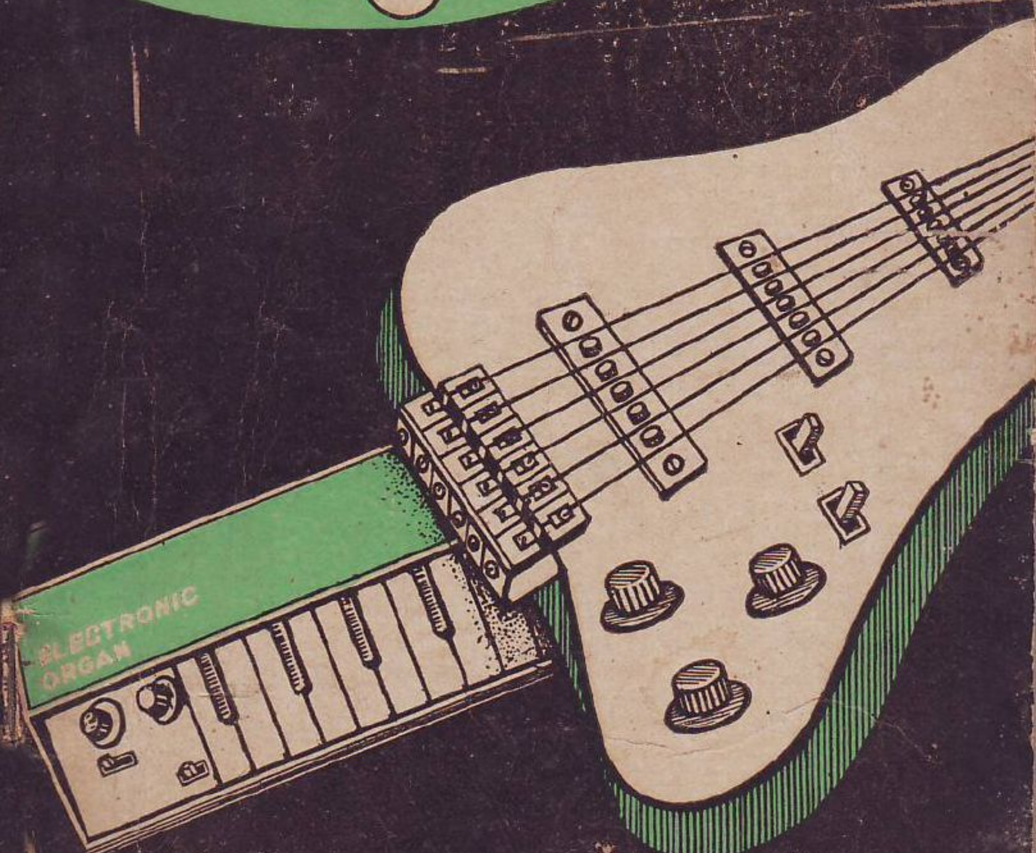
Electronic Musical Projects



BUSINESS PROMOTION BUREAU

ELECTRONIC MUSICAL PROJECTS

P. K. SOOD

Publishers :
Business Promotion Bureau
376, Lajpat Rai Market
DELHI-110006

ELECTRONIC MUSICAL PROJECTS
Jan. 1979

Published by G.C. Jain for Business Promotion Bureau and Printed by
Printed at Goyal Offset Printers, Delhi-110035, Phone : 535881

Preface

The history of electronic music is pobably as old as the modern popular music. One of the earliest pioneers in the field was Dr. Harry Olson of RCA Laboratories who probably developed the earliest laboratory prototype of the present day electromusic wizard 'The Sound Synthesizer'. Such effects like tremolo or vibrato were present even before the coming of present myriads of electronic devices. Later on they were substituted with their more reliable electronic counterparts. Other effects like fuzz, waa-waa phasing reverberation etc. came into wide practice with the popularity of guitars, which the teenagers could play with little practice. Electronic music suddenly caught up in the sixties with its introduction by the then current rebel groups like 'The Beatles' and 'The Rolling Stones'. Others just followed the way.

This book is not intended to be a formal course in electronic music but is just intended to introduce you, a casual experimenter, audiophile, musician or whatever your status be, to the fascinating world of electronic music. So far any mention of this word "electronic music" would draw only little response from amatuer musicians scattered throughout our country, for it would conjure up in their minds an idea of a necessarily complex and expensive gadgetry, probably supported by the wonder of the late seventies 'The Microprocessor'. Obviously most of the musicians being empty-pocketed as they are, did not go far beyond taking up demonstrations only of little variety of such commercial equipment available here.

This book should be a welcome relief to all such interested people. This book shows how you can construct many types of devices with common components that are presently available in India. The book progresses logically through different projects and assumes a prior knowledge of electronic components and contruction techniques. Readers feedback is invited on this book as it is a relatively new topic for most of you. All recommendations for improvements should be sent to the author through the publishers and would be gratefully accepted. For those who enjoy constructing many varied projects described in this book and would like to go in for more advanced projects, it would be interesting to keep in mind that I have planned a second part of this book that shall include such sophisticated projects like a micro synthesizer, an integrated circuit full-scale synthesizer, automatic rhythm generator, automatic melody generator using IC's, Ring modulator etc. Most of the work described on these pages has been carried out in our independent laboratory.

Lastly, I would be failing in my duty not to acknowledge the encouragement given to me by Mr. G.C. Jain of M/s. Business Promotion Bureau, for taking up this new venture. So wishing you all prospective readers, successful project making. I eagerly await your comments.

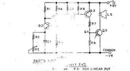
Praveen K. S. o

New Delhi

PROJECT 1

Transistorised Audible Metronome

The classical mechanical metronome is a spring powered clockwork mechanism mounted in a pyramidal box and controlled by an adjustable inverted pendulum. Its disadvantage is that it must be rewound. The electronic version described here has none of these drawbacks. If its rate control is adjusted to give one sound click every second then by counting the number of seconds a very simple timer is at your disposal.



PARTS LIST
WATT ±5%
R5: 50K LINEAR POT WITHOUT SWITCH
R4: 68E R5: 470E
R6: 1K R7: 120E R8,9: 150E
C1, C2: 16MFd 10V. LS: ANY 3Ω TO 8Ω
Q1,Q3: AC128 Q2,Q4: SL 100 OR BEL 100N

The circuit diagram and parts list are given in figure 1. Transistors Q_2 and Q_1 are wired to simulate the function of a unijunction transistor. This pair has high impedance unless it is triggered when its impedance becomes low. On initial switch-on C_1 charges through the emitter of Q_2 and Q_1 in the regenerative switch turns on as Q_1 goes into conduction. Current is then conducted through C_2 to the base of Q_3 which also turns on, switching Q_4 on; which is in series with the speaker producing a loud click. When the charge on C_1 increases, the emitter of Q_2 becomes more positive, turns off the regenerative switch comprising of Q_1 and Q_2 and stops the flow of current to Q_3. When this occurs C_2 must discharge through R_4 and the combination of R_9 with Q_3. As the charge on C_1 lessens, the emitter of Q_2 becomes less positive, the regenerative switch is triggered into conduction and Q_3 receives another pulse which is heard in the loudspeaker through the switching action of Q_4.

Potentiometer R_3 controls the discharging rate of capacitor C_1 and hence the number of beats per minute. It should be calibrated using a stop watch, if desired. Since the circuit draws 25 mA current typically, no special power supply is required; any 9 volts source would do.

PROJECT 2

Drum Beat Simulator Metronome

Although the simple metronome described in project one would suffice in most cases, it might be necessary in some cases for a more real lifelike beat like that of a bass drum to be essential. The circuit given here achieves just that but needs an additional amplifier to make its signal useful.

The complete diagram is given in figure 2. Unijunction transistor Q_1 has been wired as a conventional relaxation oscillator. This particular UJT is not critical and any UJT may be used so far as the connections for the particular UJT used should be checked. Potentiometer R_3 is a pre-set control for controlling the maximum and minimum beat rates of the Panel control R_4. These resistors along with R_5 control the charging rate of capacitor C_1 and hence the pulse repetition rate at the emitter of UJT.

Pulses produced at E are passed through a pulse shaping network R_6. C_2, C_3 and R_7 to achieve the desired transient characteristics of a typical bass drum. The **shaped pulse** is applied through R_8 to a bass drum simulating circuit built around Q_2 wired as a Twin-T oscillator. The output is taken via C_7 to an audio amplifier.

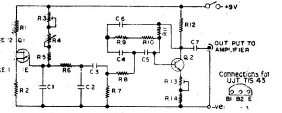


FIG: 2

PARTS LIST

ALL RESISTORS ¼ WATT ±5%

R1,R2,R5: 100 OHMS
R3: 1M PRESET R4: 2M POTENTIOMETER
R6: 22 KILOHMS R7: 3K9 R8: 2K2
R9,R10,R12: 56 KILOHMS R11: 1MEGAOHMS
R13: 4K7 PRESET R14: 82 OHMS

C1,C7: ·33Mfd 50V
C2,C3,C4,C5,C6: ·1Mfd 12V
Q1: TIS 43, 2N4870 OR 2N2646 ANY GENERAL PURPOSE UJT
Q2: BC 148b

The setting procedure for this is very simple. With power applied to the circuit adjust R_{13} until an oscillation starts appearing at the amplifier output. Then back up the preset till the the oscillation just ceases to oscillate on itself. Preset R_3 should be adjusted next to achieve the minimum desired beat rate with potentiometer R_4 fully open (so that it gives its maximum resistance). An optional foot-switch may be added by breaking the connection between point E of UJT and the junction of R_5, R_6 and C_1. The circuit will operate only when these two points are connected.

