MORE ABOUT GUITAR AMPLIFIERS AND THEIR SPECIAL EFFECTS

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Wide interest in guitar music is obviously due to the ease with which one can be initiated into its mystries. It does not need the discipline or the hard work expected of a pianist. Besides, there is a lot of scope for experimentation.

Earlier (EFY Oct. '77, pp 23-26) we saw something of the circuitry of a guitar amplifier: the preamplifier, power amplifier, reverb section along with tremolo and the power supply section. Now we would see the amplifier as a whole and some alternate circuits of reverb and tremolo.

Politics is called an art of the possible. In India we consider it as an art of the impossible. The same applies to technical matters also, as we must try to make the best of what is available and learn to live within the limitations.

The electric guitar pick-up consists of a magnet with one pole towards and one pole away from the strings. Around this magnet a coil is wound. Some guitars utilise a single magnet and coil for all strings while others use separate magnets for each string or a group of strings.

The vertical component of the string vibration varies the length of the airpath for the flux and therefore varies the flux density. This varying magnetic flux passing through a coil of wire produces an output voltage representative of

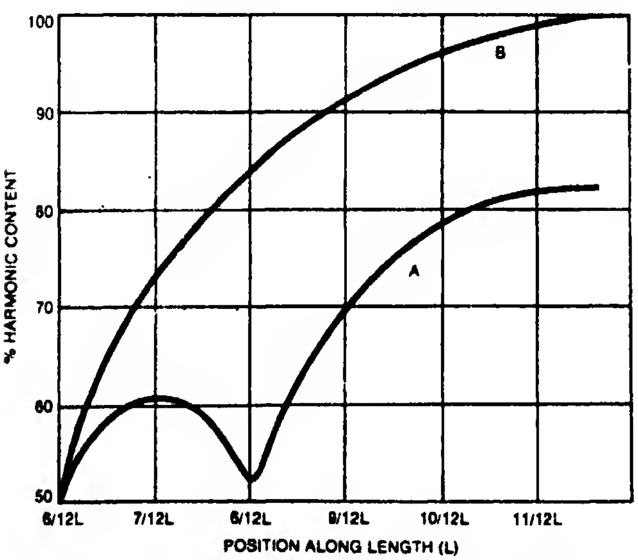

Fig. 1: Harmonic content for various positions of the pick-up: curve 'A' when the fundamental and second and third harmonics are excited equally, and curve 'B' for a fundamental with infiite harmonics.

the string motion. Steel wires must be used for electronic guitars since the strings are to influence the magnetic flux.

The string motion varies along its length. At the ends, where it is clamped, there is no motion. The greatest mo-

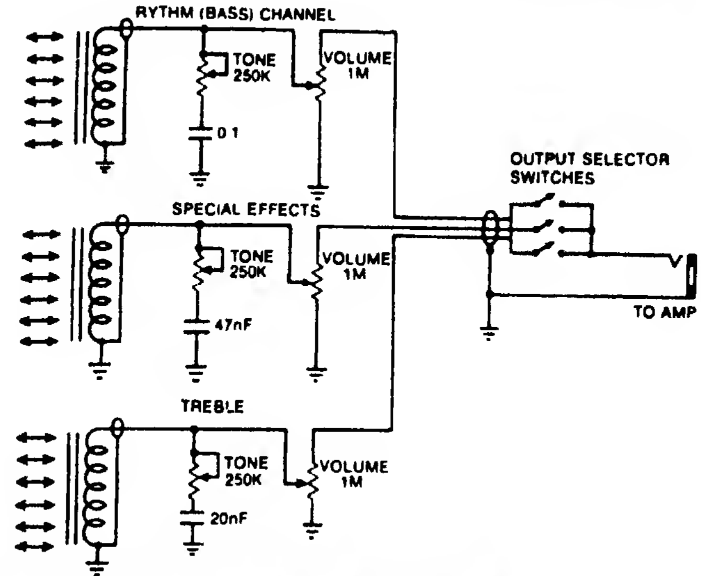

Fig. 2: A three pick-up arrangement for a guitar.

tion is at the centre. The vibratory motion has a fundamental frequency and its harmonics. The extent of harmonics very much depends on the point of initial plucking. In an electronic guitar only that part of the string which is above the pick-up has its motion reproduced as sound. All harmonics and transients present at the pick - up can be converted to electrical output, if desired. Tone of the pick-up can be varied by positioning the pick-up. Curves in Fig. 1 show the harmonic content of the pick-up for various positions. Curve A shows the harmonic content when the fundamental and second and third harmonics are excited equally. Curve B is for a fundamental with infinite harmonics.

