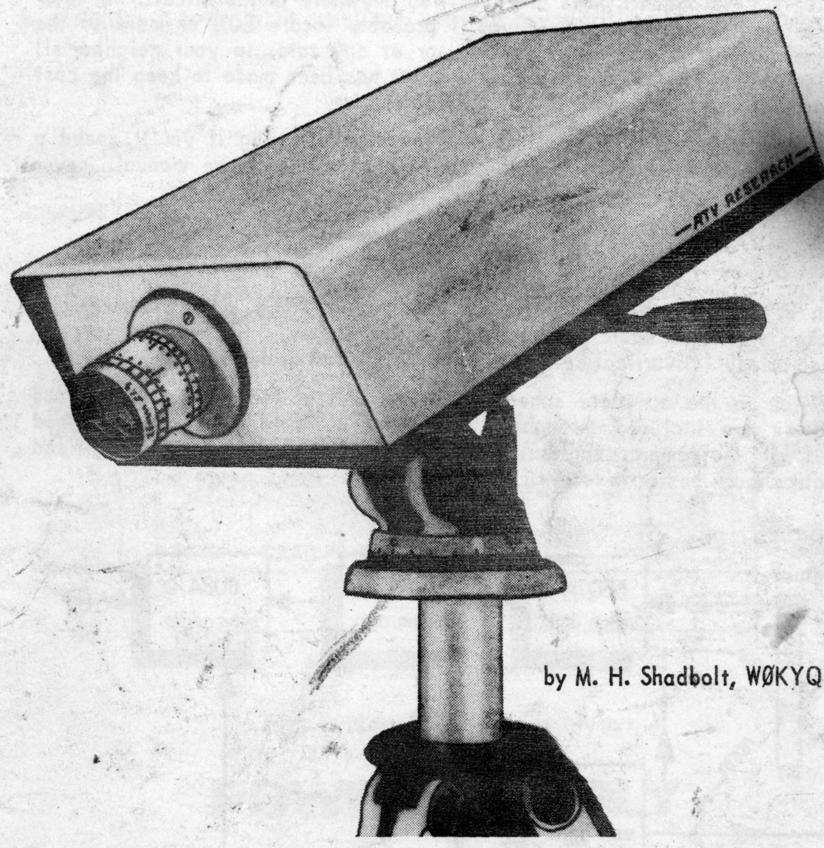
ATV RESEARCH

VIDICON
CONSTRUCTION MANUAL

Complete details for building your own 5 tube "LIVE" camera.



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INTRODUCTION

This camera is a completely self-contained package...incorporating its own sync-generator, power supply, video amplifiers, and deflection circuits...in otherwords, the works. Just plug it into the 120VAC outlet and you're ready to start televising. Best of all, it's done with only FIVE tubes plus vidicon! Even though originally designed specifically for the less experienced beginner, its excellent performance (and convenience of operation) has proven it to be equally ideal for the more advanced constructor.

One feature which makes this camera QUITE different from its former counterparts is the fact that it's been designed to use nothing but standard, easy-to-locate components. No oddball parts are specified anywhere in the circuit. In fact, if you're like many constructors you'll probably locate 80% or more of the components right in your own junkbox...or at any rate...in your neighbor's!! In designing this camera every possible effort has been made to keep the cost of the project within the reach of all constructors.

Considerable time can be saved in the layout and wiring if you'll spend a few extra moments prior to construction and read the entire manual...cover to cover.

LAYOUT

As can be seen by the block diagram shown below, (fig. 1) the camera can be broken into five basic sections; (1) power supply, (2) vidicon control, (3) video amps, (4) vertical deflection, and (5) horizontal deflection.

In addition to the complete schematic at the end of the text, sectionalized schematics are included throughout the manual. Until you've familiarized yourself with the camera...and during construction...you'll find the sectionalized schematics much easier to follow.

