Division 6 - Lincoln Laboratory
Massachusetts Institute of Technology
Cambridge 39, Massachusetts

SUBJECT: BLOCKING OSCILLATOR CORE DRIVERS FOR USE IN DISPLAY GENERATOR BUFFER STORAGE

To: N.H. Taylor

From: Eli Anfenger

Date: 11 May 1954

Abstract: A cheap core driver has been built which is a blocking oscillator triggered from a standard pulse. The output pulse lengths are determined by lumped constant delay lines, the amplitude by the B+ to bottoming of the tube excursions. For high current sources the pulse is amplified by a power pentode whose plate is driven from B+ to bottoming and transformed to the desired level.

Introduction

It was desired to develop a cheap drive for use in a display generator buffer storage as illustrated in Fig. 1. In this figure each winding represents the output transformer of a driver. The drivers are returned to voltages such that each core winding is held from conduction because of the switch action of the diode in series with it. The bit and word drivers are 40 volt pulse sources; the bit driver pulsing negatively and the word driver pulsing positively. Either driver alone will reduce the bias on the diode to zero, whereas the coincident operation of both drivers will give a 40 volt source to drive current through the core winding. Read is accomplished by a 150-volt pulse on a second core winding. The read windings are connected in series as dictated by the logical use of the information. A third winding on the core is the output terminals for read.

The requirements for the above circuits are as follows:-

1) Bit Driver

   a) Isolated 40-volt pulse max., 35-volt minimum at 28 ma.

   b) 3 μsec pulse.

   c) Driver must trigger from positive standard pulses +20 v. to +40 v.

d) Driver must be capable of operating in a burst of 8 pulses spaced 10 μsec apart, with a burst repetition rate of 1000 cycles.

2) Word Driver

a) Isolated 40-volt pulse max., 35-volt minimum zero to 800 ma.

b) Good regulation from no load (no cores) to full load (32 cores)

c) 4 μsec pulse.

d) Driver must trigger from positive standard pulses of 10 to 40 volts.

e) Repetition rate 1000 cycles.

3) Read Driver

a) Isolated 150-volt pulse at 1 amp.

b) 1 μsec pulse.

c) Driver must trigger from positive standard pulse 20 to 40 volts.

d) Repetition rate 1000 cycles.

Circuits

1) Bit Driver

The bit driver circuit is shown in Fig. 2. It consists of 1/2 5965 connected as a blocking oscillator. The pulse length is determined by a delay line in the grid circuit. The tube bottoms during the pulse. The 33 K resistor in the plate circuit reduces the overshoot and adds damping for stability. Delay of the Output pulse compared with the input pulse is about 0.2. The characteristic waveforms are shown in Fig. 3.

The input impedance to a pulse which will trigger the blocking oscillator is 400 ohms. The maximum cathode current is on the order of 80 ma. All possible voltage measurements were made directly on the plates of the scope. When the levels were too low to be read this way they were read through the amplifiers and calibration of the scope. In every case when direct and amplifier measurements were compared the amplifier measurements were about 30% higher than the direct measurements. Since all current measurements were made by measuring the drop in a small series resistor, it is assumed these readings are slightly high. Because

of this observation those diagrams that have photographs show approximate voltages when the measurement could not be made directly on the scope plates. The maximum grid voltage during conduction of the tube is +7 volts.

2) Word Driver

Two word driver circuits are shown in Figs. 4a and 4b. Each consists of a blocking oscillator (1/2 5965) driving a power amplifier (6293). The blocking oscillator bottoms. The output is stepped up to drive the power amplifier from cut-off to bottoming. The plate voltage of the power amplifier is transformed to the desired output level. Pulse length (4 μsec) is determined by the delay line in the grid of the blocking oscillator. Characteristic waveforms of Fig. 4b are shown in Fig. 5. The blocking oscillator peak grid voltage is +7 volts; the peak cathode current is about 60 ma. The peak current of the power amplifier cathode loaded (47 ohms) is 300 ma and the screen is 100 ma. Unloaded the peak current is 200 ma on the cathode and 100 ma on the screen.

3) Read Driver

Two read driver circuits are shown in Figs. 6a and 6b. These are essentially the same as the word drivers with the exception of the delay line of the blocking oscillator. Here the pulse length is 1 μsec. Characteristic waveforms of Fig. 6b are shown in Fig. 7. The peak cathode current of the blocking oscillator is about 60 ma; the peak grid voltage is +7. The peak cathode current of the power amplifiers is about 1 amp. and peak screen is about 0.5 amp.

The reason for two types is that at first the maximum B+ was 250 volts but later it was learned that 600 volts would be available.

Circuit Margins

Curves of the input triggering voltage versus bias for the three types of drivers are shown in Figs. 8, 9. and 10. These are shown for a bogie 5965 and a down 5965. The characteristic of the bogie and down 5965 are shown in Fig. 11.

It was found that the blocking oscillator worked well when the plate voltage was changed between ± 50 volts, however, the output is a function of the plate voltage. The blocking oscillator also works well when either a 12AY7 or 12AU7 are substituted for the 5965.

A table of screen margins of the 6293 for the various circuits is shown in the table below.

Circuit	Min. Screen Voltage for satisfactory Opr.	Max. Screen Voltage tried	Nominal Voltage
Fig. 4a	90	440	240
Fig. 4b	60	440	150
Fig. 6a	320	590	400
Fig. 6b	210	440	250

Shunting the diodes of the blocking oscillator grid circuits with 10K resistors had no effect on the output of the circuits. Raising the screen voltages on the power amplifiers lengthened the pulse on the order of 0.2 to 0.5 μsec. at the extremes. The delay of the output pulses relative to the input pulses is a function of the triggering pulses. Over the required operating range of triggers the delay is 0.5 μsec at most.

Suggested Improvements

It appears that the only handle for marginal checking the blocking oscillator is the triggering level. If a pentode is used such as a 7AK7 the screen could serve as a convenient handle.

While the maximum tube rating of the 5965 is not exceeded in the present application, an increase in the grid to plate winding ratio of the blocking oscillator transformer would reduce the maximum cathode current and the maximum positive grid voltage. A five to one ratio was tried and found to be marginal for triggering and bottoming. Perhaps a four to one ratio would be a good compromise.

