

ZENITH COLOR T.V. RECEIVER

In the past two sessions we have talked about the N.T.S.C. color TV system as a whole and about the three gun tube. In the 1st session we finished up with a crude block diagram for a typical receiver. It will be the purpose of this session to develop this diagram to that of the Zenith color receiver. At the same time we will also consider the circuits that provide for the high voltage--convergence voltages and purity current necessary for the proper operation of the three gun tube.

Referring to the block diagram, you will see that it is divided into four separate sections which we consider in order.

The 1st block includes the turret, I.F., sound channel, 2nd detector and 1st video. The most obvious deviation from our ordinary black and white sets is taking off sound ahead of the second detector. This is done to permit high attenuation of the sound in the video signal. Most of this attenuation of the sound as far as the video signal is concerned takes place in the plate circuit of the 4th I.F. This is in addition to the regular series trap at the input of the I.F. strip. This large amount of sound rejection is necessary to prevent a highly visible 900kc C.W. interference which is the result of beating between the sound and color subcarriers.

The turret is essentially that with which you are familiar. The I.F., with the exception of treatment of sound and band pass is again quite similar to that of a black and white set. The pass band is essentially flat to 41.75 mc in order to not cause attenuation of the color part of the signal. The pass band then drops off rapidly from 41.75 to 41.25 megacycles.

The sound strip is likewise straightforward. There is one stage of 41.25 mc amplification followed by the sound second detector and a 4.5 Mc amplifier. This signal passes thru a limiter and then to the 6BN6 discriminator and 6BK5 sound output stages.

The 1st video stage is included in this section because it again serves the same purpose as the 1st video of a black and white set, serving principally as the origin of the signal to the sync.clipper.

The circuits in the left hand section of the second block are again practically identical to the corresponding circuits of a black and white set--conventional sync. separation, vertical deflection, horizontal AFC, and gated AGC circuits. On the right are the circuits concerned with the generation of the proper local color oscillator signal, and we will consider these in some detail.

The input signal to the burst amplifiers is taken from the grid of the 2nd video and applied to the grid of the 1st burst amplifier. Note that it is taken off ahead of the contrast control and so is not affected by the setting of the latter. The coupling is such that only the 3.58Mc components of the composite video are present at the grid. This means that not only the burst but all of the color signal is present at this point. To separate the burst from the rest of the signal in the plate circuits of the burst amplifiers a positive horizontal pulse from the flyback transformer is applied to the screens of