PROJECT 3

Audio Visual IC Metronome

With more and more musical sessions becoming louder with the passing of each day the necessity for a metronome that gives a visual indication along with an audible click becomes more apparent. One such circuit using the popular integrated circuit timer NE 555 is given here. The range of control is from 40 beats per minute to 240 beats per minute.

The complete circuit is given in Figure 3. Initially capacitor C_1 charges up to the applied battery voltage through R_1, R_3 and R_4.

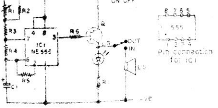


FIG. 3

IC1: 555 IC in mini DIP packerge
R1: 250K log Pot with S.P.S.T switch
All Resistors ¼watt ±5%
R2: 680K R3: 33K R4: 1K
R5: 5K6 R6: 560E R7: 470E

As soon as the voltage across C_1 reaches about two thirds the supply voltage the IC discharges capacitor C_1 through R_4 until the voltage across C_1 reduces to about $\frac{1}{3}$ Vcc. At this point C_1 starts to accumulate a fresh charge and the above cycle repeats. This results in [illegible] of short pulses of approximately 7 ms. duration at the out[illegible] No. 3 of the IC. The [illegible] then used to switch on a [illegible] that has either an LED with current limiting resistor as a load or LED with loudspeaker.

Time period between these is dependent on the values of R_1, R_2, R_3, R_4 and C_1. This time is adjustable between 278 milliseconds and 1.5 seconds (Corresponding to 210 to 40 beats per minute). Resistor R_3 controls the maximum number of beats per minute and is adjusted on test to compensate for variations in the value of C_1. The purpose of R_2 in parallel with R_1 is to reduce the resistance of R_1 in parallel from 250 kilo-ohms to a nominal 185 kilo-ohms to obtain the correct range. Resistor R_5 is included to prevent a latch up of IC in the discharged state when the power is first applied to to the circuit.

A high impedance loudspeaker is used against a standard 8 ohms loudspeaker keeping in mind the limited current capability of the output transistor. If a high power silicon transistor is available with the hobbyist, he may use a standard impedance loudspeaker. Otherwise a 35 ohms to 8 ohms matching transformer may be used. The current limiting resistor in series with light emitting diode limits the diode current to about 20 mA taking into account the saturation voltage drop.

The integrated circuit must be carefully soldered on to a suitable circuit veroboard. For those who are not very much familiar with these devices, use of good quality IC sockets is strongly recommended. Make doubly sure that there is a proper contact between corresponding pins of IC and its socket. The cathode side of light emitting diode has a notch on it and it may be tested on a standard volt-ohm-meter when it will glow on the lowest resistance measuring egrah of your multimeter with the positive red probe of the multimeter (which is actually internally connected to the negativeof the battery) connected to the notch or cathode side.

PROJECT 4

Accented Beat Metronome

The simple metronomes described so far only provide a variable rate beat and as such are useful for only simple musical lessons. Most of the music is composed on so many beats per bar scale. Audibly one out of a number of beats, selected by the operator sounds louder than the others to put emphasis on that particular beat. The complete circuit diagram that uses five transistors and two diodes is given in Figure 4.

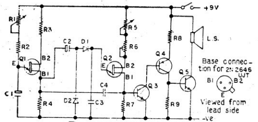


FIG: 4

All Resistors ±5% ¼Watt.

R2: 100K R3,4,7,8: 100E
R9: 470E R1: 50K Pot:
R5: 5K Pot: R6: 10K Preset.
D1,D2: OA79diode
L.S. 35E

C1: 2·5 Mfd 64V
C2: 4 Mfd 40V
C3: ·47Mfd C4: ·22Mfd
Q1,Q2: 2N2646
Q3 Q5: AC 127 Q4: AC 126

Unijunction transistor UJT Q_1 is wired as a conventional RC Relaxation Oscillator whose basic repetition rate is determined by the components R_1, R_2 and C_1. Every time C_1 discharges through the base emitter junction of Q_1, a positive going pulse is produced by R_4 in the base B_1 of Q_1. These basic beats are coupled through C_4 to the direct coupled amplifier consisting of Q_3, Q_4 and Q_5. In addition to providing basic pulses the positive going section of the pulse available at the base B_1 of Q_1, also charges capacitor C_3 through diode D_1. Diode D_2 shorts any negative going portion of the pulse.

Capacitor C_3 therefore accumulates a charge over a number of cycles and eventually reaches the firing voltage of Q_2, whereupon a reinforcing pulse is produced. The charge required to fire Q_2 depends on the voltage at which the bias across the junction goes forward which is controlled by reducing the potential on B_2, so that the junction potential must also drop. R_5 was chosen so that in the prototype at maximum resistance it lowered the junction potential so far that the unit triggered on every input pulse while at minimum. The preset R_6 limited accentuation to no higher than one in six. This range would encompass any musical scale in use today. These accentuation pulses are fed to the base of first audio amplifier transistor Q_3 where it is mixed with the main pulses coming through C_4.

PROJECT 5

Guitar Practice Accompaniment Drummer

A close look at this circuit would show its apparent similarity with the last project. In fact it is a mixture of the project number four and three. It should be a welcome relief to all those amatuer guitarists who have so far been at the mercy of their drummer for their practice. This low cost device does many tricks that its expensive big brother automatic drummer does. It produces a bass drum sound on any every beat and can provide a woodblock sound on any of the two different beats in a bar. These beats may be adjusted to be simultaneous or separated depending upon the positions of potentiometers R_1, R_5 and R_8.

The circuit diagram is given in figure 5. Here transistar Q_1 provides the basic timing pulses which are coupled through R_{20} and C_7 to the base of a two transistor Twin-T Oscillator whose feedback components are so chosen as to give the sound of a bass drum, when shocked into oscillations. The pulse on R_3 is also utilised as in last project to deposit charges on capacitors C_2 and C_3 through isolating diodes D_1 and D_3. When available, capacitors C_2 and C_3 should be of the low leakage tantalum type.

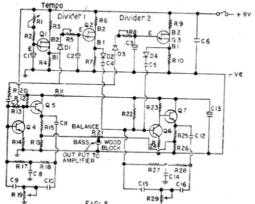


FIG: 5

PARTS LIST
All Resistors ¼ watt ±5%

R1: 100K linear pot with spst switch
R2: 15K R 3: 47E R4,R11: 100 E
R5,R8: 1K lin. pot. R6,R9: 10K
R7,R10,R14,R16,R26; 100E R13: 1M
R12,R23,R27, R28; 39K R15,R25: 1K
R17,R18: 68K R20: 150 K R21: 5K lin.
R19,R29: 47K preset R22: 3·9 M
R24: 330E

C1,C2,C3: 2·5Mfd 64V
C4 C5, C14 } ·0047Mfd ±10%
C6 C9 C10, C11 C12 } ·1Mfd ±10%
C7: ·001Mfd ±10%
C13: 100Mfd 10 Volt
C15,C16: ·01Mfd ±10%

Q1,Q2,Q3: Any general purpose UJT like 2N4871, TIS43, 2N2646
Q4,Q5,Q6,Q7: BC 148b
D1,D2,D3,D4: OA79 or any general purpose germanium diode

The amplitudes of charges across C_2 and C_3 increase with every successive pulse from the clock generator. At some point during the voltage build up Q_2 and Q_3 fire, either simultaneously or independently and rapidly discharges C_2 and C_3 respectively. The resulting pulses that appear across R_7 and R_{10} are then coupled to the base of the woodblock oscillator through isolating diodes D_2 and D_4. Potentiometers R_5 and R_8 can be varied independently so that frequency dividers Q_2 and Q_3 fire at different rates to produce a wide variety of syncopated rhythms.

The two Twin-T oscillators are almost identical in operation consisting of one common emitter and one emitter follower circuits. Presets R_{19} and R_{29} are so adjusted that with no pulse applied to these transistors there is no continuous oscillation. A slight shock like that given from a pulse should be sufficient to cause its oscillation which should then decay naturally. By varying the values of components in Twin-T oscillators shown below each transistor pair other instruments may be imitated. The balance potentiometer adjusts the balance between the sounds of the bass drum and the woodblock. The output should be fed into the auxiliary input of a good quality amplifier.

PROJECT 6

Bass Booster For Electric Guitar

Electric guitar has been a very popular instrument with modern teenagers. Its usefulness and variety of sound is greatly enhanced with use of electronic effect units. The simplest and most economical in the list of such devices are the various units that alter the tonal quality of sound emanated from the guitar. The bass booster described here, when used in conjunction with a good quality medium impedance pick up and medium priced guitar would produce the bassy sound often found on huge bass guitars.

The circuit diagram given in Figure 6 shows that it is a straight forward direct coupled amplifier with feedback applied from collector to base of each transistor. This feedback applied through capacitors C_4 and C_5 is frequency selective by nature. The impedance of the capacitors decreases with increasing frequency which means that a higher feedback is available at high frequency. More feedback means less amplifier gain. As a result higher frequencies are attenuated more in this amplifier as compared to low frequencies. The value of capacitors C_4 and C_5 can be any thing between .001 Mfd to .05 Mfd but both of these should be of the same value. Using a larger capacitor for these would give

BASS BOOSTER FOR ELECTRIC GUITAR

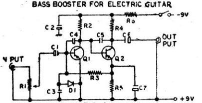


FIG: 6

PARTS LIST
All Resistors ¼ watt ±5%
R1 : 5K log Pot with switch.
R2 : 22 K R3 : 10K R4 : 3·3K
R5 : 1 K R6 : 1 K
D1 : OA79 or any general purpose germanium diode.

