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LB-913

A VIDICON CAMERA ADAPTOR FOR TELEVISION RECEIVERS

RADIO CORPORATION OF AMERICA
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Approved

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Introduction

Closed circuit television systems based on the Vidicon photo-conductive pickup tube have been designed and built and are proving satisfactory for many industrial and educational purposes. LB-851, *An Industrial Television System*, describes a developmental model of such equipment. There are many applications, however, where the cost of such equipment, simple as it is, is still too high to make its use economically practical. Widespread use of television in school classrooms in connection with the light microscope or to bring small demonstration setups to large groups, inter-office communication systems or its use in surveillance applications in small stores and the like, are examples where the utility of closed-circuit television is definite and the principal problem is economic. This bulletin describes a closed circuit system which uses the highly developed circuitry in a modern television receiver to reduce the cost of the system. The simple adaptor described should open entirely new fields for closed-circuit television where reduced cost is paramount.

The device consists of a Vidicon camera which is attached by means of a cable and adaptor plug to a standard television receiver. The receiver supplies all plate and deflecting power to operate the camera. A control unit containing only passive circuits provides the necessary controls to operate the camera. A photograph of the camera adaptor operating with a standard television receiver is shown in Fig. 1.

Fig. I - The camera adaptor operating with a standard television receiver.

General Problem of Adaptation

In general there are four functions necessary to operate a Vidicon closed-circuit system. First, there must be provided a monitor kinescope on which to view the picture. This of course is already available in the receiver. Second, the relatively weak signal generated by the pickup tube must be amplified to a level suitable for modulation of the kinescope. Amplification of a high order is accomplished in the receiver. This amplification is, however, performed at radio and intermediate frequencies, while the signal generated by the pickup tube is usually at video frequencies extending from near d.c. to several megacycles. Third, voltages must be supplied to the pickup tube to generate and focus the scanning beam. In the case of the Vidicon these voltages are in the range of those present in the receiver. Lastly, signals of proper waveform must be supplied to deflecting coils to cause the pickup tube beam to scan the target in synchronism with the beam in the monitor kinescope. Since the Vidicon requires about one-tenth the number of ampere turns of deflection as does a 70-degree kinescope operating at 15 kilovolts the necessary deflecting power for the camera can be taken from the receiver with negligible effect upon its operation.

Description of Adaptor

In accomplishing these functions the second operation mentioned, that of proper amplification of the weak signals from the Vidicon, required the greatest amount of attention. A typical highlight signal current from the Vidicon is one-tenth microampere. It has been found in practice that an input resistance of 50,000 ohms is the maximum that can profitably be used and still allow for adequate high-frequency compensation. This means a maximum low-frequency signal input of 5 millivolts. Two methods of handling the amplification are possible. First, the signal may be amplified directly as a video signal to a level to operate the video portion of the amplifier in the receiver. In most modern receivers this is a level of a volt or more. Alternatively, use can be made of the existing r-f and i-f amplifying circuits in the receiver by converting the video signal to a modulated carrier at some point in the camera. The latter method was chosen because the signal can be transmitted over a low-impedance line to the receiver at a low power level requiring little power output from the camera and because of the convenience of coupling the signal to the receiver at radio frequency. In multiple unit setups considerable flexibility can be achieved by tuning the several cameras to different receiver channels and making use of the channel selector to select the desired camera signal.

Amplifier

Fig. 2 is a schematic diagram of the camera. Dual tubes were used to conserve space, the 6U8 triode-pentode being chosen as offering the most video gain in a single envelope. The circuit consists of a four-stage video amplifier driving a modulator tube electron coupled to a vhf oscillator. $V_{1a,b}$ are conventional single-peaked video amplifiers. V_{2a} is a frequency compensating stage to compensate for the loss of high frequencies at the input to the amplifier. L_3 is an inductance whose natural resonance in the circuit is adjusted to be above the normal pass band of the amplifier. The gain of this stage can be made to increase with frequency from essentially zero gain at low frequencies to a gain limited by the impedance which can be achieved in the coil and associated circuitry at the top of the pass band. The low-frequency gain is then adjusted by insertion of a variable resistor R in series with the inductance. By adjusting this resistor the shape of the gain characteristic of this stage can be made to match closely the attenuation characteristics of the input circuit. V_{2b} is a conventional double-peaked stage. V_{3b} is connected with its cathode, grid and screen in a Hartley type oscillator, while the triode section, V_{3a}, is used as a modulated amplifier. The plate of V_{3b} is coupled to the cathode of V_{3a} which has r-f impedance but essentially none at video frequencies. The video signal from V_{2b} is applied to the grid of V_{3a} and effectively modulates the plate current. This

