

ELECTRONIC SOUNDS AND MUSIC

BY F.C. JUDD, A. INST. E.

ELECTRONICS and magnetic tape have become very prominent in the creation of new sounds used in modern but otherwise conventional music and in the actual making of so called "electronic music", which is of somewhat abstract nature. It is not intended to discuss here electronic musical instruments, neither should the reader confuse music produced by electronic organs and electric guitars with that created on or with the aid of magnetic tape and electronic devices.

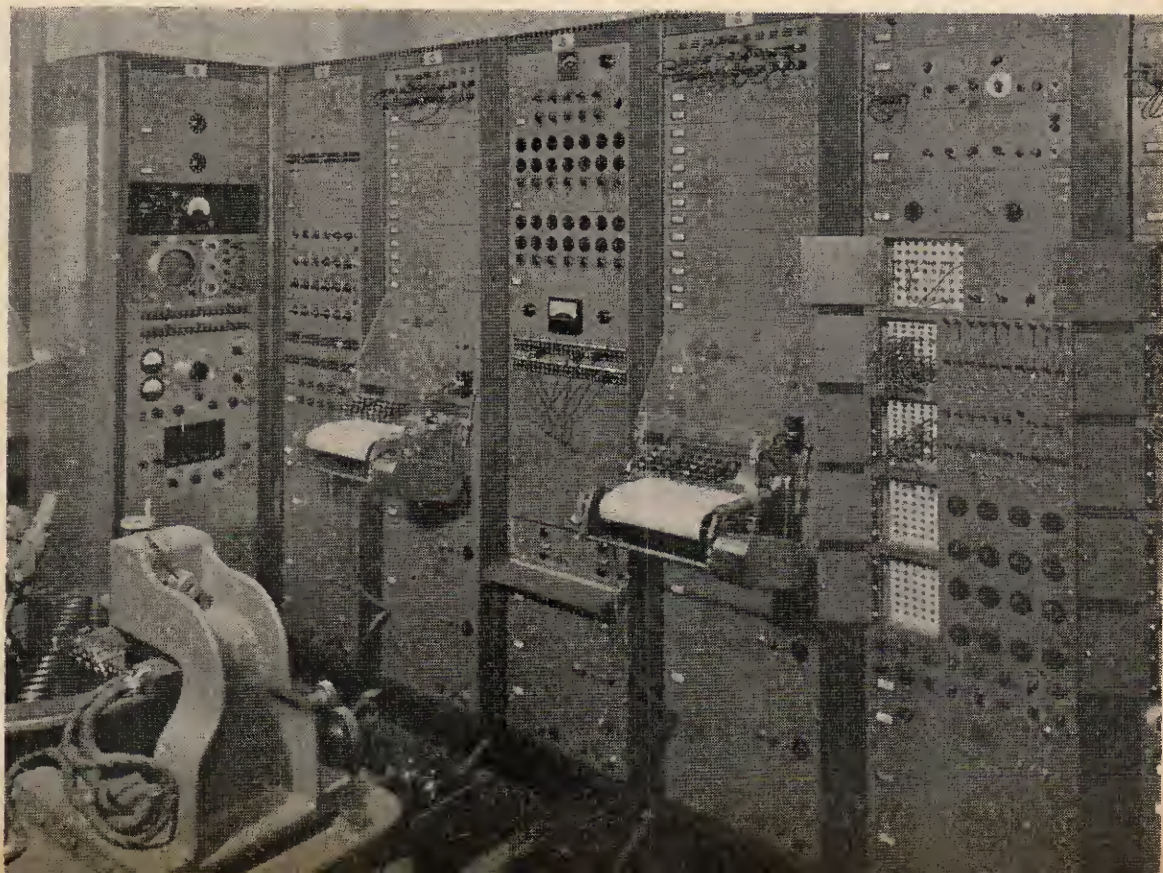
Electronic music is derived from basic tone and noise generators; magnetic tape features very prominently in the composition and actual making. There is, however, another and similar form of music which can be created out of tape recorded natural sounds and this is the more surrealist "Musique Concrète".