Q1,Q2 : AC 126
C7 : 100Mfd 6·4V
C1 : 10Mfd 12V
C2 : 100Mfd 10V
C3 : ·001Mfd
C4,5 : ·001 to ·05Mfd
C6 : 50Mfd 12V

more of bass boost. If desired, different capacitors may be switched in for varying degrees of bass boost. Resistor R1 is a simple level control.

PRJETCT 7

Treble Boost Preamplifier

This circuit does exactly opposite of the previous one. As such it is more useful for rhythm or lead guitarists to emphasize melody in music. The principle employed here may also be employed to get extra treble boost from an existing guitar amplifier because most of the modern day silicon solid state guitar amplifiers will have an input circuitry identical to the circuit given here. However, such an alteration should only be attempted by the technically astute person who is familiar with the interiors of his amplifier.

Typical passive treble controls often found on some guitar often provide as little as 6db. of gain at 3KHz. as compared to its gain at 300Hz. This figure transformed into numbers would mean that with full treble boost a doubling of the voltage would only result. However, due to our ears logarithmic response to increased stimuli, a 10 db. change is necessary to make a sound twice louder. The circuit gives 20 db. of boost at 3 KHz w.r.t. 300 Hz and as such subjectively sound: four times louder at 3KHz with full treble boost.

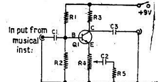


FIG: 7
TREBLE BOOST PRE-AMPLIFIER

PARTS LIST
All Resistors ¼ watt ±10%

R1	120K	R2	56K	C1:	·22Mfd
R3	8K2	R5	560E	C2:	·22Mfd
R4	5K linear pot: with switch			C3:	·47Mfd
				Q1:	BC 148b

The amount of treble boost necessary can be adjusted with potentiometer R_4 which is in the emitter of Q_1. At low frequencies this potentiometer introduces a large degenerative feedback and the stage voltage gain is only slightly greater than unity. However, as the frequency increases the R_4 impedance is progressively shunted by the series combination of C_2 and R_5. to a point at about 3 KHz where the gain is 20 db. and limited only by the 560 ohm resistor. Output from the guitar pickup should be connected to the units input while its output to the actual input of the amplifiers (main).

PROJECT 8

Presence Boost For Musical Instrument

This circuit is identical to the earliest circuit except that due to the larger values employed for input and output coupling capacitors slightly more gain is available in the mid-frequency region of guitar sound spectrum. Also due to the absence of R_5 in this circuit another 6db.

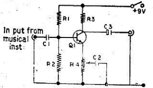


FIG: 8
PRESENCE
BOOST

PARTS LIST
All Resistors ¼ watt ±5%

R1: 120 K C1: 33 Mfd
R2: 56 K C2: 1Mfd, C3: 25Mfd
R3: 6K8 Q1: BC 149c
R4: 5K.log pot.with switch.

of gain in addition to existing 20 db. is available from this circuit. However, this additional gain may cause some problems of RF breakthrough in regions of high transmitter signal. In such cases a 460pf, to 1000 pf. condenser connected at the input of the unit would cure the problem.

PROJECT 9

Connecting Pickups To Guitar

It is useless to proceed further without understanding the working of the electric guitar pickup the starting point for the musical signal. If this signal is of a poor quality then no amout of electronic processing can render it musically acceptable. There are many types of guitar pickups commercially available and it is advisable to buy a commercial pickup. There are basically two types of pickups: the cantact microphone type and the electromagnatic type. The former picks up the sound from the hollow sounding board of a hawaiian guitar whereas the latter depends upon an induced electromagnetic current due to the vibration of plucked steel strings. This latter type works best with solid body guitars and is the most popular.

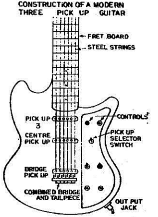


FIG: 3

An electromagnetic pickup consists essentially of a permanent magnet around which are wound a number of coils. In the economy model less sensitive pickups there is only a single coil of a moderate number of medium guage enamelled copper wire, wound around an array of correctly aligned magnets. The medium model pickups employ a separate coil for each magnet placed below each string. The wire used is generally hair thin and a large number of turns are given to increase sensitivity. All coils are then connected in series in proper phase. The most expensive hum bucking pickups used by professionals where there is risk of hum being introduced through long connecting wires, use a set of coils for each string which are wound reverse with respect to each other. It is essential that the pickup impedance be matched to that of playback amplifier for optimum results.

The placement of the pickups with respect to guitar bridge is also important. A pickup placed close to a bridge produces a thin hard tune while the one nearest to fret board a deeper and more mellow. In between these two positions we get varying mixtures of

L.S. Minimum
impedance
35 ohms
C1: 10Mfd 10 or 16V
Q1: BEL 100P or
SK 100

TWO pick up electrical connections for reversing the phase of one remote pick up

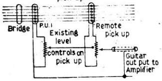


FIG: 10 A

Another arrangement using a switch to reverse the phase of remote pick up

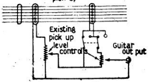


FIG: 10 B

A Tone & Volume cir cuit for medium to high impedance single pick ups

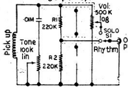


FIG: 10 C

different tonal character. A typical arrangement of volume and the controls for a single pickup guitar is shown in Figure 10 C. Switch S_1 is connected to give a fixed attennuation thereby reducing the output automatically for rhythm or chord playing. All these controls are generally provided on the guitar body. Two different arrangements are given for connecting two pickups to achieve wide effects from these. Relative settings of two level controls determine the output level and tonal quality. While the circuit in Figure 10 A uses a special tapped potentiometer for reversing the phase of one remote pick up, the circuit in Figure 10 B uses a more conventional · potentiometer with a phase reversing switch.

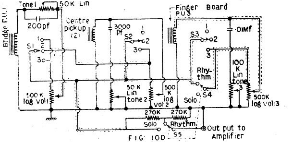


FIG 10D

Physical appearence of a modern three pickup electric guitar s given in Figure 9 while typical circuitry connecting all these is given in figure 10 D. The dotted lines show where shielded wires are to be used and these must be grounded at one end only to minimize the possibility of hum picking. Finally the circuit ground must be connected to a metallic plate on the guitar body.

PROJECT 10

Simple Preamplifier for Electric Guitar

It would not be long before you are asked for assistance by a neighbouring teenager, if you happen to be famous as an electronics wizard in your locality, to build a guitar matching preamplifier that should give adequate signal from low cost electric guitars to enable them to be used on ceramic or crystal pickup amplifiers generally available in every house. This project does just that and is one of the most sought after projects. The circuit given in Figure 11 is a single transistor common emitter amplifier with

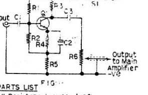


FIG.

PARTS LIST

All Resistors ¼ watt ±10%

R1: 470K	R2: 68K	C1: 22 Mfd
R3: 10K	R4: 560 E	C2: 64Mfd 6.4v
R5: 220E		C3: 47Mfd
R6: 22K log with switch		Q1: BC149C

degenerative feedback in the emitter and a boot strapped bias divider to secure increased input impedance. Input impedance is greater than 50 Kilo-ohms while voltage gain is about 18 which can be increased by reducing the value of R_5. However, this should be necessary with only poor sensitivity pickups. With the component values given, the maximum RMS output voltage is 2V and the required input for this level to be reached is just a little more than 100 mV. If the amplifier is driven beyond this distortion would start to occur. Level control R 6 should be adjusted for minimum distortion. However, the amplifier could be over driven for a fuzzy effect.

PROJECT 11

Multi Control Tone for Guitarists

Most of the guitar amplifiers have only two tone controls Therefore it is very difficult for a musician to achieve a proper tona balance. An ideal arrangement could be to have a control for each string. The circuit given in Figure 12 achieves this with a minimum

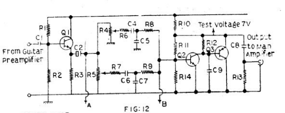


FIG: 12

PARTS LIST
ALL Resistors ¼ watt ±5%
R1: 120K R2: 120K R3: 1K R4, R5: 10K Linear
R6, R7, R8, R9: 100K R10: 1K R11: 330K R12: 5K6
R13: 220K R14: 33K
C1: 47Mfd C2: 10Mfd 16V C4-C7 See Text C9: 100 pf
C8: 47Mfd C3: Not Used
Q1: BC149b Q2: BC 149b Q3: BC 157b

of components. The unit should be inserted between the guitar preamplifier such as described in previous project and main power amplifier such as given in project No. 13. On its own it provides little voltage gain as the first transistor is wired as a simple emitter follower with a stage gain little higher than unity. This signal is then passed on to a number of wien-networks R_6, C_4, C_5, R_4, R_7, C_6 C_7, R_9 etc. connected between points A and B. Different values for these components would place the centre frequencies at different points e.g. with

C4, C5 = 39n	fcet. = 40 Hz
C6, C7 = 10n	fcet. = 155 Hz.
C6, C7 = 2500pf.	fcet. = 625 Hz.
C6, C7 = 180pf.	fcet. = 2.5 KHz.
C6, C7 = 330pf.	fcet. = 5 KHz.
C6, C7 = 160pf.	fcet. = 10 KHz.

