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Solid-State IF Stages—CTC 38

The CTC 38 chassis features a three-stage transistorized IF system. Figure 1 (IF Input Circuit) illustrates that output from the VHF tuner (KRK 140) is applied to the first picture IF stage (Q203) via a double-tuned link circuit comprised of the mixer output coil (located on tuner), bandwidth adjustment capacitor (C220), and input transformer (T204). The CTC 38 (unlike the CTC 31, which has a similar link circuit) does not utilize a sound rejection control in the primary circuit of transformer T204. Instead, a 12K, 5% fixed resistor (R216) is used to provide adjacent sound rejection in conjunction with the 47.25 MHz trap coil. The simplified schematic also illustrates that separate 41.25 and 47.25 MHz sound traps are used as they were in the CTC 31.

Link circuit output is coupled via a 10 pf capacitor and 47 ohm resistor to the base of the first IF stage (Q203). Amplified signal from the collector of the 1st IF transistor is coupled to the 2nd IF stage (Q204) through a similar impedance matching network consisting of a 10 pf capacitor and 56 ohm resistor.

The 1st and 2nd IF stages in the CTC 38 are stagger tuned. The 1st IF transformer (L203) peaks near 42.17 MHz. Signal from the 2nd IF stage is then impedance coupled to the base of the 3rd IF

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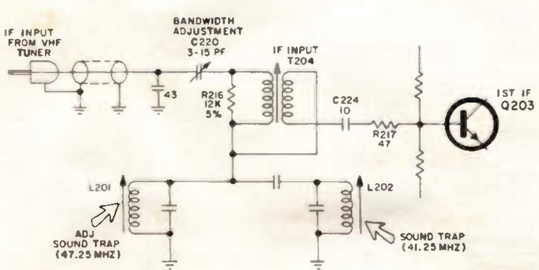

Figure 1—IF Input Circuit

CTC 40 Brightness Limiter

One of the interesting and unfamiliar new circuits in the CTC 40 chassis is the Brightness Limiter circuit. The drive capability of the new horizontal deflection system in the CTC 40 is such that with high, nonlimited brightness settings, it is possible to exceed the current capabilities of the picture tube. The limiter circuit is employed to maintain picture tube beam current within proper limits. It is important to note that the correct limiter control setting in the CTC 40 chassis may **not** be coincidental with the point at which the raster "blooms" or defocuses at high brightness settings as in previous RCA tube chassis employing a brightness limiter circuit.

The brightness level (picture tube beam current) in the CTC 40 is controlled basically by the emitter-base bias of the second video amplifier transistor. Changes in this bias vary the current flow through the second video amplifer load resistance that is translated by the remaining video amplifiers as changes in picture tube cathode bias. Brightness limiting action in the CTC 40 operates by reducing the forward base bias voltage on the second video amplifier when the preset limit of picture tube beam current is reached; beam current limit is preset at 1600 μa (1.6 ma) by properly adjusting the brightness limiter control.

The brightness limiter circuit operates as follows: Referring to Figure 2, the high voltage transformer secondary winding is returned to B+ through the brightness limiter potentiometer (R129). Therefore, all of the beam current drawn by the picture tube must pass through R129. However, placed between the low side of the brightness limiter control and ground is the brightness limiter transistor, (Q301). The fixed base bias on this transistor allows it to operate in such a manner that the voltage drop across it is relatively independent of the current through it, as long as it is conducting. Therefore, the transistor acts much like a zener diode, the "zener" voltage being determined by the resistive divider network in the limiter base

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Brightness Limiter

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circuit (Figure 4). The current through R129 flows through two parallel paths — one through the brightness limiter transistor, Q301, and the other through the picture tube. If the brightness control is set so that the picture tube is cut off (black screen) the only path for current flowing through R129 is via Q301. With the picture tube cut off, the current through Q301 is set at 1600 μa—the desired picture tube beam current limit (first condition, Figure 2). When the brightness control is advanced so the picture tube draws beam current (second condition, Figure 2), part of the 1600 μa current through R129 flows through the picture tube, while the remainder flows through Q301. The second condition in Figure 2 exemplifies a brightness control setting such that the picture tube draws 1000 μa (1 ma). The remaining current, 600 μa, flows through the brightness limiter transistor.

The constant voltage on the brightness limiter emitter supplies a constant bias voltage of approximately 4 volts to the base of the second video amplifier throughout the operating range of the brightness limiting system. When the brightness control is advanced to the point where the picture tube draws the preset limit of 1600 μa (third condition, Figure 2), all of the current through R129 flows as beam current. There is no remaining current to sustain Q301 conduction, and it stops its regulating action. As a result the voltage on the base of the second video amplifier will no longer be held constant. If more current is demanded by the picture tube, the voltage at point "A" drops, decreasing the forward bias on the second video amplifier. This action rapidly decreases the average conduction of the second video amplifier, decreasing brightness, and therefore reducing picture tube beam current to the desired 1600 μa limit.