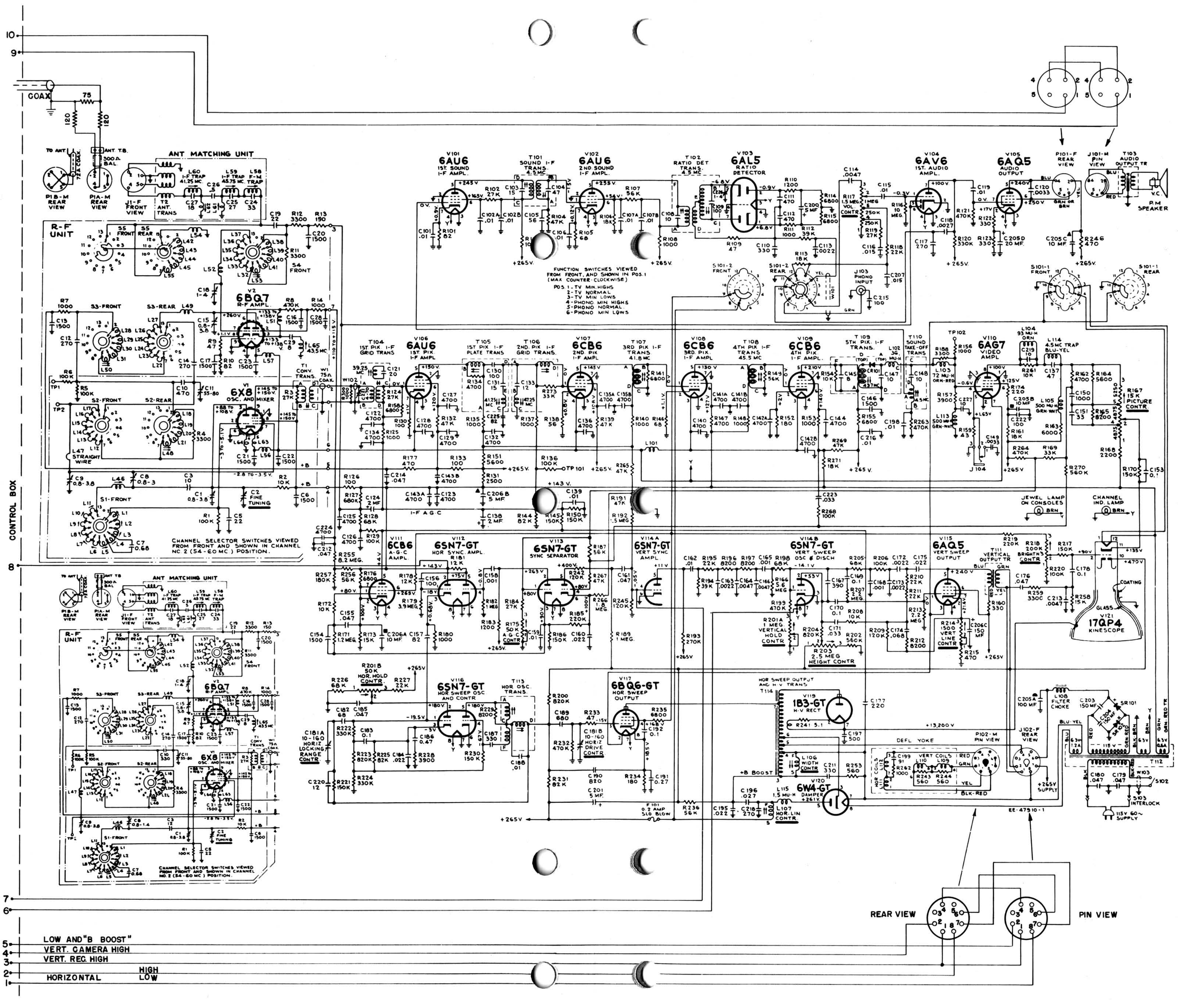

Fig. 4 - Schematic diagram of RCA 17T150 receiver showing connections to the camera.

