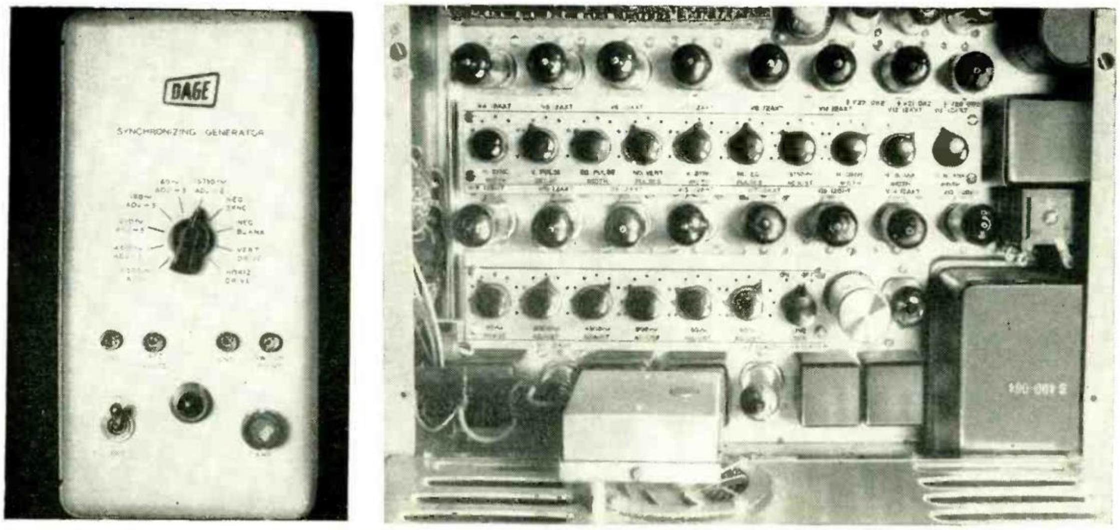

Rear-panel view of sync generator, left, and tube and adjustment side of chassis, right

Portable Sync Generator for TV Broadcasting

Miniaturized synchronizing pulse generator supplies standard RETMA signal at 4 volts negative peak to peak. Unit weighs only 20 lbs and is interchangeable with conventional television broadcast equipment. Built-in power supply is gas-tube regulated

PORTABILITY AND SIMPLIFICATION of television broadcast studio equipment may be achieved by use of the synchronizing pulse generator to be described.

The generator furnishes standard RETMA synchronizing signals at 4 volts negative peak to peak across 75 ohms. It is housed in a briefcase-sized cabinet that also contains its regulated power supply. The photographs illustrate the tube and adjustment side of the chassis and the rear panel of the generator. Figure 1 is a functional block diagram and Fig. 2 is the complete schematic.

Timer Section

The master oscillator and the 7-5-5-3 divider chain incorporate five blocking oscillators each isolated by 1N51 germanium diodes. The timer generates the 31.5-kc and 60-cps trigger pulses to time the gates and multivibrators in the shaper section. All grid circuits in the timer section are connected through their respective time-constant controls to a +150-volt bus that serves as the afc line-lock path.

Tuned circuit $C_1 - L_1$ in the master-oscillator grid circuit is a resonant stabilizer for maximum frequency stability. Shock excitation of this resonant circuit by the grid-current pulse produces added potential at the desired resonant frequency resulting in a high degree of grid stability.

Point J at the cathode of the master oscillator terminates at the rear-panel waveform selector switch providing a signal at the rear-panel switch point for scope observation. Points A, B, C and D in the grid circuits of the 7-5-5-3 divider provide the same function.

Line-Lock

The negative plate pulse and positive cathode pulses at V_{3A} are supplied to a balanced R-C network terminated in germanium diode clampers. The 6.3-volt 60-cycle reference from point Y in the power supply is injected at the junction, also designated Y.

