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LB-859

A VIDEO TEST SIGNAL GENERATOR

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Approved

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Introduction

This bulletin describes a new type of test signal generator for use with video frequency circuits and terminal equipment. The test signal consists of a simulated horizontal sync pulse, a blanking pedestal, and five discrete sinusoidal frequencies. The frequencies produced, their duration, and amplitude are adjustable by the operator. An oscilloscope is used as the indicating device. The generator is extremely useful for making rapid system checks and also for testing systems or terminal equipment, especially those requiring horizontal synchronizing pulses for normal operation.

General Discussion

Video frequency response checks of television equipment are usually made by one of two methods. The most rapid, and therefore the most common, is to apply the output of a video sweep generator to the input of the equipment to be checked and to observe the output with an oscilloscope. This gives a rapid check, but because of the apparent simplicity, operators tend to become careless, with resulting inaccuracy; also, it cannot be used with equipment requiring the presence of a horizontal synchronizing pulse unless changes are made in the equipment.

A second method consists of feeding an oscillator signal to the equipment under test and measuring input and output levels for many known frequencies. Although this point-by-point method is capable of high accuracy, it is very slow and it cannot be used with equipment requiring synchronizing pulses without modification of the equipment.

Considerable emphasis has been placed on the lack of a synchronizing pulse in other test methods. This is considered proper since devices are continually encountered throughout a television system which require the presence of a horizontal sync pulse for normal operation. Included in this group are stabilizing amplifiers, television transmitters, and some video amplifiers. Also, in considering an overall television system it must be remembered that some relay facilities clamp on the peak of sync to establish the operating point and may not operate normally if a sync pulse is not present. For facilities under the control of the person making the test, it is frequently possible to alter the circuits in such a way that the synchronizing pulse is not needed. However, the changes made may affect the frequency response and, obviously, a frequency check cannot be made quickly or frequently.

Description of the Generator

The new video test signal generator to be described is shown in Fig. 1 and a typical test signal is shown in Fig. 2. The synchronizing pulse is so located on the blanking pedestal that no "front porch" is produced. This simplifies the device without detracting from its usefulness. Referring to the exterior view, Fig. 1, the five large knobs control the five frequencies generated. Each of the five small knobs, directly below these, controls the amplitude of one of the five frequencies independent of the other four. A master gain control is located near the upper right hand corner of the panel, and the power switch is

Fig. 1 - Video test signal generator.

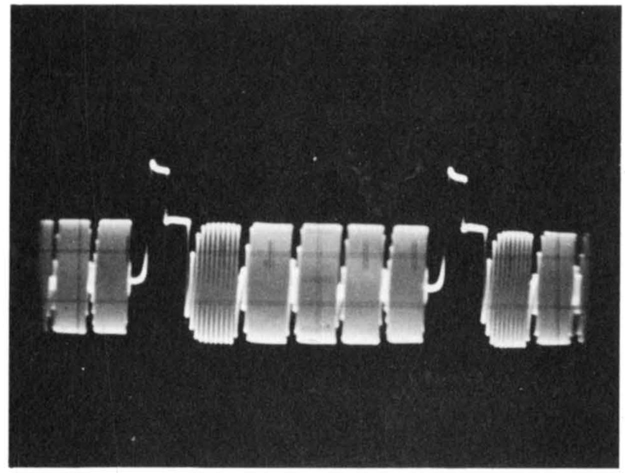

Fig. 2 - Typical test signal.

located near the upper left hand corner. Additional controls to be described later are located within the cabinet.

Starting from the left side, the first oscillator is variable in $\frac{1}{4}$-Mc steps from $\frac{1}{2}$ to $1\frac{1}{2}$ Mc. The remaining four are continuously variable, one covering each of the following ranges: 1 to 2.1 Mc, 1.4 to 3 Mc, 2.2 to 3.8 Mc, and 3 to 5.4 Mc. A coarse frequency calibration for each control is engraved on the panel. The ranges are made to overlap so that in most cases a particular frequency can be set on one oscillator, and the response at nearby frequencies can be investigated by varying one of the adjacent oscillators.

