## ATTACK DELAY UNIT

EVERY MUSICAL instrument owes its unique sound to a certain combination of inherent characteristics. For instance, the number of harmonics produced, combined with their magnitudes and phase relationships, play an important role in creating the instrument's distinctive sound.

Another important characteristic is attack time—the speed with which sound is built up after a tone is initiated. Reed instruments such as the clarinet produce sounds which can be described as "soft" because they have a relatively slow attack caused by the time it takes for the reed to build up to its maximum vibration. On the other hand, instruments such as the guitar have a very rapid attack because maximum amplitude vibration is started as soon as the string is plucked or struck.

By changing an instrument's attack, we can make it sound different and, at the same time, not like any other instrument. That is what the "Attack Delay Unit" (ADU) does for the guitar. By slowing down the guitar's attack, a brand new sound can be obtained. The effect can also be produced by recording a guitar passage on tape and then running the tape backwards through the player. Instead of sharp, clean tones, a hard-to-describe "whoop" is heard for each note played. Although the note is on pitch, it doesn't sound like it belongs to any known musical instrument.

**Construction.** The circuit of the ADU, shown in Fig. 1, is fabricated on a printed circuit board whose foil pattern is shown in Fig. 2. Once the board has been made (or purchased), install the components as shown in Fig. 2. Be sure to install the semiconductors and electrolytic capacitors correctly. Use a heat sink (such as long nose pliers) on the transistor and diode leads while soldering to avoid possible thermal damage. Also, use a low-power (35 watts) soldering iron. Connect sufficiently long leads to the various external connection pads before mounting the board in the chassis.

Almost any type of metal chassis may be used as long as it will hold the PC board, the power transformer, and the associated rectifier and will permit the installation of four switches on the front and three phone jacks on the back.

The choice of switches for *S2*, *S3*, and *S4* should be made carefully. During use, it may be necessary to manipulate these switches rapidly in various combinations so they should have large paddle-type handles and operate with a light pressure. Any type of s.p.s.t. switch may be used for power switch *S1*.

Using the ADU, attack can be delayed for a very short period so that only the sound of the pick hitting the string is eliminated or it can be delayed so that the music builds up over the length of a run. A foot control switch makes it easy to delay particular notes selectively.

Mount the power transformer (*T1*) and a seven-lug terminal strip at one end of the chassis and drill a hole in the wall for the line cord. Put a grommet in this hole. Build up the power supply and attach the positive lead to *S1*. Do not ground either side of the a.c. to the chassis. Mount the three capacitor-selector switches (*S2*, *S3*, and *S4*) on the front wall and three phone jacks (*J1*, input; *J2*, foot control; and *J3*, output) on the rear wall.

Mount the PC board on four ¼" insulated spacers so that *R21* will be accessible from the side. Wire the complete circuit as shown in Fig. 1. Put four rubber feet on the chassis bottom to keep it from slipping around when in use.

**Setup.** Prepare the unit for operation by running a short length of cable from the output of the ADU to your amplifier input and plugging the instrument output into the ADU input. For the time being, do not use the foot control switch. Turn the ADU on and set the delay to 4.

Since a certain minimum signal is required to operate the delay unit, the instrument's gain should be turned up almost all the way and the volume adjusted by using the amplifier's control.

The only thing that needs adjustment in the ADU is potentiometer *R21*. At one end of this pot's rotation, there is little or no delay in the instrument attack; with the opposite setting, there is no sound for an instant, then the vol-