To improve the screen margins of the read driver a circuit configuration as shown in Fig. 6b with the cathode of the 6293 returned to -150v and the blocking oscillator output winding returned to -300v is worth trying. The output transformer will have to be changed.

1) Blocking Oscillator Transformers

Wound on Ferramic H Core F109-3 die size

Grid winding	50T	#36	Formex
Plate winding	150T	#36	Formex
Output winding	57T	#36	Formex

2) Word Driver and Read Driver Blocking Oscillator Transformer

Wound on Ferramic H Core F109-3 die size

Grid Winding	50 T	#36	Formex
Plate Winding	150 T	#36	Formex
Output Winding	225 T	#36	Formex

3) Word Driver Power Amplifier Transformer (Fig. 4a)

Wound on 2 mil Westinghouse L4 Hypersil

Primary	250 T	#36	Formex
Secondary	25 T	#36	Formex

4) Word Driver Power Amplifier Transformer (Fig. 4b)

Wound on 2 mil Westinghouse L4 Hypersil

Primary	375 T	#36	Formex
Secondary	25 T	#36	Formex

5) Read Driver Power Amplifier Transformer (Fig. 6a)

Wound on 2 mil Westinghouse L1 Hypersil

Primary	70 T	#36	Formex
Secondary	35 T	#36	Formex

(Could just as well be 50 turns and 25 turns.)

6) Read Driver Power Amplifier Transformer (Fig. 6b)

Wound on 2 mil Westinghouse L1 Hypersil

Primary	100 T	#36	Formex
Secondary	25 T	#36	Formex

Signed Eli Anfenger
Eli Anfenger

EA:cs

Approved R. L. Best
R. L. Best

Figure Number	Drawing Number
1	A-58979
2	A-58980
3	A-58981
4A	B-58982
4B	B-58983
5	A-58984
6A	B-58985
6B	B-58986
7	A-58987
8	A-58988
9	A-58989
10	A-58990
11	A-58991

