Project Whirlwind
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: SCOPE SYNCHRONIZER

To: 6345 Engineers, Sylvania

From: R. L. Best

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Description

The Scope Synchronizer will take positive pulses of any prf between 500 cycles and 6 megacycles, and divide these to any output frequency between 500 cycles and 30 kc. The output pulse may be delayed over a 10 μsec range, and synchronized with one of the input pulses if desired, to produce a jitter-free output. Two input jacks are provided, one for input prf's above 500 kc, and the other for input prf's below 500 kc.

When the input sync. selector is in position 1, the signal applied to input jack #1 is fed to the first multivibrator, which divides this frequency to about 100 kc. The free running period of this multivibrator may be varied a small amount by the "first M.V." control. The output of this first multivibrator is fed to a second multivibrator, whose free running period is controlled by the "output frequency" control.

When the input sync. selector is in position 2, the signal applied to input jack #2 is fed to the second multivibrator directly, and power supply voltage is removed from the first multivibrator.

The output of the second multivibrator triggers a single shot multivibrator, which puts out a gate, variable in length by the "delay" control from about 5-15 μsec.

When the "output sync. selector" is in position 0, smooth delay is obtained. When this switch is in position 1, the signal applied to input 1 is also fed to this delay circuit in such a manner that the trailing edge of this gate is synchronous with one of the incoming pulses, the delay then being in steps equal to the time between pulses. When this switch is in position 2, the signal applied to input 2 is used to sync. the delay.

The output circuit is an RLC peaker, which puts out a positive pulse at the end of the variable length gate. This pulse is a half sine wave of .5 μsec duration, variable in amplitude from 0 to 175 volts.

The input pulse should be at least 15 volts in amplitude. One convenient method of using the unit is to feed the "100 kc sync. pulse" from a restorer pulse generator into input 2, and put the "input sync. selector" in position 2. One mc clock pulses are fed into input 1, and the "output sync. selector" is put in position 1. Then the unit divides the 100 kc signal by some integer, which may be varied by changing the "output freq." control, and the output pulse is synchronous with a clock pulse, the delay being in steps of 1 microsecond. The "sync. gain" control varies the amplitude of the pulse fed to the multivibrator selected by the "input sync. selector", but does not vary the amplitude of the sync. pulses fed to the delay circuit.

Circuit

Drawing B-39822 shows the circuit of the Scope Synchronizer. Both multivibrators are similar except for the time constant of the crossover networks, the first multivibrator being the faster. With the "input sync. selector" on position 1, the incoming pulses are applied to the cathode of the first multivibrator through the "sync. gain" potentiometer and a crystal diode. These positive pulses are amplified by the conducting tube, and appear as positive pulses on the plate of this tube. The amplified pulses are coupled throug the crossover capacitor to the opposite grid, so that the rising exponential of the grid of the non-conducting tube has pulses superimposed on it. As this grid nears cut-off, one of these pulses causes the multivibrator to flip, whereupon the operation is repeated with the other side. Thus the multivibrator is synchronized with the applied pulses.

One plate of the first multivibrator is connected to each plate of the second multivibrator through small capacitors which differentiate the waveform of that plate of the first multivibrator. The alternately positive and negative pips which therefore appear on the plate of the off tube in the second multivibrator are passed through the crossover capacitor to the grid of the on tube, which amplifies them. These amplified pips are large enough to overide the oppositely phased pips coming directly to this plate through the small capacitor from the plate of the first multivibrator. The amplified pips are fed through the crossover capacitor to the grid of the off tube, being superimposed upon this rising exponential. When this grid nears outoff, it is one of these pips which causes the multivibrator to flip, synchronizing it. The operation is then repeated for the opposite side of the multivibrator. When the "input sync. selector" is in position 2, the second multivibrator operates in a manner similar to the preceding description of the first multivibrator, the sync. pulses being applied to the cathode.

A small capacitor is connected from one plate of the second multivibrator to a voltage divider, differentiating this waveform, and putting the result at a d-c potential of about 20 volts. Only the negative pip caused by this plate conducting is large enough to pass through the crystal connected to the normally on grid of the single shot or delay multivibrator, and this pip flips this delay multivibrator. The "delay" control determines the length of the gate generated at the plate of this tube. The normally off plate conducts during the delay interval, and is connected to the output sync. selector through a crystal diode and capacitor. The pulses selected by the "output sync. selector" are fed to this plate, and to the exponentially rising grid of the off triode through the crossover capacitor. The end of the gate is therefore synchronous with the pulses selected by the "output sync. selector" switch. After the delay multivibrator has returned to its original state, the crystal diode connected to the normally off plate passes no synchronizing pulses, since its cathode is at +150 volts, while its anode is at about +70 volts.