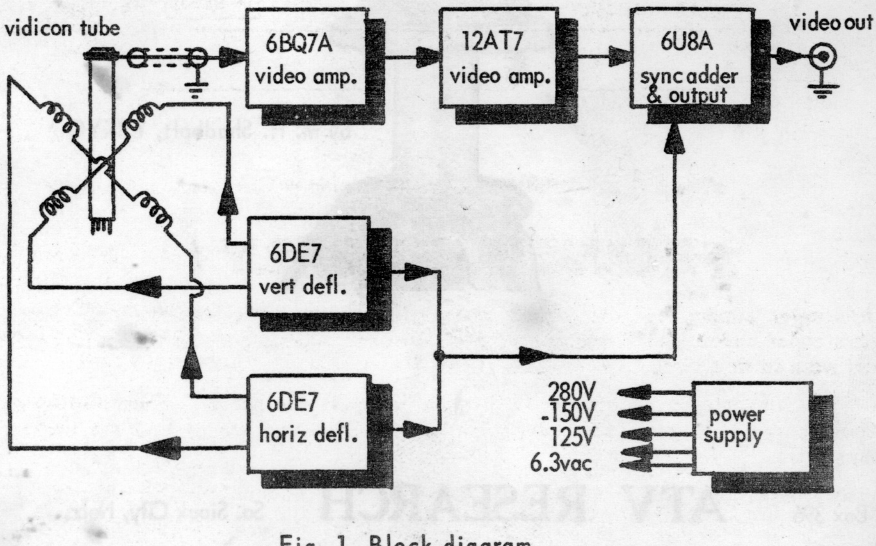
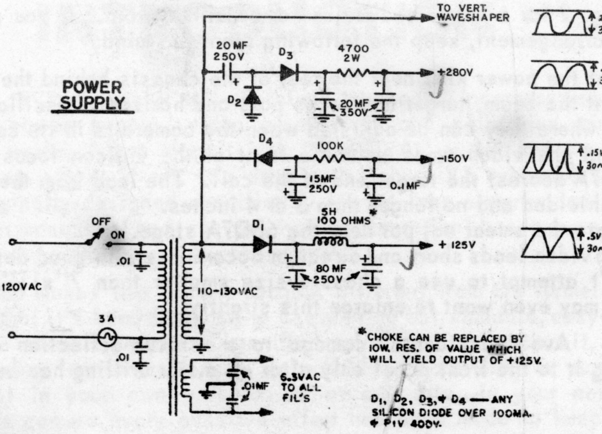


Fig. 1 Block diagram



The +280 volts for the vidicon screen and focus grids, vertical discharge and horizontal oscillator is derived from the same 120 volt winding by using a voltage doubling circuit. The 20mfd series capacitor is charged to the peak value of the secondary through D2 on the negative cycle. This is then added to the output on the positive cycle when D3 is in a conducting state and D2 is cutoff. This configuration allows a single 120 volt winding to furnish all the required B voltages, thus making it feasible to use cheaper and more readily available transformers.

NOTE: The filaments MUST be bypassed as shown to prevent feedback from occurring in the high gain video amps via the filament line.

VIDICON CONTROL

The next section to be wired is the vidicon control. Use the sectionalized schematic on the next page as a guide. The beam, target and electrostatic focus pots are operational controls and are all mounted on the rear panel where they can be adjusted throughout the period of operation. The target lead is a short length of low capacity mike cable. This cable is connected to the target connector which protrudes through the bottom of the front end plate of the focus coil. NOTE: This is a shielded target. The center connector ties to the center lead of the cable while the outer portion is for the shield. BE SURE TO GROUND the cable shield near the 6BQ7A. Failure to do this may result in excessive pickup of the horizontal retrace pulse as well as local radio station interference. REMEMBER: Total length of this lead should be no longer than 3 or 4 inches.

The vidicon and vertical discharge tube share a common cathode resistor. In this manner, vertical blanking is injected into the vidicon to drive it to cutoff during retrace. Horizontal retrace blanking is applied to the beam grid from pin 9 of the horizontal deflection tube. The beam adjust pot is on the same shaft as the on-off switch and wired such that pin 2 receives maximum negative voltage when the pot is in its counterclockwise position. By so doing, it is mandatory that the beam be cutoff when the camera is first turned on. Never decrease the beam bias until the deflection tubes are functioning properly. It could burn a spot on the delicate photosensitive target!

When using a 6326A vidicon tube, be sure pins 3 and 6 are tied together! Proper focus cannot be obtained if you fail to perform this step.

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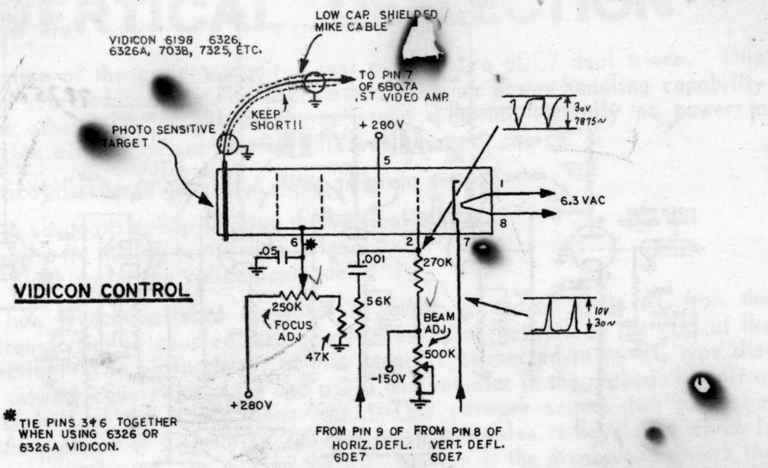