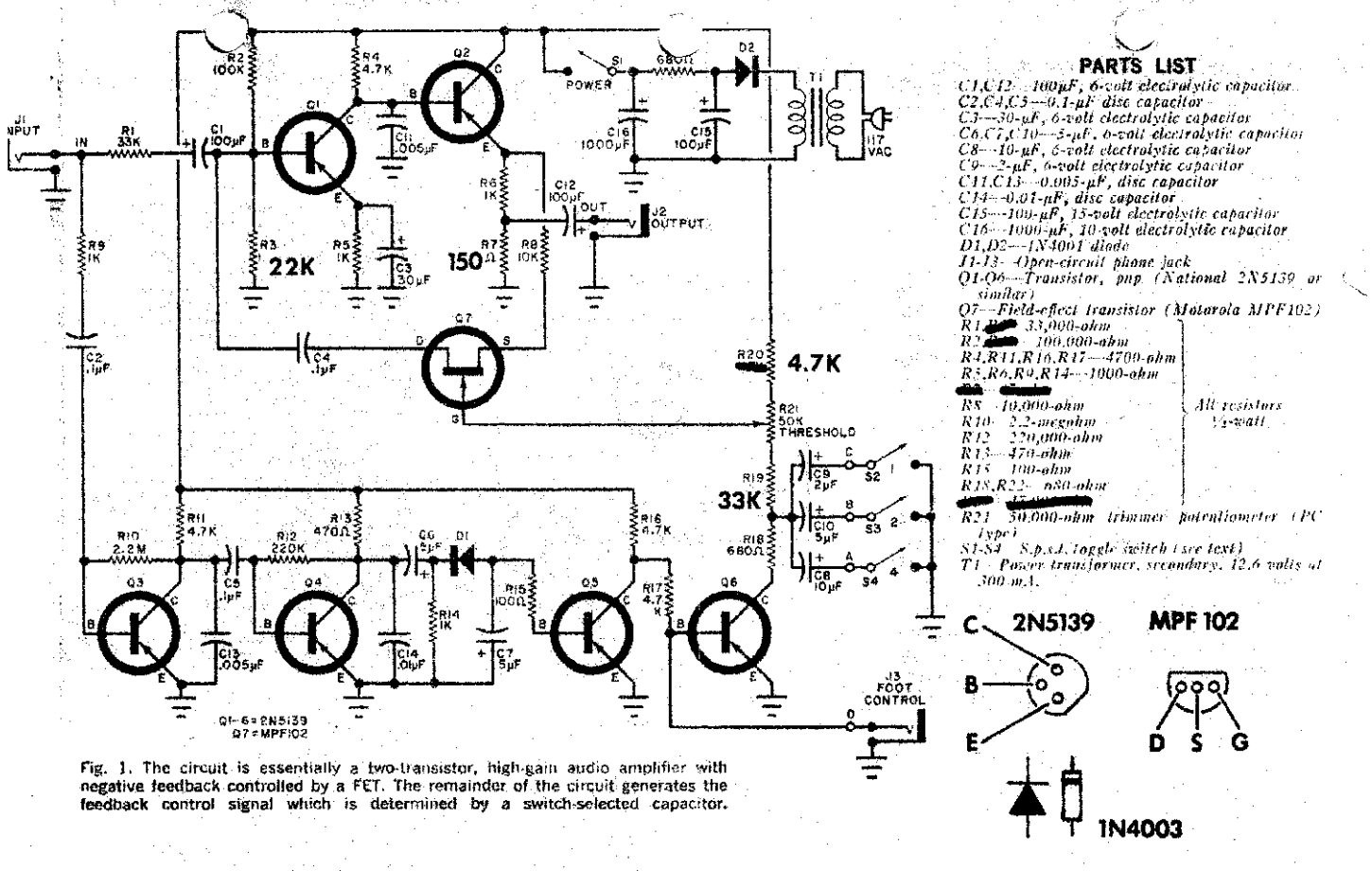
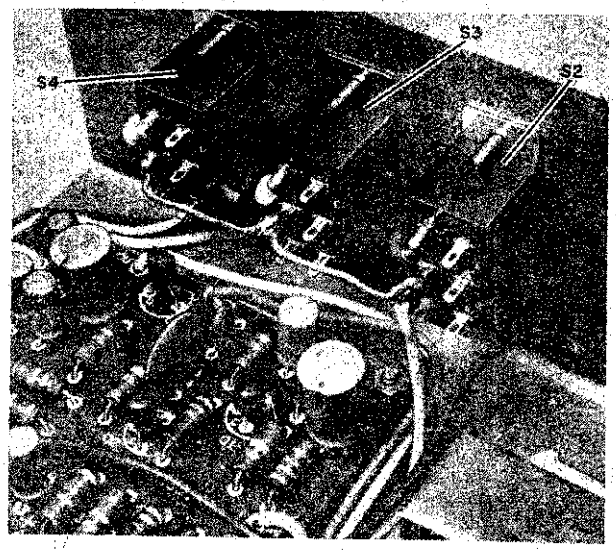
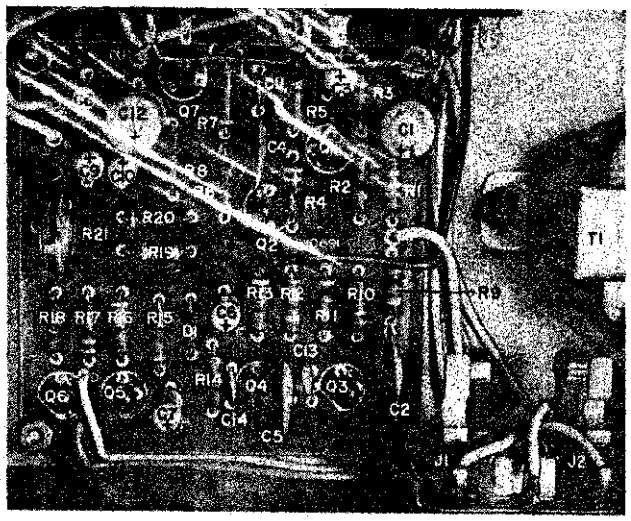