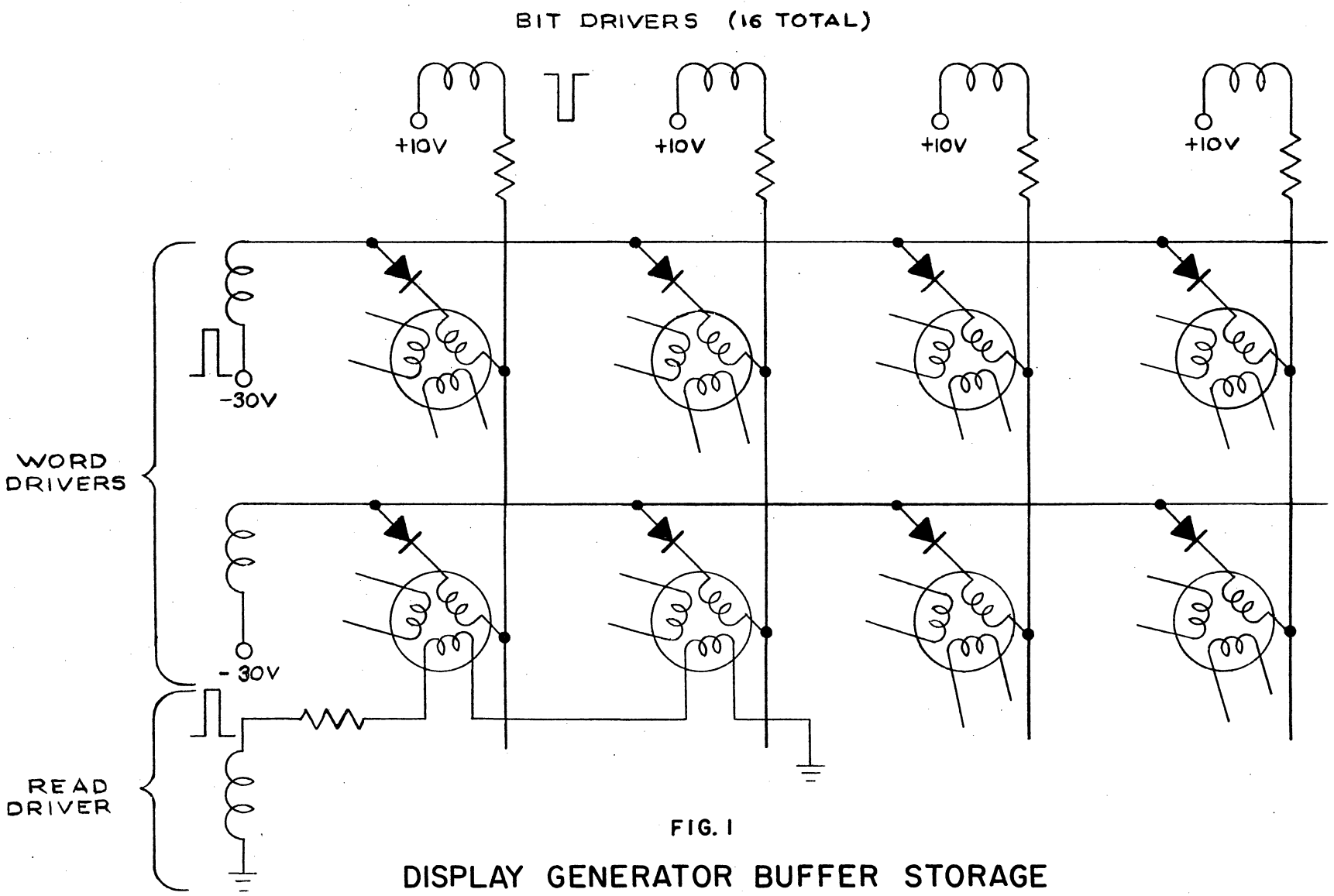


FIG. 1

DISPLAY GENERATOR BUFFER STORAGE

A-58980

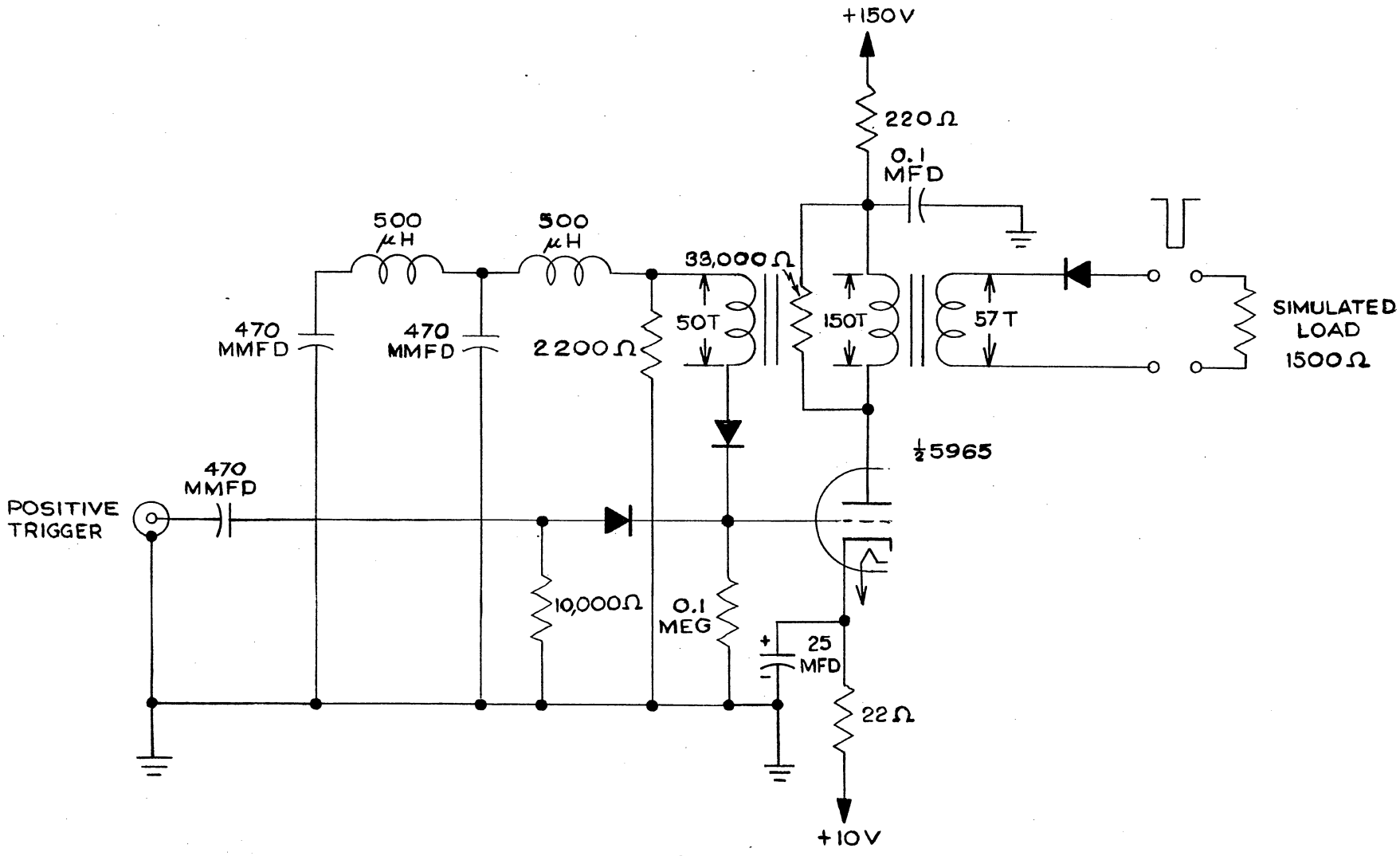
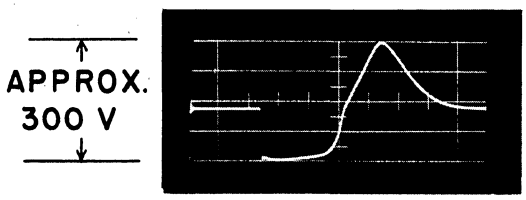
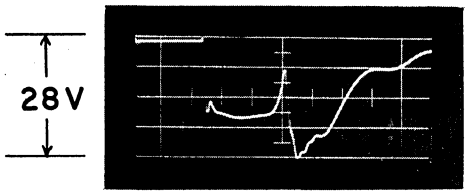