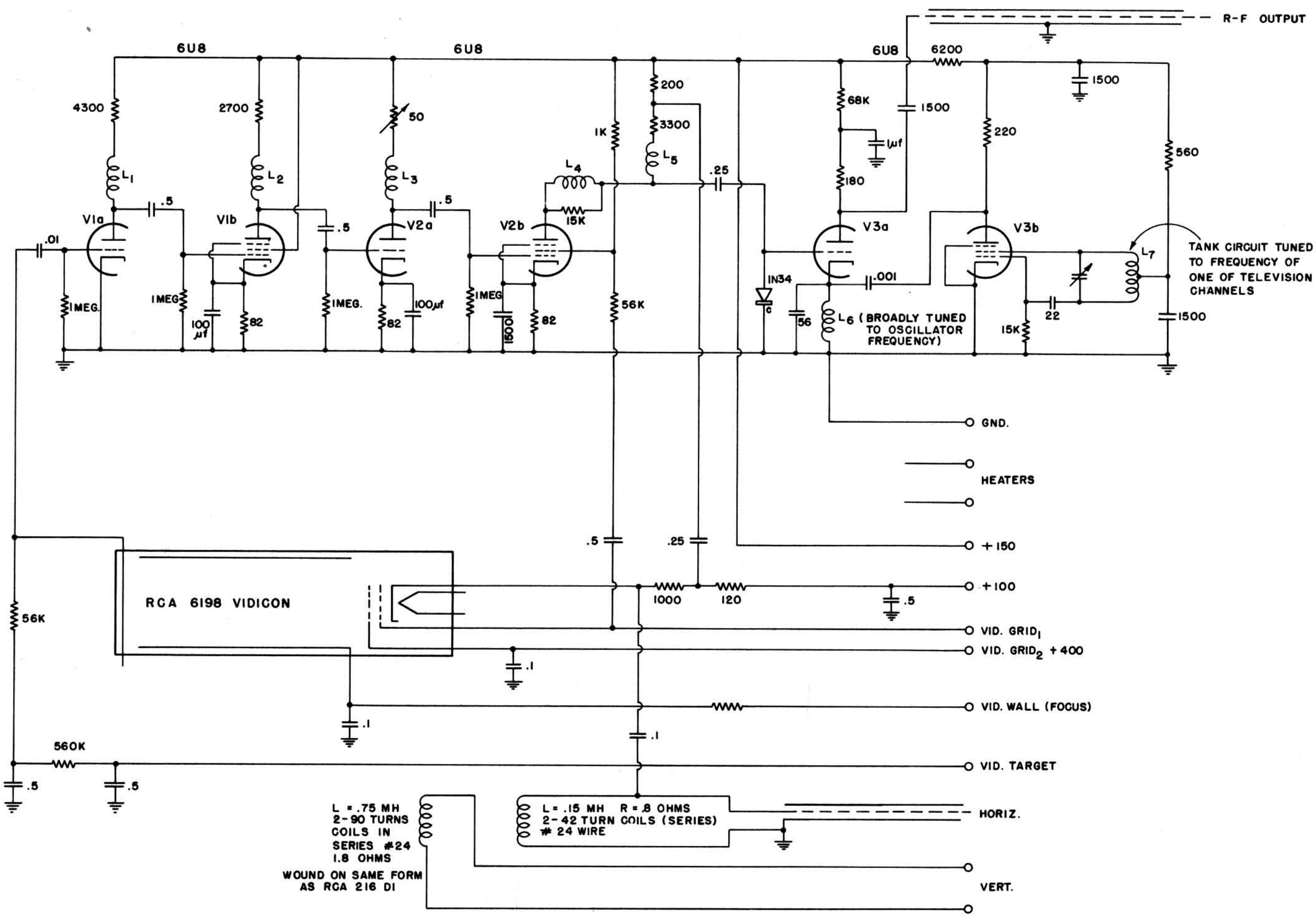

Fig. 2 - Vidicon camera adaptor for receiver.