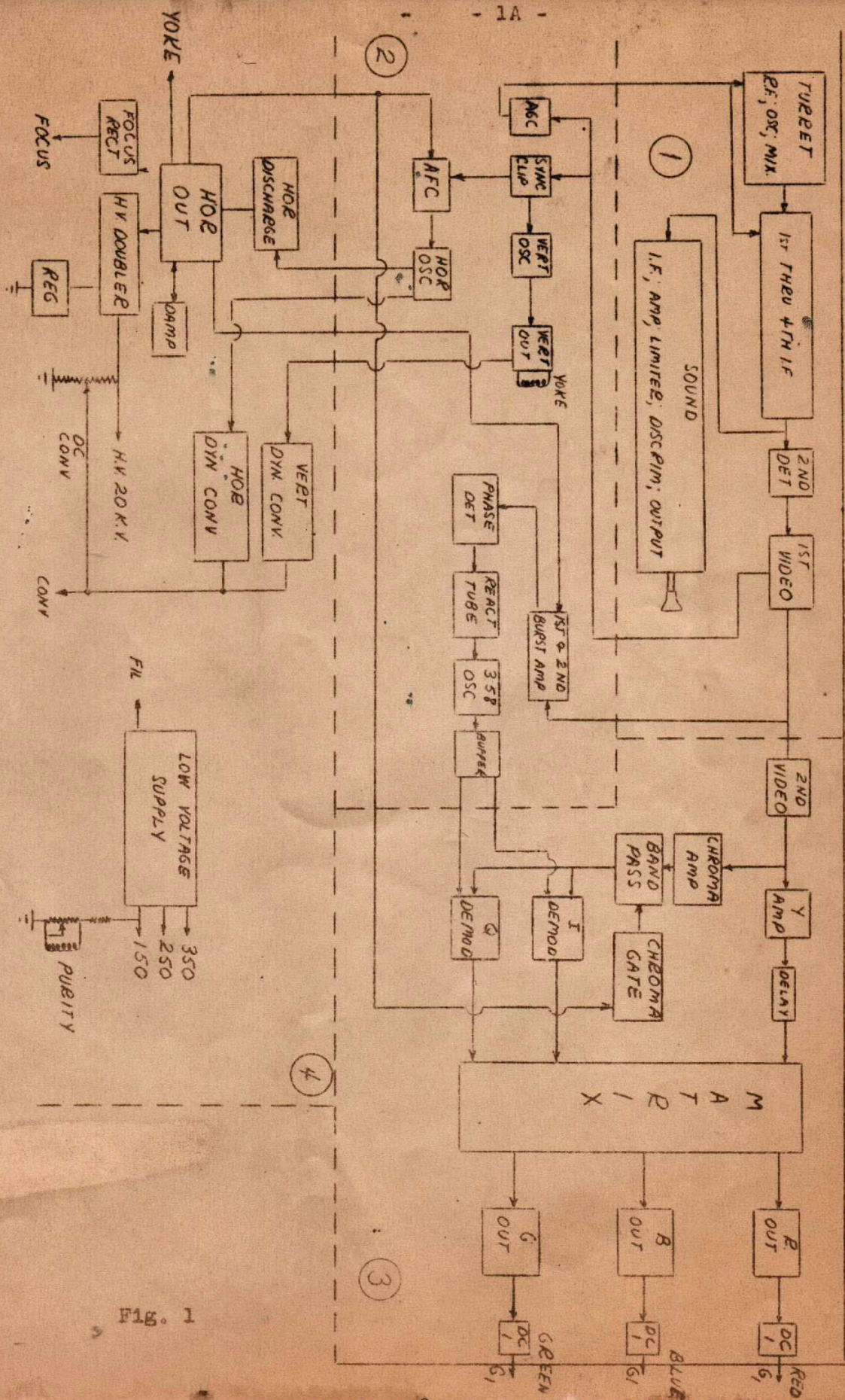


Fig. 1

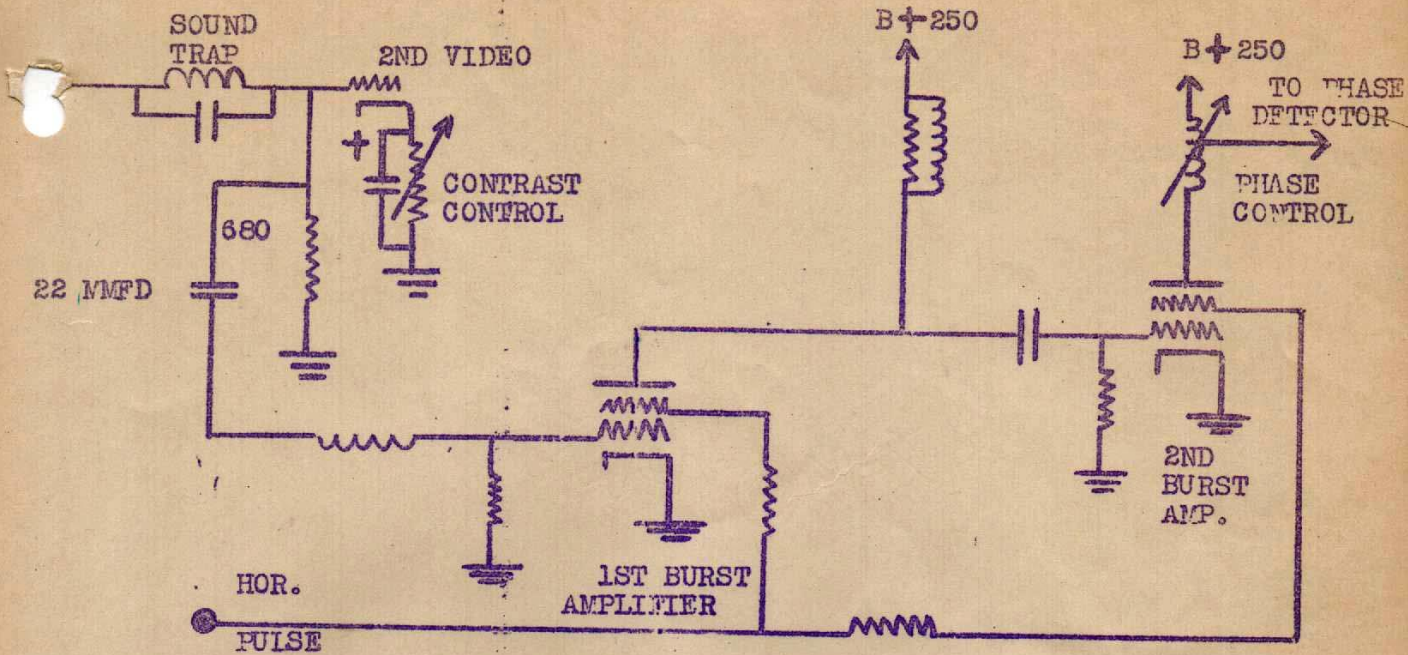


Fig. 2

both burst amplifiers. This means that the tubes can conduct only during the time of this pulse (which corresponds roughly to retrace.) Hence no signal current flows in the plate circuits except during retrace time. During retrace time the plate current has an R. F. component proportional to the burst voltage. The plate circuit of the 2nd burst amplifier consists of a variable inductance which is turned to approximately 3.5 Mc. This is a front panel control and is called the phase control. By varying this inductance the phase of the amplified burst which is applied to the phase detector is varied.

The amplified burst is taken from a tap on this coil and applied to one end of the bifilar coil in the Phase detector.

The phase detector operates in much the same way as the horizontal A. F. C. circuit. In this case the burst acts as a gate. That is the diodes can conduct only during the peak negative swings of the amplified burst. If the local oscillator is in the proper phase, the reference 3.58 Mc signal developed across the auxiliary phase control is passing through zero at this time. Hence the D. C. potential applied to the reactance tube is equal to the D. C. reference voltage applied to the center tap of the bifilar. If the phase is incorrect then the 3.58 Mc reference signal is no longer zero. For example, assume it is 2V positive at the time of diode conduction. Under these conditions the upper R C network has a larger potential developed across it and the lower R C network is a smaller potential than in the "in phase" condition. The result is that the D. C. applied to the reactance tube grid is now 2 V above the reference D. C. potential.