VIDEO AMPLIFIER

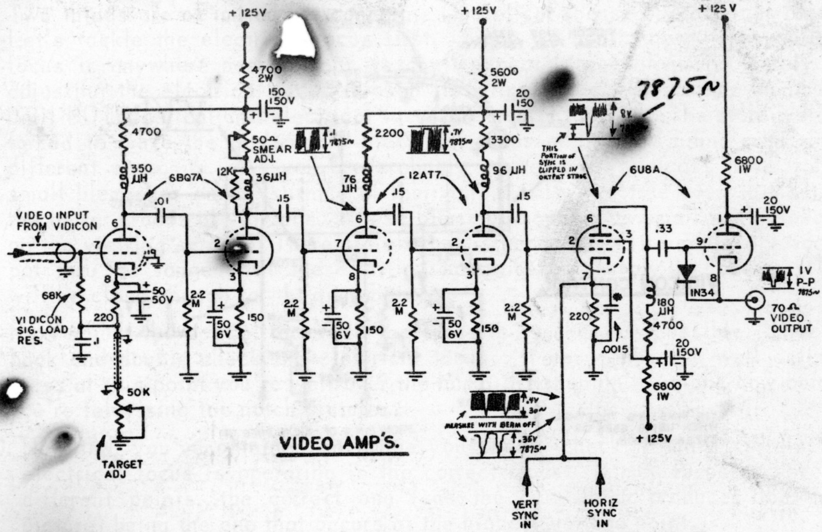
The signal from the vidicon target is direct coupled into the grid of the 1st video amplifier, ½ of a 6BQ7A. The 68K grid resistor for this stage also serves as the target signal load resistor...the bottom end of which is returned to the junction of a 220 ohm resistor and a 50K pot in the cathode. By varying the 50K pot the required target voltage is applied to the vidicon through the 68K resistor. Generally the target is operated at a potential between +10 and +30 volts. This varies with different vidicons, lighting and iris settings.

To correct for capacitive shunting effects on the higher frequencies a variable "smear" correction pot is incorporated in the plate circuit of the 2nd video stage. This pot is adjusted for minimum smear following any large black or white object. The signal is still further amplified (after correction) by a 2 stage 12AT7 circuit.

The output of the 2nd section of the 12AT7 is then fed to the pentode section of a 6U8A where the vertical and horizontal sync-blanking pulses are inserted. The output of this stage is then DC restored and fed to the triode section of the same tube where it is converted to a low impedance signal suitable for feeding a 70 ohm coaxial cable.

Now for a few pointers:

1. Connect the 68K signal load resistor very near pin 7 of the 6BQ7A.
2. The target pot should be mounted where it can be adjusted while the camera is in operation, as stated previously. Even though this pot is effectively carrying only DC due to the fact that it's in the very sensitive 1st stage, it's possible for it to pick up some extraneous signals unless you use shielded cable between it and the junction of the 68K signal load and the 220 ohm cathode resistor in the 6BQ7A stage.
3. Be sure to mount the smear adj pot near the 6BQ7A. It is not an operational control. Once set, it requires no further adjustment unless a tube (or some other component) is changed.
4. Note that the cathode of the output section of the 6U8A is lacking a cathode resistor. This prevents the camera from working unless the



VIDEO AMP'S.

*High frequency boost. Vary for desired "crispness" of picture. Do not exceed a value of .0022mfd. In certain instances it may not be required at all. Typical values range from .00047 to .0015mfd.

output cable is terminated on the far end. The value of the termination should be between 68 and 82 ohms. This resistor thus serves both as a cathode resistor and a termination resistor.

When wiring the video section take your time and follow good wiring techniques. Use short leads...avoid haywiring! The improved results will be more than worth the little extra effort.

The values of the peaking coils are not overly critical. If you wish to wind your own you may do so by random winding the required number of turns (see table) on any 1 watt resistor (standard IRC diameter) with a value of 100K or higher. Use #36 enamelled wire. Solder the ends of the coil to the resistor pigtails and coat with a layer of Q dope.

INDUCTANCE	TURNS
36uh	100
76uh	145
96uh	165
180uh	200
350uh	300

TABLE I Peaking coil turns data.