Additional components in the brightness limiter circuit (Figure 3) provide necessary filtering and circuit stabilization duties. Filtering action and arc suppression are provided by a circuit consisting of C121, R115 and C113. This filter is physically and electrically associated with the high voltage transformer secondary winding and removes most of the horizontal "ripple" from the brightness limiter circuit. It also acts to initially suppress any "spikes" resulting from high voltage arcing.

Adjustment Procedure

The brightness limiter control is factory preset and normally needs no adjustment. However, if components are changed in the limiter circuitry or if the control is misadjusted for any reason, the limiter control must be reset. Misadjustment of this control may result in damage to the kinescope. (The correct procedure as outlined in Service Data covering the CTC 40 should be followed.) Referring to Figure 4, the brightness limiter control (R129) is set for Q301 collector current of 1200 μa (1.2 ma) at minimum brightness. Limiter current is set for 1200 μa instead of 1600 μa since other elements of the kinescope, not returned through the limiter, draw approximately 400 μa.

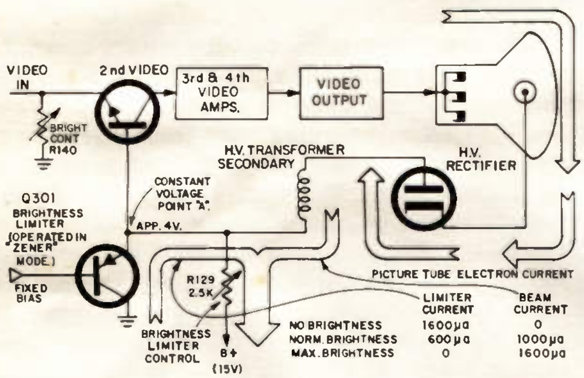


Figure 2—Brightness Limiter Operation

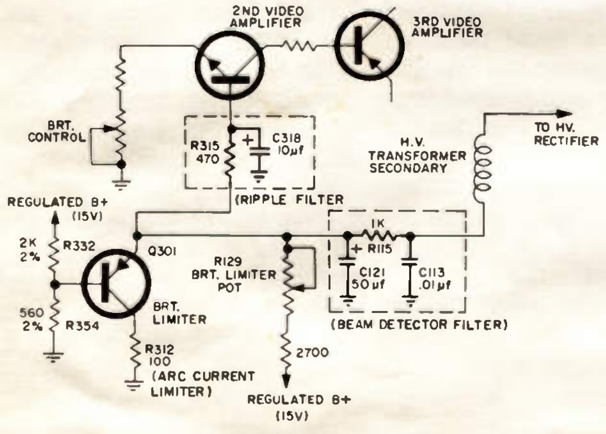


Figure 3—Simplified Brightness Limiter Circuit

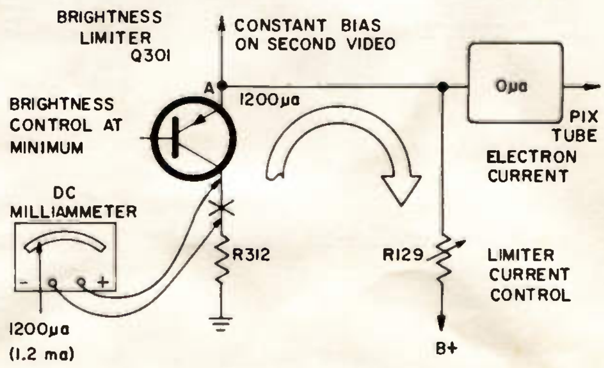


Figure 4—Limiter Current Measurement

Servicing Direct-Coupled Circuitry

Technicians are being required to service more and more equipment that utilizes direct-coupled transistor stages. This type coupling is simple and transistors readily adapt to it. Many service technicians first encountered direct-coupled stages in portable radio audio output circuitry. Next came complete direct-coupled amplifiers for stereo instruments. Now, with the advent of transistorized television, even more direct-coupled circuits are being used.