Method of Operation

Use of the generator is simple. Most video systems are designed to operate with 75-ohm unbalanced lines in and out. Therefore, the low-impedance output of the generator is connected to the input of the video system to be checked and the system is properly terminated. An oscilloscope having an input impedance that is high compared to 75 ohms for all frequencies to be tested is bridged across the input of the system. The generator is adjusted to produce frequencies throughout the frequency band to be checked and the amplitudes are adjusted to give uniform response on the oscilloscope. The oscilloscope is then changed from the input to the output of the system and the test signal is observed. Any variation from uniform response is clearly caused by the system and can be measured directly.

A typical test is shown in Fig. 3 in which the input signal is shown at (a) and the output at (b). The test frequencies are 1.0, 1.5, 2, 3, and 4 Mc. It can be seen that the amplifier being tested has a sag in the response near 2 Mc and cuts off between 3 and 4 Mc.

Of course, certain precautions must be taken with such an approach. First, the frequency response of the oscilloscope must be at least comparable to that of the system, otherwise overloading may occur in either the oscilloscope or the system while attempting to produce uniform input. It should be emphasized, however, that the response of the oscilloscope does not have to be flat. Second, only five discrete frequencies are being checked at one time, and there may be "holes" in the response. Therefore, it may be necessary to set all the oscillators to a new group of frequencies or to vary them one at a time to investigate the complete spectrum. With these exceptions there is very little chance for error.

One other problem is obvious. If both the input and output of the system being checked are available, the same oscilloscope can be used on both the input and the output. If both are not available, oscilloscopes with bandwidths greater than the system must be used or the response of the oscilloscopes used must be known, by previous check, to be identical.

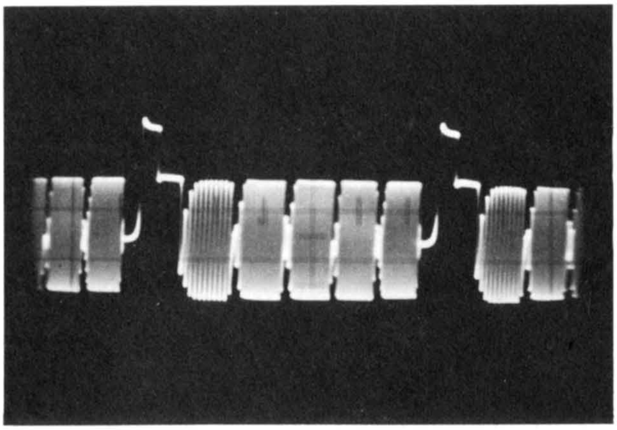

Fig. 3 (a) - Input signal.

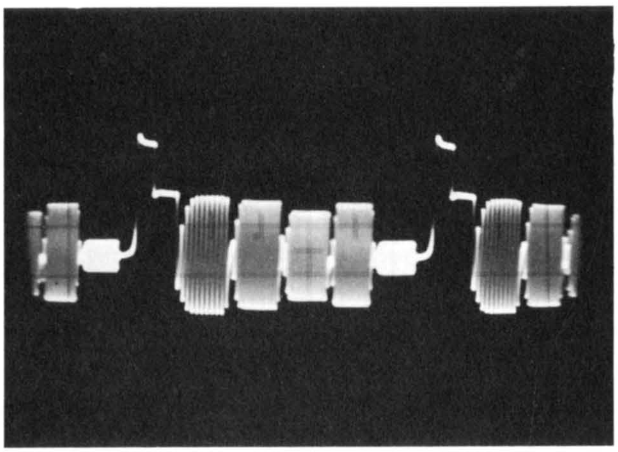

Fig. 3 (b) - Output signal.