When the 60-pps final divider output is in phase with the 60-cps line voltage, the equal-amplitude pulses occur at the instant the sine-

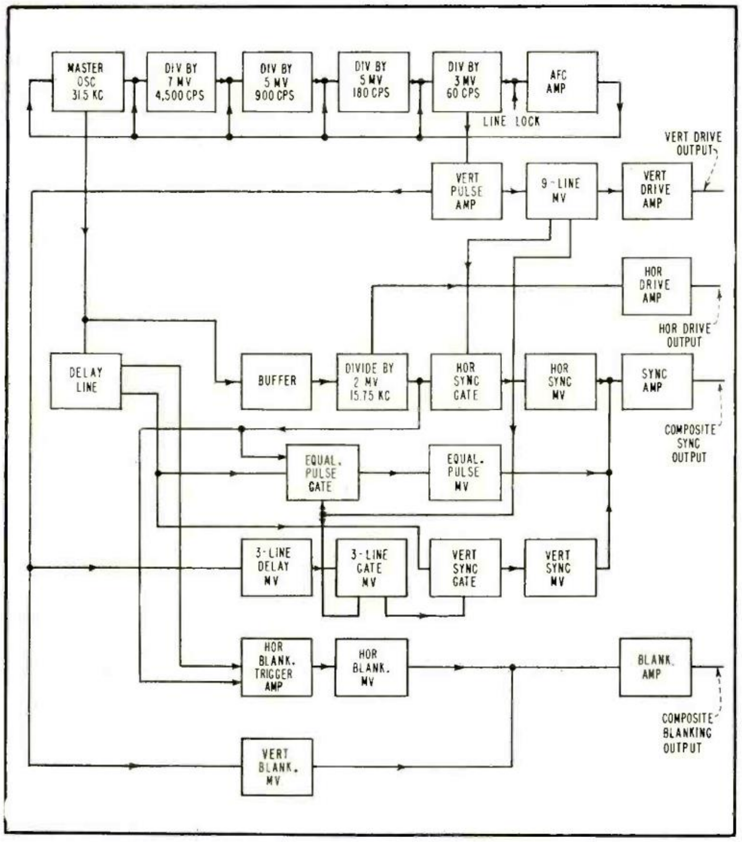

FIG. 1—Functional block diagram illustrates interconnection of stages

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wave reference is crossing its axis and the voltage appearing at the clamped grid of V_{3B} is zero.

If, however, the pulses occur early or late, the voltage rises or falls depending upon whether the positive or negative value of the a-c is clamped. Thus the pulses are caused to slide on the slopes of the sine-wave alternation until they coincide with the axis of the line voltage and the timer is locked with the line frequency.

Switch S_1 is open for the line-lock position and V_{8B} serves as a d-c amplifier for the afc voltage fed to all grids of the timer section. Filter $C_2 - R_1$ smooths out current variations. The circuit comprising R_2, C_3 and C_4 provides a time-constant for afc action to prevent instability from too-rapid action. With S_1 closed, automatic frequency control action is removed.

Synthesis of the output pulses is best described with the aid of the waveform diagram, Fig. 3. Italicized letters in text refer to waveforms shown in Fig. 3. All multivibrators are of the driven type and must receive enabling voltage from associated gate tubes.

Camera Drive

Camera driving pulses are delivered only to the camera chains and slightly precede the composite sync signal to compensate for interconnecting cable delay. Positive 31.5-kc trigger pulses *A* from V_{1A} cathode are fed to the horizontal-drive buffer amplifier V_{8B} and appear as amplified negative triggers at the grid of V_{16A}, the divide-by-two multivibrator. This section is driven to cutoff and drives V_{16B} into conduction.

This condition prevails in the absence of further triggering for an interval determined by the grid-potential adjustment and circuit time constant. Adjustment of R_3 determines within limits the potential and time-constant of V_{16B} grid. With proper adjustment, alternate 31.5-kc pulses occur when V_{16A} is cut off and have no effect. Thus only 15.75-kc pulses *B* appear at the output. Different values of resistance and capacitance in the two grid sections result in asymmetrical pulses; the on time is less than the off time. Resistor R_4 adjusts the width to system standards, ½ to 1 times blanking width. The 1N63 clamps the pulses on the grid of the horizontal drive amplifier V_{19} at 9 volts assuring flat-topped pulses in the plate circuit.