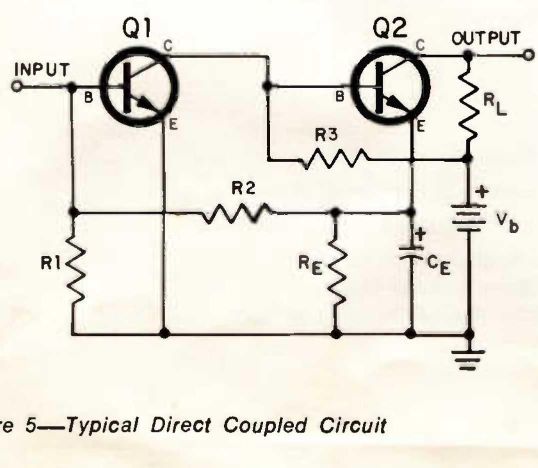
In the direct-coupled circuit shown in Figure 5, resistor R3 serves as both the collector load resistor for transistor Q1 and the bias resistor for transistor Q2. Resistor R_L is the output load of the amplifier. If another stage were added, R_L would serve the same function as R3—collector load for Q2 and bias supply for the added stage. Resistors R1 and R2 enhance circuit stability for providing a feedback path. Stability is of prime consideration in direct-coupled stages since temperature-caused bias variations in one stage will be amplified by all following stages, resulting in temperature instability. This is often a limiting factor to the number of stages that can be direct-coupled.

Servicing direct-coupled stages requires a technique that is somewhat different from those used to troubleshoot R-C or transformer-coupled stages. A different approach is needed since each stage is dependent on the preceding stage for bias. If several stages are direct-coupled, a defect causing incorrect operation of one will affect the bias of the next, and therefore all succeeding stages. Normal signal injection/tracing techniques cannot completely isolate the trouble.

The actual troubleshooting technique involves checking individual transistor element bias potentials. Start at the output stage of the circuit and check back through each stage to the input of the circuitry involved. Each reading is noted (written down if necessary) then compared to both the expected normal reading **and** to the readings taken at other points in the circuit. The starting point for troubleshooting circuitry in Figure 5 would be to measure the voltage drop across R_L to determine the operating condition of Q2. Little (or no drop) would indicate non-conduction, while heavy conduction would cause a large drop. In either case, it is necessary to measure the bias potentials on Q1 to determine whether the trouble is **actually** in the circuitry of Q2, or caused by **incorrect** bias supplied to Q2 (as a result of Q1 circuit defects). As an example: if tests indicate Q2 is conducting heavily, the cause could be Q2 emitter-to-collector leakage; however, the symptom would be similar if a defective Q1 did supply excessive bias to the base of Q2. The defect can be isolated to a particular stage by checking bias potentials of **all** transistors in the circuit (starting at the output), and comparing these readings to the normal expected potentials and to each other.

Other methods of direct coupling may be encountered. One is illustrated in Figure 6. The servicing technique described in this article is also applicable to this, and most other direct-coupled circuits.

Don't overlook the possibility of a defect in one stage supplying excessive bias to one or more succeeding stages, thereby causing other devices to fail. Some circuit designs have current limiting built-in to prevent subsequent device failure; in other designs, multiple device failure is quite possible. Remember, however, a logical analysis of all the DC bias potentials in a circuit will greatly simplify the troubleshooting procedure—regardless of the circuit configuration.