Here basic sounds are treated and manipulated in various ways and re-recorded into a whole composition. The techniques are too numerous to discuss here and could in fact become the subject of a complete article.¹ On the other hand many of the methods applied to electronic music and musique concrète can be adapted by the amateur in the making of interesting electronic sounds and with a little skill and practice, complete electronic music compositions.

SYNTHETIC SOUNDS

The idea of applying electronics in the creation of new sounds and music is not new and even completely synthetic music and voices have been produced with the equipment such as that shown in Fig. 1. Computers have also been put into operation to compose

Fig. 1. The R.C.A. music and voice synthesiser



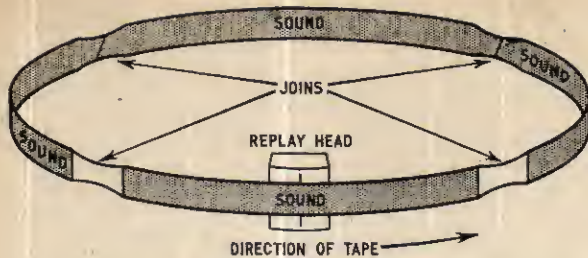


Fig. 2. Tape loop rhythm. Each sound on equal length of tape

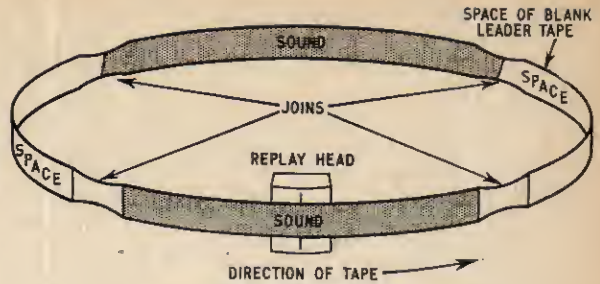


Fig. 3. Two-sound, four-beat rhythm

and actually produce music and some workers in this field have integrated the various techniques to produce music which has a popular appeal music-wise, but with new sounds to the "instruments". Even "pop" record groups and recording studios are employing electronics and tape to produce new musical sounds and unusual, though not always elegant effects known otherwise as "gimmicks".

New techniques however, generally call for specialised equipment, but with a tape recorder plus a few simple electronic circuits any enthusiast can indulge in the making of fascinating new sounds and if by nature he happens to be something of a musician, some quite unorthodox kinds of music too.

TAPE RECORDER AS A MUSICAL INSTRUMENT

The use of "tape loops" is fairly well known and a small loop of recorded sounds can be repeated over and over again so long as the tape recorder is left running. This simple technique can be used to provide a per-



fectly timed rhythm against which to play a musical instrument or set a melodic line from a tone generator.

Here is a simple exercise to show what can be done. Record four different sounds on tape at $7\frac{1}{2}$ inches per second and cut out about three inches of each sound. Join these together with splicing tape to form a loop as shown in Fig. 2 and replay at $7\frac{1}{2}$ inches per second. This will demonstrate the basic method and you will find it quite easy to count four beats to a bar with this simple rhythm. Now try a two piece loop by recording some percussive sounds and selecting from these two of different pitch, they should be cut and jointed as shown in Fig. 3 with lengths of leader tape in between. The pieces of recorded tape and leader tape must each be of the same length, say three inches.

If you make the pieces shorter the rhythm will be faster and vice versa. When this "sound-space-sound-space" loop is played you can again count four beats to the bar, i.e. 1(sound)-2(space)-3(sound)-4(space). The loop can then be re-recorded on to another tape and at the same time you record more sounds in tempo and with accent on the second and fourth beats (spaces in the loop). This does of course require a second tape recorder and a means of mixing the output from the loop replay recorder and a microphone. The BBC Radiophonic Workshop have produced two records which employ this technique (Fig. 4). Details of the records are given at the end of this article.

Once you have tried these simple exercises the use and making of loop rhythms should be quite easy. If you have "echo" facilities on your tape recorder then the rhythms might be enhanced by this also. Alternatively, the effect of different speeds might be found interesting. Incidentally, in making loops one can of course operate at a much slower rate during the first process, i.e. by running the primary loop at half speed. Re-recording and the addition of new sounds is done at the same speed. The final result is replayed at the original speed. The second batch of sounds will of course be raised in pitch by one octave and sound completely different from the original.