Vertical Drive

Positive 60-cycle pulses from V_{3A} cathode amplified by V_{11B} appear as negative triggers at the grid of the on section of the 9-line multivibrator, V_{17}. The NUMBER-OF-EQUALIZING-PULSES control R_5 in the V_{17B} grid circuit determines the gating-pulse width for the vertical-equalizing and sync interval and automatically sets the width of the vertical-drive pulse. The positive pulses from the plate of V_{17B} applied to the grid of the vertical-drive amplifier V_{15} appear as standard negative-polarity pulses *C* at the plate.

Horizontal Sync

The horizontal-sync multivibrator V_4 is gated by the horizontal-sync gate V_{5A}. The cathode of V_{5A} is tied to the cathode resistor of V_{17A}. In the period between fields when V_{17} is not triggered, V_{17A} is cut off and the cathode potential is negative.

The grid of V_{5A} receives delayed 31.5-kc trigger pulses from the delay line and 15.75-kc pulses from V_{16}. Since the grid of V_{5A} is biased to −108 volts by the regulated power supply, only the 31.5-kc *D* triggers occurring at horizontal-pulse time are of sufficient ampli-

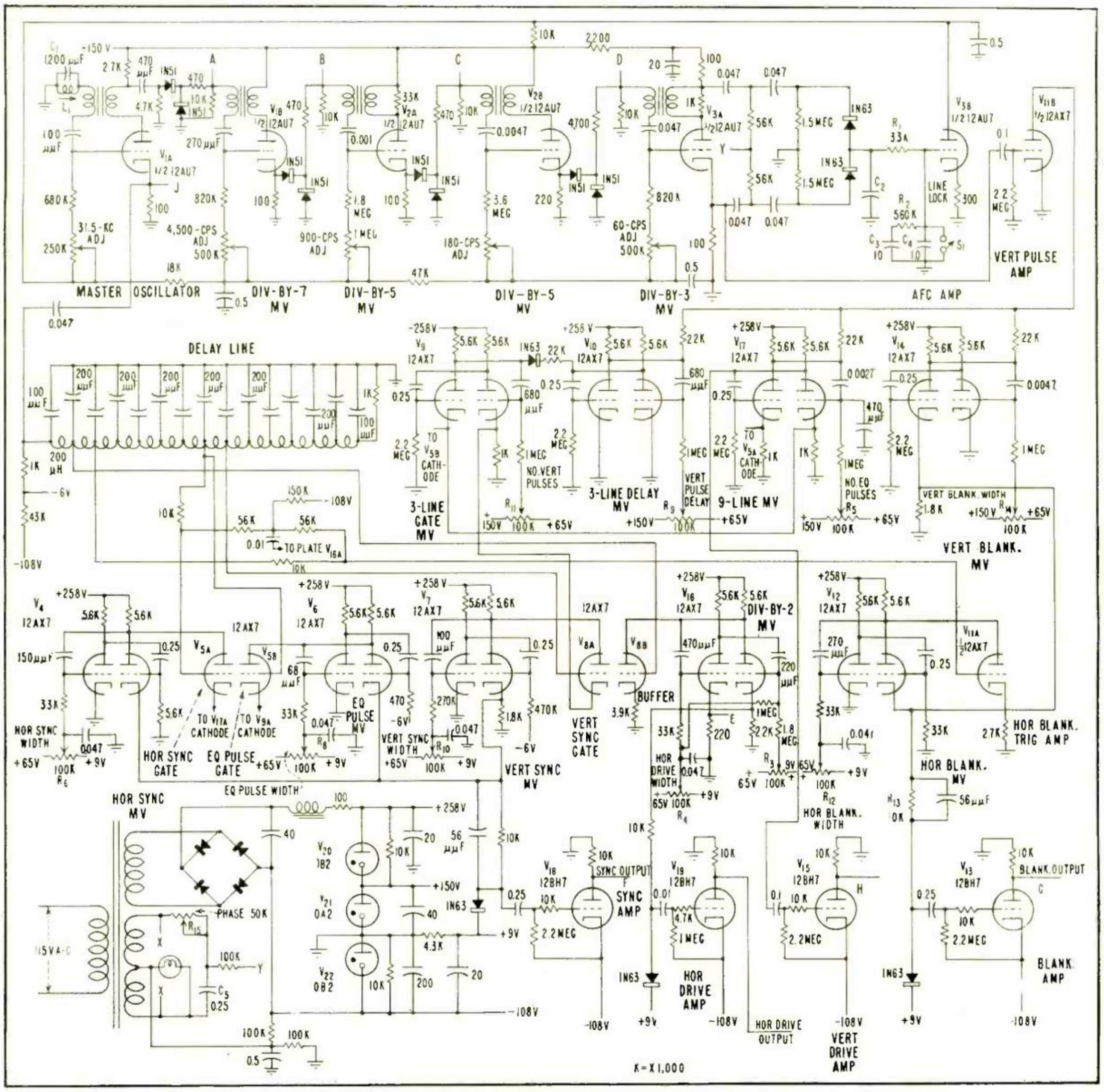

FIG. 2—Complete schematic shows how the 22 miniature tubes provide RETMA standard sync signal

tude to rise above cutoff level. The resultant negative 15.75-kc trigger pulses applied to the on section of the horizontal-sync multivibrator V_4 drive that section off and opposite section on. The narrow triggers are widened by the horizontal-sync control R_6 to standard horizontal-sync width. The cathode output pulses E feed through a common 10,000-ohm resistor to the sync amplifier stage V_{18}.

The horizontal sync multivibrator is gated off for the duration of the vertical interval. When the 9-line multivibrator V_{17} is triggered at the 60-cps field rate V_{17A} is driven on with its cathode going positive. With the horizontal-sync gate V_{5A} cathode also positive, the gate is closed at the start of the vertical interval. The gate remains closed for the 9-line duration of the vertical-sync interval.

Vertical Sync