VERTICAL DEFLECTION

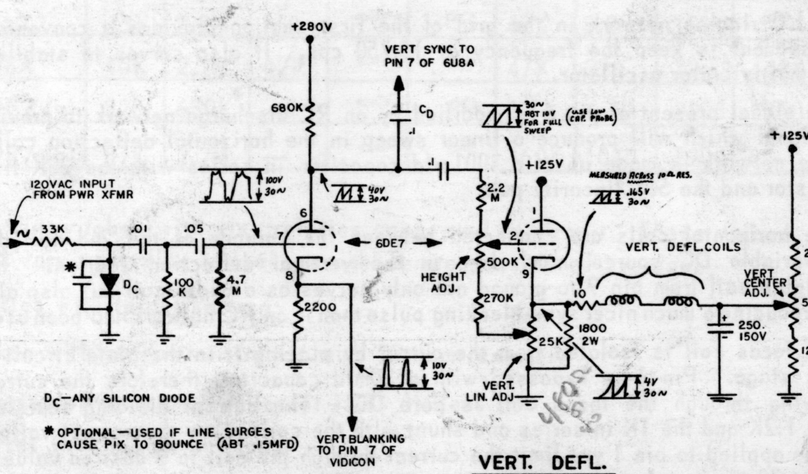
This portion of the camera requires just one tube, a 6DE7 dual triode. This tube was selected because one section has a higher power handling capability than the other. With the discharge stage requiring virtually no power in comparision with the output section, this was a natural choice.

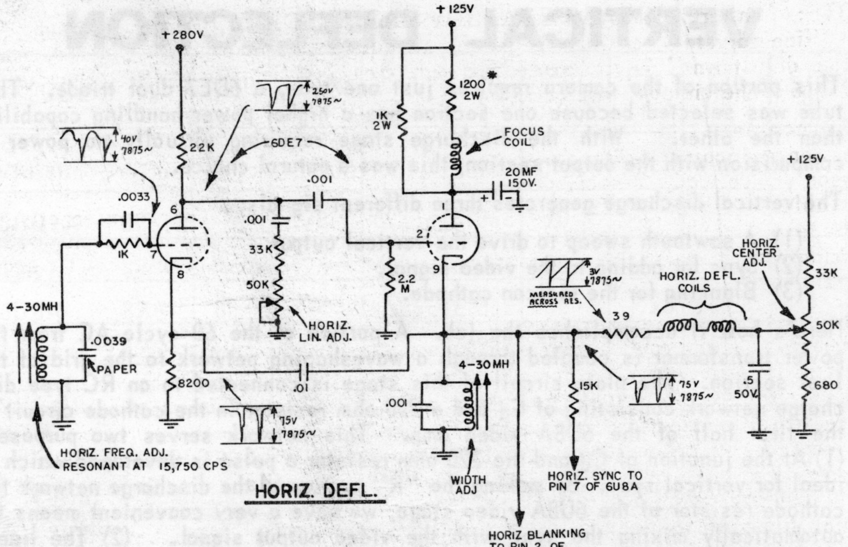
The vertical discharge generates three different signals:

(1) A sawtooth sweep to drive the vertical output.
(2) Sync for adding to the video signal.
(3) Blanking for the vidicon cathode.

Here's how it accomplishes the job. A portion of the 60 cycle AC from the power transformer is coupled through a waveshaping network to the grid of the first section. The plate circuit of this stage is connected to an RC type discharge network consisting of C_d and a 220 ohm resistor in the cathode circuit of the first half of the 6U8A video amp. This network serves two purposes: (1) At the junction of C_d and the 220 ohm resistor a pulse is developed which is ideal for vertical sync. By making the "R" portion of the discharge network the cathode resistor of the 6U8A video stage, we have a very convenient means for automatically mixing the sync with the video output signal. (2) The linear charging rate of C_d modifies the signal (normally present at pin 6 of the 6DE7) into a sawtooth wave. This signal is capacitively coupled through a gain control (height adj) to the grid of the second half of the 6DE7. The grid return connects to the arm of a 25K pot (linearity adj) in the cathode circuit. This allows the grid bias to be varied over a wide range inorder to further correct the waveform...thereby insuring maximum vertical linearity. The deflection coils are connected between the cathode and a variable DC source. This allows the DC current flowing through the coils to be varied for the purpose of vertically centering the raster on the vidicon target.

As stated earlier, the 2200 ohm resistor in the cathode of the first section also serves as the vidicon cathode resistor. By sharing a common resistor the pulse present at this point is of sufficient value to drive the vidicon cathode to cutoff during retrace...thus eliminating objectionable retrace lines in the output of the televised picture.





*May be varied as required for correct scan sensitivity. Correct value is that which will allow proper scanning within the range of the height and width controls. Typical values range from 390 to 1200 ohms. See text.

HORIZONTAL DEFLECTION

This, the final section of the camera also requires only one 6DE7. A cathode coupled multivibrator circuit serves the same function as the discharge/amplifier combination in the vertical deflection...namely, (1) to provide sweep for the horizontal coils, (2) sync for the video amps and (3) blanking for the vidicon grid.