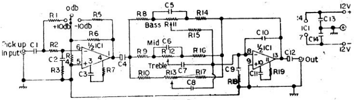
Where fcet stands for centre frequency :

Any intermediate value for desired frequency may be interpolated keeping in mind that with all resistor values constant the capacitor values should be halved for every doubling of the central frequencies. Any number of desired controls may be used by inserting the proper network between A and B. Wien-network is a passive filter and attenuates the signal by about three times. To overcome this loss the transistor pair of Q_2 and Q_3 is used which has a gain of three.

PROJECT 12

Complete Guitar Preamplifier

Here is a modern circuit for a complete guitar preamplifier which would accommodate any guitar pickup and has three tone controls for versatility. It uses a modern low noise fairchild operational amplifier IC but any other operational amp. may be used if low noise is not of paramount importance and proper care is taken about the various inputs, outputs, freq. compensation and supply pins of IC. Instead of a continuously variable level control it has a switched level control giving—10 db, 0db and + 10 db. gain, as the pickup used is likely to have a level control with . —10 db. position is to be used with high sensitivity high output pickups giving an attenuation of 316 times. 0db position is to be used on medium price pickups and does not give any appreciable gain. A gain of 316 times is available on the 10 db. position, potentiometers R_{11}, R_{12}, R_{13} are respectively the bass, midrange or presence and treble controls. While layout is important in this circuit and standard practice used in audio amplifiers must be



F I G: 13

PARTS LIST
All Resistors ¼ Watt ±5%

R1,R5: 330K   R2,R6: 680K   R3,R8,R14,R15: 10K
R4: 220K   R7,R,19: 150E   R9,R16: 3K3   R10,R17: 1K8
R11,R12: 100K Lin   R13: 470K Lin   R18: 270E
IC1: μA739

C1,C13,C14: ·1Mfd   C5: 56Kpf
C2: ·01Mfd   C6: 5K6pf
C3,C9,C11: 1Kpf   C10: 100pf
C4: 25Mfd 25V   C8: 4K7pf
C7: ·022Mfd
C12: 4·7Mfd 25V

adhered to. However, it is important that RF bypass and supply decoupling capacitors C_{13} and C_{14} should be installed as near as possible to IC supply pins. The complete circuit diagram is given in Figure 13.

PROJECT 13

Guitar Practice Power Amplifier

No book on the electronic music would be complete without a musically sounding power amplifier. This circuit which complements the previous project and is compatible with most guitar pre-amplifiers gives 20 watts of continuous sine wave power at less than 5% distortion in a speaker load of 8 ohms. The same figure when quoted in terms of musical power and peak music power would be 30 and 60

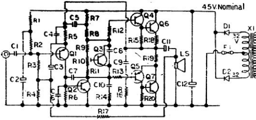


FIG: 14

PARTS LIST

All Resistors ½watt ±10%

R1: 47K R2,R3: 150 K R4: 33 E
R5: 4K7 R6: 1K5 R8: 2K7
R7,R10,R11: 1K R9: 2K2
R12,R13: 470 E R14: 220 E
R15,R20: 56 E R16: 10 E
R17: 1K8 R18,R19: 47 E 2Watt(w.w)
Q1: BC 157 Q2: 2N3053 Q3: BC 148
Q4: BD 137 or BEL 100N
Q5: BD 138 or BEL 100P
Q6,Q7: 2N3055x2 Matched Pair on Heat Link

C1,C9: -1Mfd 50V C2: 5Mfd 50V
C3: 100Mfd 50V C4: -0015Mfd
C5: 25Mfd 25V C10: 330 pf
C6,C8: -01Mfd 50V C7: 27 pf
C11,C12: 2500Mfd 50V
LS: 8E Minimum
X1: 240 volts primary 32-0-32V
2Amp secondary.
F1: 1·5Amp fuse.

watts respectively. The circuit is a straight forward quasi-complementary power amplifier. Transistor Q_1 acts as a pre-amplifier for the pre-driver transistor Q_2, Q_3 acts as a quiscent current stabiliser against temperature to provide standing current for output transistor. The preset R_{10} in the base of R_3 should be adjusted to give a no load current of 40 mA with a miliammeter connected in series with supply positive and collector of Q_6. Transistors Q_6 and Q_7 should be mounted on a heat sink.

PROJECT 14

Guitar Envelope Control

Instrument envelope is a very important factor in the characteristic sound emitted by a particular instrument. It relates to the way a musical note rises to its peak amplitude with respect to time and then retains its value. The beginning period is called attack and the latter period is called sustain. When the sound producing stimula is removed the sound decays to its minimum in a finite time called decay time. Different instruments have their characteristic attack, decay and sustain times. By altering the envelope of musical waveforms it is easy to imitate different instruments. While still on the topic of sound processors, let us examine a typical circuit giving such control. Referring to figure No. 15B F.E.T. Q_3 is used as a voltage

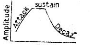


FIG. 15A

controlled amplifier whose gain is inversely proportional to its bias voltage. This bias voltage is dependent on the charge applied to capa-

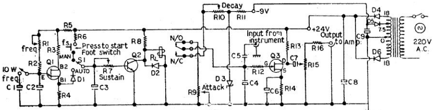


FIG: 15 B

PARTS LIST

All Resistors ¼ watt ±5%

R1: 100 K logarithmic R2: 3K3 R4: 100 E R16: 100 K
R3: 470 E R5, R11: 1K R6: 1K5 R8: 4K7 R12: 1Meg
R7: 100K linear R9, R10: 500 K lin R13: 10K R14: 2K2
R15: 1Meg log

Q1: 2N2646 UJT Q3: 2N3819 or 2N5459 fet Q2: 2N2926
D1, D2: IN914 D3: 43V 400mw ZD D4, D5, D6: EC051
Transformer 220V primary 18, 7.5-0-18V secondary

RL: 24V Relay
C1: 100 Mfd 25V C4: 10Mfd 16V
C2, C3, C6: 25Mfd 25V
C5: ·1Mfd 50V C7: 1Mfd 12V
C8: 1000Mfd 25V C9: 500Mfd 12V

citor C_4. To some readers capacitor C_4 would appear to be connected the wrong way out. But this has been deliberately done and is essential for the functioning of the circuit. A separate negative voltage has been supplied to charge C_4. The manual trigger for the envelope generator is built around transistor Q_2 while UJT Q_1 wired as a conventional relaxation oscillator is used in the automatic mode. With switch S, in manual mode and foot switch FS momentarily pressed, capacitor C_3 in the base of transistor Q_2 is charged to a positive voltage. This charge cuts off Q_3 pulling the relay on. Initially capacitor C_4 is kept charged to a negative voltage with respect to circuit ground through normally connected contacts of relay RL. As a result any signal applied to the gate of Q_3 through C_5 would not pass through. When the footswitch FS is momentarily depressed capacitor C_4 is shorted through resistor R_9 through the normally open contacts of relay due to circuit action described above. As a result the negative bias voltage at f.e.t. gate begins to diminish progressively allowing the gradual build up of input signal. This resistor R_9 therefore controls the attack time.

After the footswitch has been released, capacitor C_3 would hold its charge for a very short period depending upon the setting of potentiometer R_7. Hence this potentiometer determines the sustain time of the unit and this would be typically between 10 to 20 seconds. Once the charge is lost on C_3, the relay would be released and capacitor C_4 would once again get charged to the negative voltage through R_{10}. This potentiometer therefore, determines the decay time. Once the capacitor is fully charged, no signal would pass through.

In the auto mode, the trigger produces pulses periodically over a wide range of frequencies. These pulses close and open relay RL as periodically as a pulse occurs. Pulse rate is determined with potentiometer R_1. For very low speeds an additional capacitor C_1 may be switched in addition to C_2 in the UJT relaxation oscillator.

PROJECT 15

Guitar Fuzz Box

One of the most commonly used black boxes in conjunction with an electric guitar is fuzz unit. This particular unit deliberately introduces distortion in the guitar sound and provides a spiky sound with over abundance of harmonics. A footswitch S_1 normally by-passes the unit. However when it is pressed with foot, signal gets processed through a high gain two transistor amplifier. It is distorted in the process and the amount of fuzz or distortion introduced is dependent upon the setting of potentiometer R_3. This potentiometer in fact changes the working point for transistor Q_2. Overall volume in fuzz mode is determined with R_5. R_5 should be so adjusted that there is no apparent loss of volume when the unit is in the signal path as compared to when it is bypassed. The complete circuit diagram is given in Figure 16.

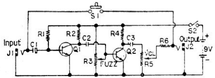


FIG: 16

PARTS LIST
All Resistors ¼ Watt ±5%

R1: 1M	R2: 4K7	C1: 50 Mfd 6V
R3: 1M Lin	R4: 10K	C2: 047Mfd 12V
R5: 100K log with switch		C3: 01MFd 12V
R6: 100K	Q1,Q2 BC 148b	S1: FOOT Switch

PROJECT 16

Simple Waa-Waa Unit

Waa-Waa units that produce the famous crying and weeping woan-woan sound from musical instruments are very popular. Actually the unit is an active bandpass filter whose pass band frequency range is varied up and down the audio spectrum by means of a potentiometer coupled to the foot pedal. The complete circuit is given in Figure 17 and it could be fed directly from a high sensitivity pickup. However, while using low sensitivity pickups, it must be preceded with a single stage preamplifier.

Components R_7 R_8, C_6 and C_4, C_5, R_9 for a Twin-T net work are incorporated in a phase shift oscillator built around Q1. Negative feedback is obtained by feeding part of the signal back to the base via C_2. The waa-waa effect is achieved as certain frequencies are amplified more than others. The values of C_4. C_5 and C_6 are chosen so as to emphasize waa-waa effect on the higher audio frequencies. This gives the desired brilliance. These values can be toyed with by the experimenter to achieve the desired effect.