Circuitry

As mentioned previously, the generator has several additional controls within the cabinet. These provide increased usefulness in a variety of applications. The operation of these controls will be apparent from a description of how the composite signal is produced. A block diagram of the unit is shown in Fig. 4 and reference will be made to this and the photograph, Fig. 5. A circuit diagram of the generator is given in Fig. 6.

The Blanking MV is a non-symmetrical multivibrator[1] which has a basic repetition rate of 15,750 cycles. However, it may be varied somewhat from this frequency by the control marked FREQ. This tube generates not only the basic control frequency but also the

[1] J. L. Potter, "Sweep Circuit", *Proc. IRE.* June 1938, p. 713.

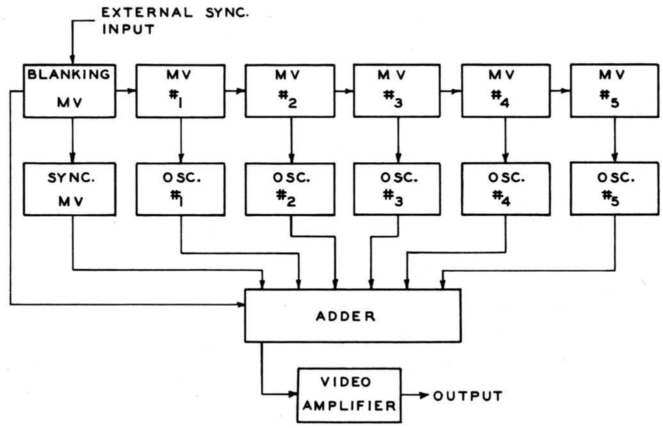

Fig. 4 - Block diagram of generator.

blanking pedestal. Note that it is very simple to lock this multivibrator, and therefore the entire instrument, to an existing television system by injecting horizontal synchronizing pulses into this stage.

Two multivibrators are synchronized with the Blanking MV. The first is also non-symmetrical and produces a signal which, when added to the blanking pulse, forms the synchronizing pulse. The second, marked MV No. 1, is the first in a chain of multivibrators and oscillators. The blanking pulse is differentiated and the trailing edge spike is used to trigger MV No. 1. This tube produces the keying pulse which turns on the first oscillator (Osc. No.1). The duration of the keying pulse is determined by the cathode resistor of the multivibrator and is varied by the knob marked WIDTH 1. Therefore, the WIDTH 1 control will determine the duration of the frequency produced by oscillator No. 1. The trailing edge of the keying pulse produced by MV No. 1 is differentiated and used to start MV No. 2, which also controls an oscillator. The chain is continued, each oscillator being started by the trailing edge of the preceding keying pulse multivibrator. Note that the sum of the "on" times of the five oscillators does not have to correspond to the time between synchronizing pulses. For most purposes it is desirable to have the five frequencies contained completely between synchronizing pulses. In a few applications, however, it is useful to have a signal on the "back porch", and this generator provides for this contingency. For example, an NTSC color signal can be partially simulated by spreading the first three frequencies over the usual