An LC ringing network in the grid of the first section provides a convenient adjustment to keep the frequency at 15,750 cps. It also serves to stabilize the multivibrator oscillator.

The signal present at pin 6 is modified by an RC discharge network to provide a signal which will produce a linear sweep in the horizontal deflection coils. This network is made up of a .001 mfd capacitor in series with the 33K fixed resistor and the 50K linearity pot.

The horizontal coils are connected between the cathode of the 2nd half and a variable DC source...much like in the vertical deflection section. The variable coil from pin 9 to ground not only serves as a width coil but also aids in producing a much nicer sync-blanking pulse than if an RC network had been used.

The focus coil is isolated from the output by placing it in the plate circuit of this stage. Pin 1 is bypassed with a 20mfd capacitor, therefore the current flowing through the focus coil is pure DC. The current dividing resistors (the 1.2K and the 1K in series and shunt with the coil) allow the correct voltage to be applied to pin 1 yet limit the current through the coil to a desired value of about 30ma.

NOTE: Contrary to what you might first assume, the focusing of the vidicon is not "fine adjusted" by varying the current through the focus coil. Instead, the "fine adjustment" is accomplished with the electrostatic control connected to pin 6 of the vidicon (focus grid).

This completes the camera construction. Before applying power check the resistances against those shown below in Table 2. If these all check within reason you're ready to apply power and check the voltages against those shown in Table 3. BE SURE TO KEEP THE BEAM BIASED OFF (maximum negative voltage) during these preliminary tests. Also, be certain the 6U8A is properly terminated, otherwise the readings associated with this stage will not be the correct value.

If you own a scope we suggest you check waveforms against those shown in the schematics. Take particular note of the waveforms obtained ACROSS the 10 ohm resistor in series with the vertical deflection coils and the 39 ohm resistor in series with the horizontal deflection coils. These waveforms are a direct indication of normal sawtooth current flowing through the coils. It is important to remember that the scope must be connected ACROSS the series resistors inorder to observe the TRUE current flowing in the coils. This is due to the fact that the coils are inductive...to overcome this reactance the voltage signal driving them must be predistorted inorder that the signal CURRENT be linear. This is far more predominant in the higher frequency horizontal circuit than in the lower frequency vertical circuit.

Once assured that the vertical and horizontal deflection circuits are BOTH functioning properly proceed to the Tune-Up section.

TABLE II TYPICAL RESISTANCE READINGS

TUBE	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
Vidicon	∞	770K*	36K*	NC	135K*	36K*	2200	∞	---
6BQ7A	38K*	2.2M	150	∞	∞	44K*	83K"	6K"	0
12AT7	43K*	2.2M	150	∞	∞	42K*	2.2M	150	∞
6U8A	40K*	2.2M	42K*	∞	∞	47K*	220	72 #	450#**
6DE7 (v)	32K*	630K●	---	∞	∞	1M	4.7M	2200	1750
6DE7 (h)	31K*	2.2M	---	∞	∞	160K*	1040	8200	80

*Readings taken with electrolytics connected in circuit. These values will vary according to leakage...these are considered average.

"Varies with target setting.

#Taken with output terminated with 72 ohm resistor.

**Varies slightly with different 1N34 diodes.

●Varies with height setting.

ALL READINGS MEASURED TO GROUND, using 20,000 ohms per voltmtr.

TABLE III TYPICAL VOLTAGE READINGS

TUBE	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
Vidicon	6.3ac	-50 *	** 70-200	I.C."	280	** 70-200	.55	6.3ac	---
6BQ7A	82	---	.78	6.3ac	6.3ac	70	---	15	0
12AT7	87	---	.25	6.3ac	6.3ac	90	---	.3	6.3ac
6U8A	82	0	74	6.3ac	6.3ac	68	1.25	.4	-1
6DE7(v)	125	---	---	6.3ac	6.3ac	44	-22	.55	31
6DE7(h)	85	---	---	6.3ac	6.3ac	230	---	18	5

* Adjusted for picture; varies with different vidicons.

** Varies with focus coil current. NOTE: Pins 3 & 6 tied together on 6326A. "Internal connection...do not connect to this pin.

ALL READINGS TO GROUND EXCEPT FILAMENTS.
Readings taken with 20,000 ohms per volt meter.

TUNE-UP

Begin by setting all adjustments to the position shown in Table 4.