FIG. 2

BIT DRIVER

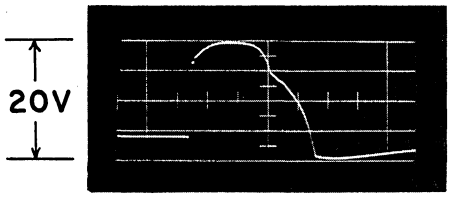


1 μ SEC./DIV.
PLATE VOLTAGE

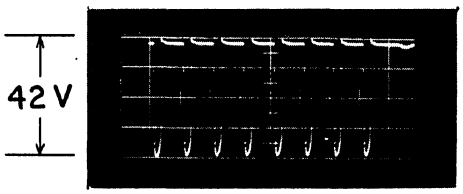


1 μ SEC./DIV.
DELAY LINE INPUT

1 μ SEC./DIV.
OUTPUT VOLTAGE



1 μ SEC./DIV.
GRID VOLTAGE



10 μ SEC./DIV.
BURST OF EIGHT
OUTPUT PULSES

FIG. 3

BIT DRIVER WAVEFORMS

A-58981

B-58982

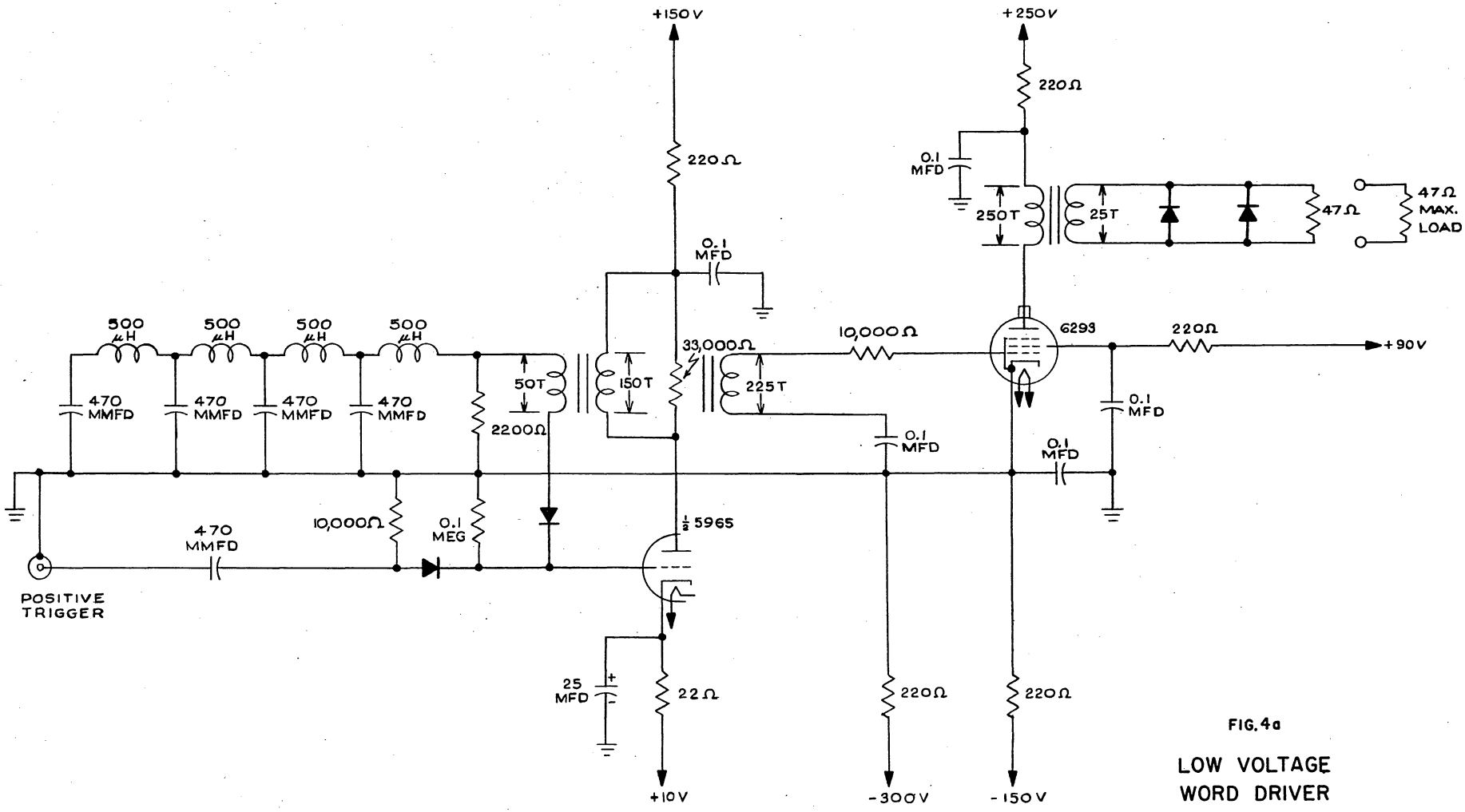


FIG. 4a

LOW VOLTAGE WORD DRIVER

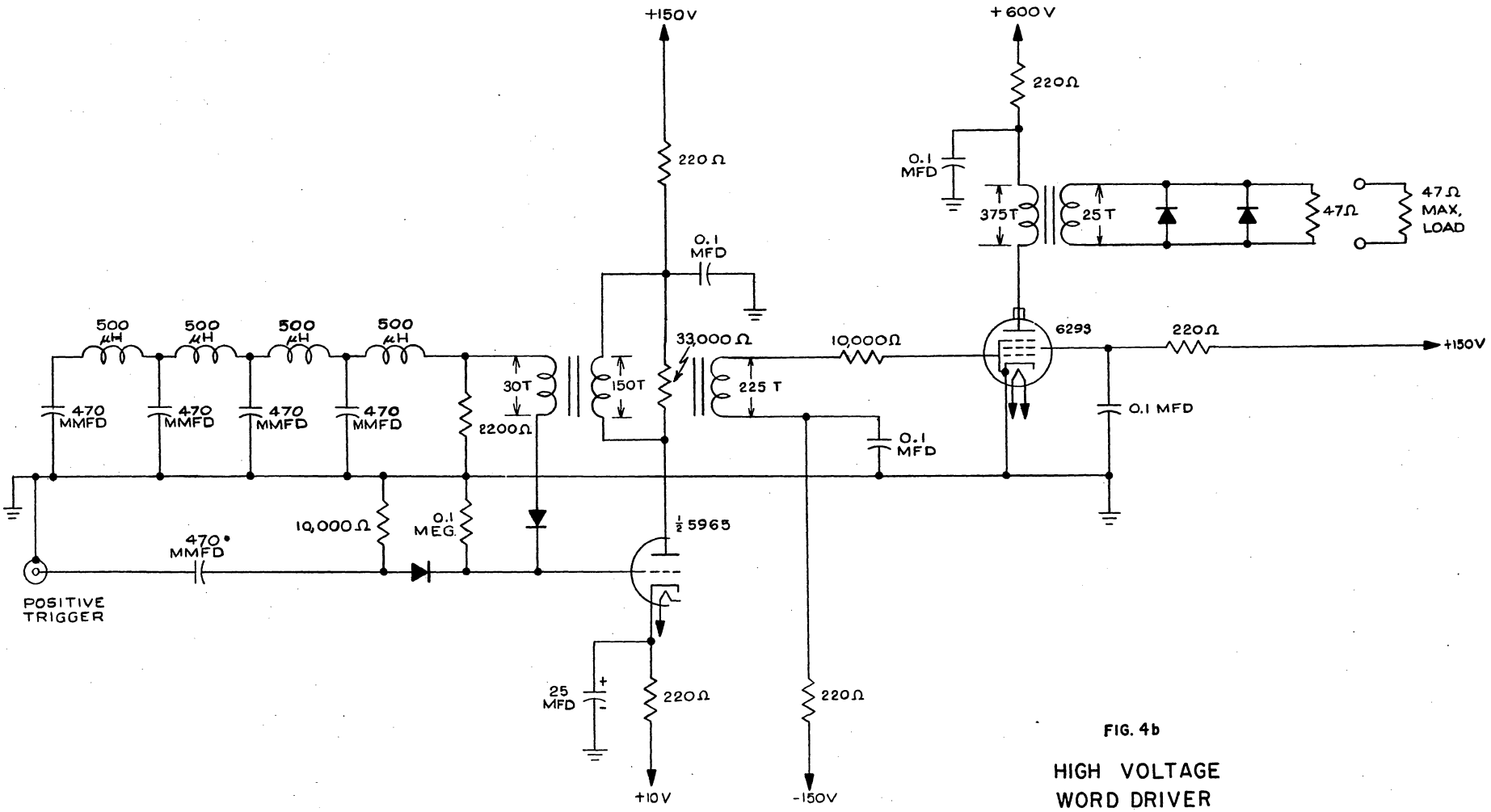
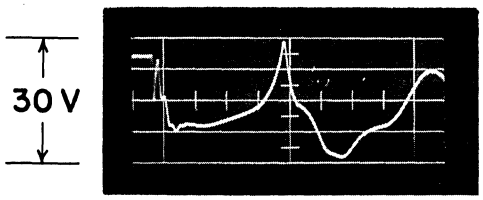
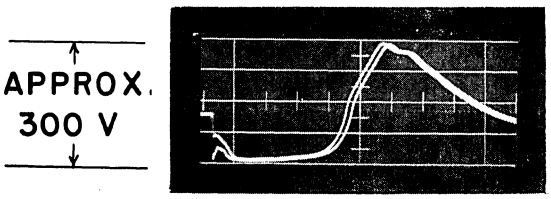