When the 9-line multivibrator V_{17} is triggered by a 60-cycle pulse, the cathode potential of V_{17B} falls in the negative direction. This point is common to both V_{9A} the 3-line gate multivibrator and the equalizing-pulse gate V_{5B}. Since the cathode of V_{5B} is now negative, the gate is on, F. The delayed 31.5-kc trigger pulses on the grid of V_{5B} are transferred as negative triggers to the grid of equalizing-pulse multivibrator V_6. The on section of V_6 is driven to cutoff and triggers the other section on. The narrow triggers are widened to standard equalizing-pulse width by the EQUALIZING-PULSE-WIDTH control R_8. Cathode output pulses G are fed to the same common 10,000-ohm load resistor as the horizontal sync, and hence to the grid of sync amplifier V_{18}.

At this point the first 3-line interval containing six equalizing pulses is ended. Equalizing-pulse multivibrator V_6 is gated off, and the vertical-sync multivibrator V_7 gated on. This action involves four stages: the 3-line delay multivibrator V_{10}, the 3-line gate multivibrator V_9, the vertical-sync gate V_{8A} and also the vertical-sync multivibrator V_7.

The grid of the on section of 3-line delay multivibrator V_{10} receives a 60-pps negative trigger simultaneously with that applied to the 9-line multivibrator V_{17}. With V_{10B} driven to cutoff, the positive pulse on the plate holds the negative terminal of the 1N63 diode too far positive to allow conduction, hence prevents interaction between V_9 and V_{10}. During this time the cathode of V_{9B} (3-line gate multivibrator), being common to the cathode of the vertical-sync gate V_{8A}, is of positive polarity and gates off the vertical-sync multivibrator V_7. This is the first 3-line interval of the total 9-line interval.

With proper adjustment of the VERTICAL-PULSE-DELAY control R_9 in the V_{10} grid circuit, V_{10} returns to its nondriven state under control of its time-constant and grid potential. Tube V_{10B} returns to on, and the resultant negative plate pulse allows the 1N63 to conduct. The passed negative trigger drives multivibrator V_9. The V_{9A} cathode goes positive gating off V_{5B}, the equalizing-pulse gate, and the V_{9B} cathode goes negative gating on V_{8A}, the vertical sync gate.

Thus the equalizing pulses are shut off and vertical-sync pulses driven on. The 31.5-kc triggers on the grid of V_{8A} are passed as negative triggers to grid of the vertical-sync multivibrator V_7. The VERTICAL-SYNC-WIDTH control R_{10} widens the narrow triggers to standard vertical-sync width and the cathode output pulses H are combined in the common load and passed to the grid of sync amplifier V_{18}.