circuit thus provides an electron coupling between the oscillator and the modulator V_{3a} so that there is a negligible amount of frequency modulation of the oscillator as the output signal is amplitude modulated. The plate of V_{3a} is coupled directly to a 75-ohm line which carries the r-f signal to the receiver. A crystal diode on the grid of the modulator maintains an approximate d-c level and stabilizes the black level of the picture. Pulses from the blanking circuits were inserted at the screen and plate circuits of V_{2b} to provide synchronizing pulses in the signal which can then be used to operate auxiliary receivers if desired.

The amplifier has a bandwidth of four megacycles; a reasonable light level on the Vidicon (about two-tenths microampere photo current) provided 80 per cent modulation of the carrier. An r-f signal level of about 100 millivolts can be supplied to the 75-ohm line.

A heater current of 1.35 amperes at 6.3 volts and a plate supply of 50 milliamperes at 150 volts are required.

Deflection

With an accelerating voltage of 300 volts and a magnetic field of 40 gauss a deflecting field produced by 40 ampere-turns with the particular yoke construction used is required to deflect the Vidicon.

A typical receiver (RCA 17250DE) provides a 1-ampere peak-to-peak deflecting current in the horizontal yoke. If the Vidicon coil is placed in series with the receiver coil a camera coil of about 80 turns is sufficient. Such a coil has about 0.1 mh inductance compared to 10 to 13 mh in the receiver coil. Thus it can be seen that the presence of the

Vidicon coil in series should have negligible effect upon the receiver deflection. This was found to be the case.

The same was true of the vertical circuit; adequate deflection of the Vidicon was obtained with its deflection coils in series with the receiver deflection coils. In the receiver mentioned, as well as in several others, the horizontal deflection coils do not return to a-c ground. In order to bring the horizontal circuit in the camera to ground, desirable since fairly long cables are involved, it seemed advisable to couple the camera horizontal-deflection coils to the receiver through a transformer, the primary of which was in series with the receiver coil. This has several other advantages; for instance, there is no danger of opening the receiver horizontal-deflection coil if the camera coil becomes disconnected. A two-to-one step-up in the transformer was desirable since it reduces the I^2R loss in the cable and provides a higher pulse voltage across the camera coil which is also to advantage since this pulse is used for Vidicon blanking as will be discussed later. The camera vertical coils, shunted by a resistor which can be variable for size control, were directly in series with the low side of the receiver vertical-deflection coils.

With the above arrangement for deflection the horizontal sweep is free running although the vertical is synchronized with the 60-cycle power line in a manner shown later. This means that there is no definite relationship between the horizontal and vertical speeds and hence no definite interlace. However, neither is there a definite non-interlaced condition so that as the horizontal frequency drifts slightly there is a condition of random interlacing which reduces the deterioration of vertical resolution which might be expected with no interlacing. The random spacing of horizontal lines does show up in a "twinkling" of sharp horizontal lines occurring in the picture because of the randomness of the interference between horizontal lines in the picture and in the raster. This is not noticeable in most pictures and has seldom been objectionable.

Voltage Supply

Desirable d-c voltages for the Vidicon are given with respect to cathode: +300 for acceleration, +250 to 300 for focus, +10 to 50 for target and 0 to -100 for control grid. Most modern receivers do not have a negative supply so it is necessary to elevate the Vidicon cathode above ground to obtain the necessary control grid bias. Many such receivers do have a rather stiff low-voltage supply running between +120 and +160 volts. This can be conveniently bled down to about 100 volts since the total cathode plus bleeder current need not run more than 2 or 3 milliamperes. In other receivers the +100 volts may be obtained by bleeding down from the B+ voltage. Likewise, practically all receivers have a "boosted B" voltage of 400 to 500 volts which can supply the necessary voltage above cathode for acceleration and focus.