For setting up the unit initially R_6 is turned to its minimum value. R_9 is now adjusted to and fro till a point is found at which an audible whistle appears indicating oscillation. R_6 is then adjusted till the oscillation just disappears. R_9 is turned over its whole range and if at any point oscillation occurs again R_6 is again advanced till is ceases. It should be possible to set R_9 to any value over its range of adjustment without any oscillation being apparent. This should also be achieved with the minimum possible value of RVI.

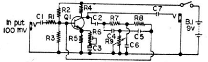


FIG. 17

PARTS LIST
All Resistors ¼ Watt ±5%

R1,R3: 100K R2: 470K
R4: 10K R5: 2K2
R6: 4K7 Preset
R7,R8: 56K R9: 100K Lin.
C1,C2: ·1Mfd 12V

C3: 50Mfd 6V
C4,C5: 2·2nf
C6: 47nf
C7: ·47Mfd
Q1: BC149c

PROJECT 17

Electromechanical Echo and Reverberation

Echo and reverberation are two distinct effects. Reverberation is the effect that is achieved due to multiple reflections caused in a closed space like that of an auditorium. The audible effect is that of the sound decaying slowly in a finite time depending upon the characteristic reverberation time of the environment. An echo is produced when the same sound reaches a receiver after an interval of time from different directions traversing different path lengths. Professional echo producing gadgetry is quite complex and employs a special tape-recorder which has a number of playback heads placed in the path of tape head at certain regular distances. All the signals are then summed up.

There are many imported reverberation units available that use electromagnetic spring drivers. Due to the limited availability and expense of such assemblies, use is made here of an inexpensive home brew crystal pick-up driver assembly.

The delay unit consists of two crystal pick up units with a series of metal springs between them. If an audio signal is fed into one crysal unit the crystal itself vibrates and this vibration is coupled to the spring. The spring begins to vibrate in sympathy and due to its mechanical inertia, the vibration takes a short time to reach the far end where the signal is reconverted into an electrical wave form by the other crystal unit. Thus the signal entering the first or driver crystal and the signal taken from second pick up crystal have a time delay between them, the length of the time delay depending entirely on the characteristics of the spring. If these two signals are fed simultaneously to an amplifier the effect heard would be similar to the one where an instrument is played in a large hall adding to its reverberation. If this delayed signal is interrupted at a pre-determined rate, an effect similar to the echo would be obtained Referring to Fig 18A the rate of repetitive echo is determined by the setting of potentiometer Vr.1.

Three valves of the twin triode type. ECC 83 are used in the circuit, Valves are used because of relative complexity of the unit. In addition many guitarists tend to favour the use of valve type guitar amplifiers. The unit may be incorporated in the existing amplifier if – 250V.H.T. and 6.3V, 1A heater supplies are available in the main amplifier circuit. Otherwise a simple supply such as shown in Fig 18C may be built.

The twin input jacks are matched for either high impedance microphones or guitar pickup. First valve V_1 is wired as a cascade R-C amplifier. At its first grid the signal is split by a voltage divider net-work consisting of resistor R_1 R_4. A proportion of it is fed into V_1 (a), the remainder to the grid of V_3 b (the direct signal amplifier). The two stages of V_1 bring the signal upto a high level where it is fed to the drive crystal on the delay unit. The resulting mechanical vibration is recovered in electrical impulses by the pick up crystal and fed into the pick up amplifier V_2. The output of this stage is taken via a capacitor network 3×.005 Mfd. to a gain control VR_3 which determines the overall proportion of delayed signal present in the final output. The network is to remove any low frequency component present when the echo repetition oscillator is in use ; further, the output of the network tends to rise with frequency and so removes any low frequency noise due to external vibration of the delay unit. Capacitor C across this netwok and chassis is a tone compensating device and may be of any value between .005 Mfd and .05 Mfd depending upon the output tone required.

Section V_2 (b) is a cathode follower used to modulate the cathode circuit of this amplifier with the output of the low frequency phase shift oscillator built around V_3 (a). If desired the unit may be by—passed for only direct signal by shorting the foot switch S_2. The repetition oscillator output is coupled to the grid of V_2 (b). A 2 Mfd capacitor has been used as a decoupling capacitor for the two cathodes of V_2 tied together. This has a low impedance at the signal frequency but allows sufficient low frequency component to appear at the cathodes from the oscillator. As this swings the cathode

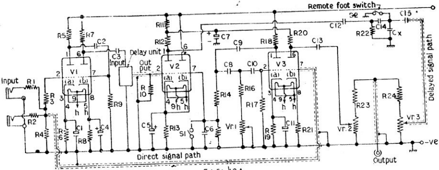


FIG: 18A

PARTS LIST
All Resistors ½watt ±10% unless otherwise stated.

R1,R2,R3,R15,R23,R24: 47K
R4,R9,R10,R14,R16: 470K
R5,R12,R18: 220K R13: 5K
R6,R8,R19,R21: 1K5
R7,R20: 100K R17: 2M2
R22: 100K R11: 10K 1Watt
Delay Unit: See Fig 18B.

C1,C4: 25Mfd 25V
C2,C3,C8,C9,C10,C13: ·01Mfd 400V
C5: 25Mfd 64V C7: 16Mfd 350V
C6: ·5Mfd 160V C11: 100Mfd 25V
C12,C14,C15: 5000pf or ·005Mfd 400V
V1,V2,V3: ECC83 Cx: SEE TEXT
Vr1: 1ME LIN. Vr2Vr3: 250K LOG

voltage the gain of the pick up amplifier is varied in sympathy with the oscillator giving a repetitive effect to the signal. Switch S_1 enables straight or repetitive echo to be obtained at will by interrupting the oscillator feed to V_2 b. Potentiometer Vr. 2 determines the overall proportion of direct signal present at output.

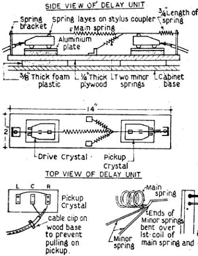


FIG: 18b

The complete construction of the delay unit is shown in Fig. 18B.

First of all two small squares of aluminium are cut which are just larger than the area of pick up covers. Each pick up is attached to the metal base by cementing its metal base to the aluminium plate with araldite. The pickups used should be of the Ronnette type. When thoroughly dry two pieces of 3/8 in, thick foam plastic the same size as the aluminium plates are cemented lightly to the under side of each CAPS. Then the entire pick up unit is cemented to the three ply base so that they rest on the foam plastic supports. Allow approximately 1 in. clearance between the end of the plywood base and each pickup unit.

The height between the wood and the top of the stylus couplers on each pick up should be noted and two aluminium brackets made for the springs, each with two 1/16 in. holes drilled in them at the height where the spring leaves the stylus coupler and attaches to the bracket. Before mounting the brackets to the base remove the stylus on each pick up by gently pulling the needle towards the rear of the pick ups with a pair of long nosed pliers or tweezers. The two small brackets are made in a similar method to the end ones except they are half the height of the former type and they mount approximately in the centre of the wood base, one near each edge as shown in Fig. 18B. Connect two lengths of thin single core screened cable to the pick up tags as in Fig. 18B and clip this cable to the wood base by means of a small metal U clip or staple, leaving some slack between this and the tags. The springs can now be fitted

To make the main spring first unwind about ½ in. of one end ot the spring and pull it straight. Make a small hook on this straight piece and carefully insert through the holes in the bracket at the pick up crystal end. Pull the spring gently straight over the pick up (without stretching it too much) and note where the spring meets the rear of the pick up. Leaving about ¾ in. of coiled spring between the bracket and the rear of the pick up unwind sufficient wire so that a straight length appears over the length of the pick up over the stylus coupler. Allow enough to clear the pick up at each end by about ¼ inch.

Now hold the spring (still attached to the bracket) over the drive crystal and a gain note the position on it about ¾ in. from the edge of the drive crystal. From this position to past the other bracket, straighten out the coil so that another straight length of wire appears over this pick up and stylus coupler. Insert this straight end into the bracket holes and after pulling just enough to keep the spring from sagging too much in its centre, make fast on the bracket.

The two small springs are made in a similar way, leaving enough straight wire where they join the main spring so that the small springs do not touch the main one along their length. The tension on these springs should be very low, in fact just enough to hook

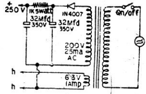


FIG 18C

them over the main one so that they don't pull on the small ¾ in. coil at the pick up crystal end and cause it to foul the end of this pick up. Making sure the main spring lies in each stylus coupler : a small dab of clear cement will hold them in place. Another dab of cement keeps the small springs in place on the main one. To reduce hum it is advised that one spring bracket and the plate under the pick up crystal be returned to chassis via screening on the pickup lead. Small solder tags are bolted to these and connections made with thin flex will suffice. Type of spring material used can be obtained from a heater element. The lightest gauge of wire that is available for this should be used. The more highly tempered the spring the better will be its characteristics arrangement.

PROJECT 18

Guitar Tremolo Unit

When sub-audible low frequency amplitude modulation is applied to musical waveform, the resulting waveform produced is said to have undergone tremolo. The audible effect is that of instantaneous amplitude wavering high and low at the sub-sonic frequency. It is important that to prevent damage to the speakers, the low frequency signal itself should not appear at the output. Initially people used a lamp whose intensity was modulated by the low frequency signal to control the resistance of a light dependent resistor. This system was not popular due to the high current consumption of the dial lamp.