1. Prepare a simple test card as shown in fig. 3. Don't use complicated patterns to start with...this test card was purposely designed to be as plain as possible. Even then you'll be very lucky if you can recognize it when you first turn on your camera. There's plenty of time for the more sophisticated test patterns once an image has been obtained.
2. Position the camera, light and test card as shown in fig. 4. Connect the camera to the monitor and scope. NOTE: The camera must be terminated before it will work. The monitor should be set very near the correct vertical & horizontal scanning frequencies prior to feeding the camera signal to it. This can best be done by checking it out on a local broadcast station.
3. Apply power to both the monitor and the camera and allow 3-5 minutes for warmup.
4. Begin adjusting the horizontal frequency slug till the monitor locks horizontally. If the oscillator seems erratic and you're unable to lock it to the monitor try varying the linearity pot slightly. It's in the plate circuit of the oscillator and if set too far one way or the other it can cause the oscillator to become erratic...especially when the horizontal frequency adjust is quite aways off frequency. This is a normal characteristic of this type sweep circuit...a variation of which is used in many CCTV cameras. Once correctly set it will be no problem. The important thing to remember is to start with the freq. adj. slug at MINIMUM inductance (slug all the way out). Then begin adjusting it in (lowering the frequency) until the monitor locks.

No frequency adjustment is needed on the vertical sweep since it is locked directly to the 60 cps power line.

5. Uncap the lens and set it between F4.5 and F8.

TABLE IV PRELIMINARY SETTING OF CAMERA ADJUSTMENTS

ADJUSTMENT	POSITION
Frequency adj slug	minimum inductance
Width adj slug	minimum inductance
Horiz. linearity pot	mid-range
Vert. linearity pot	mid-range
Vert. height pot	mid-range
Smear adj pot	mid-range
Horiz. centering pot	mid-range
Vertical centering pot	mid-range
Electrical focus pot	set for 70-125 volts on pin 6 of vidicon
Target pot	set for about 20 volts
Beam	set for maximum negative voltage

6. Advance the beam slowly until a "wiping" effect occurs across the screen. Don't be surprised at what you see on the screen! It won't be much at this point.
7. Wave your hand slowly back and forth (horizontally) in front of the test card. You should see a poorly focused shadow of your hand move across the screen. (It may move sideways or even up and down...this is caused by misorientation of the yoke...a problem not to be concerned about at this point.) Next wave your hand up and down and see if a shadow can be detected moving across the screen in the other direction. If so, all is well...you're doing great! We now know you have vertical and horizontal sweep, a live vidicon tube and six amplifiers which are actually amplifying. VERY GOOD! Let's continue.

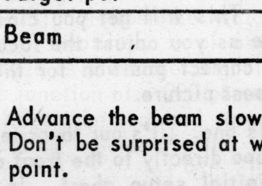


Fig. 3 "Cross" test card used for preliminary tune-up of camera.

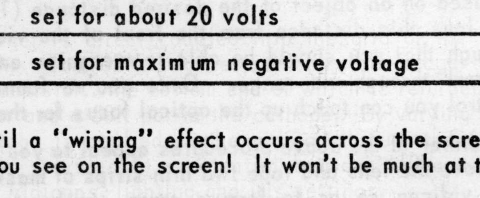


Fig. 4 Recommended monitoring during preliminary tune-up. Although scope is not required, it is desirable.

8. Two things are of immediate concern; (1) optical focus (2) electrical focus. Let's tackle the electrical focus first. Since we don't know if the optical focus is anywhere near correct we can't expect to see an image merely by adjusting the electrical focus through its range. You will not see an image until BOTH optical and electrical focus are nearly correct. Therefore we are forced to make the preliminary electrical focus adjustment using a slightly different approach. As you are probably aware, most vidicons have a few small blemishes on the surface of their target. This is true even in most of the better grades of vidicons. These blemishes appear as small white specks on the viewing screen. Therefore all that is necessary is to adjust the focus pot thru its range until these little spots appear sharply in focus. This will be close enough for the time being.

9. Next adjust the optical focus till the cross is as sharp as possible. Now go back and double check the electrical focus. If you can see a well defined cross at this point you're well over the hump...it shouldn't be long now before you're televising top notch pictures.

10. Now that you've obtained an image you should check to make certain the electrical focus is operating in the correct mode. It may focus at several different points...the correct one (and the one which produces the best picture) being the one that occurs at the highest voltage point.

ALTERNATE PRELIMINARY FOCUSING METHODS: Determine with the aid of a ground glass the exact distance from the glass to the back of the lens when focused on an object of the desired distance (1-3 feet in this case). Then set the lens this distance from the front of the vidicon. This will get you close enough that you should be able to recognize an image as you adjust the focus control through its range. Once you've found the correct position for this control you can touch up the optical focus for the sharpest picture.

