

Radio-Electronics EQUIPMENT REPORT

Dynaco Stereo 120 Solid-State Power Amplifier

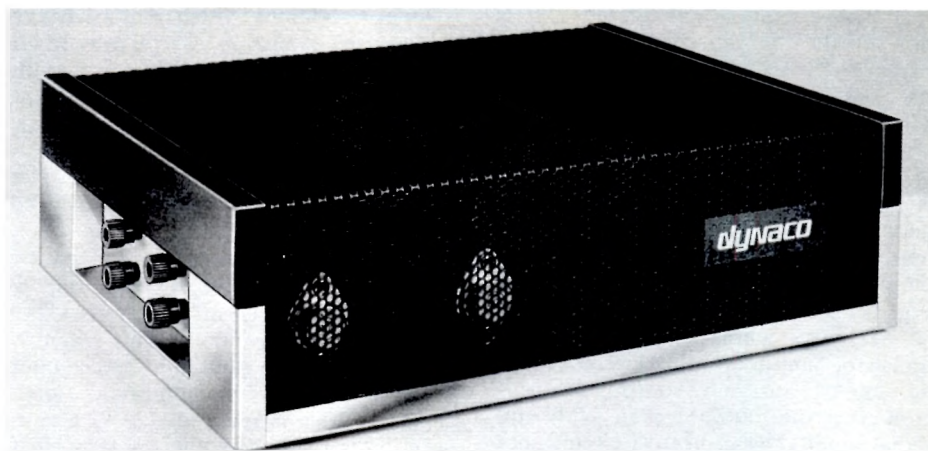
THIS IS AN AMPLIFIER THAT RADIO-ELECTRONICS tested with more than a little curiosity. Dynaco has a reputation for well-engineered, high-fidelity electronics at low prices. The company has refused to jump into the transistor-amplifier market until good and ready, as they announced at the 1963 and 1964 New York hi-fi shows. They debunked the notion of "transistor sound" and disputed the claims that transistor amplifiers are more reliable than tube amplifiers and that they cost less. Dynaco's claim: For equivalent quality and reliability, a transistor amplifier must cost more than a tube amplifier.

Dynaco's long-awaited solid-state amplifier is called the Stereo 120, and it *does* produce 120 watts (60 watts per channel) in 4-ohm or 8-ohm loads. It's a power amplifier only (no controls or preamp) and can be bought in kit form for \$160 or wired for \$200. This, Dynaco points out, is just the price of two of its (tube) Mark III 60-watt mono power amplifiers.

RADIO-ELECTRONICS used the Stereo 120 in a series of audience-perception tests which you'll be reading about in a later issue. The tests attempted to determine whether listeners can really perceive a difference between recorded or broadcast music reproduced through a very wideband system (one whose frequency response extends beyond the normally accepted limits of human hearing, roughly 20 to 16,000 Hz) and through a system whose response is limited to that range. As part of the procedure, the same signal (white noise in one series, music in another) was passed to a speaker alternately through the Dyna Stereo 120 and through a top-quality tube amplifier.

The results were analyzed statistically. The listeners' judgements about which amplifier was being used were shown conclusively to be pure guesswork. The obvious conclusion is that the Dynaco Stereo 120 does not *sound* different in any way from the best available tube amplifier.

I compared the Stereo 120 with a Dyna Stereo 70, a 35-watt-per-channel tube amplifier. After setting the levels across the speakers to within 1/4 dB, I