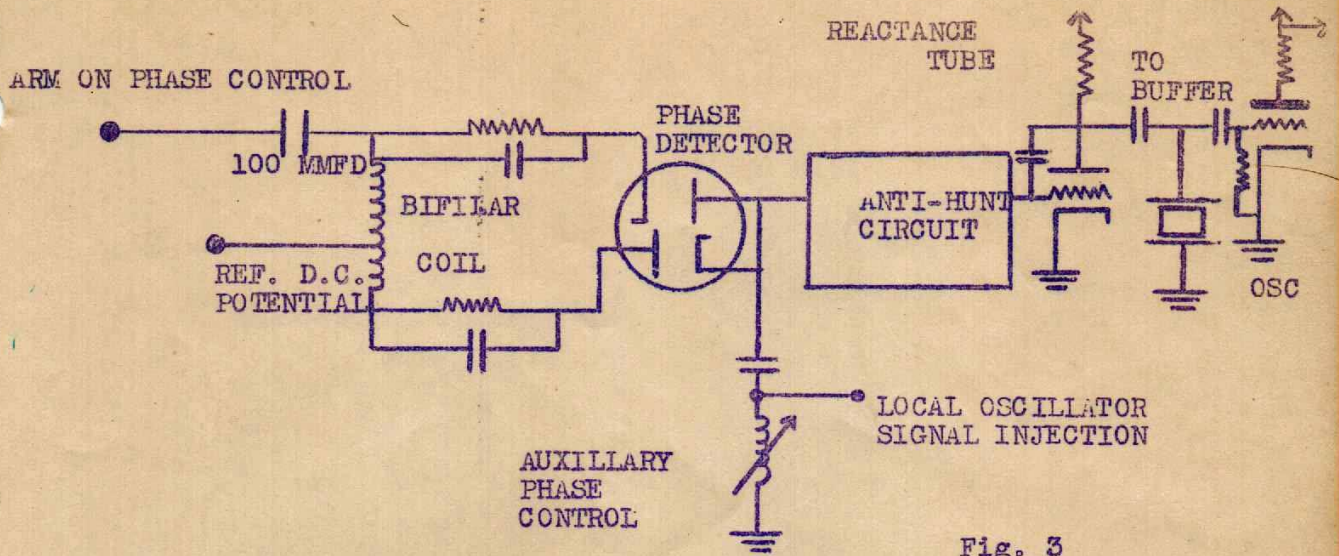


Fig. 3

The reactance tube then behaves like a larger capacity across the crystal and hence the local oscillator frequency is slightly lowered. This process continues until the oscillator output is the proper frequency. By having the loop gain very high a shift of 100 cycles due to warm up or changing stations etc. will cause only a few (4 or 5) degrees phase error.

The oscillator and buffer are quite ordinary with the exception of the buffer plate circuit. You can see that we have two coils coupled by a small condenser (4MMFD). Both coils are resonant at 3.58Mc and this arrangement allows us to obtain the 90° phase shift between the local oscillator injections to the I and Q demodulators.

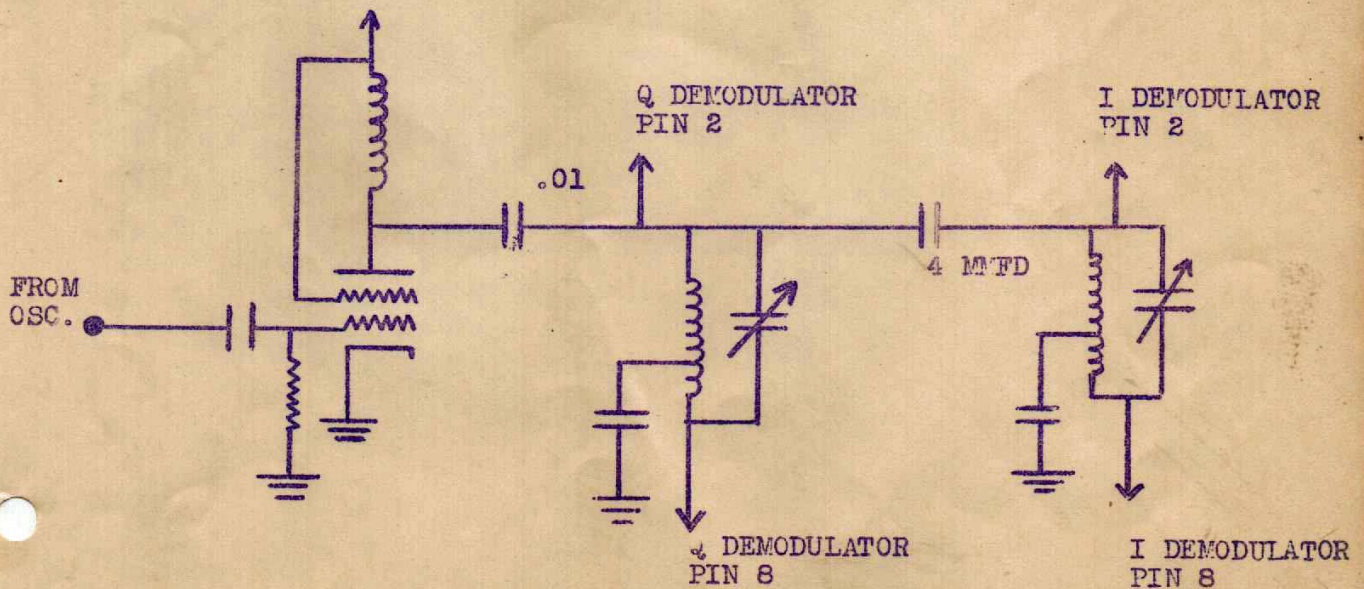


Fig. 4

The third section contains the video frequency circuits and it is here that most of the variations from a black and white set occur. The second video amplifier has another sound trap in its grid circuit. a 5K pot in its cathode circuit changes the bias of this stage and serves as the contrast control. (See Fig. 2)

