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Report No. 8016

THREE-STAGE 40 MC IF AMPLIFIERS

May 8, 1953

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Printed in U. S. A.

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APPROVED W. O. Swingard

THREE-STAGE 40 MC IF AMPLIFIERS

This report describes the design, construction and performance of two types of three-stage 40 Mc IF amplifiers which may be found useful in moderate cost television receivers. The two amplifiers differ from a design standpoint but are quite similar in performance characteristics. The essential features of each are as follows: In both versions a double-tuned low-side capacity coupled circuit is used between the mixer plate and first IF grid. Following this, the first design employs a staggered triple arrangement, whereas the second employs a staggered pair followed by an overcoupled double-tuned stage. Design information and measurement data for the two types are presented for comparison purposes and also to give an indication of the performance capabilities of each design.

When either amplifier is used with a typical cascode turret type tuner, picture carrier sensitivities for one volt dc above noise at the video detector are approximately as follows:

Channel	Picture Sensitivity (db below 1 volt)
2	92.5
6	90.5
7	90
13	89

The average picture carrier sensitivities, when using either system and a typical video amplifier tube such as the 6CL6 or 12BY7 should be of the order of 90-92 db below one volt or about 30 μv.

The circuit of amplifier No. 1 is shown in Fig. 1. Bifilar coils are used except in the input circuit. The stagger frequencies and operating Q's of each circuit were computed from the formulae in Henry Wallman's article, "Stagger-Tuned Amplifier Design," Electronics, May 1948 (see also letter in July 1948 issue, p. 224). Individual stage measurements were made and the load resistors were adjusted to give the computed bandwidths. Care was taken to remove or greatly detune the traps during bandwidth adjustment. It was necessary to add shunt capacity to the two high Q circuits of the staggered triple in order to obtain the desired Q, which was about 27. Increasing the Q by capacity division circuits was not as successful from the stability standpoint, since this increases the circuit impedance and the grid-to-plate gain.

Erie type GP2 (K120031) 680 μμf ± 20% disc type ceramic capacitors were used for screen bypassing, and disc-type ceramic capacitors of 1000 μμf capacity were used as bypasses on heaters, AGC, etc. Experimentation showed that 1000 μμf capacitors with 1/8" leads were also quite satisfactory as screen bypass capacitors.