Normal B supply voltage in receivers is usually between +220 and 280 volts. This was dropped by means of an RC decoupling filter to supply the 150 volts for the camera amplifier.

Blanking

It is necessary to blank the Vidicon beam during vertical and horizontal flyback to prevent the generation of spurious signals. Horizontal blanking was accomplished as previously mentioned by applying the positive pulse across the camera horizontal coils (about 10 volts) to the Vidicon cathode. In order to obtain a vertical pulse adequate for blanking, a pulse transformer which may be of the blocking-oscillator type was connected across the receiver vertical coils. The transformer may be connected either step-up or step-down and in such a polarity as to give a negative pulse of 30 to 50 volts on the secondary for the particular pulse direction on the receiver coil. This is important since vertical pulse amplitude and polarity have been found to vary with different makes of receivers. The base line was straightened and the pulse lengthened by means of a biased crystal rectifier and a RC circuit. The negative pulse thus obtained was applied to the control grid of the Vidicon.

Control Unit

The physical and electrical connections of the camera to the receiver were given considerable attention. The camera contains the Vidicon and the amplifier-modulated oscillator unit. At the end of 50 feet or more of cable and near the receiver is a control box containing the necessary controls to operate the camera, the horizontal transformer, vertical blanking circuits and miscellaneous dropping resistors, plus a heater transformer for the camera, which is necessary since sufficient heater voltage must be provided to compensate for drop in the cable. A schematic diagram of the control box is given in Fig. 3. There are no tubes and only a few components in the control box.