In the present circuit figure 19, a UJT is wired as a relaxation oscillator with frequencies variable from 1 to 12 HZ. The generator

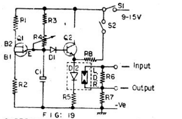


FIG: 19

PARTS LIST

All Resistors ¼ watt ±10%

R1: 470E	R2: 47E	C1: 10Mfd 16V	D2: Red Led
R3: 5K6	R7: 10K	Q1: 2N2646	LDR: Light dep resistor
R4: 47K Lin.	R5: 330E	Q2: BC149c	
R6: 100K	R8: 220E	D1: 1N914	

drives an NPN transistor with one LED in its emitter. This LED is coupled to a light dependent resistor in a light proof small housing painted black on the inside. Alternatively ready built opto-couplers having a LED and photocell or LDR may be purchased. The light intensity of the LED varies in sympathy with the modulating signal which affects the LDR resistance which is optically coupled to it. Since the LDR is inserted in series with the signal path, it modulates the signal to create the tremolo effect. Tremolo rate is governed with potentiometer R_4 and if desired the effect may be by-passed by closing the footswitch S_2 whereby the LED D_2 is permanently illuminated.

PROJECT 19

Simple Sustain for Guitar

The importance of musical envelope control has been high-lighted in project fourteen where a suitable circuit for controlling the important parameters of envelope was given. However, many interesting sounds can be produced from an electric guitar simply by controlling its sustain time. The circuit given in fig. 20 achieves just that and a variable sustain time is available using potentiometer R6. The circuit can be directly fed from a guitar pickup while its output should go to a suitable amplifier Transistors Tr. 1 and Tr. 2 form a high gain self-stabilising pair.

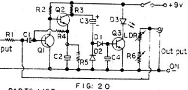


FIG: 20

PARTS LIST

All Resistors ¼watt ±5%

R1: 82 K	R2, R4 47K	C4: 25Mfd 64V
R3: 10 K	R5: 1K	C1, C3: 4Mfd 40V
R6: 5K Linear with switch		C2: 10Mfd 16V
LDR: Light dependent Resistors ORP12 or similar		Q1 to Q3: BC148B
D1, D2: OA91	D3: Red high intensity led	

The output is rectified by D_1, D_2, smoothed by C_4 and applied to TR_3 which controls the brightness of the LED D_3. The light from the LED, falls on the light dependent resistor, varying its resistance and so controlling the level of the input signal by voltage divider action via R_6. The LED used should be of the high intensity type and it should be tightly coupled to the LDR in a light proof housing. Alternatively apto isolators employing a LED and photocell could be used.

PROJECT 20

A Single Tansistor Phaser

The use of phasers in electronic music in India is relatively new. The effect of a phaser on a musical signal is that it has many crests and troughs in its frequency response curve. So the sound passing through it is selectively boosted at certain frequencies while simultaneously getting attenuated at different frequencies. We all know that in a common emitter stage

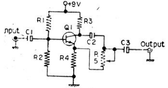


FIG: 21

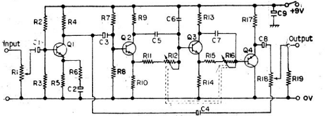
PARTS LIST
All Resistors ¼watt ±5%
R1: 47K R2: 22K Q1: BC148b
R3, R4: 2K2
R5: 2K5 C1,C2,C3: 1Mfd 80V

amplifier, the output at collector is 180° out of phase with respect to the input signal at base. The signal at the emitter, however, is in phase with the input. By mixing the proportion of the signals at the collector and emitter of Q_1 it should be possible to get a signal that is delayed with respect to the input in terms of phase

PROJECT 21

A Professional Mini Phaser

The single stage phaser described in the previous project is limited in applications as its total phase shift range of 0° to 180° is not enough for all applications. However several of these stages may be cascaded to achieve a larger phase shift range. A professional mini phaser that gives 0° to 360° of control is prescribed in fig. 22. It can be driven directly from a guitar pick up.



F I G: 22

PARTS LIST

All Resistors ¼ watt ±5%

R1: 22K log with switch R2: 120K
R3: 39K R4,R17: 10K R6: 100E
R5,R9,R10,R13,R14: 4K7 R7: 68K
R8: 39K R11,R15: 68E R19: 100K
R18: 10K Lin R12,R16: 47K Lin
Stereo tandem potentiometer.

C1,C2,C3,C4,C8: 10Mfd 16V
C5,C6: ·015Mfd 100V
C7: ·1Mfd C9: 100Mfd 12V

Q1: BC149c Q2,Q3: BC148b
Q4: BC158

Transistor Q_1 is used as a simple preamplifier. Since the phase shifting circuitry does not provide any gain, all of it is supplied by Q_1. R_1 acts as a gain control and if this control is advanced then depending on the signal level, clipping may occur. This increases the harmonic content of the input signal and enhances the phasing effect, which can be desirable on the occasion.

At the output from Q_1 the signal is split. A portion is fed direct to R_1 and a portion to R_{18} through the phase shifter. The phase shifter comprises two phase splitters Q_2 and Q_3. These have equal emitter and collector resistors, so that the signals appearing at the emitters and collectors have the same amplitude but are inverted with respect to one another. The phase of the signal at the junction of C_5/R_{12} and C_7/R_{16} may be varied by adjusting the tandem potentiometer R_{12}/R_{16}. Each stage can introduce a phase shift from a few degrees to 180° or 360° in all.

Transistor Q_4 is connected as an emitter follower, providing a very high input impedance to buffer the output of the second phase shift network and a very low output impedance. The output signal is fed from the emitter of Q_4 via C_9 to one end of R_{18}. The direct (non-phase shifted) signal is fed to the other end. R_{18} acts as a balance control between these two signals and varying R_{18} alters the proportion of direct to phase shifting signal. It may be adjusted so that when 180° phase shift occurs the direct and phase shifted signal cancel each other. In practice potentiometer R_{12} R_{16} is coupled to a foot pedal and the frequency range over which the phaser acts is swept up and down as desired.

PROJECT 22

Four Piece Electronic Bongo

So far we have primarily dealt with circuits that generally relied upon some external source of tone generator. From there onwards we march forward to electronic circuits that generate sound which are imitations of musical instruments. Described in fig. 23 is one such circuit that generates a familiar bongo drum sound when one of its touch plates is momentarily touched. There are four twin T oscillators built around transistors Q_1 to Q_4 and a mixer stage Q_5. All oscillators are identical except for the values of twin—T filter components. Using higher values of capacitors results in a thicker sound. The instrument sustain can be controlled with one of potentiometers .Vr. 1 to Vr. 4. Vr. 5 sets the over all volume. To set up the bongo all presets Vr. 1 to Vr. 4 are turned for miximum resistance. Each of these is then slowly turned back towards its minimum resistance till a point is reached where continuous oscillations start to appear. The control is then just backed up so that when any external stimulus or pulse is applied to the touch plate associated with that oscillator, a bongo type sound is heard.

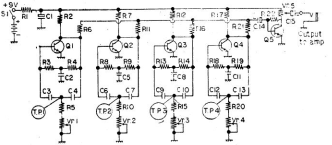


FIG. 23

PARTS LIST

All Resistors ¼ watt ±5%.

R1: 10K R2: 100K
R7,R12,R17: 100K R6,R11,R16,R21: 22K
R3,R4,R9,R10,R8,R13,R14,R15,R18,R19,R20: 47K
R5;12K T.P1-T.P4 Metallic touch plates
Q1-Q5 BC148b Vr.1,Vr.2,Vr.3,Vr.4: 22K Preset
Vr.5: 10 K log

C1: 25Mfd 12V C2,C6,C7: .01Mfd 50V ±10%
C3,C4: .0047Mfd ±10% C8: .033Mfd 10%
C5,C12,C13: .022Mfd ±10% C11: .04Mfd ±10%
C9,C10: .015Mfd ± 10%
C14,C15: 2.5Mfd 25V

Since the human body accumulates a definite electric charge the oscillators are triggered by merely touching the touch plates with your fingers. In case any difficulty is experienced in getting the instrument work in this fashion as might happen in certain environments, a 15k resistor should be connected to the battery positive at one end and to your thumb or wrist at the other end. Capacitor C_{11} is made by paralleling one .022 Mfd. and one .018 Mfd. capacitor. The output of the unit is fed into the auxiliary input of an audio amplifier.

PROJECT 23

Electronic Percussion Box

An electronic percussion box is one of the most sought after items. Percussion instruments are those which have a relatively small attack time compared to the sustain or decay times. Some of the instruments that fall in the this category are bass drums, bongos, cymbals etc. Fig. 24 is a complete electronic percussion box which can simulate any of the following sounds: (1) bass drum (2) low bongo (3) high bongo (4) short cymbal (5) long cymbal and (6) Marccass. Push button PBI gives the sound of Marccass when pressed while PB2, PB3, PB4, PB5, PB6, give the sounds of short cymbal, long cymbal, low bongo, high bongo and bass drum respectively.

The circuit operation for the short cymbal, long cymbal and marcass sound is identical as all these instruments use filtered white noise at the output. They only differ in their attack, decay and sustain times which are dependent upon RC networks connected immediately after the respective push buttons. Transistor Q_1 is used as a zener diode in the avalanche mode and as such generates white noise whose amplitude is controlled by preset Vr. 1 to give a most natural imitation of traditional instruments. Its output is fed via C_5 to the base of transistor Q_2. This transistor is used as a switch whose on/off time is controlled by the RC network associated with various push buttons. Supposing PB2 (short cymbal) is pressed. This charges up capacitor C_3 through R_1 and the voltage across the capacitor turns Q_2 on allowing the white noise signal from Q_1 to pass through. The collector load for Q_2 contains an inductor whose impedance increases with increasing frequency. As a result the amplifier gain of Q_2 increases with rising frequency as a result of which more of high frequency signal of the white noise is passed.