EXPERIMENTAL EQUIPMENT

The photograph of Fig. 5 shows part of the author's studio for recording and creating special electronic effects. The central "rack" contains two tone generators (sine wave and square wave), a ring modulator, electrical audio filters, pre-amplifiers with variable frequency characteristics, provision for mixing up to 12 signal channels, a level meter, and an oscilloscope.

Fig. 4 (left). Corner of the BBC Radiophonic Workshop

To the left of the picture can be seen a keyboard, which operates a series of tone generators in tempered scale and which has provision for controlled "attack" and "decay" of any sound fed through or produced by the system. Another item frequently used in the studio is a "Theremin", which is an electronic musical instrument operated by the "hand capacitance" effect. The remainder of the equipment consists of various tape recorders and amplifiers, not all of which are shown in the photograph. This is of course a quite ambitious studio since it has to produce music for television and films.

Simple equipment is quite capable of producing excellent results; Fig. 6 shows a typical circuit of a simple transistor tone generator for keyboard operation. Ordinary tone generators can be used for specific sounds, most of which can be altered by means of a "ring modulator". This device can be constructed from a pair of audio transformers with centre-tapped secondary windings; a circuit is given in Fig. 7. It has two inputs and one output. Sounds fed into the two inputs will be "ring modulated" and appear at the output with two extra tones, the frequencies of which will be the sum and difference of those at the input. When two sine waves of different frequency are passed through a ring modulator the resultant output is a chord of unusual timbre; an effect greatly favoured by composers of electronic music.

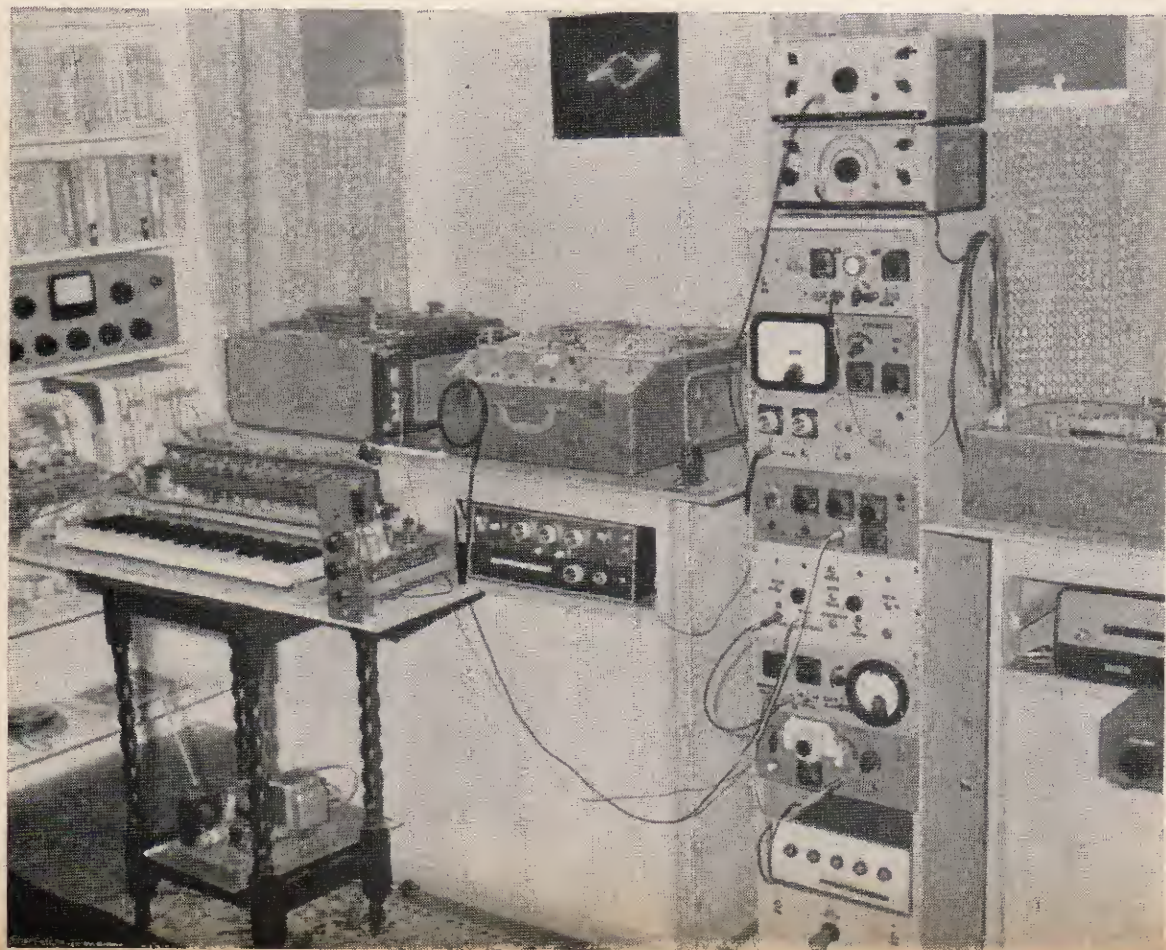
Another useful circuit is the vibrato oscillator shown in Fig. 9. Tones and sounds applied to this may be