Fig. 1. The circuit is essentially a two-transistor, high-gain audio amplifier with negative feedback controlled by a FET. The remainder of the circuit generates the feedback control signal which is determined by a switch-selected capacitor.

### PARTS LIST

*C1,C12*—100µF, 6-volt electrolytic capacitor
*C2,C4,C5*—0.1-µF disc capacitor
*C3*—30-µF, 6-volt electrolytic capacitor
*C6,C7,C10*—5-µF, 6-volt electrolytic capacitor
*C8*—10-µF, 6-volt electrolytic capacitor
*C9*—2-µF, 6-volt electrolytic capacitor
*C11,C13*—0.005-µF, disc capacitor
*C14*—0.01-µF, disc capacitor
*C15*—100-µF, 15-volt electrolytic capacitor
*C16*—1000-µF, 10-volt electrolytic capacitor
*D1,D2*—1N4001 diode
*J1-J3*—Open-circuit phone jack
*Q1-Q6*—Transistor, pnp (National 2N5139 or similar)
*Q7*—Field-effect transistor (Motorola MPF102)
*R1*—33,000-ohm
*R2*—100,000-ohm
*R4,R11,R16,R17*—4700-ohm
*R5,R6,R9,R14*—1000-ohm
*R8*—10,000-ohm
*R10*—2.2-megohm
*R12*—220,000-ohm
*R13*—470-ohm
*R15*—100-ohm
*R18,R20*—680-ohm
*All resistors ½-watt*
*R21*—50,000-ohm trimmer potentiometer (PC type)
*S1-S4*—S.p.s.t. toggle switch (see text)
*T1*—Power transformer, secondary, 12.6 volts at 300 m.a.



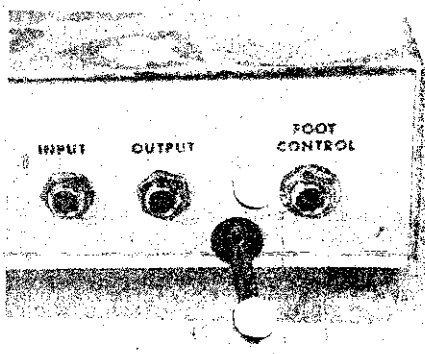




ume will come up full. Between these two extremes, are a variety of settings which can be selected strictly as a matter of personal taste. Ideally there should be very little or no sound when the note is first struck, followed immediately by a noticeable increase in volume with a smooth glide to maximum.

**Operation.** T[illegible]hree delay switches on the ADU can [illegible]used singly or in combinations to yield up to seven different delays. The numbers above the switches represent some arbitrary unit of delay (which varies [illegible]h the setting of *R21*) and may be a[illegible]d together to get the longer delays. For instance, if the "2" and "4" switches are down, the attack delay is 6 times longer than if only the "1" switch is down.