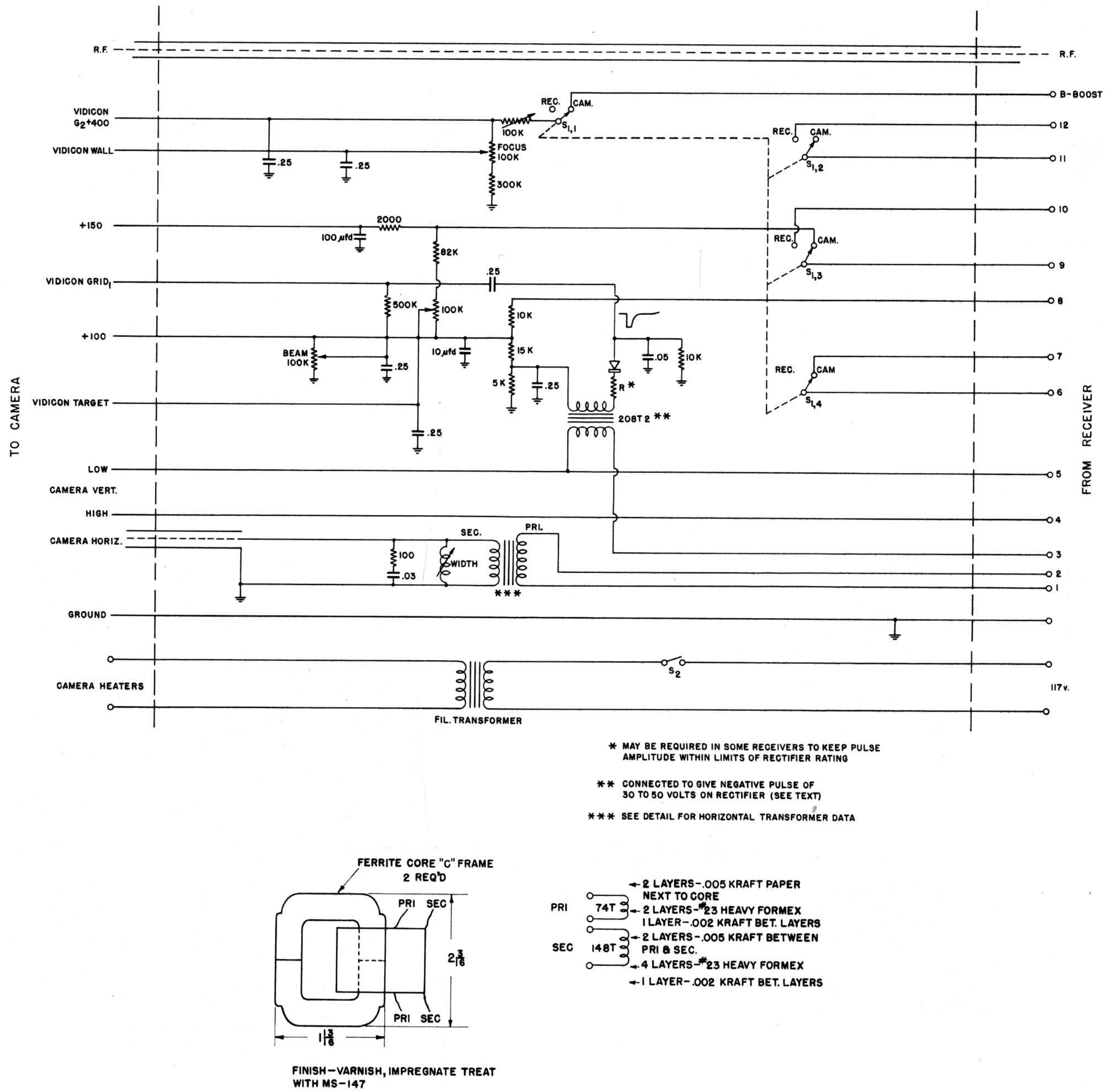

Fig. 3 - Schematic diagram of the control box (with detail of horizontal transformer).

Adaptation to Receiver

In order to make the adaptation of the camera to a receiver relatively simple, wherever possible all connections to the receiver were made by means of adaptors which were placed under tubes and in the deflection plug in the receiver. In practically all receivers in which the deflecting coil is connected to the chassis by means of a plug the adaptation can be made with no alternation of the receiver since invariably all the other voltages appear at some of the tube pins. In receivers without a deflection plug the necessary wires to the deflection coils can be cut and a connector inserted without removal of the chassis. The camera has been adapted to several models of 1951 and 1952 RCA receivers, as well as others makes of receivers. As with the RCA receivers some others required no alteration, it being necessary only to obtain proper blanking polarity and d-c voltages and to provide proper adaptors. All these adjustments were made in the control box. In the case of some receivers, in addition to the adaptors for voltages, it was necessary to open the deflection coil circuits to insert the camera circuits since these receivers were not provided with a deflection plug. A study has been made of many current receivers and no difficulty is anticipated in adapting the camera to any of them.

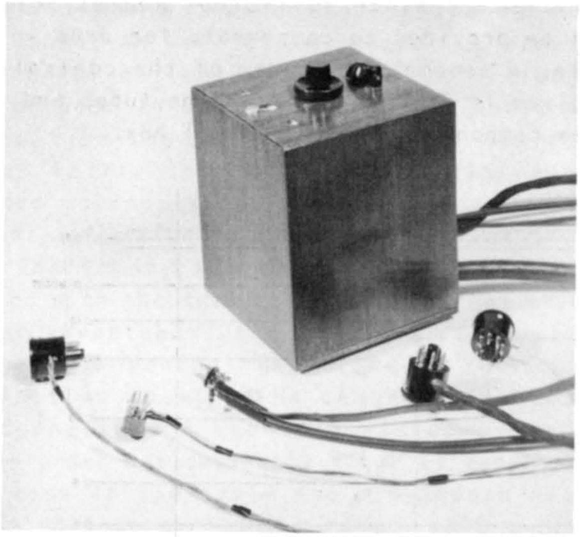

Fig. 5 - Control box with the adaptors necessary for connecting it to the receiver.