FIG. 4b

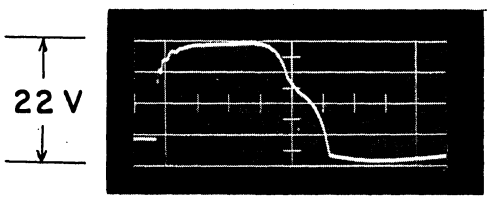
HIGH VOLTAGE
WORD DRIVER



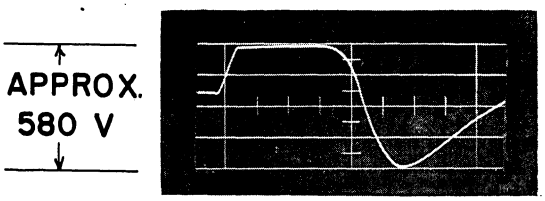
1 μ SEC./ DIV.
B.O. DELAY LINE
INPUT



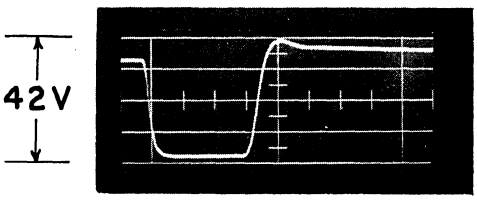
1 μ SEC./DIV.
B.O. PLATE VOLTAGE
(UPPER) (20 VOLT TRIGGER)
(LOWER) (30 VOLT TRIGGER)



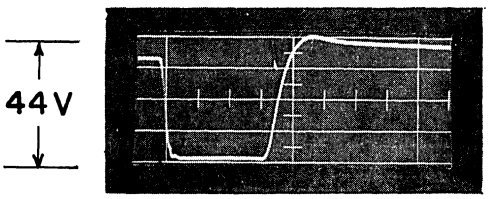
1 μ SEC./ DIV.
B.O. GRID VOLTAGE



1 μ SEC./ DIV.
P.A. GRID VOLTAGE



1 μ SEC./ DIV.
OUTPUT PULSE
(47 Ω LOAD)



1 μ SEC./DIV.
OUTPUT PULSE
(UNLOADED)