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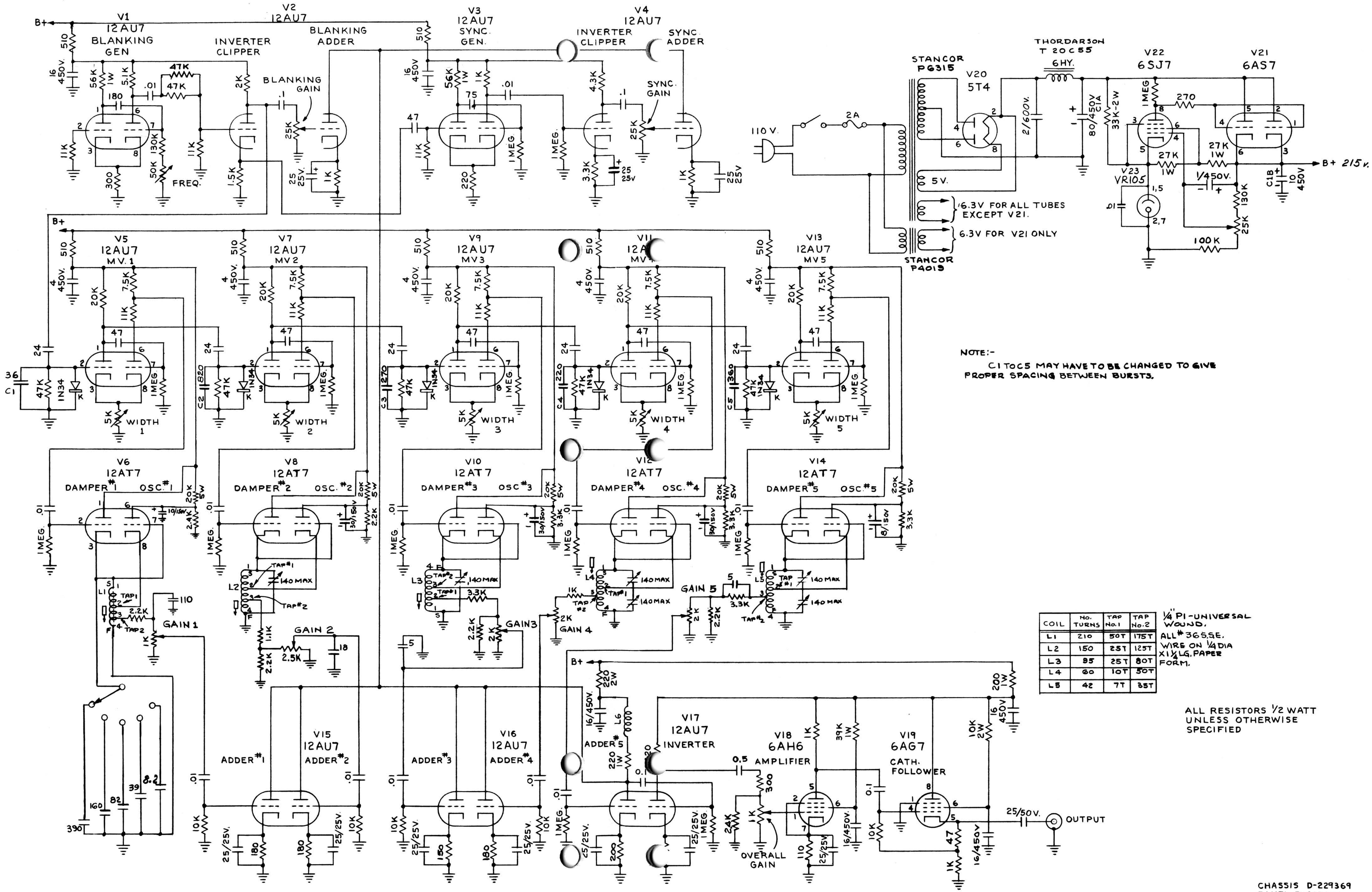

COIL	NO. TURNS	TAP No.1	TAP No.2
L1	210	50T	175T
L2	150	25T	125T
L3	95	25T	80T
L4	60	10T	50T
L5	42	7T	35T

Fig. 6 – Schematic diagram of video test chassis.