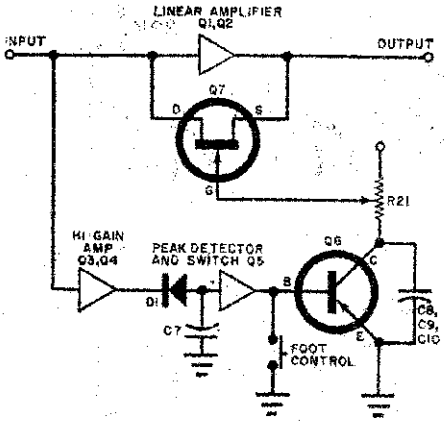
Since the ADU requires a short, no-signal dead time for the circuits to reset, all strings on a guitar must be silenced before the next chord or note is struck. If single notes are being played, just lifting the finger from the finger board will ordinarily accomplish the deadening, but for chords with open strings, it is necessary to deaden the strings with the palm of the strumming hand. The resetting time is actually very short (on the order of a tenth of a second) so very rapid runs can be played with the delay still occuring on each note.

The foot control switch is a single-pole, single-throw type and can be housed in a sturdy case of metal or a block of wood. The switch can be a push-on/push-off type but experience has shown that a spring-loaded, normally closed switch works best. With this arrangement, selective delay can be accomplished by pressing the switch when delay is desired and releasing it to sustain a note. -30-




Phone jacks for input, output, and foot control are located most con[illegible]ntly on back of chassis. Colorful vinyl cloth [illegible]sed to cover prototype.