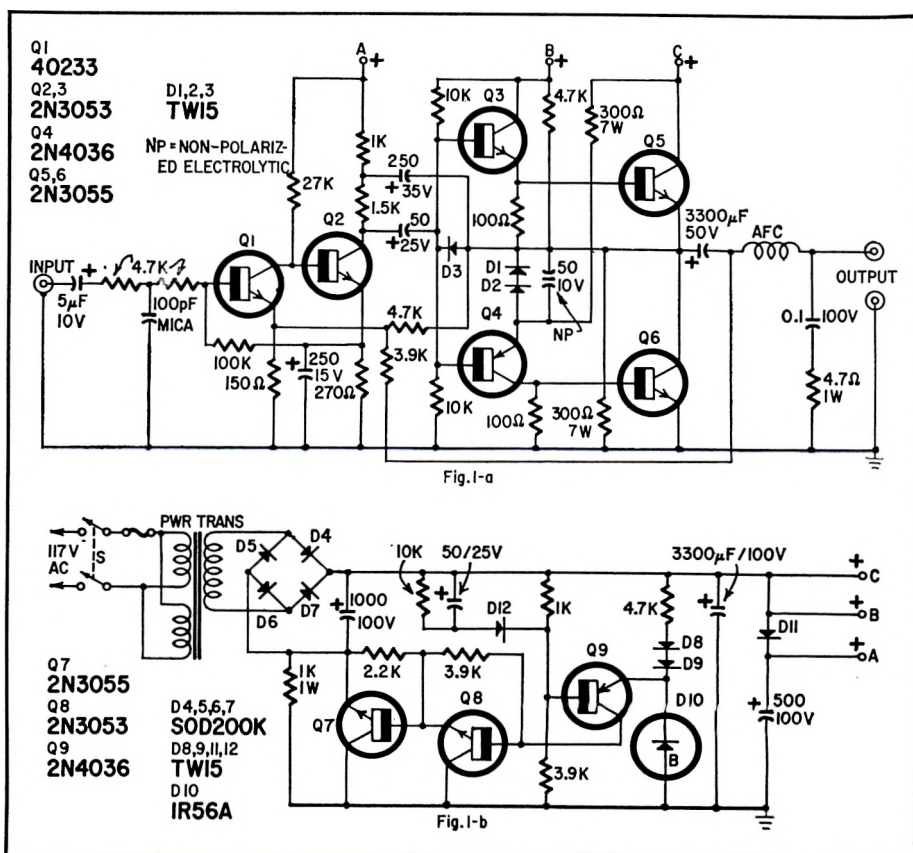


switched quickly back and forth between the two amplifiers on approximately the same passage of music. There was a noticeable difference in favor of the 120. The test was not completely fair, because of the power-output difference.

The loudness difference between the two is barely perceptible. But when the two amplifiers are set to produce the same level, one may be operating near its maximum output, possibly clipping peaks, while the other, at the same level, is still in some low-distortion middle range of power. The 120 sounded very clear, while the 70's sound came through a light curtain and was a wee bit muddier at times.

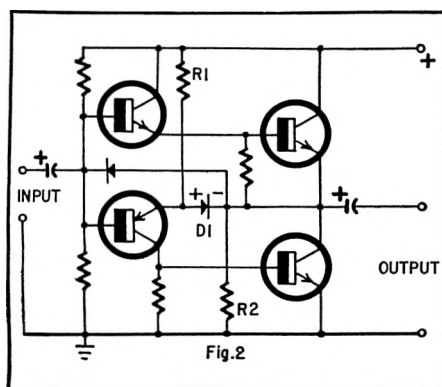
Measurements confirmed Dynaco's specifications. The 120 has the widest power bandwidth of any amplifier I've tested.

Another feature of the Dyna Stereo 120 is that its distortion does not increase at low power levels. It is not difficult to produce 50 or 60 watts at 1% harmonic distortion from a transistor amplifier. What is seldom listed in the specifications is the harmonic distortion at 1 watt, or 50 mW. At such levels, distortion is often 5 times higher because of *crossover distortion*. It's caused by class-B operation of output stages. Most hi-fi transistor amplifier distortion rises at low power levels. Not the 120, though.



The circuit of the Stereo 120 is not drastically different from many other "quasi-complementary-symmetry" designs—output transistors of the same "sex" (polarity) driven by a complementary-symmetry driver which is also a phase inverter. The amplifier is dc-coupled throughout, except that a giant electrolytic (3,300 μ F) keeps dc out of the speaker voice coil. Fig. 1-a is the complete schematic of one channel. Fig. 1-b is the power supply.

Dynaco claims that, unlike other transistor amplifiers, the 120 is almost immune to damage by shorting or open-circuiting the output—even with full signal input. The protective circuit does not use circuit breakers or fuses. Instead, a novel biasing circuit for the driver and output transistors does the trick. Fig. 2 is a simplified circuit of the protective circuit.



The input bases are at one-half the supply potential as is the output which is taken at the junction of the output series pair. The output will follow the input through the signal cycle because any deviation between the output and input in also a deviation which varies the emitter potential of the pnp driver as compared to its base potential. Actually, there is a feedback connection from the collector of the lower output transistor back to the emitter of the pnp. This feedback tends to correct any difference between input and output potentials.