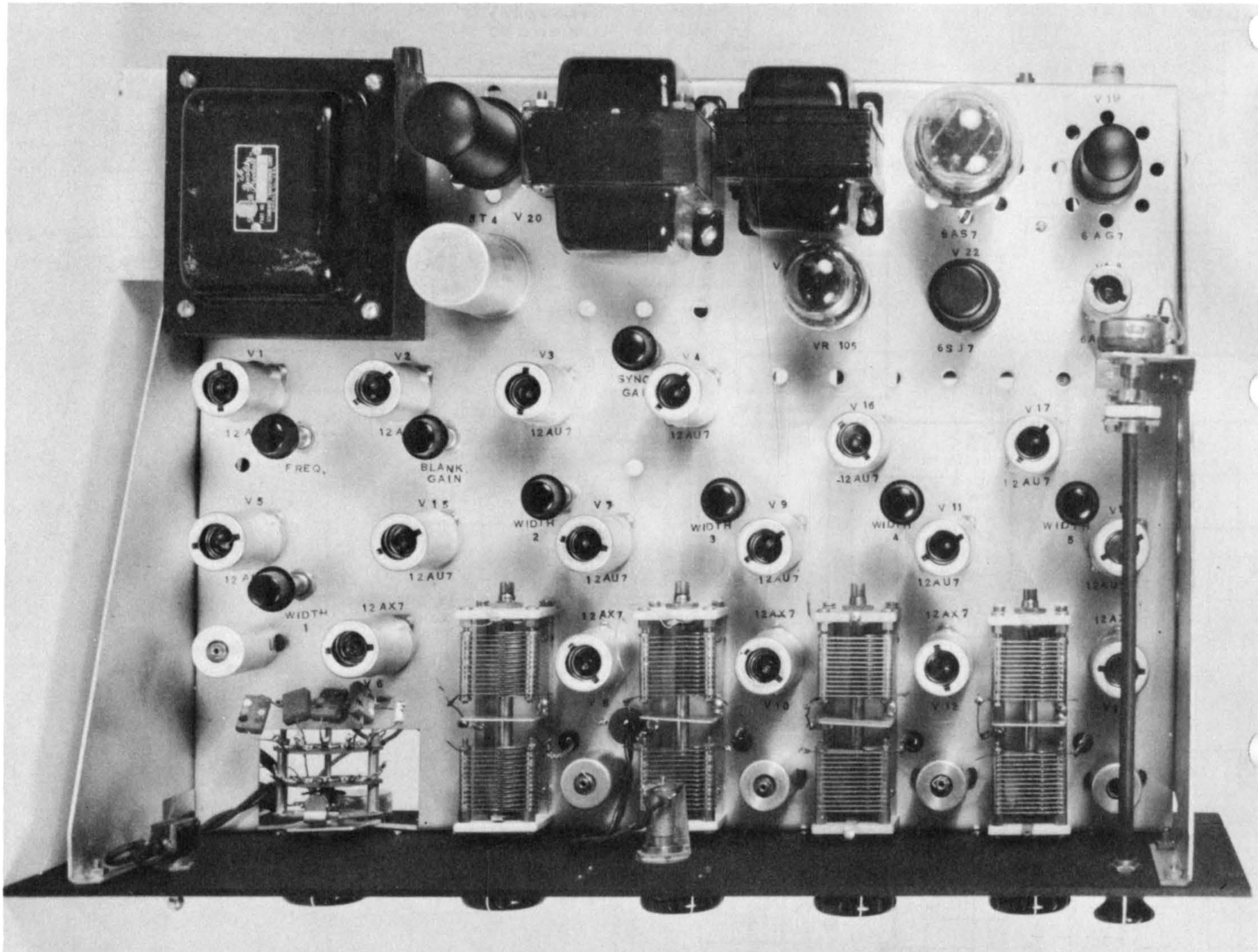

Fig. 5 - Top view of generator chassis.

video portion of the space between sync pulses, making the amplitude of the fourth oscillator zero and the duration of its keying pulse just long enough so that the fifth oscillator starts on the "back porch" of the blanking pedestal. Thus the fifth oscillator can partially simulate the color synchronizing burst.

The height of the sync pulse is adjustable by means of the control marked SYNC GAIN. The control marked BLANK. GAIN adjusts the height of the blanking pedestal. By setting the level of all the burst frequencies to a relatively low value and then adjusting the BLANK. GAIN control, the amplitude linearity of a system which utilizes d-c setting can be investigated since this adjustment moves the test frequencies through the amplitude range of the system.