given a tremolo (trembling) effect which can sound very pleasing. The keyed tone circuit shown in Fig. 7 has its own vibrato oscillator. Incidentally the vibrato device consists of a low frequency phase-shift oscillator which controls the gain of the pre-amplifier (V2). The control VR2 effects the amplitude of the sine wave applied to the suppressor grid of V2 and if turned too high can result in an unpleasant "thumping" sound. Of course if you require a "thumping" noise then the device will produce it (electronic "heart beats" effect).

Control over "attack" (beginning of a sound) and "decay" (end of a sound) can be produced with the circuit shown in Fig. 10. It is not difficult to construct, but since it has a high gain pre-amplifier like that in the vibrato circuit, precautions must be taken against hum pick-up. These circuits should be constructed like any high gain audio amplifier and completely screened. The "attack" time is controlled by VR2 and C5, although in practice it is better to leave C5 at a suitable value and modify VR1 and R5 for the required delay, i.e. the time needed for the sound to commence. A few trials with different component values will soon produce the desired effects.

With the help of electronic circuits such as those described, plus a tape recorder, quite fascinating sounds can be created. If the tape recorder has "echo" facilities, i.e. a separate replay head that will pick up the recorded signals and feed them back through the recording amplifier, so much the better. A signal mixer of some kind is also advantageous especially