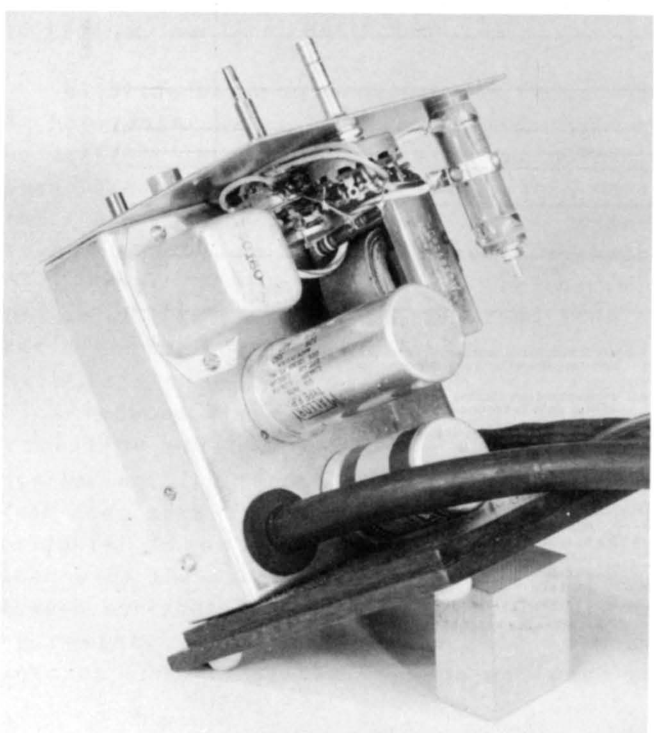

Fig. 6 - Top view of interior of control box.

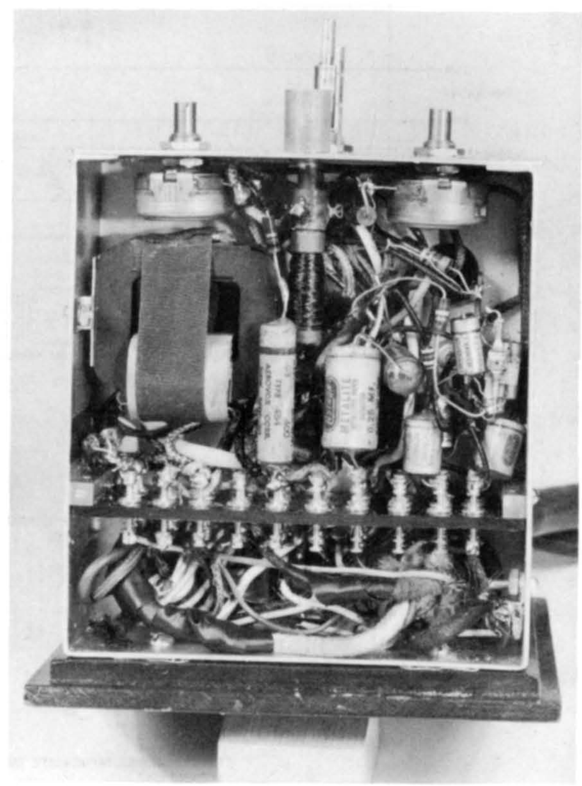

Fig. 7 - Bottom view of interior of control box.

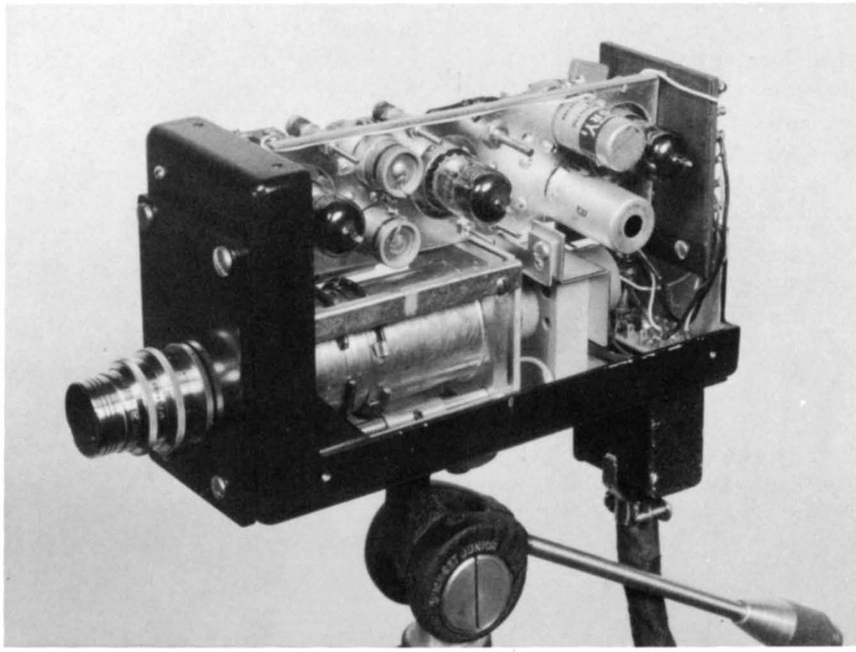

Fig. 8 – View of camera interior.