If neither of the above procedures appeal to you try this one. (It's our favorite.) Remove the lens and tape two thin strips of masking tape directly to the front of the vidicon so as to form a cross similar to the initial setup chart. In a semi-darkened room place a 100 watt bulb directly in front of the camera about 10 to 15 feet away. This will cast a shadow of the cross onto the target. All that is necessary is to adjust the focus pot throughout its range until the correct focus mode is located. Once this is accomplished the strips of tape can be removed, surface of tube cleaned and the lens put back in place. Then all than remains is to adjust the lens through its range until optical focus is attained. This method is virtually foolproof. Just remember to do it in a semi-darkened room so that the majority of the light is effectively coming from the point source of the light bulb. Otherwise, a sharp shadow of the cross will not be formed on the vidicon target.

11. At this point you can further adjust the lens iris and target voltage for the proper video level. See fig. 5.

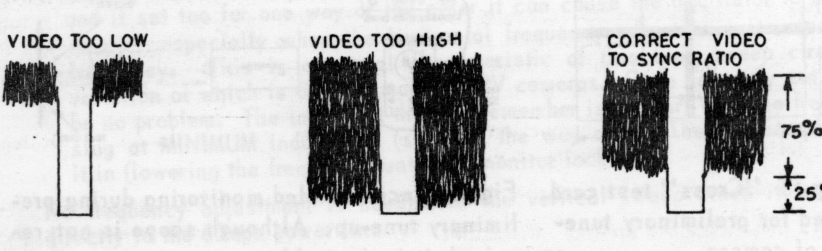


Fig. 5

12. If the picture is tilted, rotate the yoke until it appears straight on the monitor. (NOTE: Front of yoke should be kept about ½" from target.)

13. If the picture is upside down and/or inside out, reverse the polarity of the yoke leads.

14. Adjust the centering controls (both vert. and horiz.) until the picture is properly centered as shown in fig. 6.

MIS-CENT. HORIZ. MIS-CENT. VERT. PROPERLY CENT.

Fig. 6

15. Now transfer to a standard test pattern and adjust vertical height and linearity the same as you would on a TV receiver. (In place of a standard test pattern a homemade pattern similar to the one shown in fig. 7 will be found to serve the purpose. Adjust the height and linearity controls until all bars are the same size.) When making these adjustments always keep in mind that maximum sweep should be used without overscanning the target. See fig. 8.

16. Next adjust horizontal width and linearity in the same manner. (If using the homemade pattern similar to fig. 7, turn it so the bars will be vertical instead of horizontal.)

Fig. 7

OVERSCAN NORMAL SCAN

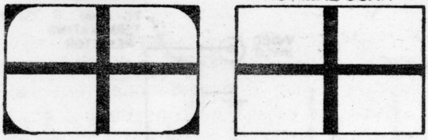


Fig. 8

NOTE: Width and height adjustments may not give adequate range. If this is the case, vary the value of the 1200 ohm resistor in series with the focus coil until you achieve the correct size. This will naturally require a new setting of the electrical focus pot. As focus current is increased, so must the electrical focus be increased. For instance, with the 1200 ohm resistor, focus will occur with about 70-125 volts on pin 6 of the vidicon. With a 560 ohm resistor, it will occur near 200 volts. Higher focus current reduces scanning sensitivity and thus can be used (within limits) as a coarse "size" adjustment.

17. Adjust the smear correction pot for minimum trailing blacks or whites following large contrasty objects.

18. For optimum results go back now and recheck each adjustment very carefully.

This concludes the tune-up. WELCOME TO THE EXCITING NEW FIELD OF TV!

* * * * * * *

THE TV MONITOR

Basically two choices are available when it comes to the TV monitor. In either case all that is required is a reasonably good TV receiver.

(1) If you don't care to make modifications on your present receiver, or if you plan to use an AC/DC set (one without a power transformer) we suggest using a Pixe-verter. This is a transistorized modulated RF oscillator designed to be connected between the output of your TV camera and the antenna terminals of any TV receiver. No wiring changes are required on either the camera or the TV. The receiver is merely tuned to a blank channel between 2 and 6 and the Pixe-verter adjusted until the televised picture appears on the screen. Further details on this device can be obtained from our TV Catalog.

(2) If you have no objection to making a minor modification on your receiver you can convert it to a direct feed video monitor much like those used by TV stations and most industrial CCTV users. Fig. 9 below can be used as a representative guide when making this modification. Only three parts are required; a coaxial connector, a terminating resistor and a spdt switch. When the switch is in one position the set is a video monitor...when in the other position the receiver is returned to normal. Two points should be kept in mind when considering this system; (1) Stay away from AC/DC sets. They are too dangerous when interconnecting to other equipment! (2) Select a set inwhich the video for the 1st video amplifier is taken from the anode of the detector. This will assure you that the signal from the camera will be the correct polarity to feed this point. Most any serviceman can help you determine this very quickly by looking up the schematic in his Sam's Photofact.

