NOISE SUPPRESSION IN PULSE RECEIVERS*

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In the course of measuring Southern Hemisphere meteor rates by radar methods, difficulty has been experienced in combating the effect on the meteor rate of a variable background, due to noise of both solar and man-made origin.

The equipment, operating at $69 \cdot 5$ Mc/s, radiates pulses of 23 μsec duration at a pulse recurrence frequency of 150 per sec, and a peak power of 90–100 kW. The echo is detected by a very low noise receiver and applied to the grid of a cathode-ray tube, the trace of which is completely blacked out in the absence of signal. Echoes are recorded on 35 mm film which moves continuously at the rate of 1 ft/hr past the face of the tube. Alternate sweeps of the time-base are shifted slightly in order to present echoes with more certainty as double dots.

A serious shortcoming of this fairly standard system is that any appreciable rise in background noise results in excess darkening of the film, and hence lowered recognition of echoes. This effect is somewhat aggravated by the inherent short grid base of the average cathode-ray tube. The incidence of total black-out due to man-made interference has been greatly reduced by the inclusion of a compression amplifier in the video section of the receiver.

Receiver Modifications

The compression amplifier extends the principle of a constant volume audio amplifier described by G. J. Pope (1952).‡

The essential control element is a cathode follower used as an anode load of a pentode voltage amplifier. Referring to Figure 1, V1 is arranged to give sufficient amplitude of video signal from the receiver, and to be of such a phase that the final video amplifiers V8 and V9 can be operated with positive-going signals from a near cut-off point. The gain control R1 is adjusted so that V2 will not be overloaded by the strongest video input signals.

The resistive anode load of V2 is shunted by the cathode-anode impedance of the cathode follower V5 biased towards cut-off. As the signal applied to V2 is essentially positive-going, V2 is also biased towards cut-off. The anode of V2 feeds the voltage amplifier V3, whose output is rectified by the diode V4 to provide the positive voltage necessary to offset the standing negative bias on V5.

The restricted bandwidth of the V3 circuit, together with the very long time-constant of the rectifier (V4) load circuit, serves to make the bias on V5—and hence the gain of V2—a function of the steady background noise, while it is unaffected by the signal pulses. The tendency of the cathode choke (L1) to oscillate on the receipt of very strong pulses was adequately suppressed by the

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‡ Pope, G. J. (1952).—*Electron. Engng.* **24** : 464.

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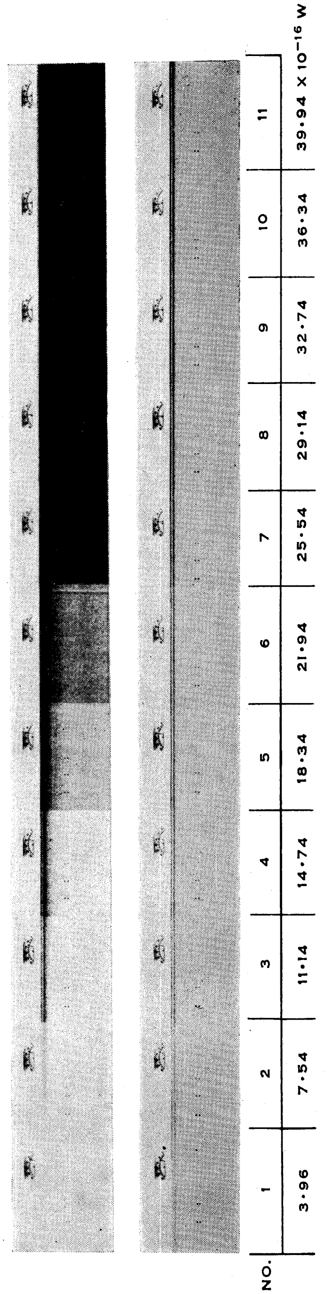

Results of tests, (*a*) without circuit modifications, (*b*) with circuit modifications.