If the pick-up is near the centre of the string, it will produce more of the fundamental and lower harmonics, resulting in a mellow sound. If it is placed near one end of the string, it will pick-up more of the upper harmonics and result in a sharper sound. Fig. 2 shows a three pick-up arrangement for a guitar. The pick-up placement decides the content of the signal which is accentuated by adjustment of the tone control. The volume control is adjusted to match the sensitivity of the amplifier. The desired signal can be chosen by the output selector switch.

Normally each channel of the guitar amplifier allows two inputs to be fed in, normal and bright (with treble accentuated). The mixed signal is amplified. Fig. 3 shows the block schematic of the amplifier using the circuits discussed in Oct '77 issue of EFY. The guitar amplifier should have at least two input channels, one for straight amplification of normal signal and the second for special effects such as reverb and tremolo.

A third channel is provided for microphone input. In case the dynamic microphone has sensitivity and input signal comparable with that of the guitar, the microphone channel may use the same pre - amplifier circuit. As the guitar channels as well as the microphone have low input signal, it is essential to ensure that the input cable is properly shielded to eliminate hum pick-up.

As indicated in Fig. 2, each pre - amplifier channel has its own volume control and bass-treble tone control. If desired, a master volume control may be introduced at the input of the power amplifier. Series resistors in the output of the pre - amplifiers allow proper mixing of the output signal. In the case of special effects channel, part of the

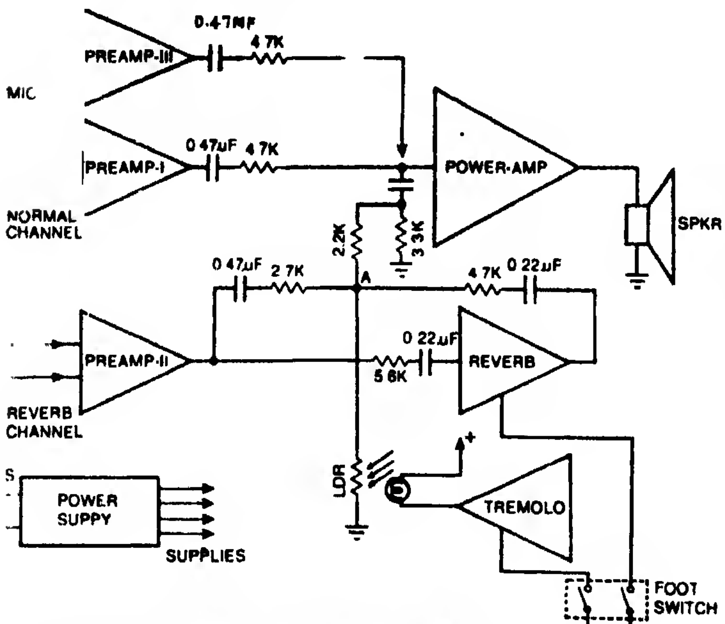

Fig. 3· Block diagram of a guitar amplifier

output signal is fed to the reverb unit, the output of which is fed back to the input of power amplifier at point A in Fig. 3. At this point the light dependent resistor (LDR) of the tremolo section is also connected. It is obvious that the variation in the resistance of the LDR would affect the signal passing on to the input of power amplifier from the special effects channel. Reverb and tremolo effects are not always used; they are controlled by the operation of a foot switch. Depending on the effect desired, the special effects signal may be processed through reverb or tremolo alone or through both reverb and tremolo together.

The reverb section described earlier was high impedance type. As such it was directly coupled to the collector of the transistor. The electromechanical units are available with low input impedance as well with the input voltage requirement of over one volt. An alternate arrangement shown in Fig. 4 uses a low impedance unit of 8 ohm or so;

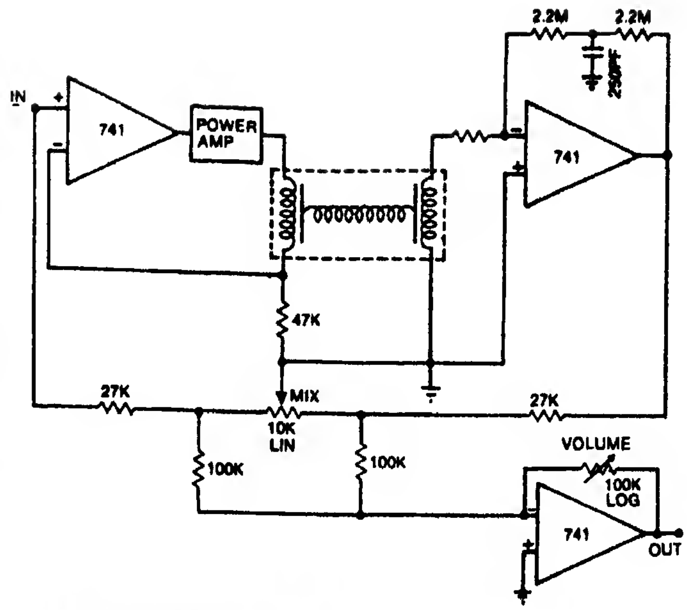

Fig. 4: An alternate arrangement using a low impedance unit of 8 ohm or so.

the input amplifier is therefore followed by a power amplifier. The power requirement is not particularly high. A direct coupled four - transistor circuit with AC187/AC188 as complementary output pair operating on 6- or 9-volt power supply would provide adequate output.