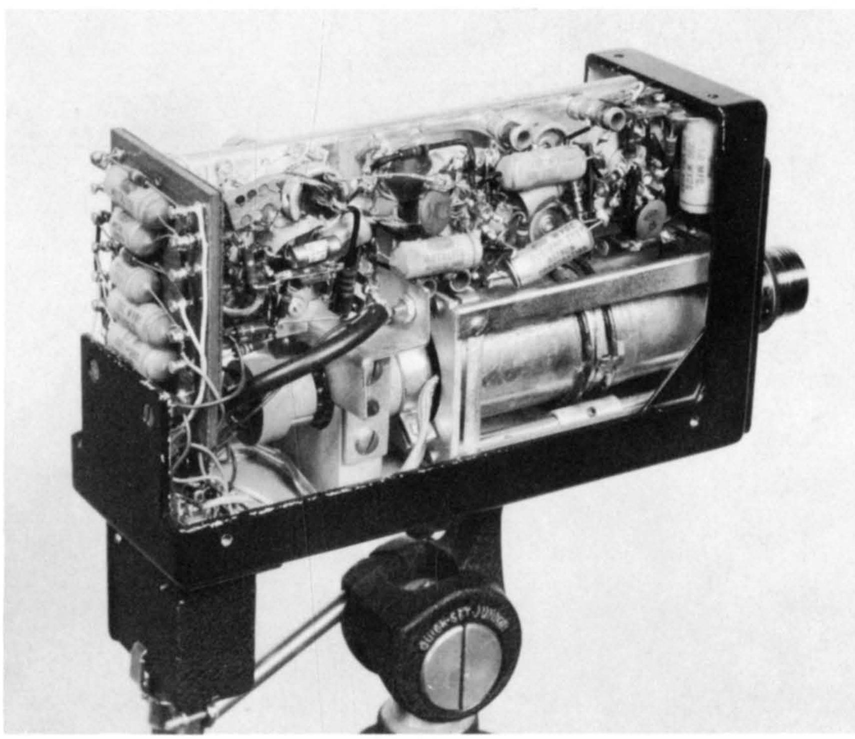

Fig. 9 – View of camera interior.

Fig. 4 shows a schematic diagram of an RCA 17T150 receiver with the connections to the camera shown. A switch was provided on the control box for switching from normal receiver operation to camera. As shown on these diagrams and on the diagram of the control box, this switch, when in the camera position, applies voltage to the Vidicon and plate voltage to the amplifier. It also removes the load of the audio output tube to compensate for the load of the camera. A 60-cycle signal was inserted into the sync amplifier to lock the vertical deflection to the power line in the camera position.

Fig. 5 shows the control box with the adaptors necessary for connecting it to the above receiver. Figs. 6 and 7 are interior views of the control box.

Figs. 8 and 9 give interior views of the camera.

Operation

As was mentioned before, the r-f signal from the camera contains synchronizing information which permits auxiliary receivers to be operated merely by connecting the signal output line to the antenna input of the receivers. A multiple control box has also been made which permits the selection of the signal from any one of three cameras. At the same time the camera voltages and deflection are switched to the camera being operated.

In many receivers it would be possible by means of a relatively simple service operation to couple a switch directly to the channel selector to accomplish camera switching by turning the selector to the channel to which the camera has been tuned. In a receiver designed with adaptation in mind provision could be made for easily attaching this switch section.

Operation of the adaptors has been quite satisfactory. The bandwidth of 4 Mc provides adequate response to utilize the full capabilities of the receiver.

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