Fgure 5—Typical Direct Coupled Circuit

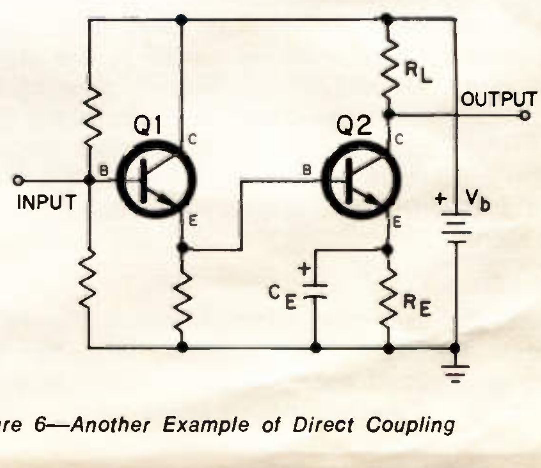


Figure 6—Another Example of Direct Coupling

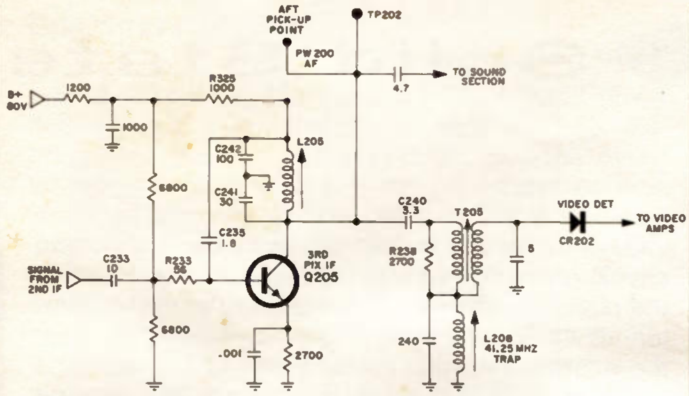


Figure 7—CTC 38 Third IF Stage

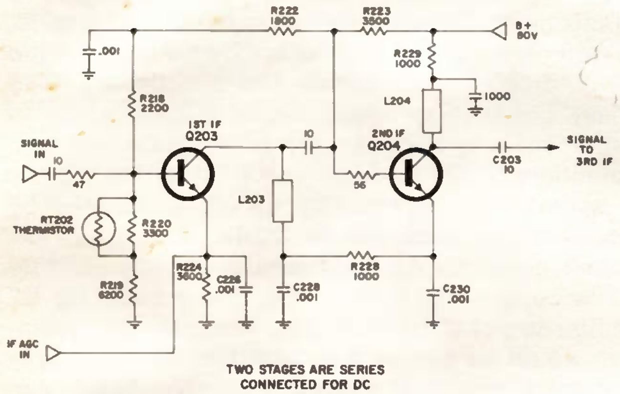


Figure 8—CTC 38 IF Bias Circuit

IF Stages

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transistor, arranged in a conventional grounded emitter stage that includes a double-tuned transformer in the collector circuit. The simplified schematic of the 3rd IF stage (Figure 7) illustrates the double-tuned circuit that couples the 3rd IF stage to the video detector. In the CTC 38 chassis the double-tuned transformer circuit utilizes separate coils: the primary consists of L205 (located in the collector circuit); the secondary is comprised of T205. Primary-to-secondary coupling is accomplished via a 3.3 pf capacitor (C240). The action of this double-tuned circuit is similar to the input link circuit. In this case C240 is analogous to the link circuit's bandwidth capacitor, and its value is chosen to optimize coupling between primary and secondary, and therefore the bandwidth.

The secondary of transformer T205 is part of the 41.25 sound trap circuit. Trap L208 develops a 41.25 MHz voltage which is added to the signal in the secondary of T205; by properly phasing the secondary, the voltage developed across the trap acts to cancel the 41.25 signal coupled through T205. When the trap is properly aligned, the 41.25 MHz sound carrier is effectively removed from the video signal.

IF Bias Circuit

The first and second IF DC bias circuit (Figure 8) connects the transistors in series with the B+ supply; the circuit configuration is such to keep the DC current through both transistors the same.

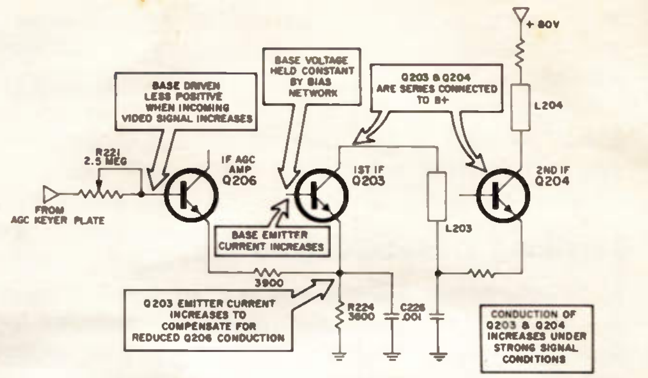

Figure 9—CTC 38 IF AGC Action

In the CTC 38, the IF transistors have a property wherein the high frequency beta **decreases** as collector current **increases.** It is therefore quite easy to apply AGC to these two stages by varying collector current. The series connection of the two stages makes it possible to shift the bias of one transistor and indirectly shift the operating point of the second. This changing bias action is accomplished by the IF AGC circuit.

AGC Circuit

The AGC circuit in the CTC 38 uses a familiar keyed AGC system (tube type) in which the AGC output voltage is driven more **negative** under conditions of signal **increase.** The developed voltage from the keyer is applied to an AGC amplifier stage (Figure 9). The AGC amplifier transistor translates the AGC voltage into a current change that is used to effect a bias change in the IF AGC amplifier circuit. This stage is an emitter follower which operates into the emitter resistor of 1st IF transistor. Under conditions of increasing signal strength (plate of the AGC keyer stage goes more negative), the base of the IF AGC amplifier transistor (which is normally biased via R226 from the 80-volt B+ source) is driven less positive. As a result, the conduction of Q206 reduces, and the current through the two series-connected IF transistors increases sufficiently to maintain a constant voltage drop across R225. Consequently, IF gain is decreased, holding the video detector output constant. The AGC system maintains proper video detector output over widely varying input signal levels.

RCA Sales Corporation
A Radio Corporation of America Subsidiary
Product Performance—Technical Training
600 North Sherman Drive
Indianapolis, Indiana 46201