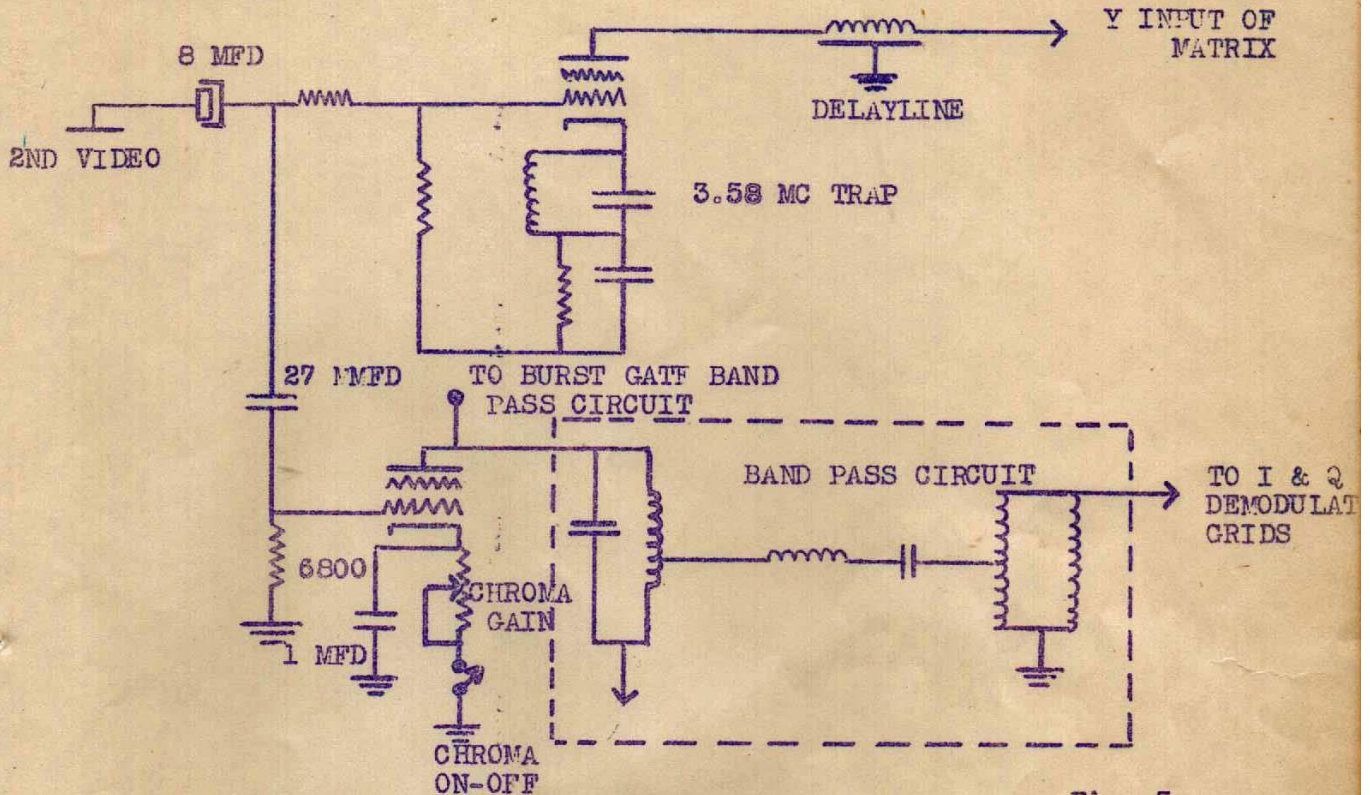


Fig. 5

From the plate of the 2nd video the signal goes to the grid of the chroma amplifier through small coupling condenser (27 MFD). The effect of this coupling arrangement is to remove the very low frequency components of the composite video signal. The output of the second video is also coupled to the grid of the Y amplifier.

The cathode circuit of the Y amplifier contains a parallel resonant circuit at 3.58 Mc. and hence the gain of this stage is greatly reduced at this frequency. This is done to remove a 3.58 pattern which can otherwise exist in colored areas. The plate is connected to the matrix thru the delay line.

The chroma amplifier has 25K pot in its cathode circuit. This pot controls the bias and hence the gain of this stage. It is a front panel control marked chroma gain. The coupling from the plate of the chroma amplifier to the grids of the demodulators is thru a band pass circuit. The pass band is flat from 2.6 to 4.1 Mc.

The demodulator tubes are of a new type developed by Dr. Adler. These tubes are of the beam type, like a cathode ray tube but have two plates instead of one and a set of two deflecting rods. If one of these rods say the left one is 60 volts or so positive with respect to the other the whole beam is deflected to the corresponding plate (in this case the left one) and there is no current to the other. If the chroma signal is applied to the grid then the amount of beam current is determined by it. With the local oscillator injection applied to the deflecting rods, the amount of the total beam current reaching either plate is determined by the local injection. In practice the oscillator injection is high enough in amplitude so that the beam can be considered as going to either one plate or the other (but not some current to each) at all times. This means that if the injection is exactly in phase with the signal the output from one plate will be a series of current pulses with amplitude greater than if no signal were present. The output of the other plate will be a series of positive pulses of less amplitude than if no signal were present.

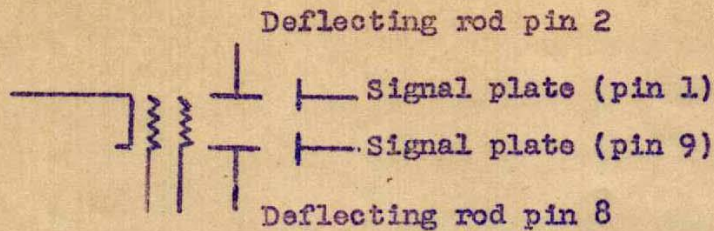
The output of either plate of the other demodulator is independent of the signal amplitude since one plate is receiving current while the signal voltage varies from its negative maximum to its positive maximum.