The magnetic flux produced in the input coil of reverb unit induces vibrations in the permanent magnet core suspended in the magnetic circuit. The vibrations are conveyed to the output unit through a spring, resulting in a delay in time. The output unit has a high impedance and a similar magnetic circuit. The spring coil at the end is attached to permanent magnet core placed in the magnetic circuit of the output coil. The vibrations of the permanent magnet in the magnetic circuit of the output coil produce electrical signals in the coil of the same order as the guitar signal, i.e. around 2 to 5 mV. Normally part of the vibrations would be reflected back and forth until they die down, thus producing a more realistic effect. Professional delay

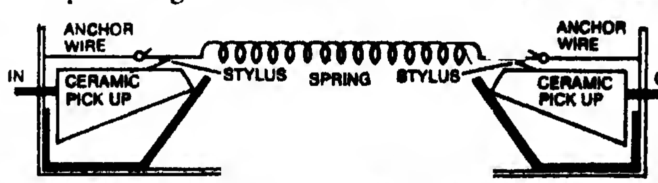

Fig. 5: An arrangement in which electromechanical units use ceramic pick-ups instead of magnetic coils.

lines can be fairly long, 45.7 cm or so. For hobbyists, smaller units, 10 cm to 15 cm in length, are available.

Because of the characteristics of the electromechanical units, treble response is not good and a certain amount of treble boost in the output becomes necessary. The output from the unit is amplified with treble boost and mixed with the input signal. The mixing arrangement used crossfades from dry to fully reverberated by shorting out what is not needed. The mixed output is amplified; gain of the output amplifier is controlled by variable resistance in feedback circuit. In case 741 ICs are used, the minimum supply required would be 12 volts, preferably higher. Two - transistor direct-coupled circuit commonly used as a preamplifier in amplifier/tape recorder circuits would normally be adequate.

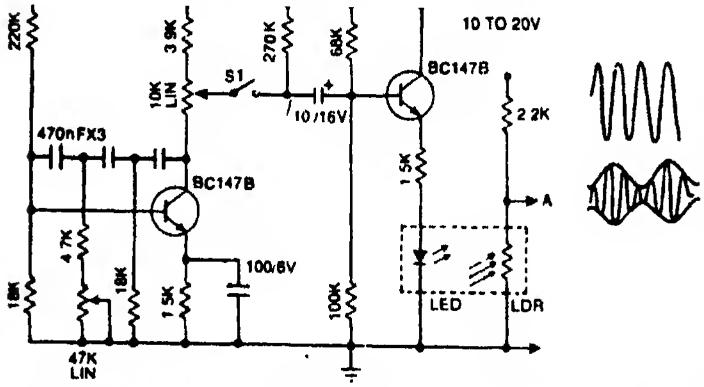

Fig. 6: An alternate circuit with LED-LDR combination in the emitter of the output transistor.

Hobbyists may also like the arrangement shown in Fig. 5. Here the electromechanical units use ceramic pick-ups instead of magnetic coils. The signal applied to the pick-up at the input end induces vibrations in the stylus, resulting in vibrations of the spring. These vibrations travel to the other end of the spring and induce vibrations in the stylus, resulting in an output signal which is a small fraction of the input signal.

An average pick-up with an output signal from 250 to 1000 mV can be used for the purpose. Proper care is very essential in the assembly of the spring coil. The spring should be so tensioned that there is hardly any permanent loading of the stylus which can restrict its freedom of movement and result in distortion of the signal. Input pick-up can be directly coupled to a small-signal amplifier with a voltage output of about a volt. At the output we would need an amplifier on the same lines as the magnetic unit. Additional care would however be essential here to prevent hum pick-up as it is a high impedance circuit. It would be better if the complete assembly is floated on springs to isolate it from stray vibrations.

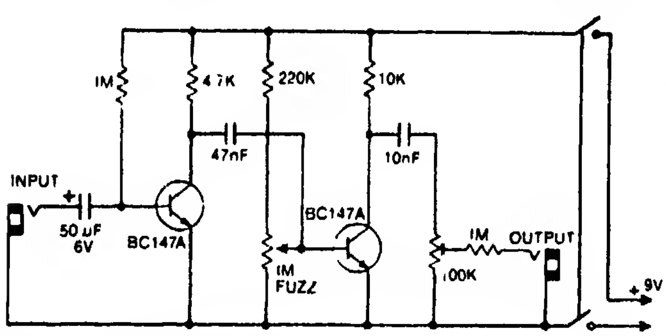

Fig. 7: Circuit for 'fuzz' effect.