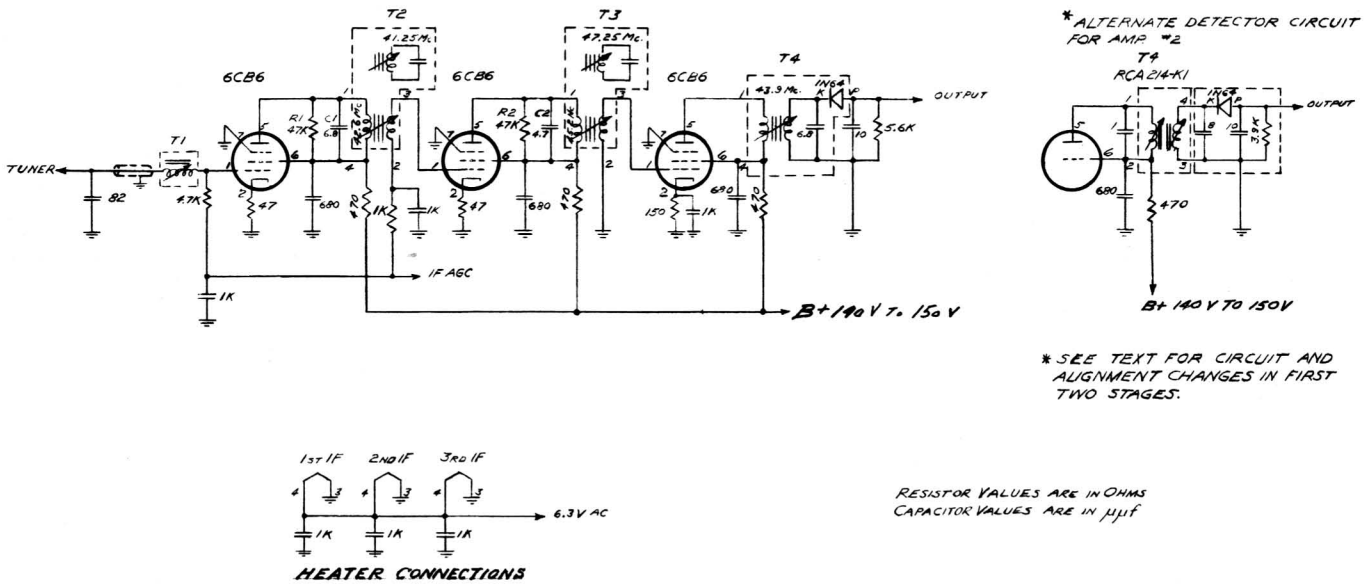

Fig. 1 - Three-Stage 40 Mc IF Amplifier

A typical response of the broad-band mixer plate network is shown in Fig. 2. This circuit is customarily sweep aligned and is normally symmetrically disposed with respect to the response of the staggered triple. As used with both amplifiers described herein, the response is maintained flat at least to the picture carrier frequency inasmuch as the correct picture carrier attenuation is obtained in the following stages. The bandwidth of the network may be narrowed for a slight gain increase. However, the relatively non-critical nature of the system alignment with the curve shape shown seems to be well worthwhile.

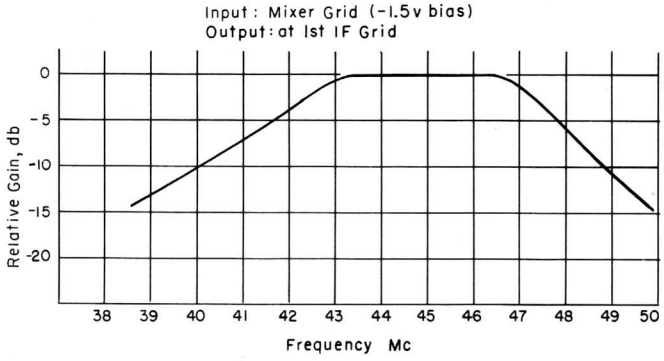

Fig. 2 - Frequency Response of Mixer Plate Circuit Amplifiers No. 1 and 2

The response of the staggered triple as measured from the first IF grid is shown in Fig. 3. The circuit is aligned at -3 volts bias. The overall response as measured from the modulator grid is shown in Fig. 4. The bandwidth at 6 db points is 3.4 Mc. The sound carrier is approximately 31 db, and the adjacent sound about 30 db below the maximum response.

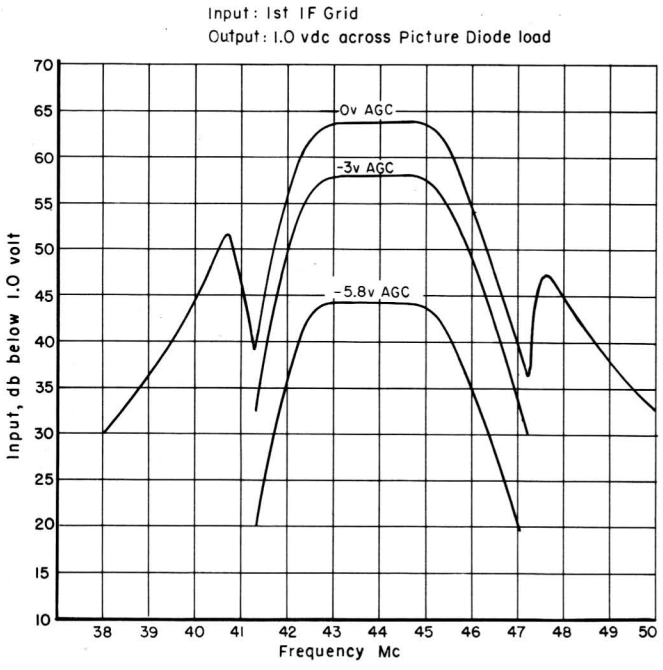

Fig. 3 - Frequency Response of Staggered Triple

Each amplifier was constructed on a 2" x 7 1/4" subchassis, the details of which are shown in Fig. 5. All tubes are shielded. The layout and socket orientation is such that leads are quite short. A tinned wire lead is bridged across pins 3 and 7 and the center post of each socket. The ends of this lead are soldered to the lances which have been pushed through the chassis near terminals 3 and 7 of each socket. This lead acts somewhat as a shield between input and output circuits of each tube.