Thus we see that the I demodulator give both $+I$ and $-I$ and the Q demodulator gives both $+Q$ and $-Q$.

From the plates of the I demodulator the signal passes to the matrix thru low pass filters which pass frequencies up to 1.5 Mc and which of course removes the 3.58 Mc component of the plate current. The outputs of the Q demodulators pass thru a low pass filter also but in this case only frequencies up to .5 Mc are passed. The cathode ckt. of the I demodulator has a 500 ohm pot which is used to vary the bias and degeneration of this tube in order that its gain be correct with respect to the Q demodulator. This is a service control called Demodulator Balance.

The matrix consists of 13, 5% resistors and the 2, 3900 Ohm 10% pots. This array takes $+I$, $-I$, $+Q$, and $-Q$ and Y and adds up the proper amounts of each to give the original red, blue and green signals across the fixed 3900 ohm resistor and the upper and lower pots respectively. The pots are provided to enable various amounts of the blue and green signals to be applied to the C. R. T. This is done to account for differences between tubes and hence these are service controls.

The output tubes are conventional.



Schematic representation of switch tube

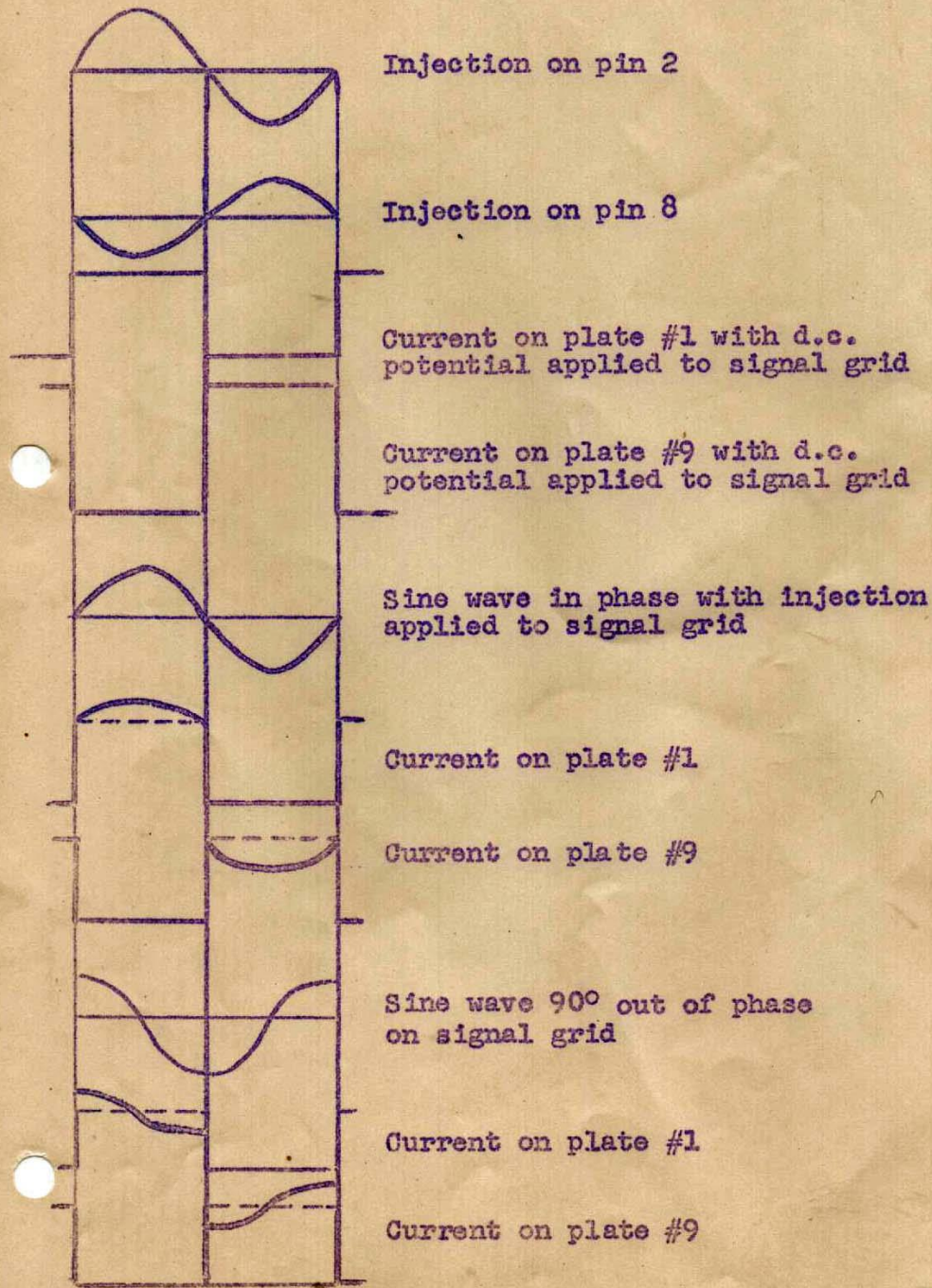


Fig. 6

Because capacity coupling has been used in the set a triple diode is used as a d.c. restorer, one section for each grid of the C.R.T. Since the most negative portion of the signal is sync, the insertion takes place on the sync. tips. The operating bias can be altered on the blue and green guns by the blue and green background controls and the bias on all three guns is changed by either the master brightness control (which with the background controls is located on the rear of the chassis) on the front panel. In all of the above controls the grid potential is determined by setting the sync. tips voltage with respect to the C.R.T. cathode potential by varying the reference voltage for the D.C. inserters.