The output circuit is an RLC peaker, operating on the positive gate generated by the normally on plate of the delay multivibrator. This gate is R-C coupled to a variable bias, varied by the "output amplitude" control, which determines how heavily the output tube conducts during the gate interval. At the end of the gate interval, the output triodes are sharply cut off, and the resulting inductive voltage swing in the plate circuit is the output pulse. Negative voltage swings in the plate circuit are clipped by crystal diodes. Due to the method of coupling the gate to the peaker, variations in output frequency and delay effect the output amplitude. The output pulse is a $\frac{1}{2}$ μsec half sine wave, that may be varied from zero to + 175 volts.

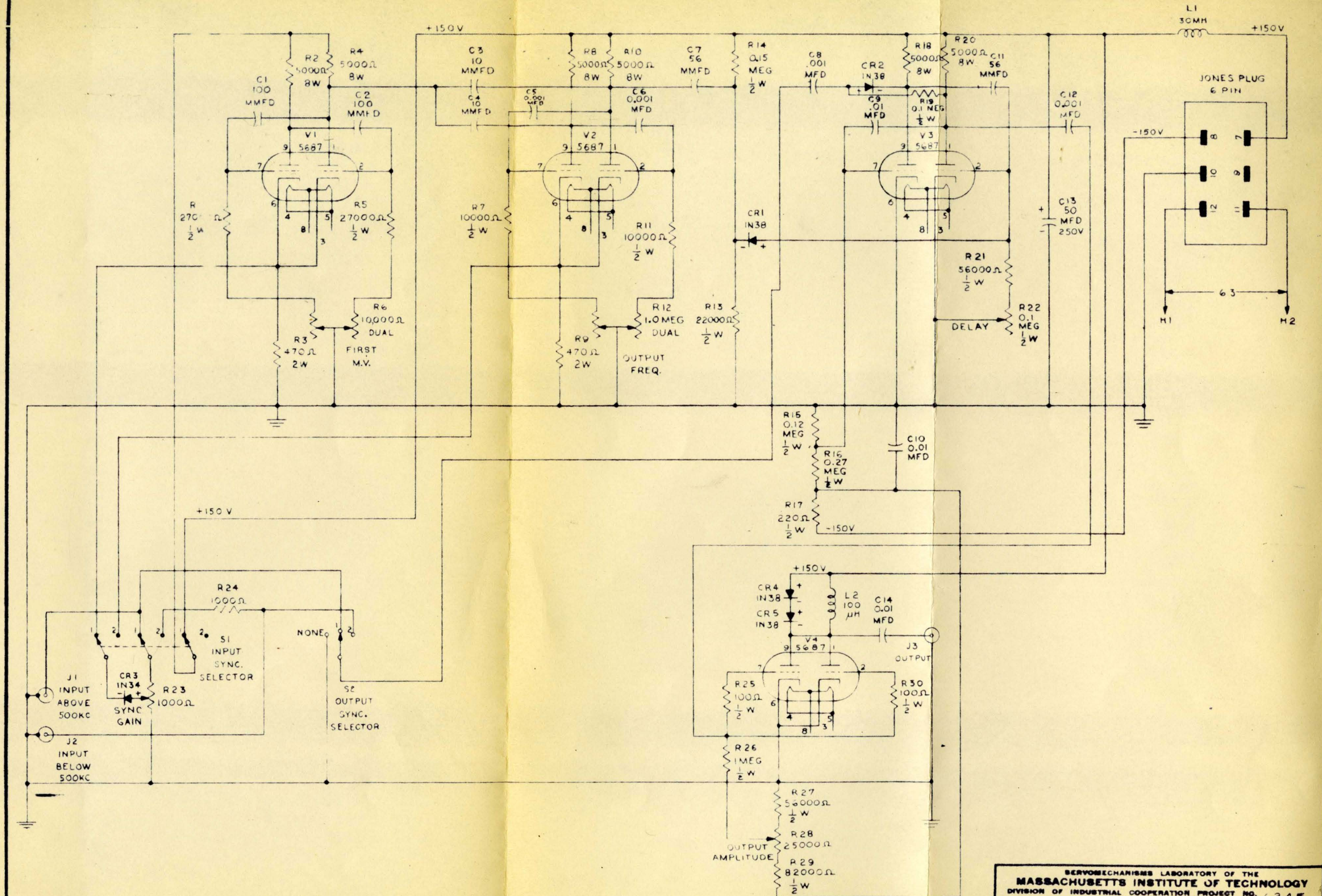
Signed R. L. Best
R. L. Best

Approved N H Taylor
N. H. Taylor

RLB/spr

Drawing: 39822

B-39822



SERVOMECHANISMS LABORATORY OF THE
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SCOPE SYNCHRONIZER

SCALE:	DR A M G.	B-39822
ENG. R.L.B	CK VL 6-21-48	APP.	B-REDUCTION

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