Design of an

ELECTRONIC GUITAR SYSTEM

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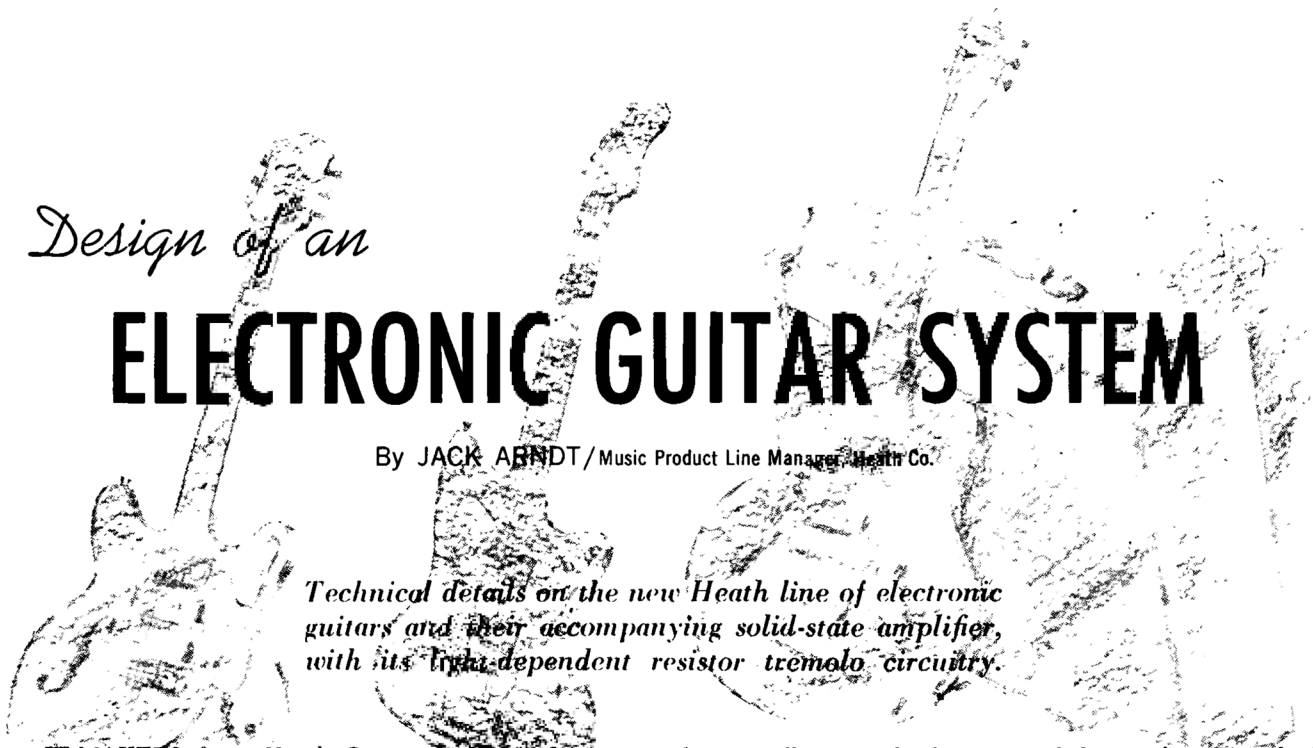

Technical details on the new Heath line of electronic guitars and their accompanying solid-state amplifier, with its light-dependent resistor tremolo circuitry.

KIT-MAKERS from *Heath Co.* working with guitar-makers from *Harmony Co.* have recently introduced three styles of American-made electronic guitars, all in kit form. Following detailed instructions, the kit builder assembles and installs the electronic parts, mounts the vibrato assembly, tuning keys, bridge, strings, and other hardware, and then adjusts and tunes the entire guitar. There is no wood working or wood finishing involved. The guitar body and neck wood parts are supplied prefinished in a gleaming cherry red along with the carrying case which will later hold the assembled, tuned instrument. *(See cover photo for the Model TG-46 guitar and amplifier. —Editors)*

The three guitar kits are different in construction and therefore different in assembly. Average building time is from three to six hours, depending upon the unit. The two-pickup solid-body guitar is the easiest to build. On this unit, the two volume and tone controls, the pickup selector switch, and the output jack are mounted on and wired to a plastic guard plate before they are fastened to the guitar. On the two-pickup single-cutaway and the three pickup double-cutaway electro-acoustic guitars, the wires and components are formed into a completed harness before installation. The harness is fed into the guitar body through the F-shaped holes, and detailed instructions tell how to "fish" the components through the proper holes in the body. (Fig. 1 shows the circuit used in the three-pickup guitar.)