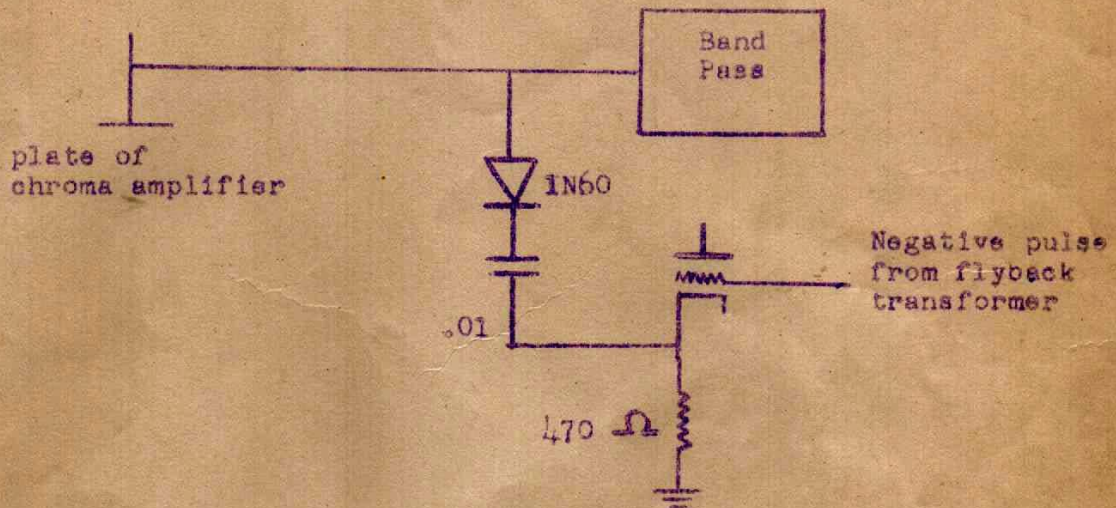


Fig. 7

For proper operation of the inserters it is necessary that sync. form the most negative part of the signal. However, it is possible that under some circumstances the demodulated burst may be more negative than sync. For this reason a burst gate is included in the band pass circuit. This gate removes the burst. Briefly, its operation is as follows: A negative pulse from the fly back transformer is applied to the grid of a pulse clipping triode. This pulse cuts the tube off and hence a negative pulse with a flat bottom appears across the cathode resistor. This pulse is coupled thru an .01 condenser to the cathode of the crystal and hence the crystal conducts and appears as a very low impedance across the band pass circuit. This effectively shorts out the signal during the time of the pulse which is of course burst time.

The final block contains the power supply and circuits for developing various potentials and currents for the operation of the three gun tube. As in the sync. block the circuits on the left hand side are quite similar to those which you have seen in various black and white sets. The flyback transformer has been modified to provide for the horizontal pulse used in the gating circuit. The only other changes are the addition of a divider to furnish the D. C. convergence voltage and a regulator system to keep the high voltage constant under varying C. R. T. load. The operation of the regulator is such as to keep the total load to the power supply constant. That is if the C. R. T. draws no current, the regulator draws say .7 Ma. If the C. R. T. draws .250 micro. amps. then the regulator draws 450 microamps etc.

The dynamic convergence of the three gun tube requires a parabolic shaped voltage. These wave forms at both horizontal and vertical rates are easily derived from the horizontal and vertical wave forms already present in ordinary black and white sets. Actually it has been found that applying a horizontal rate sine wave is sufficient for horizontal dynamic convergence. Therefore, it is only necessary to amplify the sine wave appearing at the grid of the horizontal oscillator and apply it in the proper phase. This phasing is accomplished by tuning of the resonant plate circuit of the horizontal dynamic convergence amplifier. This is a screw driver adjustment marked horizontal phase. The amplitude of the horizontal dynamic convergence voltages is controlled by the screwdriver adjustable pot, marked horizontal dynamic convergence, in the amplifier grid circuit.

