SOUNDS INCREDIBLE - 1

By R.C. MILLS.... B.B.C. RADIOPHONIC WORKSHOP

TO THE man in the street, the "BBC Radiophonic Workshop" conjures up all sorts of pictures. The immediate association is with radio and television programmes like "Dr. Who", with its science fiction sound effects, which the Radiophonic Workshop provides, as well as the electronic signature tune. How are these sounds and music made?

THE BBC Radiophonic Workshop was formed in 1958, after experimental work in the field of radio drama had developed a need for special sound montages and sound treatments. A prime factor in the development of this form of creative art, was the increasing use of magnetic tape in the production studio itself, as opposed to the recording channel where the whole production was finally recorded.

Any sound effects used in programmes were usually from pre-recorded discs, played in at the right moment and mixed with the microphone output. The use of tape machines in the studio control cubicle meant that complete scenes could be pre-mixed; more complex sound backgrounds could be built up than would have been possible with a limited number of disc playing machines for live performances.

Most of the experimental work had to be done in spare time when studios and, more important, tape machines were freely available. These tape machines were normally used to record rehearsal work in drama studios, and were half track, 7½ and 15in/second record/replay machines, no separate monitoring head being fitted.

Producers soon became aware of the new aspect that imaginative sound could give to radio productions, and many writers, including Louis MacNeice, Frederick Bradnum and Giles Cooper, were inspired to write with the idea of special creative sound treatment in mind.

Since its inauguration, the BBC Radiophonic Workshop has expanded both physically in size and in output, from the initial concept and demand for use in radio drama to the entire broadcasting spectrum. It now contributes material for television, the BBC World Service (sound), British sound radio programmes, including religious broadcasting, and political broadcasts.

All the sound pictures, no matter how simple or complicated, are made up using ordinary tape machines, signal generators, filters, sticky tape, razor blades and a lot of imagination.

BASIC EQUIPMENT

The tape machines used now are single track, ¼in, 7½ and 15in/second, with separate record and replay heads. The majority are Philips EL 3566, three of these being in each of the three workshop areas. This uniformity is desirable so that flexibility and interchangeability can be maintained, and so that at least three tracks can be played simultaneously and stay in synchronisation with each other. This is the most important facility at the Workshop's disposal.

There is also another facility that is extremely useful: the ability to play tapes at speeds other than twice or half the recorded speed. This facility is provided by variable speed Leevers-Rich tape recorders, which are used to "tune" basic sounds. The tape speed can be continuously varied from 0–40in/second, or in fixed steps corresponding to musical intervals. These machines are capable of being used for stereo work, having stacked record and replay heads.

Two Ampex recorders, an EMI TR90 and a BTR/2 and a number of Ferrographs complete the tape machine line up.