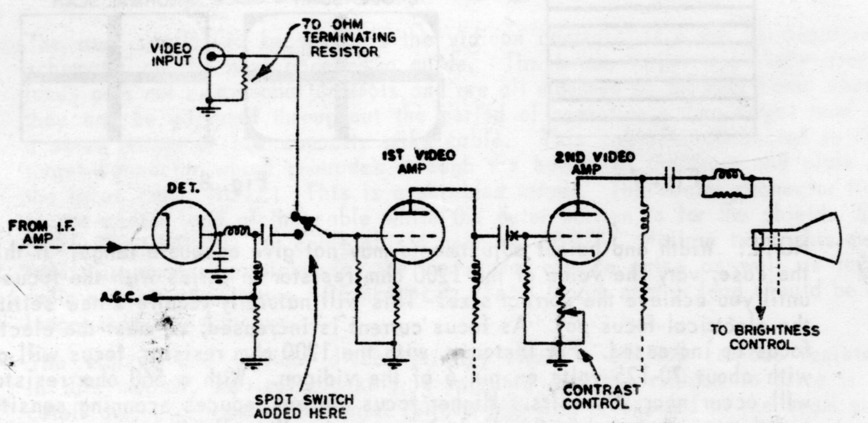
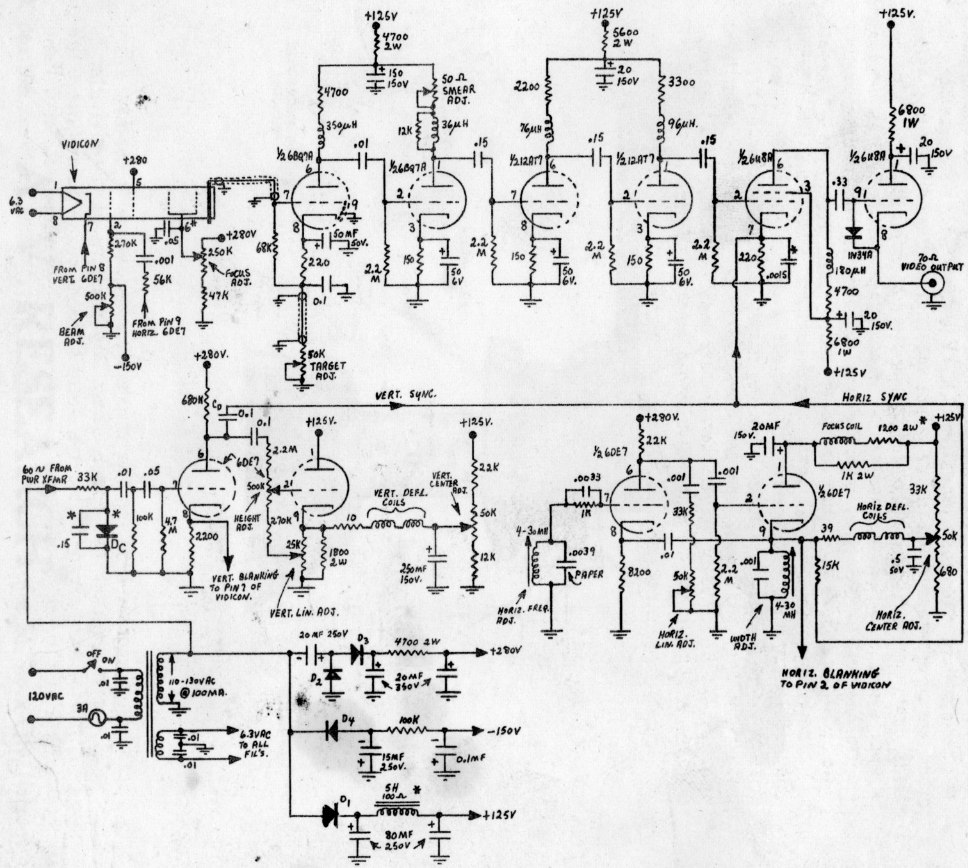


Fig. 9 Schematic diagram showing the conversion necessary to modify a TV receiver to a video monitor. In cases where the polarity of the detector is opposite from that shown, connect into the point marked X. In cases where the detector is the wrong polarity followed by only one video amplifier, it will be necessary to add an additional stage to get the proper polarity at the input of the picture tube.



Complete schematic diagram of the ATV RESEARCH vidicon TV camera.

Unless specified otherwise, capacitances are in mfd., resistances are in ohms, resistors are ½ watt.

* See text and/or sectionalized schematic diagrams.