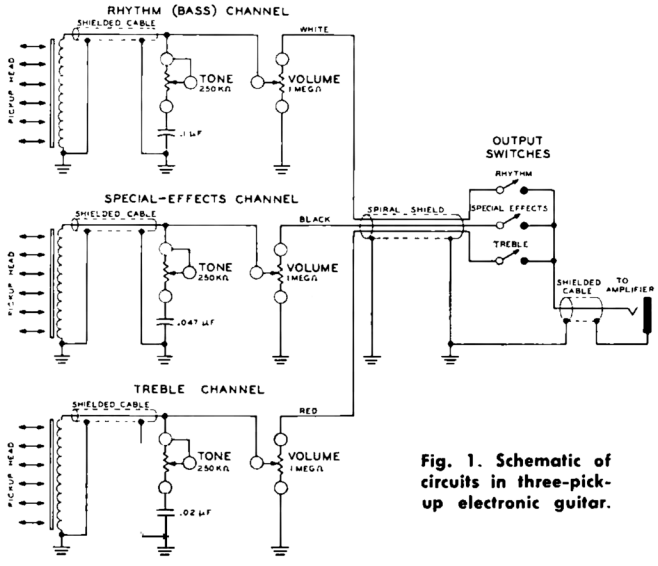

Fig. 1. Schematic of circuits in three-pick-up electronic guitar.

After the electronic elements are mounted, the hardware parts are fastened to the guitar with screws through starter holes. Next, the bridge is precisely positioned and the strings loosely strung. Careful checks are then made of the adjustments for neck-bow and vibrato action.

Tuning

After the guitar is assembled, it is necessary to tune it. Several methods of tuning are described in the manuals and two means are furnished with each kit. An audible means is provided in the form of a small phonograph record which supplies actual guitar string tones. In this case, the tuning keys are adjusted until the guitar is in perfect tune with the record.

Another means, a visual one, is provided in the form of a new and ingenious little device called a "Vu-Tuner." This uses a resonant reed and indicator tuned to the lower E or sixth string tone of the guitar. The "Vu-Tuner" is clipped to a string adjacent to the bridge, and when the sixth string of the guitar is brought into proper tune, the reed of the device will vibrate in very noticeable resonance. Then the "Vu-Tuner" is removed and the fifth string is tuned in unison with the sixth string as the sixth string is held down behind the fifth fret. Next, the fourth and third strings are tuned in the same manner, each with the preceding string held down behind the fifth fret. Then the second string is tuned to the third string, while the latter is held down behind the fourth fret. And last, the first string is tuned to the second string, while the second string is held down, again behind the fifth fret. This provides quite excellent tuning, and because of the visual check of the initial step, it becomes quite an easy operation even for the inexperienced musician.

The Model TA-16 guitar amplifier has two channels of operation, each with bass, treble, and volume controls and two input jacks. One channel has tremolo and reverberation effects available (with foot-switch on-off action) while the other channel amplifies straight through.

The amplifier is rated at 60 watts of maximum peak power (peak ratings are commonly used in this industry), 25 watts of music power out- *(Continued on page 79)*