FIG. 5

WORD DRIVER WAVEFORMS

A-58984

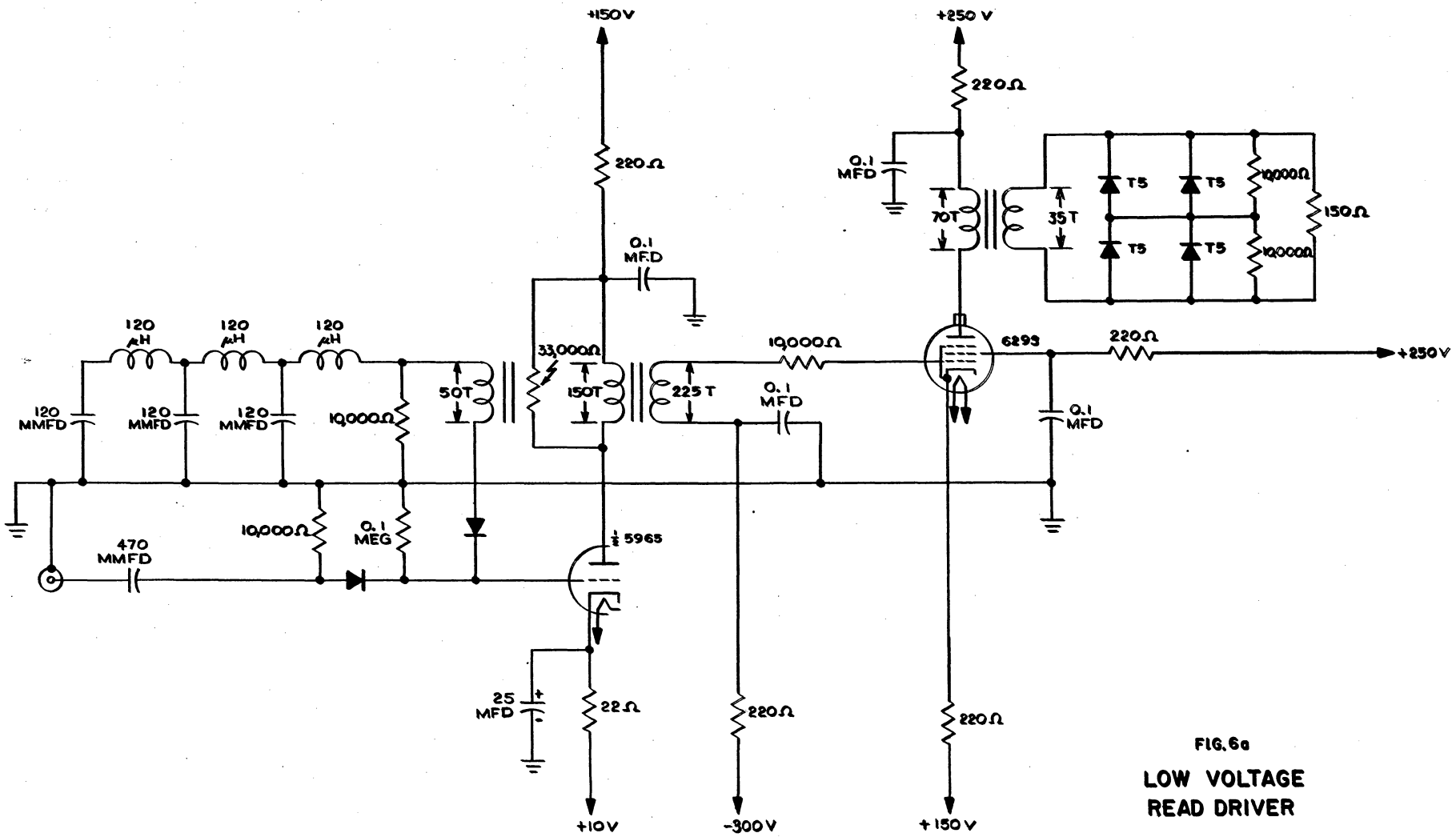


FIG. 6a

LOW VOLTAGE READ DRIVER

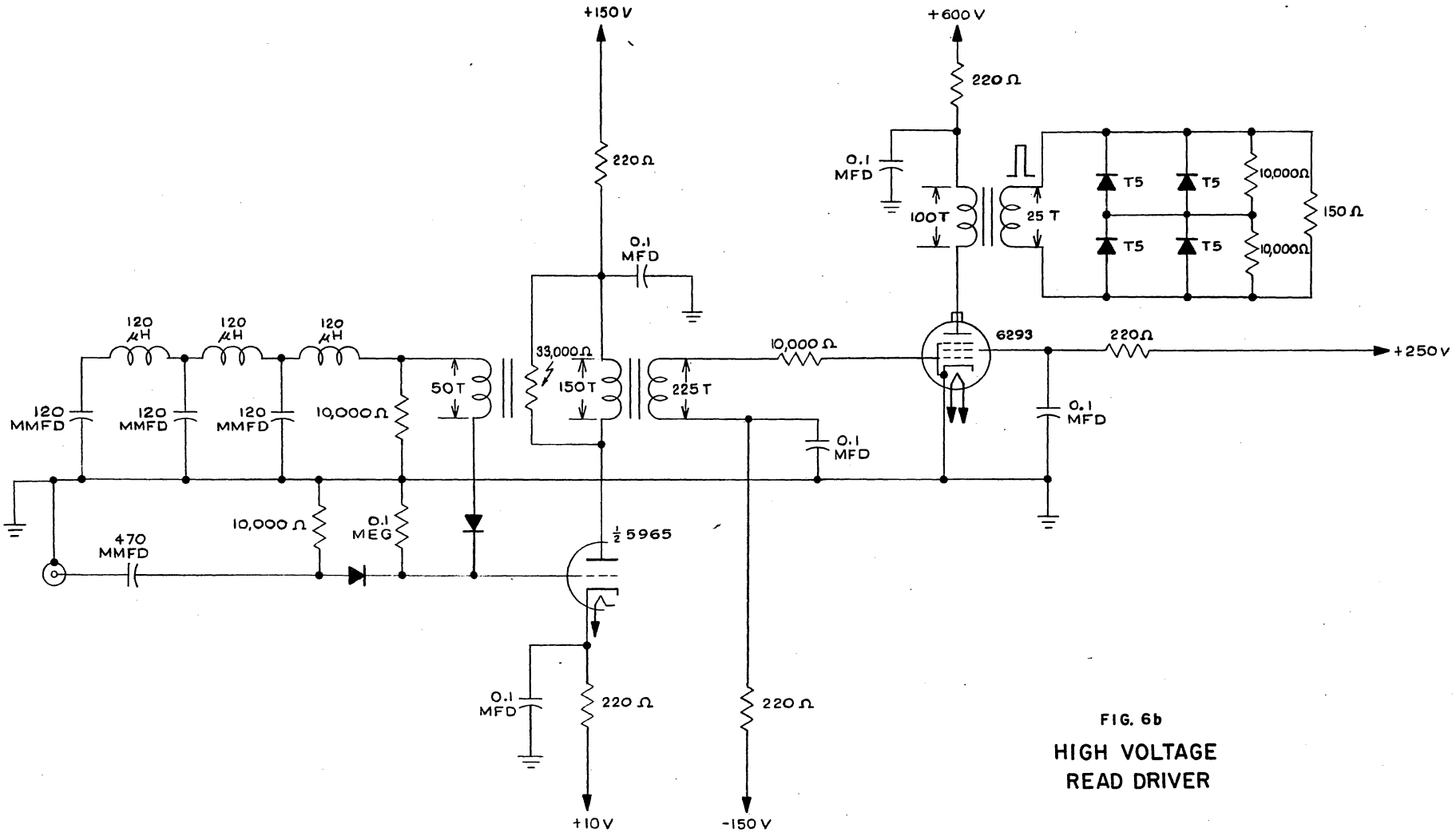
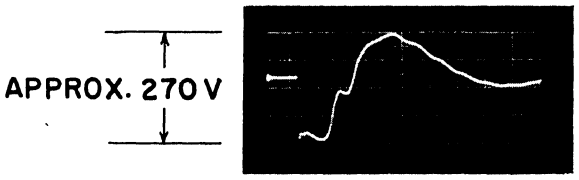
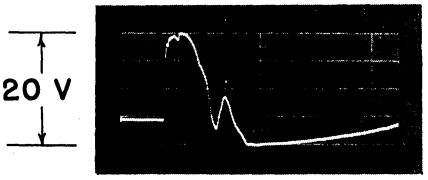