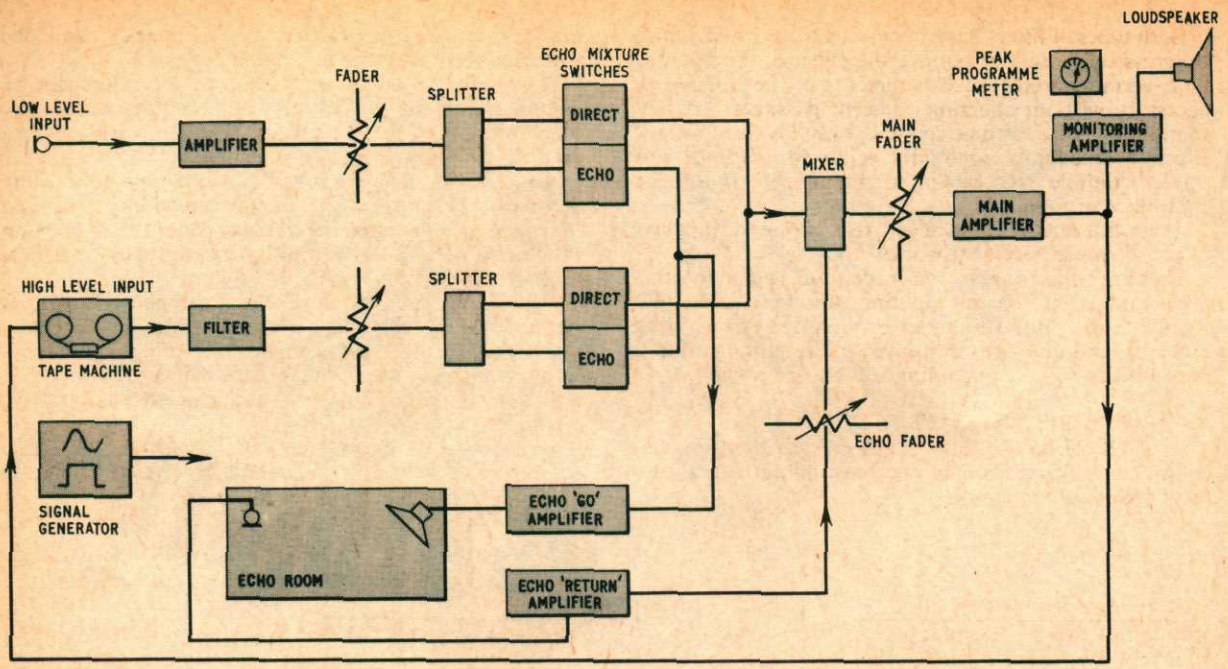


Fig. 1. Typical block diagram of a sound effects set-up for adding effects to a programme

SOUND SOURCES

The signal generators produce both sine and square waveforms over a frequency range 10Hz to 100Hz. Two other signal generators produce sine waves only, but with continuous frequency sweep. Modulated output is also available. These are used in conjunction with an accurate master oscillator that is used as a reference when tuning.

The electronic sound sources are completed with a "white noise" generator, which produces a sound like escaping steam. This can be filtered to give different "shades" of sound, "pink noise", "brown noise", and so on.

All electronic signal generators produce no noise in themselves, and the "note" is only heard when converted into sound energy by the loudspeaker. One virtue of this is that, as these sounds are recorded directly, they are not marred by extraneous noises, and can be treated "on the way" to the recording machine.

FILTERS

The filters used are of two types, passive and active. In the first type, the sound is attenuated at certain frequencies, i.e. 3,200, 1,600, 800, 400, 200Hz top cut, and 220, 440, 880, and 1,760Hz bass cut. Being passive filters, there is no compensating amplification and the sound level or volume is decreased with increasing filtering.

The active filters consist mainly of BBC designed equipment which give top cut and boost, bass cut and boost, and a peak at certain selectable frequencies around 1–5kHz, to give "presence" effect.

General view of the BBC Radiophonic Workshop. In the background is a bank of signal generators, keying unit and oscilloscope. The EMI BTR/2 tape recorder is in the centre. Behind this are the jackfields associated with the mixing desk (behind TR90 recorder on left)

Both types of filters have bypass switches fitted, which progressively insert or remove the effect of the filter, so that certain prerecorded sounds can be filtered if necessary without affecting adjacent passages. A new sound quality can also be created gradually for dramatic effect, and equally gradually removed, without any sudden audible step which might disturb and break continuity of mood.

Other filters available are octave and one third octave filters for more specialist work.

These are the tools of the trade, and with one other important item, the microphone, the scene is set for work. Every sound that can be recorded is our basic material, and anything that gives the required sound is pressed into service, including the human voice.

WORKSHOP LAYOUT

As each of the three "Workshop" areas is similarly equipped, a description of the basic pattern of equipment may not come amiss.

another for treatment such as "feedback", and the third for recording the final result.

It should be understood that in all references to sound treatment by means of tape machines, the machines are of the three head type, i.e. with separate record and replay heads.

A word about "feedback", a phenomenon quite common these days. If a tape machine is set to "record" and the machine's replay fader is left open on the desk, a "howl-round" or feedback path is established.

If this feedback is controlled, a repetitive echo is obtainable, the repetition rate of which is dependent upon the distance between the recording and replay heads and tape speed. Reference to Fig. 2 will clarify and also be useful in understanding an extension of this phenomenon.