With proper adjustment of the NUMBER-OF-VERTICAL-PULSES control R_{11}, the 3-line gate multivibrator V_9 returns to its non-driven state at the end of 3 lines. The cathodes reverse their polarities. The vertical-sync multivibrator V_7 is gated off by V_{8A} gate and the equalizing-pulse multivibrator V_6 is again gated on by gate V_{5B}.

The 31.5-kc pulses on the grid of V_{5B} are amplified as negative triggers to the grid of equalizing-pulse multivibrator V_6 and the trailing six pulses are fed to sync amplifier V_{18}.

The 9-line multivibrator V_{17} is returned to its nondriven state gating off all vertical stages, and restoring horizontal-sync gate V_{5A} to on until the next 60-cycle vertical pulse.

The composite sync appears at the grid of sync amplifier V_{18} at positive polarity, is clamped at 9 volts by the 1N63 and the resultant clipped standard negative polarity composite sync I results at the output. Waveforms meet all RETMA specifications.

Composite Blanking

The blanking pulses must slightly precede their respective sync pulses to establish front porch.

Horizontal blanking pulses are derived as follows: 31.5-kc triggers from the delay line together with 15.75-kc triggers from the divide-by-two multivibrator V_{16} are applied to grid of the horizontal-blanking trigger tube V_{11A}. Note that the 31.5-kc triggers are fed from a tap on the delay line allowing camera driving pulses to precede composite blanking but delaying composite sync from the start of blanking. Since V_{11A} grid is biased to −108 volts, only those 31.5-kc triggers occurring at the time of the 15.75-kc pulses are of sufficient height to be passed as triggers for the horizontal-blanking multivibrator V_{12}. The cathode output pulses J adjusted in width by the HORIZONTAL-BLANKING-WIDTH control R_{12}, are fed to the common load resistor R_{13}, hence to the grid of blanking amplifier V_{13}.

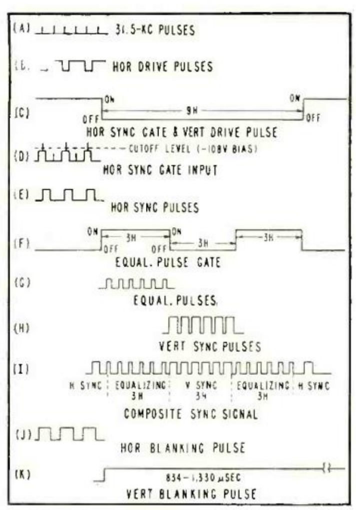

FIG. 3—Sync generator waveforms

For vertical blanking, 60-cps negative triggers from V_{11B} drive the vertical-blanking multivibrator V_{14}. The VERTICAL-BLANKING-WIDTH control R_{14} is adjusted for proper blanking width and the cathode output pulses are combined with horizontal-blanking pulses K in common load resistor R_{13} and passed to the grid of blanking amplifier V_{13}. The horizontal-blanking pulses occurring during the vertical interval stand atop the long vertical pulses and are clipped by the clamp action of the 1N63 diode in the V_{13} grid circuit.

Since the amplitude of the pulses is much higher than 9 volts at this point, a flat-topped composite blanking signal results.

The standard negative-polarity blanking pulses at the plate of V_{13} yield 4 volts peak to peak across 75 ohms at the output.

Power Supply

The rectified voltage from the bridge-type selenium rectifier is gas-tube regulated providing −108, +9, +150 and +258 volts. The 60-cps lock-in circuit that provides afc voltage to hold the master oscillator precisely 525 times the power-line frequency derives its line-frequency reference from the filament winding at point Y through the phasor control R_{15} and phase capacitor C_5.

This phasing adjustment properly times the system with shutter-type film projectors by phasing the sync pulses relative to the shutter synchronous motor so that shutter opening occurs well within the interval of the vertical blanking pulse. Resistor R_{15} is adjusted in practice for elimination of banding effects from any associated film chain.

The author congratulates G. Fathauer of Dage Electronics Corporation, upon the design of the camera chain and thanks Dage for permission to publish this article.