he will match to a standard. Satisfied that all is well, he thereafter operates the machine remotely through the glass window of the adjacent Control Room.

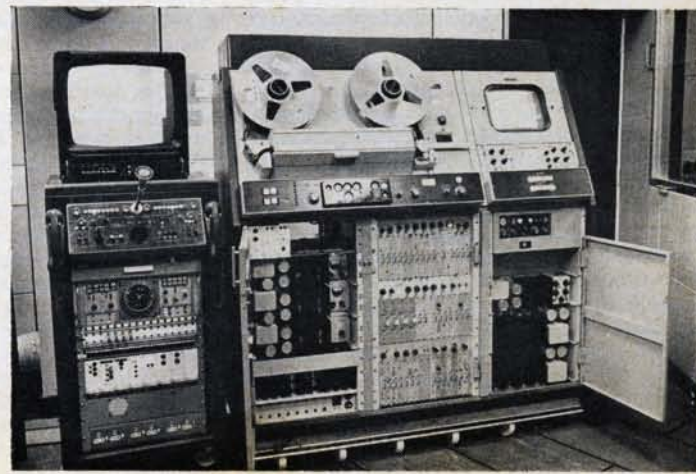
Final instructions to run the machine for playback on the network are given from elsewhere in the Television Centre by the Network Director who, at the end of the previous programme counts down the 10 second run-up of the VT machine (to ensure good stable pictures) then switches it on the air for, we hope, an

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The start of a transmission, as viewed by a Control Room engineer.



Front doors of a VT machine open to reveal most of the electronics.



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uneventful transmission.

After transmission the tape is sent back to the library and this raises the question of storage of old programmes with its biggest attendant problem—space. Simple mental arithmetic will tell you how much room is needed to store any quantity of boxes 380 by 380 mm, and 77 mm thick. Not only that, but the shelves have to be pretty strong too—the tapes weigh around 9 kg each.

For this and other reasons the BBC has decided to limit the number of tapes that should be in store at any time, so there is a constant review of the value of recorded programmes. (Is a two year old *Z Cars* really worth keeping?) Finally, therefore, after a couple of repeats and with no possibility of further overseas sales, an executive may decide that a certain programme

is no longer required and then the tortuous process of programme wiping begins; check and cross check, there *must* be no error here.

Tapes released in this manner may well go back into service for re-use. If they have been edited (a history card kept with every tape details this) it will be necessary to check how many joins there are along its length. An excessive number will destine the tape to the dustbin. If there are only half a dozen in 90 minutes, well spaced, the tape will be inspected, joins remade if necessary, and then re-issued, although it is unlikely that such a tape would be used for major colour programmes as these would always use uncut tapes. It has been found in practice that the life of a tape is determined by the number of joins it receives—they are never around long enough to wear out!

Finally, it might be of interest to readers of *Studio Sound* to look at the position of helical scan machines in broadcasting. Until now the

quality of these cheaper recorders has been such that they were only suitable for industrial closed circuit applications but recent designs have a performance that is attracting the attention of broadcasting engineers. At the rate modern technology advances, it can't be too long before a helical scan machine rivals a 50.8 mm quadruplex machine in quality; whether or not it will take over as the standard TV recorder is something we will have to wait and see. In view of the worldwide standardisation and investment in the quadruplex machine, the larger breed may well remain in command until the advent of a completely new method of vision recording. One thing seems certain—the manufacturers of tape have a very rosy future before them!

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