If a second tape machine is used, and the tape laced up as shown, a longer delay will be obtained; this is

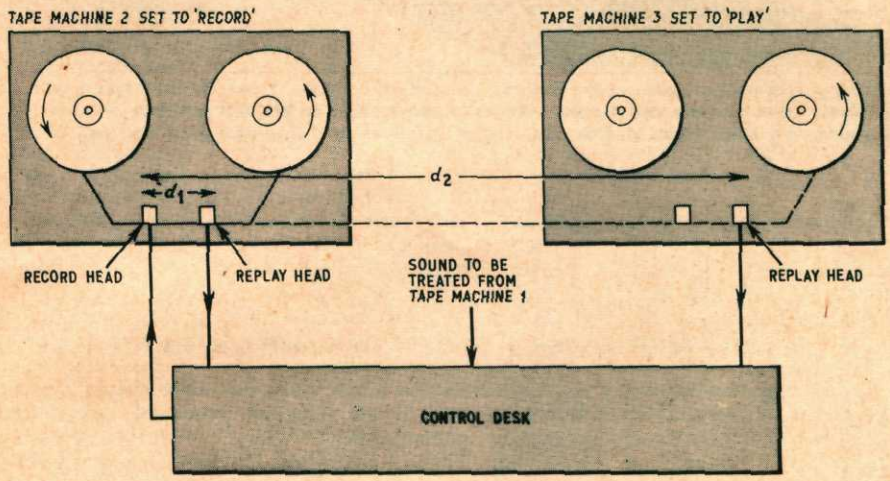


Fig. 2. Obtaining feedback effects with a sound repetition rate based on the distance between replay and record heads

Dominating the studio, is the control panel or mixing desk. This has a number of channels or faders (usually 12 or more); to each fader is connected a sound source which can be one of two types: high or low level. High level sources are tape machines, signal generators and disk players; low level sources, microphones and electronic pick-ups fitted to guitars and other instruments. See Fig. 1.

It is from the mixing panel that the recording chain is fed. This panel also houses the filters, echo mixture facilities and things like remote start circuits, cue lights, line-up reference tone and talkback circuits.

A minimum of three tape machines, a bank of signal generators, a disc playing desk, a jackfield (of terrifying appearance) and a loudspeaker complete the scene. Various other items of local development are available as "optional extras", but are not part of the basic equipment nor present in every studio.

SOUND TREATMENT

For sound treatment or manipulation, a basis of three tape machines is needed; unless a sound is to be treated "live", one machine is used for playback,

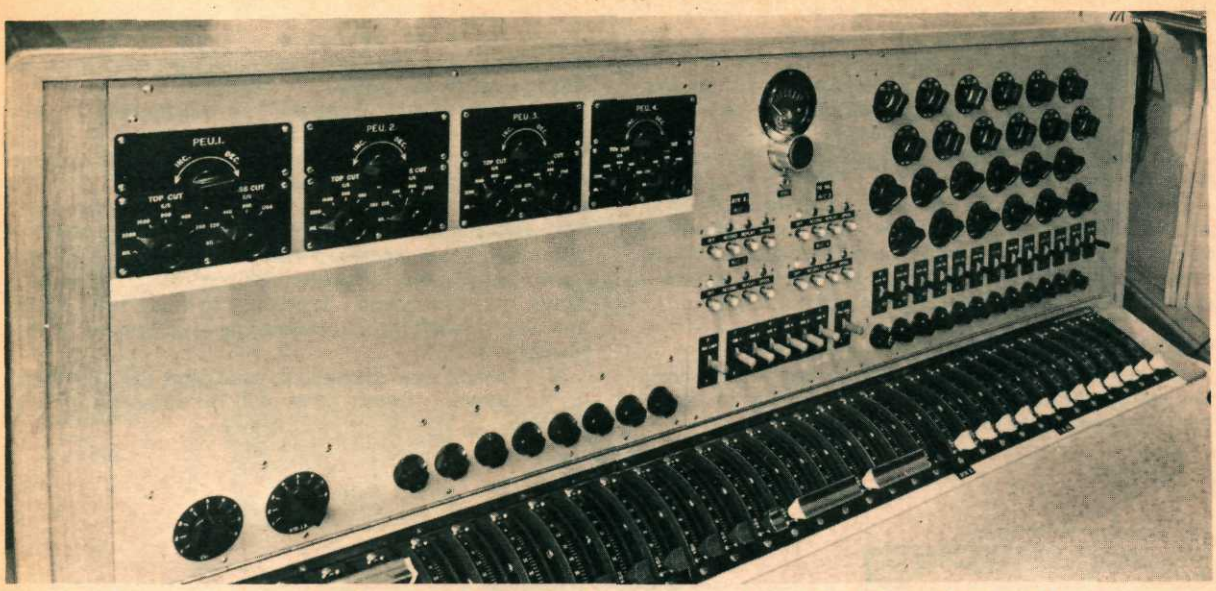
because the record head to replay head distance has increased to d_2 instead of d_1. By moving the machines apart according to the time required, a pattern can be created in sympathy with the original sound pattern.