Fig. 5. The author's equipment for producing electronic sounds and music



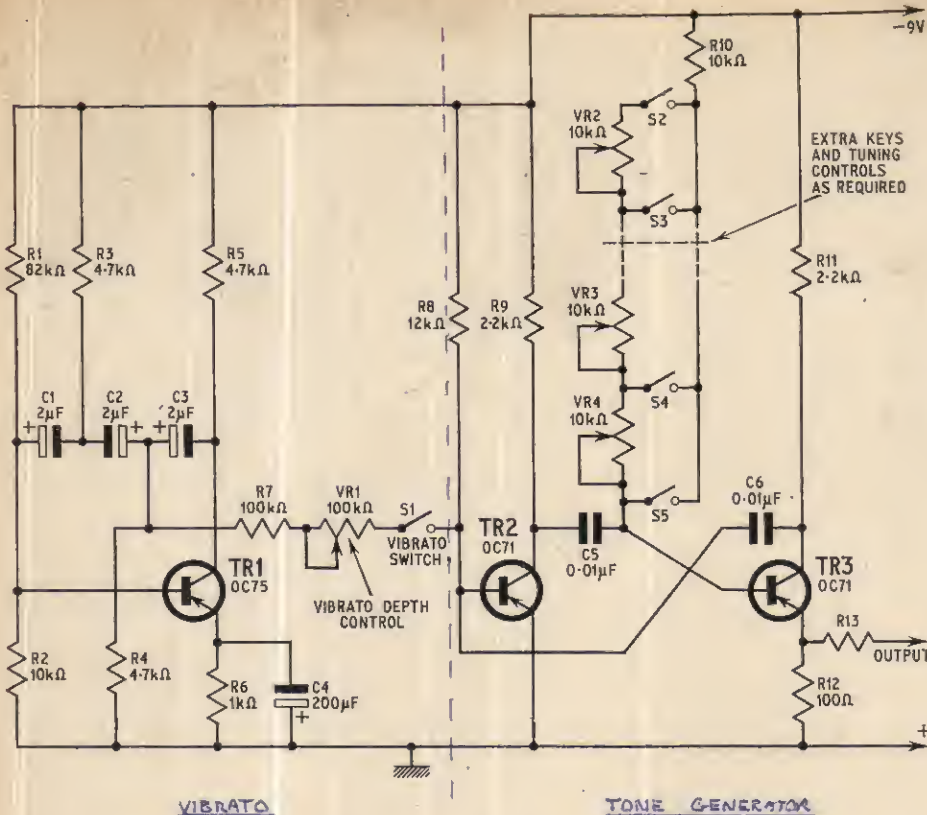


Fig. 6. Single note keyboard oscillator with vibrato oscillator, designed by Mullard Limited

when working with two tape recorders and other signal sources. Assuming one has these facilities, here are some of the techniques that can be applied:

SOUND SOURCES

1. Tone mixing from one or more generators;
2. Ring modulation of tones;
3. Use of sine or square wave tones;
4. Tone shaping circuits (simple differentiation or integration);
5. Use of keyed tone systems to tempered scale;
6. Sounds produced through a microphone.