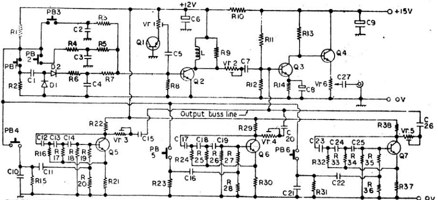


FIG: 24

PARTS LIST

All Resistors ¼ watt 5%

R1,R4,R16,R17,R24,R25,R32,R33: 10K R2: 22K R7: 470K
R3,R5,R8: 1M R6,R18,R26,R34: 100K R15,R23,R31: 27K
R19,R27,R35: 560K R20,R28,R36: 270K R10: 470E
R21,R30,R37: 1K R22,R29,R38: 2K7 R9: 4K7 R11: 68K
R12: 15K R13: 6K8 R14: 2K2 Vr.1: 100K Preset
Vr.2 to Vr.5: 47K Preset Q1 to Q7: BC148b D1,D2: IN4148
Vr.6: 5K Log

C1,C27: ·22Mfd C2: 33Mfd C3: ·068Mfd
C4,C7,C10,C20,C21: ·1Mfd C6,C9: 100Mfd 25V
C11,C15,C16,C22,C26: ·47Mfd C8: 30Mfd 6V
C5,C17,C18,C19: 4700pf C12,C13,C14: ·01Mfd
C23,C24,C25: ·047Mfd L: 100mH Inductor
PB1 – PB6 Six push buttons.

When the push button is released the charge on capacitor decays exponentially. The long cymbal operates in more or less the same manner but C_2 is larger than C_3 so the decay and turn off is relatively slower

The amplitude of the Maraccas sound builds up relatively slowly and then decays. The reason for this is that C_4 is charged up fairly slowly via D_2 and R_6. When the push button is released C_4 discharges through R_7 into the base of Q_2 and Q_2 gradually turns off as the voltage on C_4 falls.

The circuits for low bongo, high bongo and bass drum have been discussed previously. All of these are simple Twin-T feed back components. These are larger for low frequency instruments and vice-versa. All of these outputs are connected via presets and isolating capacitors to an output buss line that goes to the input of a transistor buffer mixer amplifier.

Potentiometer Vr. 6 is used to set the overall volume in conjunction with an external amplifier. Individual presets Vr.3 to Vr.5 should be used to maintain the desired sound balance between various instruments if any combination is simultaneously used. Similarly two Vr. 2 sets the level of white noise instruments.

PROJECT 24

Electronic Steam Whistle

Before proceeding with any electronic circuitry we must uuderstand or analyze the nature of sound to be imitated. The familiar electronic steam whistle produces a tone when driven by the escaping steam. The electronic equivalent would be a tone producing oscillator wlth a proportion of white noise added which sounds like hiss. Since the brute force excitation of the original team whistle gives rise to strong overtones, the oscillator will have to be some kind of multivibrator producing a fairly sharp edged waveform. Referring to to Fig. 25, 709 op. amp is selected as a square wave oscillator. The noise-generator is a reverse biased base-emitter junction of an NPN transistor.

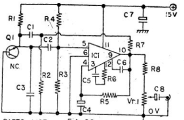


Fig : 25

PARTS LIST
All Resistors ¼watt ±10%.
R1,R4,R3: 220K R2: 1K8 R5: 22K R6: 1K5 R7: 68K
R8: 220K Q1: BC148b C1: ·033Mfd C2: ·22Mfd
C3: ·47Mfd C5: 470pf C7: 500Mfd 16V
C6: 22pf C8: 1Mfd 64V IC1: 709 Op. Amp.
C4: 47 Mfd 16V

At the supply voltage of 15V this junction operates in the break-down region (zener) producing plenty of noise. Resistor R_1 limits the current to protect Q_1. Since the noise is directly injected into the oscillator feedback path, it causes an irregular jittering of the wave-form causing the output to sound piercingly shrill very much like the steam whistle.

The pitch of the notes can be changed by altering the values of capacitors. The influence of noise generator is largely determined by R_3 and varying it adjusts the shrillness of the note.

PROJECT 25

Marine Diesel Sound Simulator

Radio control hobbyists who are having model ships can add more realism to their ships by adding this ship siren. The circuit is very much alike the previous one. In an actual ship the noise produced by a diesel driven ship is made by the thump of the engine and the regular puffing of escaping gases is imitated by a small noise generator. The thump effect is achieved by using an IC in a trapezium generator circuit, with the noise added on the leading and trailing edges. The complete circuit is given in Fig. 26.

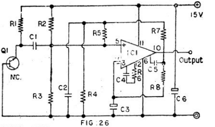


FIG. 26

PARTS LIST
All Resistors ¼ Watt 10%
R1,R2,R3: 220K   R4,R8: 18K   R5: 1M5   R6: 1K5
R7: 56K   C1,C2,C4: ·47Mfd 50V±10%   C5: 22pf
C3: 220Mfd 16V   C6: 1000Mfd 16V
IC1: 709   Q1: BC148b

The noise generated by Q_1 is fed into the non-inverting input of the op. amp. The feedback network, formed by R_4, R_5, R_7 and C_2 then determines the form of the trapezium voltage. As long as the IC has not reached saturation, the output produces a voltage ramp with superimposed noise. The noise is suppressed as soon as the IC reaches saturation. A conventional cheaper op. amp. 741 may be used by deleting the frequency compensation components and taking care of pin connections.

If it is desired to experiment with the values of different components to obtain varying sounds then C 1 would affect the noise, C_3, R_4, R_8 determine the repetition rate. Output of this unit should be connected to the input of a suitable amplifier through an isolating resistor and capacitor in case the amplifier input does not have one.

PROJECT 26

Rain Effects Synthesiser

How would you like to have the soothing sound of rain in your room without the associated water ? Many people seem to relax better when in the background the sound of rain pouring is playing. Some people even improve their concentration because the pink noise emitted by this circuit shields them from surrounding disturbances. It can also be used for a stage--rain effects by guitarists etc.

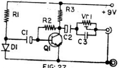


FIG: 27

PARTS LIST
All Resistors ¼Watt ±10%.
R1:100K R2:1M5 R3:10K
C1,C2: 10Mfd 16V C3:·033Mfd 100V
Q1:BC147b D1: OA79
Vr.1 100K Lin.

The complete circuit is given in Fig. 27. The internal noise produced by diode D_1 is amplified by the single stage transistor amplifier built around Q_1. The passive filter composing of Vr. 1 and C_3 acts as a tone filter which may be adjusted to obtain the effect of a light rain to a heavy storm.

Wind Sound Generator

The circuit in figure 28 generates a life like imitation of wind sound. Transistor Q_1 is connected as a zener diode and supplies Q_2

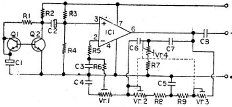


FIG: 28

PARTS LIST
All Resistors ¼watt ±10%
R1: 33K R2: 2K2 Q1: BC148 Q2: BC148b
R3,R4: 47K
R5: 47E R7: 2K7
R6,R8,R9: 470E
Vr.1: 100K pre
Vr2,Vr.3: 22K Vr.4: 10K Preset IC1: 741

with a noise signal. This signal amplified by Q_2 is fed to a selective amplifier built around a 741 op. amp. The negative feedback circuit of 741 contains a double-T filter. The centre frequency of this filter and thus the wind timbre is adjusted with the three section poteniometer Vr.2, Vr.3 and Vr.4. Potentiometer Vr. 1 is for the wind force adjustment. Potentionmeter Vr 2 to Vr.4 are in fact three vertical presets of the philips type which are arranged parallel to each other so that a rod passing through the slot in one preset does so through the holes of all the three presets. If desired other values may be substitued for the twin T components according to the following formulae :

$$f = \frac{1}{2\pi RC} \text{ with } R = Vr.\,2 = Vr.3 = 2\,Vr.4$$

$$\text{and } C = \tfrac{1}{2}\,C_5 = C_6 = C_7.$$

PROJECT 28

Novel Sounds Generator

This is one of the most rewarding project and the youngsters very much like the sounds produced by this circuit. The rarity about this unit is that a particular pattern of sound is never repeated and the slightest variation in the setting of potentiometers Vr· 1 to Vr. 3 can altogether change the pattern of sound. A typical output may consist of a short burst of tone followed by a second of silence, this is then f[illegible]ved by a series of clicks followed by a low frequency note then more silence and so, the patterns often do not repeat themselves for several seconds. The combinations and possible varieties are quite remarkable and some of the sounds are like animals or machines. The results of this circuit can only really be appreciated by listening to final **results.**

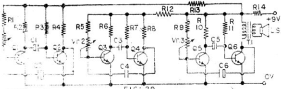


FIG: 29

PARTS [illegible]
All Resistors ¼ watt ±10%
R1,R5,R9 [illegible] R10,R12: 2K2 R3,R7,R11: 150K R14: Min 47E
R13 SEE [illegible] C3,C4: ·05Mfd C5,C6: 30Mfd 12V
Q1-Q6 [illegible] T1 9V OUTPUT TRANSFORMER
L.S 8 OHMS

The circuit [illegible] [illegible]rators, all working at very different frequencies [illegible] positive supply rail which is deliberately not decoupled and the inclusion of the resistor R_{14} in the line enables the multivibrators to be coupled together. A transistor output transformer and speaker are coupled in the collector circuit of Q_6 and it is from this point that the sounds are heard. If an amplifier is available then a louder and more versatile signal may be generated by replacing the primary of T_1 with a 2K2 resistor and a level output is then taken from the collector of Q_6 via a 1 mfd. isolating capacitor.