In amplifier No. 2 the tuner output coupling circuit is followed by a single staggered pair and a single stage employing a double-tuned printed circuit transformer. The double-tuned transformer is an RCA Type 214K1. Bifilar coils are used for the staggered pair. The design procedure of individual circuit measurement, previously mentioned, was also followed with this amplifier. The response of the mixer plate network is identical to that shown for amplifier No. 1. The double-tuned transformer used between the last 6CB6 and the crystal detector is preferably sweep aligned. The response of this circuit is shown in Fig. 6. The frequency response from the first IF amplifier grid is shown in Fig. 7 and the overall IF char-

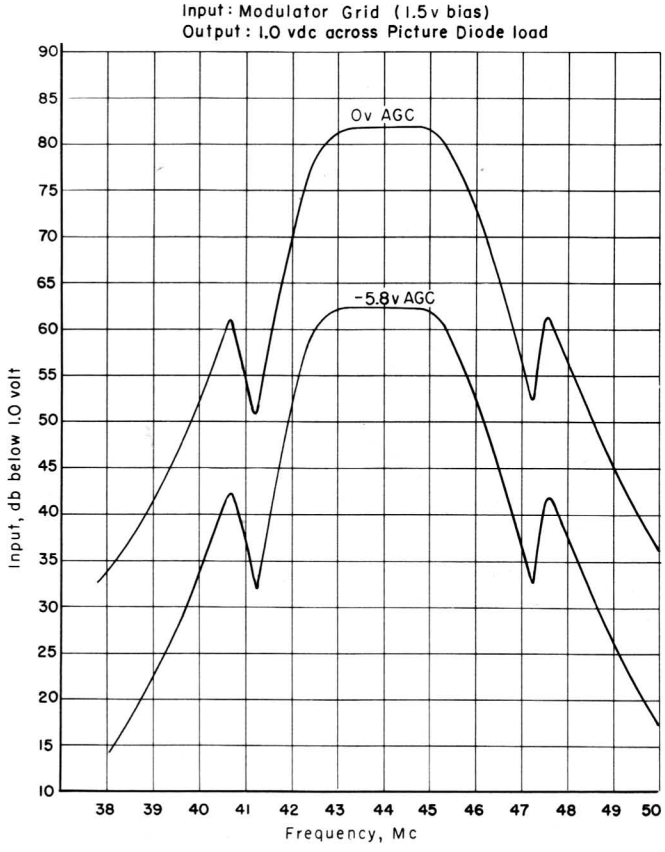

Fig. 4 - Overall IF Characteristic - Amplifier No. 1

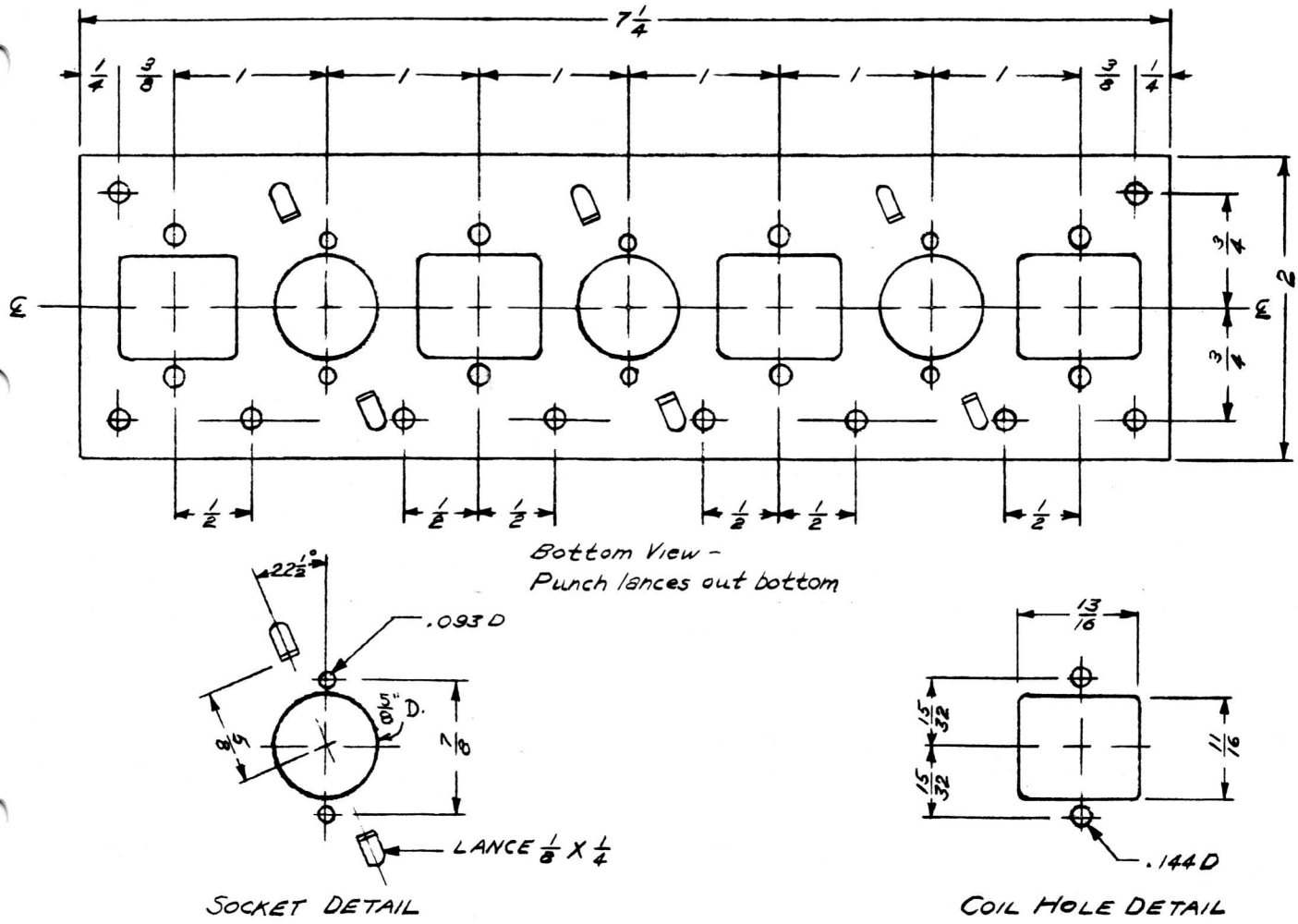

Fig. 5 - 40 Mc IF Amplifier Subchassis - Three-Stage

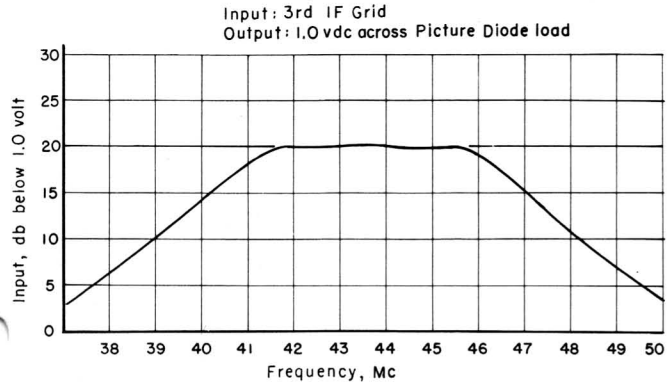

Fig. 6 - Frequency Response of Double-Tuned Third IF Stage

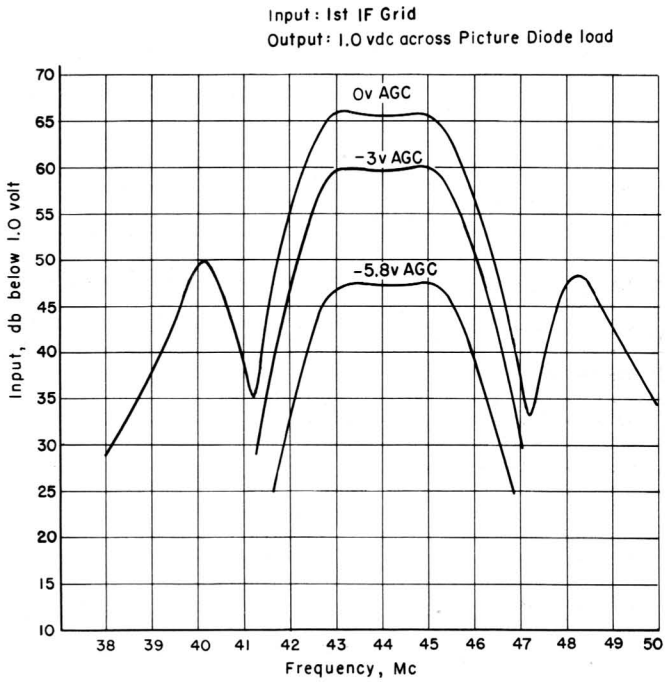

Fig. 7 - Frequency Response from First IF Grid Amplifier No. 2

acteristic in Fig. 8. The bandwidth at 6 db points is 3.3 Mc. The overall IF characteristic is slightly narrower than that of amplifier No. 1. Accompanying and adjacent sound attenuations are greater than the values obtained with amplifier No. 1 and are 34.5 and 36 db respectively, from maximum response.