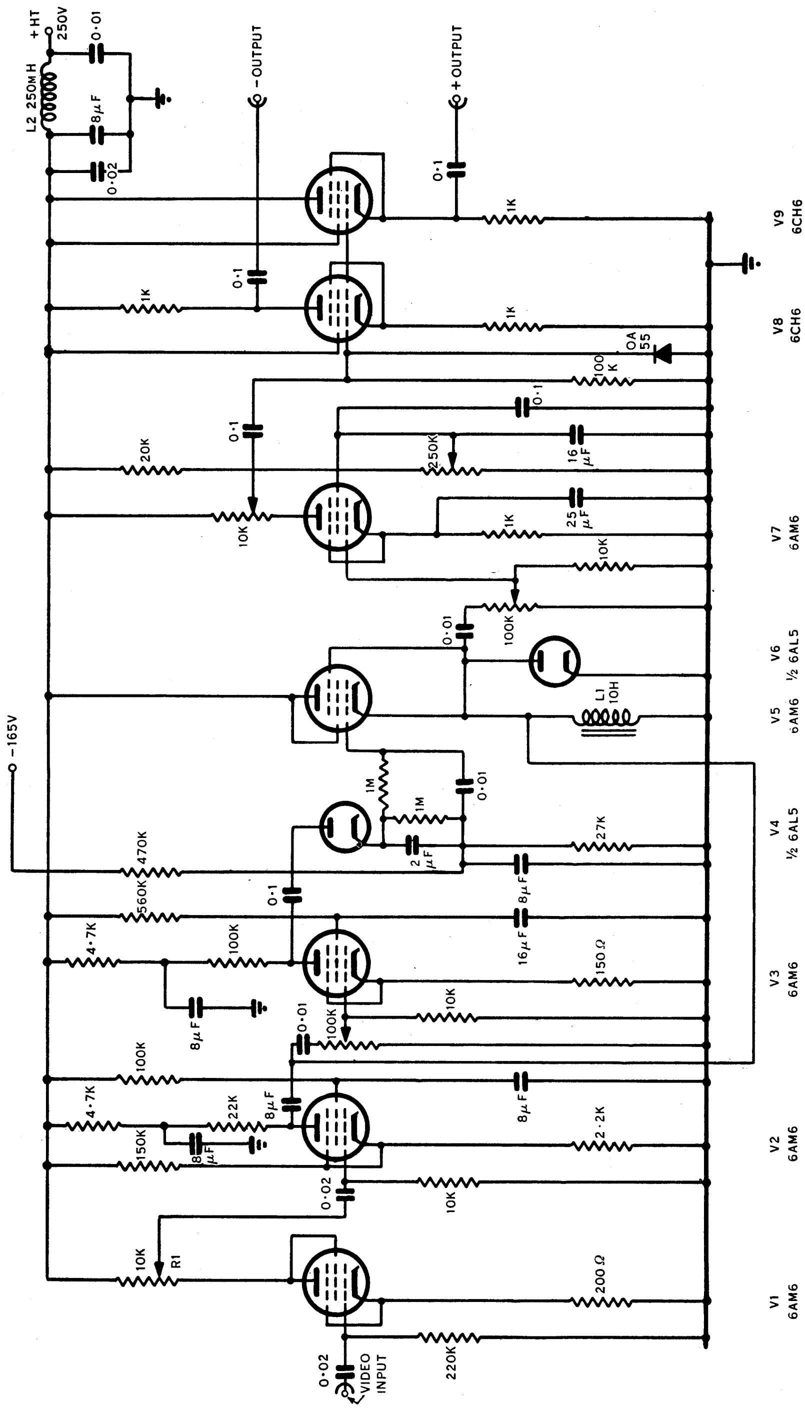

Fig. 1.—Circuit diagram of compression amplifier.

diode V6. The stage V7 acts as a conventional screen-controlled limiter, the limit level being adjusted to avoid defocusing of the cathode-ray tube under strong signal conditions.

System Efficiency

Normal conditions were synthesized for the purpose of assessing the advantage of this additional amplifier over a conventional video system. The output of a diode noise generator was injected into the receiver simultaneously with artificial echoes, of 0·2 sec duration, having the same pulse recurrence frequency and pulse width as the operational transmitter. Both the echo simulator and the noise generator were of equal output impedance.

Five echoes decreasing in amplitude from 4 to 1 μV and spaced 30 sec apart, at constant range, were recorded during each setting of the noise generator output. As the test was intended to be comparative rather than absolute, no attempt was made to match the similar impedance sources to the receiver input. (It is probable, therefore, that the minimum detectable signal power for actual echoes will be below the figures obtained in the present test.) The range of available noise power from the noise generator was less than that expected from variations of aerial noise temperature. Consequently, it was necessary to increase the receiver gain part way through the test. The results of the tests are shown in Plate 1, first for the normal video amplifier, and then with the compression amplifier added. The conditions existing at each of 11 consecutive 3-min intervals were as follows:

Step 1.— The noise generator was at zero output, and the receiver gain was adjusted to give the same detector current as when it was connected to the aerial under quiet conditions. Under these conditions the total noise power is essentially that generated by the receiver itself, which is $3 \cdot 94 \times 10^{-16}$ W.

Steps 2–6.—The noise generator output was increased in five steps of $3 \cdot 6 \times 10^{-16}$ W.

Step 7.— The noise generator output was returned to zero and the receiver gain increased to give the same receiver detector current as had been obtained in step 6. The noise generator output was then increased to $3 \cdot 6 \times 10^{-16}$ W.

Steps 8–11.—The noise generator was increased in further steps as for the stages 3–6.

Thus by adding the noise power derived from the noise generator to that generated by the receiver the total noise increased from $3 \cdot 94 \times 10^{-16}$ W for step 1 to a final value of $39 \cdot 94 \times 10^{-16}$ W for step 11. The plate shows clearly the increased readability of echo rates during periods of high noise, while those obtained during periods of low noise are unaffected.

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