FIG. 6b

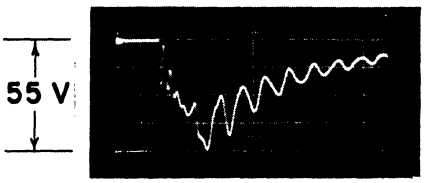
HIGH VOLTAGE READ DRIVER



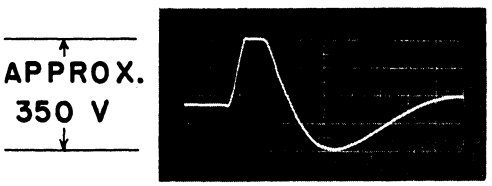
1 μ SEC. / DIV.
B.O. PLATE
VOLTAGE



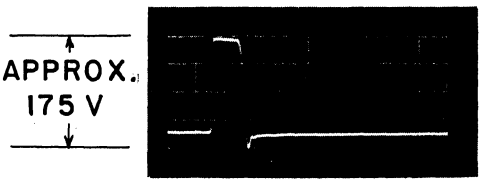
1 μ SEC. / DIV.
B.O. GRID
VOLTAGE



1 μ SEC. / DIV.
B.O. DELAY LINE
INPUT



1 μ SEC./DIV.
P.A. GRID
VOLTAGE