Inasmuch as the circuit Q's for the staggered pair are lower than those of the triple it is not necessary to use shunting capacity or a division system to obtain the required values. Amplifier No. 2 incorporates the following circuit differences as compared with amplifier No. 1:

(1) Capacitors C1 and C2 are removed.

(2) Bifilar transformers T2 and T3 are of a different design. See specifications in Table 1. (Note: The 47 kΩ damping resistors are not changed.)

(3) The bifilar transformer, T4, is replaced with an RCA Type 214K1 double-tuned transformer.

(4) The detector circuit employed is shown in Fig. 1 as an alternate. (Since detector components are now external to the transformer can the components should be well shielded.)

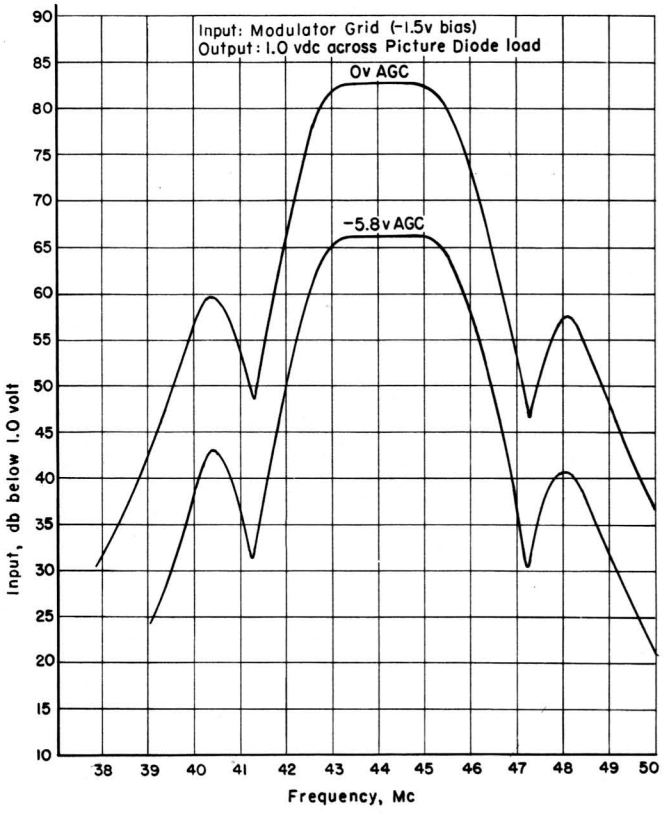

Fig. 8 - Overall IF Characteristic Amplifier No. 2

(5) T2 is aligned at 43.0 Mc and T3 at 45.1 Mc.

Both amplifier designs have good stability. It is believed that the two designs described in this report, along with the two described in Hazeltine Report No. 8015, will be helpful to engineers faced with the problem of designing 40 Mc television IF amplifiers.

TABLE I

COIL SPECIFICATIONS

Amplifier No. 1

T1 12 turns of No. 26 enamel wire closewound on 9/32" diameter form. Mounted in standard 7/8" square aluminum can.

T2 Standard Coil Type X-3469-1 transformer or equivalent. 2 turns removed from bifilar winding (4 turns of wire). Trap closewound with 8 turns No. 22 and spaced 3/16" from bifilar.

T3 Standard Coil Type X-3469-1 transformer or equivalent. 2 turns removed from bifilar winding (4 turns of wire). Trap spaced 3/16" from bifilar coil.

T4 Standard Coil Type X-3469 transformer or equivalent.

Amplifier No. 2

T1 Same as T1 in amplifier No. 1.

T2 Radio Industries Type EO-1419 transformer, or equivalent.

T3 Radio Industries Type EO-1419 transformer, or equivalent.

T4 RCA Type 214K1 printed circuit transformer, or equivalent.

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May 8, 1953