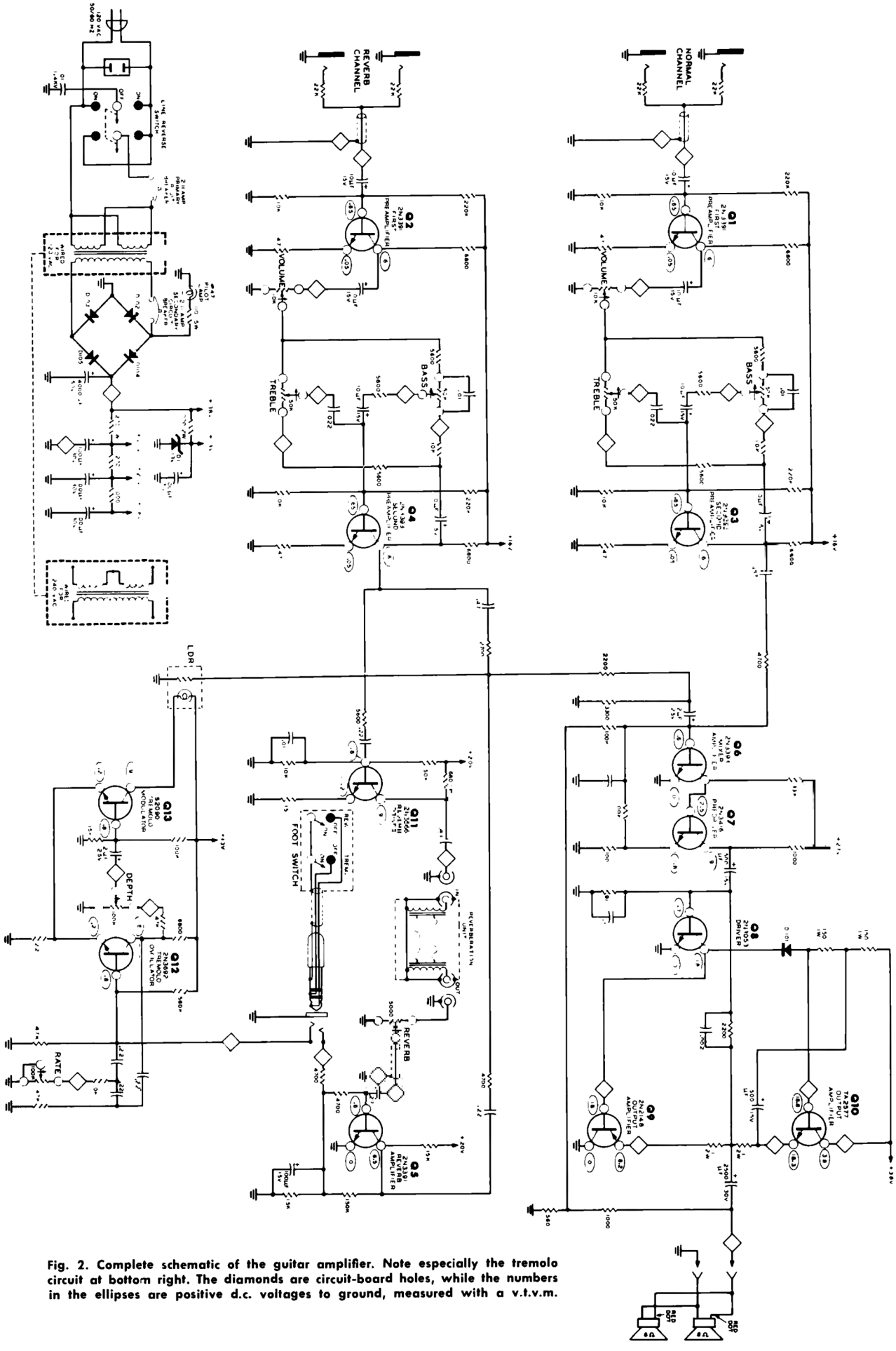

Fig. 2. Complete schematic of the guitar amplifier. Note especially the tremolo circuit at bottom right. The diamonds are circuit-board holes, while the numbers in the ellipses are positive d.c. voltages to ground, measured with a v.t.v.m.

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put, or 20 watts of continuous power output. The latter two figures are at the EIA standard of 5% harmonic distortion.

The unit employs two special-response twelve-inch speakers. The power supply can be wired for either domestic 120-volt 50- or 60-Hz sources, or for export 240-volt 50- or 60-Hz sources. A line-bypass reversing switch (which also acts as an on-off switch) can be used to select the side of the power line which provides the least hum—an important feature for electronic guitars with their magnetic pickups.

Tube amplifiers are still commonly offered in the guitar industry, but this amplifier is an all-solid-state design with a fail-safe complementary transistor output circuit. The dependability, cool operation, and low microphonics of transistors make them most desirable for rugged portable service.

Tremolo Circuit

The tremolo section of the TA-16 amplifier employs an interesting new circuit (Fig. 2). It uses a light-dependent resistor (LDR) which can be found in the lower right-hand corner of the amplifier schematic. The LDR unit consists of a low-current lamp and a light-dependent resistance element. The value of the resistance varies with the brightness of the lamp—as the lamp glows brighter, the resistance decreases; as the lamp dims, the resistance increases.

The basic tremolo frequency is developed in transistor Q12 which is connected as a subsonic phase-shift oscillator. The frequency can be varied from approximately 4 to 14 Hz by the rate control. The amplitude of the oscillator frequency can be varied by the depth control. The signal is then coupled through a 2-μF capacitor to the base of tremolo-modulator transistor Q13. Transistors Q12 and Q13 are connected to a common emitter resistor to provide additional positive feedback for sustaining oscillation.

Transistor Q13 draws collector current through the lamp element in the LDR unit, causing the lamp to glow. Since transistor Q13 is amplifying the tremolo oscillator signal, the collector current will follow this signal, causing the lamp in the LDR unit to glow correspondingly brighter or dimmer. The resistance of the LDR will vary in the same way, from a very low to a very high resistance. Since the LDR is connected between the reverb-channel signal path and ground, its resistance variations will modulate the signal with the low-frequency tremolo signal. ▲