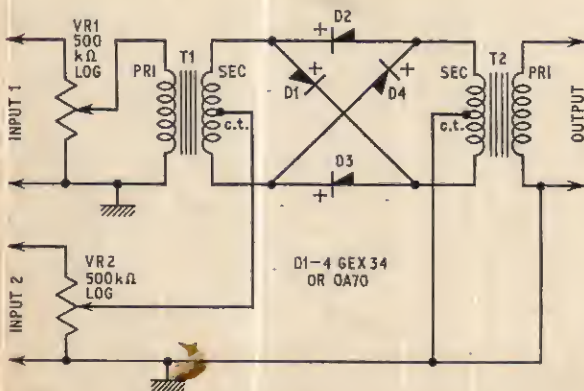


Fig. 7. A typical ring modulator circuit

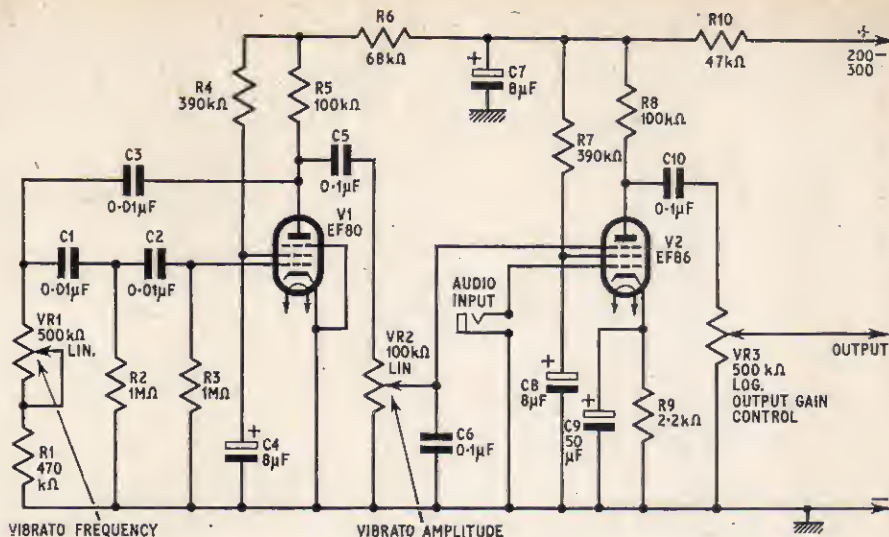
TAPE RECORDING TECHNIQUES

1. Tape editing (cutting sounds from tape and rejoining them);
2. Change of tape speed (during recording or playback);
3. Ring modulation of recorded sounds and pure tones;
4. Tape loops (rhythms and repeating sound sequences);
5. Tapes and loops running in reverse;
6. Tape "echo" (feedback from extra replay head);
7. Reverse echo (tape replayed in reverse after being echoed);
8. Cutting of tape at beginning of sound to produce new "attack";
9. Cutting of tape at end of sound to produce new "decay";
10. Stereophonic effects by employing two or more tracks;
11. Artificial stereo effect (movement of sound by panning);
12. Panning technique (fading one sound from one stereo channel to another).

ELECTRONIC TREATMENT

1. Ring modulation of any two groups of sounds;
2. Electrical filtering (altering the frequency response of amplifiers);

Fig. 8. Vibrato oscillator and pre-amplifier circuit



3. Linear mixing of any group of sounds;
4. Mechanical reverberation (with spring delay echo unit);
5. Electronic vibrato.

The above represent a few of the possibilities that electronics and magnetic tape have to offer in the creation of new sounds and most of these can be combined in various ways. For instance, *sound movement* is an interesting effect. One could make a rhythm track from a loop which is then re-recorded equally on two tracks of a stereo recorder (rhythm central). Melodic lines can be added from a keyboard tone generator and "panned" (faded from track to track) so that the melody appears to "wander"

about in space. This effect was recently demonstrated to an audience who found it quite fascinating although a little disconcerting.

Finally for those who feel they would at least like to hear what electronics have contributed to music, here are details of records now available, each of which features many of the techniques outlined in this article:

1. Music from Mathematics (music composed and played by a computer).
Brunswick STA. 8523 (stereo) available in mono.
2. Varèse. Poème Electronique (electronic music) classical.
Philips ABL 3392 (mono).
3. The Synthesis of Music, by the R.C.A. Music Synthesiser.
R.C.A. LM.1922 (available only from R.C.A. New York, U.S.A.).
4. Dr. Who (BBC recording of rhythmic electronic music by the Radiophonic Workshop).
Decca F.11837 (mono).
5. Time Beat (BBC recording of rhythmic electronic music by the Radiophonic Workshop).
Parlophone 45-R-4901 (mono).
6. Electronic Sounds and Music. F. C. Judd (for special effects).
Castle EFX-1 and EFX-2 (mono).
7. Electronic Sound Patterns. Daphne Oram.
H.M.V. 7EG-8762 (mono).
8. Electronic Movements. Tom Dissavelt (rhythmic electronic music).
Philips 430 736PE.
9. Study 1 and 2. Karlheinz Stockhausen (modern classical electronic music).
Deutsche Grammophon LP.16133 (mono).
(one of three records of similar composition.)

REFERENCE

1. "Electronic Music and Musique Concrète" (techniques). Published by Neville Spearman Limited.

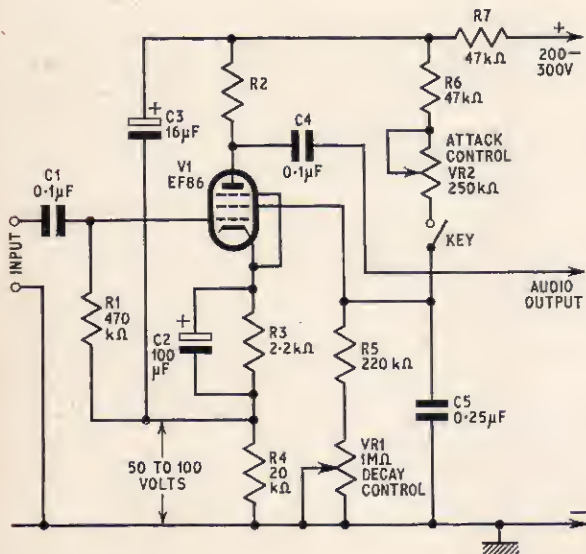


Fig. 9. "Attack" and "decay" control circuit