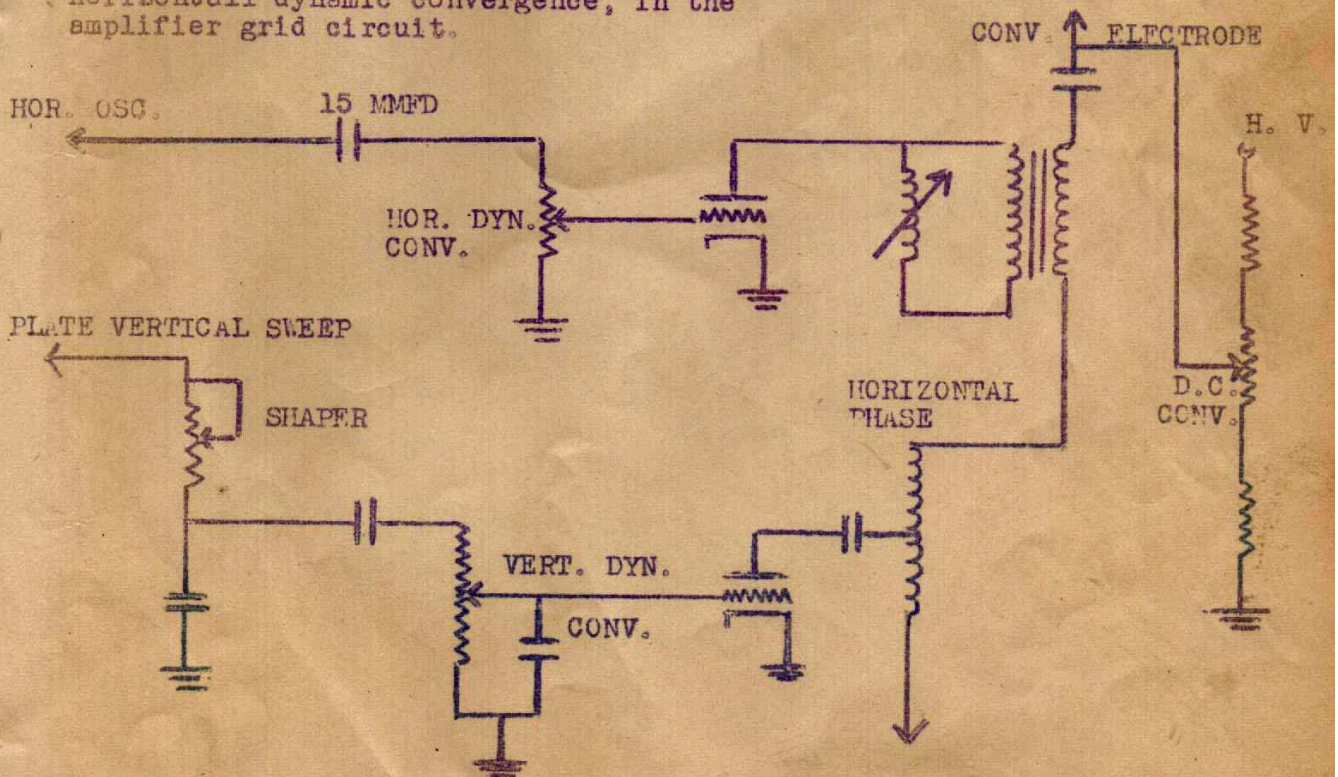


Fig. 8

The vertical dynamic convergence voltage is formed from a pulse taken from the vertical output transformer. Its amplitude and shape are determined by screwdriver adjustable pots marked shaper and vertical dynamic convergence. These are located in the grid circuit of the vertical dynamic convergence amplifier.

Both vertical and horizontal dynamic convergence are added to the D.C. convergence voltage by transformer and capacity coupling.

The purity coil current is taken directly from the 150 V low voltage supply and the current thru the coil is controlled by a resistive current dividing circuit. The screwdriver control for this purpose is the pot marked purity.

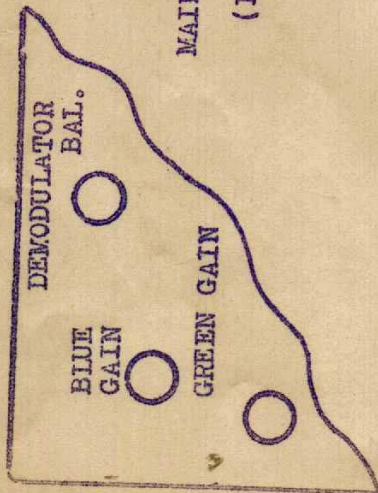
The G2 voltages for the three guns are taken from the pots connected between bootstrap and ground. These are marked Red G2, Blue G2 and Green G2.

The low voltage power supply is straight forward and supply three voltages 150, 250 and 350 volts.

This completes the discussion of the block diagram for the Zenith color receiver as well as the Color School material. It is the hope of the color T.V. engineering section that these sessions have proved both informative and helpful to you.

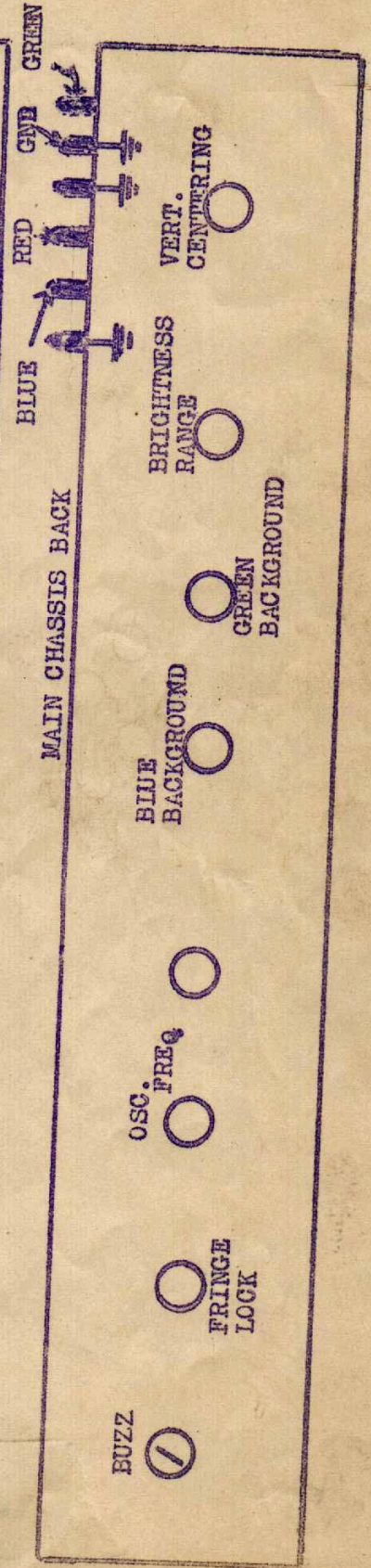
Zenith Color TV

(Controls and adjustments)



MAIN CHASSIS TOP
(Left-rear)