Thus the whole group of four transistors has no voltage gain, but it has an impedance transformation from high to low impedance. Its linearity is a function of the feedback path. Diode D1 is connected in this feedback path and is forced into conduction by the two bleeder resistors (R1 and R2).

However, when the current in the pnp is equal to the current in the bleeder resistors, D1 no longer conducts, the feedback path is broken, and the output no longer follows the input.

Under conditions which require heavy drive current such as overload by input signal or excessive load on the output, the output transistors reach a current limit which is a function of their own Beta and the amount of bleeder current. Thus, the output current can be kept under a maximum which might be destructive.

D1 also serves to give forward bias on the transistors. In addition, its position forces a small dc offset between input and output. This has two effects: (1) The high-impedance input cannot drive the low-impedance load, and the drive is reduced. (2) The connection is regenerative in the sense that the output transistors become high-impedance devices (instead of remaining in their normal low-impedance state) which cannot pass high currents. The net result is that the current in the output transistors *decreases* under conditions which in other circuits would cause excessive current. Dynaco has applied for patents on this circuit.

One of the design differences between the Stereo 120 and most other commercial transistor amplifiers is the use of a regulated power supply. This goes a long way toward insuring low distortion at high power levels with both channels driven, and allowing the amplifier to produce full power at 20 Hz and lower frequencies. The power-supply regulator is unique, and is the subject of another patent application.

The regulator provides a second overload protective circuit for the output transistors. Should a continuous-tone signal be applied to the amplifier to drive it to full output for a prolonged period, it is possible for the output transistors to draw excess current, overheat and be damaged. The regulated power supply prevents this. The supply's output impedance is zero or even slightly negative (voltage increases slightly as loading gets heavier) until a certain predetermined current drain is reached. Then the supply instantly cuts off, preventing the output transistors from destroying themselves under a severe overload.

The circuit, shown in Fig. 1-b, is an astonishingly simple one: a series-pass regulator (Q7, Q8, Q9) that uses both positive and negative feedback. Most such regulators use only negative feedback, as a way of getting low or nearly zero output impedance (no change in voltage with a finite change in load current) over a certain range of load values. This one uses a combination of negative *voltage* feedback

and positive *current* feedback. Both reduce effective output impedance. The feedback is normally governed by Zener diode D10.

If the load current rises above a predetermined maximum value, the Zener diode is "starved" and becomes a high impedance. Positive feedback then predominates, and the circuit suddenly snaps into a high-impedance "deregulator" state between the power supply and the load. The voltage and current fall to some very small value until the excessive load is removed. When it is, the amplifier instantly resumes normal operation, without the need for resetting a circuit breaker. Because of the high impedance of the "deregulator," little current flows through it and little power is dissipated in it or in the load.

I didn't get to try the kit, but I did inspect the construction of the early production model RADIO-ELECTRONICS received for testing. All stages except the output of each channel are on etched circuit boards, so there's little chance of trouble there. There is a lot of open space inside the chassis in the finished amplifier—one gets the impression that the 120 could have been compressed into about two-thirds the space—so wiring should be very easy. There are minor details of mechanical assembly that hint of having been conceived by a person with skinny fingers on three hands, but nothing in comparison to, say, stringing a dial cord in a tuner kit.

Speaker connections are made to twin binding posts which, being recessed, are not too easy to use. Since the ordinary owner will probably connect them once and never again, this is not a serious problem. They do have the advantage of being spaced $\frac{3}{4}$ inch apart. This makes it possible to plug in dual banana plugs for lab applications.

Nice job. The Stereo 120 should continue Dynaco's excellent reputation for moderately priced high-quality sound.—Peter E. Sutherland

MANUFACTURER'S SPECIFICATIONS

Power bandwidth: (3-dB power points) for 0.5% total harmonic distortion: 5 Hz to 50 kHz
Harmonic distortion: less than 0.25% at any power up to 60 watts (per channel) at any frequency from 20 Hz to 20 kHz
Intermodulation: less than 0.15% at any power up to 60 watts, with any combination of test frequencies
Noise: 95 dB below rated output, unweighted
Separation: better than 70 dB from 20 Hz to 20 kHz
Damping factor: about 40 with 8-ohm loads from 20 Hz to 20 kHz
Input: 100K; 1.5 volts for 60 watts output
Size: 13 x 10½ x 4 in.
Weight: 20 lb
Price: \$159.95 kit, \$199.95 wired END

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Printed in U.S.A.