## HOW IT WORKS

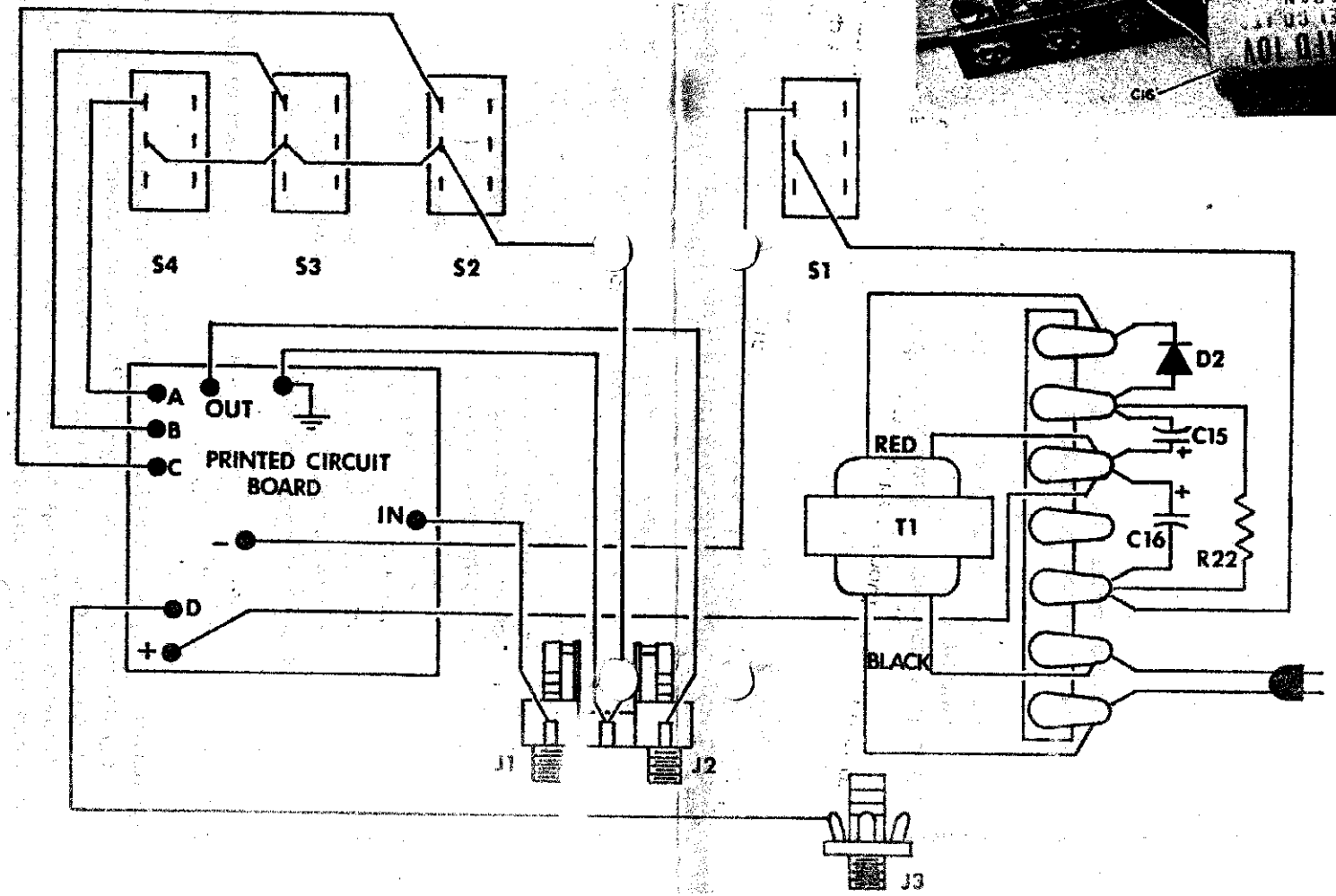



With no signal input, transistor *Q6* is turned on and acts as a short circuit around the switch-selected capacitors *C8*, *C9*, and *C10*. The gate bias of FET *Q7*, in this case, is such that the FET is turned on and its low source-to-drain resistance results in a large amount of feedback for the linear amplifier formed by *Q1* and *Q2*. Since this amplifier is designed for unity gain with no feedback, for all practical purposes, no input signal passes through it.

When there is an input signal, it is amplified by high-gain amplifier *Q3* and *Q4* and then rectified by peak detector *D1*. The resulting d.c. voltage appearing across *C7* turns on *Q5*, which then turns off *Q6* and allows the selected capacitor to charge. As the capacitor charges, the bias on *Q7*'s gate changes to increase its source-to-drain resistance. The increase in resistance around the linear amplifier loop decreases the feedback and causes the gain to go from nearly zero to approximately unity. The time required for this to take place depends on the capacitance value selected. Trimmer potentiometer *R21* acts as a threshold control and sets the bias on the gate of *Q7* when *Q6* is on.

When the foot control switch is closed, the base of *Q6* is shorted to ground, allowing the selected capacitor to remain charged. This holds the linear amplifier at unity gain and defeats the attack delay.


T1
J3
S1
C15
R22
C16
JAPAN


S4
S3
S2
S1
A
B
C
OUT
PRINTED CIRCUIT BOARD
IN
D
+
J1
J2
J3
D2
C15
C16
R22
T1
RED
BLACK

ADU CONSTRUCTION NOTES

Please note that in Popular Electronics the polarity of capacitors C3, C15, and C16 are shown reversed. The positive side of these capacitors should go to ground. The "+" marks on the circuit board are correct. In some kits it may have been necessary to substitute a 2.2mfd. capacitor for the 2 mfd. unit called out for C9 in the magazine. This change will make no noticeable difference in the performance of the unit.

Resistor color coding is as follows:

| | | |
|---|---|---|
| R1, R19 | 33K ohms | orange-orange-orange |
| R2 | 100,000 ohms | brown-black-yellow |
| R3 | 22,000 ohms | red-red-orange |
| R4, R11, R16 | | |
| R17. R20 | 4700 ohms | yellow-violet-red |
| R5, R6, R9, R14 | 1,000 ohms | brown-black-red |
| R7 | 150 ohms | brown-green-brown |
| R8 | 10,000 ohms | brown-black-orange |
| R10 | 2.2 megohms | red-red-green |
| R12 | 220,000 ohms | red-red-yellow |
| R13 | 470 ohms | yellow-violet-brown |
| R15 | 100 ohms | brown-black-brown |
| R18, R22 | 680 ohms | blue-grey-brown |

When soldering semi-conductors in place heat sink all leads with needle nose pliers. Do not use a soldering iron with a power rating greater than 35 watts. Too much heat will destroy transistors and diodes and cause the foil to separate from the circuit board. Thoroughly clean the circuit board with steel wool prior to assembly and use as little solder as necessary to make a connection. Use only rosin core solder.

If you should experience trouble a repair service is available. Charges ordinarily run about $3.00 plus any parts used and shipping charges. Kits are returned C.O.D. with an explanation of the problem found. Please write ahead for repair address and shipping instructions.

NOTE: Further study has show that 22,000 ohms is a better choice of value for R3. This change is reflected above and the substitution should have been made in the parts supply.