MAIN CHASSIS FRONT

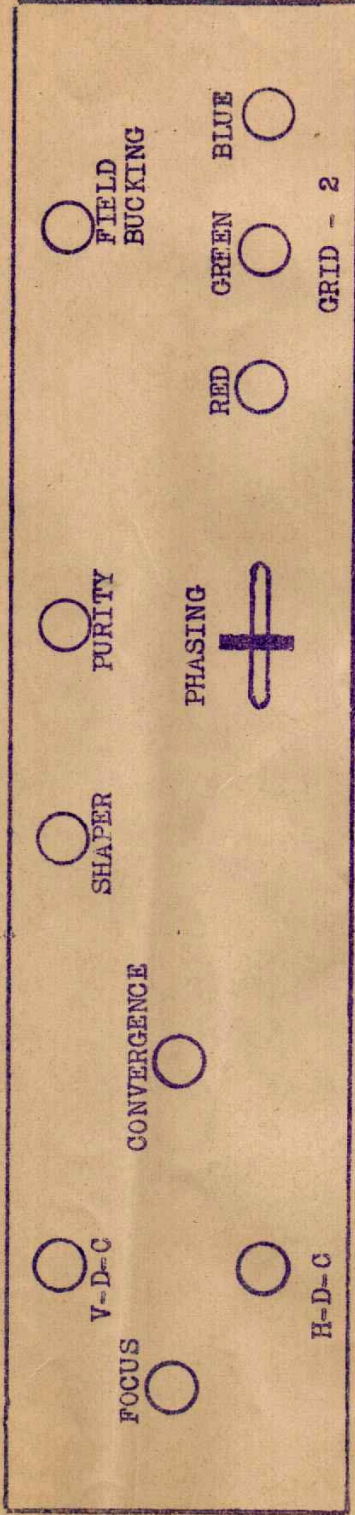


MAIN CHASSIS BACK

ZENITH COLOR TV

(CONTROLS AND ADJUSTMENTS)

POWER SUPPLY CHASSIS
(FRONT)



POWER SUPPLY CHASSIS
(REAR)

Operating Instructions

The Zenith TV Color receiver has three more front panel controls than a black and white TV receiver.

1. Color ON-OFF Switch

Set to "ON" position for viewing color telecasts.

Set to "OFF" position for regular black-white telecasts.

2. Phase Control (Color ON-OFF Switch in "ON" position)

Turn this control clockwise or counter-clockwise for the most natural looking color of the scene being viewed. (For instance, the "skin complexion" of a person's face.)

3. Chroma (Color ON-OFF Switch in "ON" position)

Set this control for the depth of color most pleasing and natural to your eye.

If the colors of a scene are not "true", black-white scenes are extremely tinted, or "color ghosts"(resulting from mis-convergence) are visible, the technical adjustments on the following pages should be made. It is important that these adjustments be made in the sequence listed.

TECHNICAL ADJUSTMENTS FOR ZENITH TV COLOR RECEIVER

Note: Make the following adjustments in the sequence listed for proper receiver operation. The use of a "DOT" generator is essential. Connect "DOT" generator output to antenna terminals. Also use background noise of "snow" and test pattern.

Set the Color ON-OFF switch at front of main chassis to "OFF" position.

A. PURITY

1. Pull out the 3 swivel type convergence magnets away from the picture tube neck.
2. Remove the GREEN and BLUE leads located at the rear of the main chassis and ground them to the adjacent ground lugs.
3. Position the deflection yoke until the total raster is "RED". (Keep deflection yoke perpendicular to picture tube neck.)
4. Rotate the "PURITY" coil located around the picture tube neck in back of the deflection yoke and adjust the "PURITY" control on the power supply chassis for best over-all RED raster.
5. Repeat operations 2 and 3.
6. Remove the RED lead located at the rear of the main chassis and connect it to the adjacent ground lug.
7. Re-connect the BLUE lead and check raster for total "blueness".
8. Ground BLUE lead and re-connect GREEN lead. Check for total raster "greenness".
9. If colors are not true, repeat operations 2 and 3 until all 3 colors are correct.
10. Re-connect the RED, BLUE and GREEN leads to their respective terminals.

B. CONVERGENCE

1. D. C. CONVERGENCE
 - a. Use a "DOT" generator and apply signal to antenna input terminals.
 - b. Turn the H. D. C. and V. D. C. controls on the power supply chassis fully counter-clockwise.

c. Adjust the FOCUS and CONVERGENCE controls on the power supply chassis.

d. Adjust the three G2 controls on the power supply chassis until the 3 color triangle dot pattern is visible.

e. Carefully rotate and push in on each "convergence" magnet (one at a time) until the three color dots (red, blue and green) converge into one white dot.

NOTE: The further distance the three convergence magnets are away from the neck of the picture tube at the proper convergence setting, the better the definition.

2. DYNAMIC CONVERGENCE

a. Track the CONVERGENCE, H.D.C. and PHASE controls, located on the power supply chassis, so that horizontal lines track across as white dots. (Touch up FOCUS control.)

b. Track the CONVERGENCE, V.D.C. and SHAPER controls located on the power supply chassis, so that vertical lines track across as white dots. (Touch up FOCUS control.)

C. BACKGROUND ADJUSTMENTS

NO SIGNAL

Short out video at Y amplifier grid (pin #1)

Contrast control at normal setting

Brightness- full up (If blooming, reset brightness range pot.)

1. Adjust G2 controls on power supply chassis for best "white".
2. Set "Brightness" at minimum and adjust Blue and Green background controls for best "gray" color.

ON SIGNAL

Minimum brightness setting and contrast control at normal level.

1. Adjust blue and green gain controls on main chassis for best "white" on picture.

2. Vary "Brightness" control. If color variation occurs, touch up the blue and green background controls at rear of main chassis for minimum variation.

Touch up FOCUS and DC convergence control on front of power supply chassis for best over-all black-white picture.