The lamps required for the tremolo unit should be rated around 10 mA, 4.5 V. In case suitable lamps are not available, it may be necessary to use LEDs in series with a suitable resistor to ensure that the peak current does not exceed 10 mA or so.

An alternate circuit is shown in Fig. 6 which operates on similar lines with the LED-LDR combination in the emitter of the output transistor. Rate of tremolo effect and the depth can be varied in the same fashion. However it must be noted that the depth control varies the amplitude of the output signal. The depth of tremolo effect would very much depend on the variation of resistance of the LDR used. An imported LDR unit ORP12 or the indigenous unit EIP-274 manufactured by Electron India may be used. Opto-couplers used in control circuits as LED-LDR assemblies can also be used. It is essential that the LDR is closely coupled with the LED and shielded from stray light.

Reverb and tremolo effects are sometimes used for microphone signal as well. An identical circuitry can be used for the microphone channel also. Reverb would add a concert hall effect to the voice, softening it to some extent and adding a slight boom to it. The addition of tremolo gives a heavy breathing effect and, together with reverb, an echo effect with proper adjustment of tremolo speed.

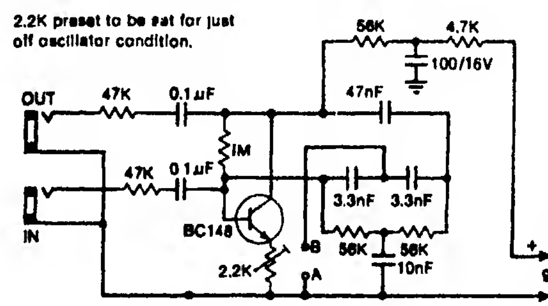

Fig. 8(a): Cuircuit for 'waa-waa' effect.

In additon to these effects, fuzz and waa-waa effects are also commonly used with guitar. The circuit for the fuzz effect is shown in Fig. 7. It is basically a two-stage transistor amplifier. The input is first amplified by T1 and then passed to the base of T2. This second stage acts as an overdriven amplifier which clips and distorts the signal, producing the fuzz effect.

The bias on the base of T2 can be adjusted by means of the potentiometer VR1. This changes the nature of the distortion and provides a certain amount of control over the quality of the fuzz. The preset VR2 is incorporated to act as a variable attenuator so as to prevent overloading of the main amplifier. The values of the capacitors C2 and C3 have been chosen so as to provide a certain amount of the treble boost which is a desirable effect with the fuzz sound.

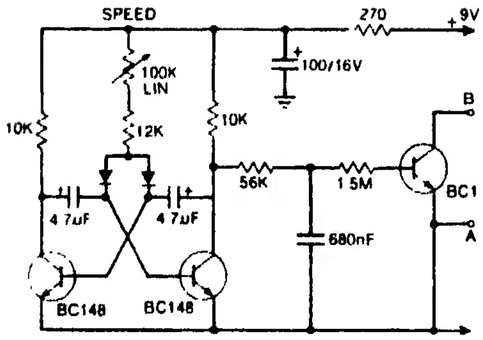

Fig. 8(b) A typical circuit for 'auto-waa

If more treble boost is desired, the values of C2 and C3 may be reduced further.

The waa-waa effect is obtained with a band-pass filter whose centre frequency is varied up and down a portion of the audio spectrum, approx. 200 Hz to 300 Hz. This is supposed to simulate the operation of the mouth when pronouncing the sound waa-waa. The mouth cavity forms a resonator whose centre frequency is controlled by the actual volume of the cavity, and this in turn is controlled by the position of the lips and gums. The electronic simulation is done by a band-pass filter whose resonant frequency is controlled by a potentiometer, usually linked mechanically to some sort of a pedal assembly. The filter takes the form of a band-stop circuit in the feedback loop of an amplifier. This produces the band-pass function required to achieve the waa-waa effect. Fig. 8(a) shows such an arrangement where a variable resistor is inserted between points A and B.

The sweeping can be controlled by another circuit to get auto-waa. A typical circuit is shown in Fig. 8(b). Here a transistor replaces the variable resistor. Use of transistor introduces non-linearity; the harmonics generated however tend to add to the general waa-waa effect. Waa-waa is often combined with fuzz, which provides more harmonics for it to work on.

These are only some of the electronic effects that can be used with a guitar to modify the natural sound of the guitar. In effect a vast horizon is open to guitar players once the limitations as well as the additional variations that are possible are clearly understood. To get the best from the guitar, of course, it is essential that the basic fundamentals of music are understood. Knowledge of music helps to manipulate the variables for the best effect. □