As all the multivibrators are working together at the same time they can all have their frequency of operation altered over a wide range by the settings of VR_1-VR_3. Q_3 and Q_4 are producing a high frequency ; Q_5 and Q_6. a very low frequeney which does not repeat for several seconds while Q_1 and Q_2 are producing an intermediate frequency.

What may at first appear to happen is that due to lack of decoupling the combined frequencies would appear at the loudspeaker at a rate approximately equal to the rate of the third multivibrator. In fact the results are much more interesting. What actually happens is that the stages each have an effect on the others and they synchronise each other in an extra-ordinary way. Due to the three controls an almost infinite variety of sounds can be produced.

Resistor R_{14} should be selected for maximum effect. its value will depend on the characteristics and values of the components used and so it is not possible to give a single best value but 47 ohms is a good one to start with. The supply lines are all joined to one point and the addition of further resistors here will also affect the output. Here again their values will depend very much on the component used and once again a value of 47 ohms is a good one to start with. There is no need to limit the total number of multivibrators to three, four would give still more varied range.

PROJECT 29

Wailing Siren Circuit

Most of the electronic sirens of the automatic type use two unijunction transistors. Here is a circuit (Fig, 30) which uses standard discrete transistors and generates a high level output which can be used to drive a 15 ohms loudspeaker. The siren produces an audio frequency which rises and falls in pitch at a fixed rate. Sirens vary in their actual sound but the circuit has plenty of room for experimenting to enable the constructor's own interpretation to be produced. If desired the output can be coupled through an isolating capacitor after replacing the loudspeaker with a 22 ohms fixed resistor, to achieve greater output.

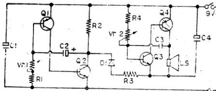


FIG: 30

PARTS LIST
All Resistors ½watt ±10%
R1: 100K R4: 100K
R2: 10E D1: IN4148
R3: SEE TEXT
Vr.1, Vr.2: 1M Linear Pot

LS 15E Loud speaker
C1: 100Mfd 12V Q1: BC158B
C2: 5Mfd 12V Q2,Q3: BC148B
C3: ·01Mfd Q4: AC128
C4: 2000Mfd 12V

The circuit makes use of two oscillators. The first, comprising Q_1 and Q_2 working at a very low frequency produces a voltage across the load resistor R_2. This oscillator controls the rate at which the siren repeats itself which is between one and two seconds The adjustment of Vr. 1 gives much wider control than this. If this is set at two seconds then at that interval for quite a short time Q_2 is switched fully on and a voltage very nearly equal to that of the supply voltage is produced across the load. This is passed on to the second part of the circuit which comprises Q_3 Q_4. These transistors, with the associated components form an audio oscillator whose frequency depends both on the setting of Vr. 2 and the applied voltage, the lower the voltage, the lower the frequency and vice versa.

When Q_2 is off there is virtually full supply voltage at the collector of Q_2 and since this line in conjunction with the diode forms the negative line of the second oscillator, there is very little voltage for this to produce an output. When the voltage across R_2 increases this is sufficient for the audio oscillator to operate and an output is produced. At the same time C_4 is charged up. When Q_2 is switched off again the inclusion of diode prevents tbe large capacitor C_4 from discharging through R_2 and this will provide sufficient voltage for the circuit to operate until the next pulse. The voltage across it will fall as the current is drawn to operate the oscillator. This will produce a falling frequency output which is developed in the load i.e. loud-speaker.

The rising of the frequency takes place as follows : when the voltage is applied from the first oscillator it is applied to a partially discharged capacitor and as this charges, it produces the reverse effect of gradually building the voltage up and so also the frequency. Depending upon the tolerance of the component used it may be found that the rise time is not balanced by the fall time : this can be corrected by inserting a low value resistor R_3 in series with the diode. The actual value will have to be found by experiment but it would lie in the vicinity of 100 ohms. The value of C_4 controls the fall time and once again experimentation is called for here. The value of R_2 also has an effect on the circuit and although values lower than that given will only reduce the life of the battery, higher values may improve the effect.

PROJECT 30

Build This Opto Electronic Organ With Tremolo

As probably the last project in this book, the instrument described here is unique and novel. Before the advent of modern electronic music synthesizers and organs. the most widely used electronic music producing equipment with stage performists was a theremin. This gadget could alter the frequency and amplitude of sweet tones emitted by it by the mere movement of hands to and fro about two simply placed metallic rods. What baffled people initially was that the performer did not need to touch any parts of the instrument yet he had all the control over the musical parameters defined and known then. Science fiction, movie makers would commonly introduce such music in their creation of space fantasy and the music was nicknamed 'the space music'. The underlying principle behind the gadget that became obsolete with the development of synthesizer was that the movement of hands around metal rods altered the effective capacitance of an IC tuned circuit to which the metal rod was connected. The oscillator would then be allowed to beat against an oscillator of fixed frequency, the resultant frequency difference intentionally kept in the audio range would then be fed to an amplifier.

The instrument to be described here differs in principle from a simple theremin in that it relies upon the change in frequency on the change in resistance of a light dependent resistor (LDR), the light falling on which is controlled by shielding it from ambient light and exposing it to a low power lamp with movment of hands controlling the quantum of light incident on it. By this yardstick, it may be called an Optomin. But it does more than this as it allows one to add termolo effect also while its frequency is controlled by the movement of hands.

The Circuit Diagram

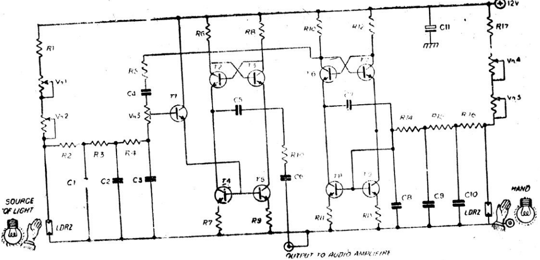
For understanding in detail the operation of this instrument refer to figure 31. Transistors T_2, T_3, T_4, T_5 as well as transistors T_6, T_7, T_8 and T_9 form two voltage controlled oscillators which are similar in operation except for the purposes to which they have been used. Transistors T_6 and T_7 form an emitter coupled oscillator with the oscillation frequency dependent on the current flowing through each lower pair of transistors. This current is controlled by the voltage applied to the junction of bases of T_8 and T_9. The oscillator built around T_6, T_7, T_8 and T_9 is used as a tremolo oscillator and value of C_7 is chosen to get the desired effect and range for tremolo sound.

On the input side resistors R_{17}, potentiometers Vr. 4 (fine termolo speed) Vr. 5 (coarse termolo speed) and LDR form a voltage divider. The voltage across LDR is fed to the control input of the VCO through a low pass filter composed of R_{14}, 15, 16 and C_8, C_8 to C_{10} which rejects the 50 Hz. hum frequencies when the instrument is used in fluorescent light illuminated auditoriums. Varying the LDR resistors alters the voltage across it which in turn changes the oscillator frequency tremolo speed in this case. Tremolo depth may either be replaced by a panel potentiometer.

The operation of main tone producing oscillator is identical to the termolo oscillator except that it has a very wide audio frequency range. In addition it has one additional transistor T_1 that controls the voltage fed to the bases of T_4 and T_5. By applying the tremolo oscillator output to the base input of T_1 which acts as an emitter follower, the voltage applied to the bases of T_4 and T_5 varies as the input voltage. Preset potentiometer Vr. 3 controls the ratio of tremolo oscillator output voltage to the input control voltage across LDR_1. Vr. 1 is the tuning and Vr. 2 is the coarse tuning control for the instrument sound.

Construction

The simplicity of the circuit makes it ideal for construction on a veroboard. However, to get the maximum benefit of the scheme devised, the arrangement of light source and LDR is critical. The details shown in fig. 32 must be followed in this respect. The LDR



12V
R1
R17
C11
R6
R8
R5
C4
T1
T2
C5
Vn4
Vn5
R14
R16
R2
R3
R4
C1
C2
C3
T4
T5
C6
C8
C9
C10
HAND
LDR2
SOURCE
OF LIGHT
LDR2
R7
R9
R11
OUTPUT TO AUDIO AMPLIFIRE

is mounted in a suitable sized opaque tube, sealed so that light can only enter from the open top end. This is mounted in a transparent plastic support and positioned in the centre of a parallel beam. When a hand is placed above the LDR, light is reflected back down into it.

The amount of light reaching the LDR is dependent on the positioning of the hand. More light is reflected as the hand is lowered until a point is reached where the hand starts to shield the LDR.

In terms of the resistance of the LDR. this means that when the hand is well above the LDR, the resistance is quite high. The actual value will depend on ambient light. As the hand is lowered, the resistance decreases, till the point is reached at which maximum light is being reflected into the tube. The actual minimum resistance will depend on a number of factors, including the reflectivity of the hand and the intensity of light.

After the completion of wiring, check the proper functioning of all the oscillators. In case you cannot get any sound then check your wiring. If it is working then adjust the setting of the potentiometers to achieve the sound you desire. With little practice, you should be able to compose your own music.