The output of each of the oscillators is obtained from a tap on the oscillator coil. Variations in the frequency of the oscillators due to changing the amplitude controls are minimized by resistance isolation. The amplitude of the signal obtained from each oscillator is determined by the front panel controls marked No. 1 AMPLITUDE, etc. The blanking pulse, the sync pulse, and all of the oscillators are added by means of individual triodes working into a common plate load. This provides a minimum of loss in the adding process and provides considerable isolation between oscillators. The composite signal is carried through a normal video amplifier containing a gain control so that the peak-to-peak value of the composite signal can be adjusted. A cathode follower provides impedance matching between the video amplifier and the low-impedance load.

Circuitwise, the only part of the test generator requiring special comment is the oscillator. The requirements that should be met are:

1. Starting and stopping the oscillator must not inject a pedestal or d-c component in the output.
2. The oscillator must start and stop rapidly.
3. The amplitude must remain constant over the frequency band covered.
4. The signal generated must be reasonably sinusoidal.

Although the oscillators used do not completely satisfy all of these requirements, they are satisfactory and far superior to other systems that were tried. The circuit of one of the keying multivibrators and its oscillator is shown in Fig. 7. Each oscillator is prevented from operating by loading the tuned circuit with the cathode impedance of a triode.

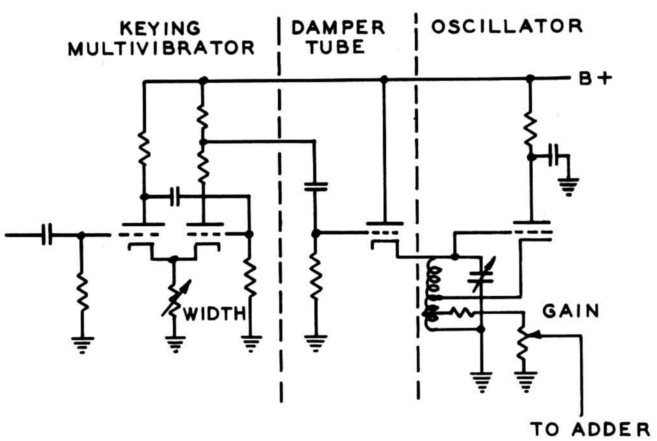

Fig. 7 – Keyed oscillator unit.

When this damper tube is driven to cutoff by the keying pulse, the load is removed and the oscillator comes up to full amplitude quite rapidly. The keying pulse does not appear in the output since the cathode current of the damper tube flows through the inductance in the resonant circuit which has very low d-c resistance. The component values for each oscillator must be individually chosen to produce the most nearly sinusoidal waveform with a minimum of amplitude variation as the frequency is changed. Many satisfactory variations of the oscillator circuit are possible depending upon what is wanted in the final device. One system used in an earlier design used the multivibrator keying pulse to shock excite the tuned circuit and the tube was used as an amplifier with just sufficient gain to compensate exactly for the losses in the tuned circuit. The result was an excellent sine wave that came up to full amplitude in the first half cycle and maintained constant amplitude for as long as required. The defect was that changing the tuning of the LC circuit changed its operating Q. Thus a different amplifier gain was needed to prevent build-up or decay in the amplitude of the waves produced. The elimination of this "flatness" control was considered well worth the slower rise time and increased distortion in the lower frequencies of the present unit.

Results

A video test signal generator has been constructed which has been found to be extremely valuable. It is particularly suited for checking extensive television systems. The test signal can be introduced at some convenient input point and simultaneous checks can be made at many intermediate points. In this way both gross errors and cumulative errors can be detected and localized. The worth of the instrument was demonstrated in connection with system checks involving television network facilities. Tests made with this new generator in preparation for color television demonstrations originating in New York and viewed in Washington, D. C., in October 1951, demonstrated that for this particular circuit the combined system was not flat at that time. The presence of the test signal greatly simplified the installation of the necessary compensation.

One advantage of this test signal over the video sweep method was totally unexpected. It is a psychological advantage. Even persons having only casual knowledge of frequency test procedures are firmly convinced of the accuracy of the method when one points to an oscilloscope which actually shows a series of cycles for each frequency.

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