This technique, with a pre-recorded track played from another machine, makes use of three identical machines, but the final recording is safely recorded on machine 2 and wound up on machine 3.

Exponents of the art will be quick to see many possibilities in this. Two delayed echoes (why not use both machines' outputs?) can be filtered on their respective channels, and reverberation can be added. In fact, the original sound can be removed altogether, and a new sound formed which contains a flavour of the original. If a mistake is made and a restart is necessary, all faders are closed down to let the system clear itself, otherwise the piece of sound on the tape between the machines will start the montage off on a wrong note.

ECHO

Echo, or reverberation, has been mentioned as a facility for treating sound. The Radiophonic Workshop has, over the past 12 years, used four types of



This photograph shows the mixing desk with quadrant type faders. Immediately above those on the right are preset level controls, echo select, echo mixture and group switches. Above those on the left are four passive filters. The centre section contains remote start facilities, cue light, talkback and line-up tone keys, and a peak programme meter

reverberation: the echo room, a magnetically coated revolving drum, a steel plate, and springs.

The echo room is a sound proof room, with bare walls to assist sound reflections. At one end is a loudspeaker fed from the echo mixture switches on the control panel, and at the other end a microphone picks up the reflected sounds.

The revolving drum system has a magnetic coating around the circumference, and erase, recording and up to eight replay heads are placed around the periphery. These heads are all set at about one "thou" away from the coating. The sound is fed to the record head, and picked off, by either a single replay head or all eight, to give "echo". This tends to be noisy and, because of the necessary gap between head and revolving drum, gives rather inferior quality compared with that of the input.

The plate system consists of a steel plate suspended on edge; a contact transducer feeds the sounds on to the plate while a contact microphone picks up the reflected sounds.

The echo spring technique is often found in electronic organs, and consists of a single or double row of springs fitted to a transducer, which converts the sounds fed to the device into mechanical vibrations. These are transmitted along the springs, re-converted into electrical energy by another transducer, and fed back to the control desk.

The reverberation times of the spring device and echo room are fixed, although variations can be achieved by moving the microphone nearer or further away from the loudspeaker in the echo room. The drum type echo time could be varied by choosing a replay head a different distance from the record head. The reverberation time of the plate is dependent upon the amount of damping applied.

Echo is derived from the sound source by splitting the sound into two separate paths, "direct" and "echo". The "direct" sound continues through the control desk to the output, where it is mixed with the echoed sound from the echo device. A proportional switch is used to feed the echo signal to the echo device. Up to the halfway position more direct sound is audible; past this point more echo is obtained.

Whilst on the subject of echo, tape can be used to modify the reverberation times, if only a fixed time is available on the device.

Echo added to a tape played at double speed will be twice as long when recorded at double speed and replayed at normal speed. Hence, a fixed reverberation time factor of $\times 2$ is applied. Conversely, adding echo to a tape played at half-speed and recording at half-speed, will result in the echo being sharper and brighter when played at normal speed again. This facility is one in which a two speed machine is essential.

SPEED CHANGE

Speed change plays an important part in sound treatment, not only for comic effect. Whilst it is a useful tool, often a change in speed is required without a change in pitch, or conversely, a change in pitch is required without alteration in the time scale. At first sight these two seem inseparable, but by means of a special piece of equipment this paradoxical problem can be overcome.

This equipment makes use of a head that rotates either in the direction of the tape movement or against it, at different selectable speeds.

With constant tape speed, and the head stationary, it behaves as a normal replay head and no pitch change is evident. Rotation in the same direction as tape movement causes a lowering of pitch, and in the opposite direction, of higher pitch. The tape can be driven at higher or lower speeds to decrease or increase time scales. The rotating head is used to maintain original tape/head speed ratio, and keeps the pitch constant.

Next month, special techniques in editing and obtaining sound effects and electronic music effects will be described.