1 μ SEC./ DIV.
OUTPUT PULSE

FIG. 7

READ DRIVER WAVEFORMS

A-5898

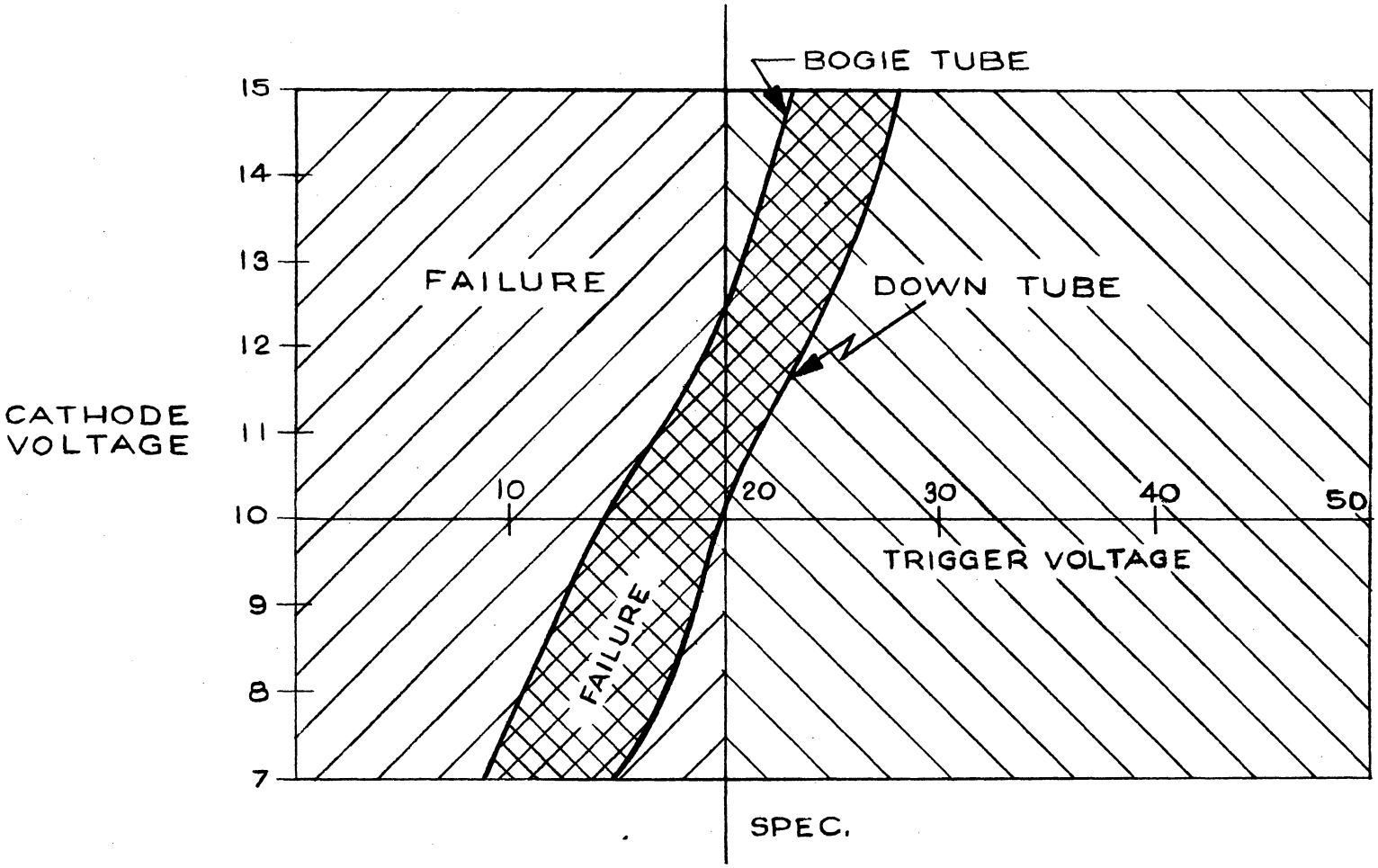


FIG. 8

BLOCK OSCILLATOR, BIT DRIVER

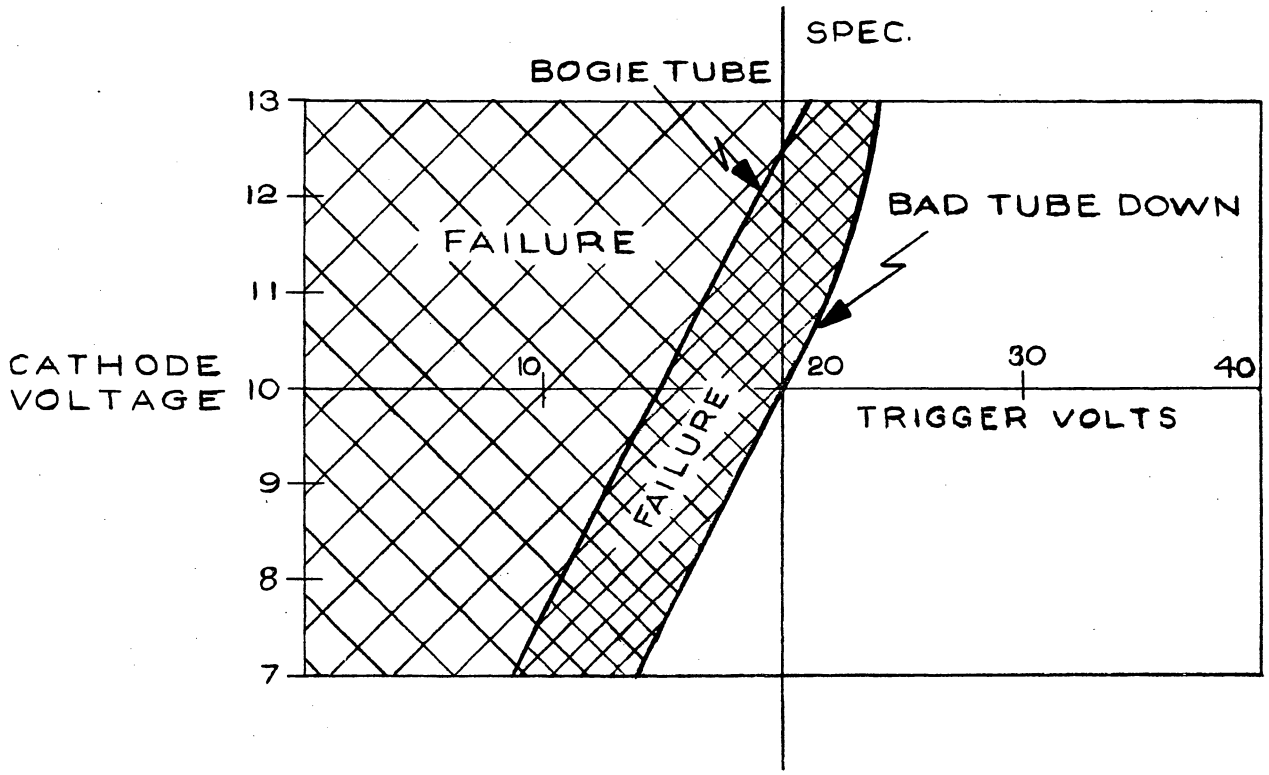


FIG. 9

BLOCK OSCILLATOR, WORD DRIVER

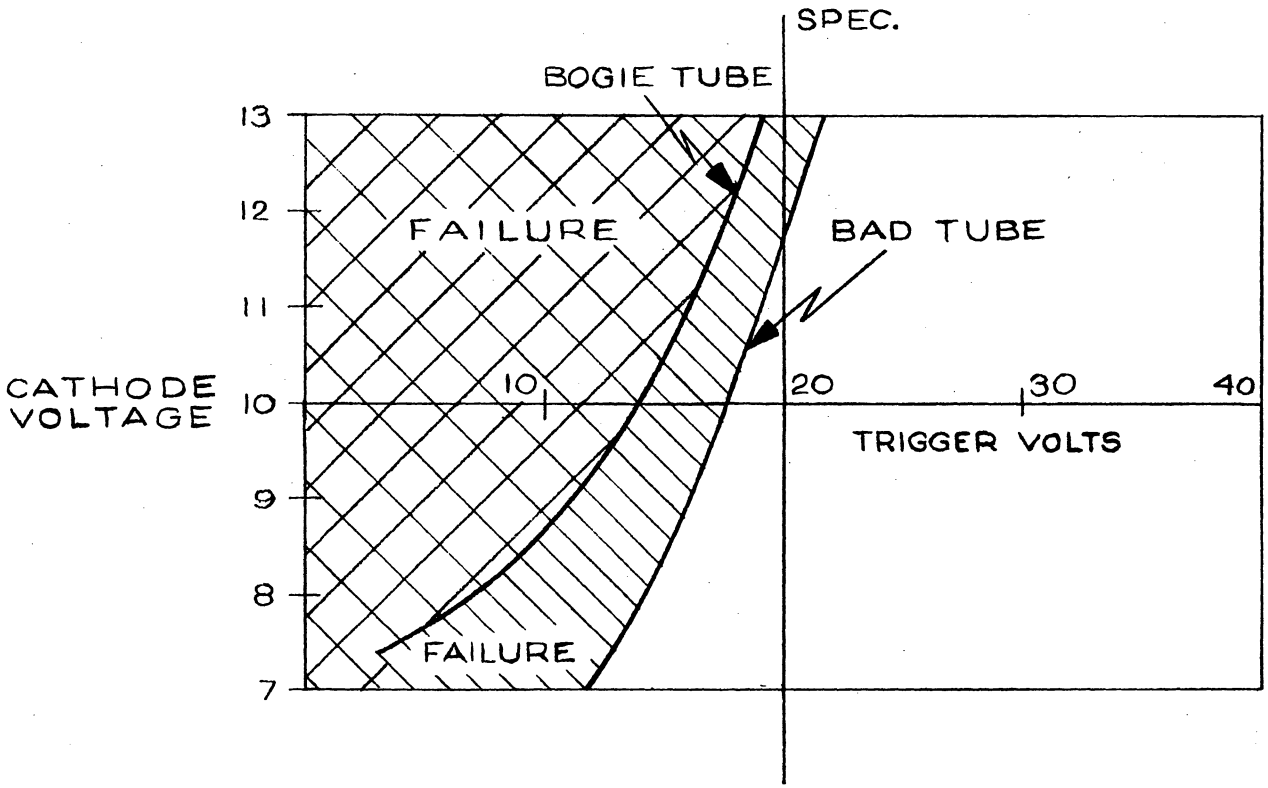


FIG. 10

BLOCK OSCILLATOR, READ DRIVER

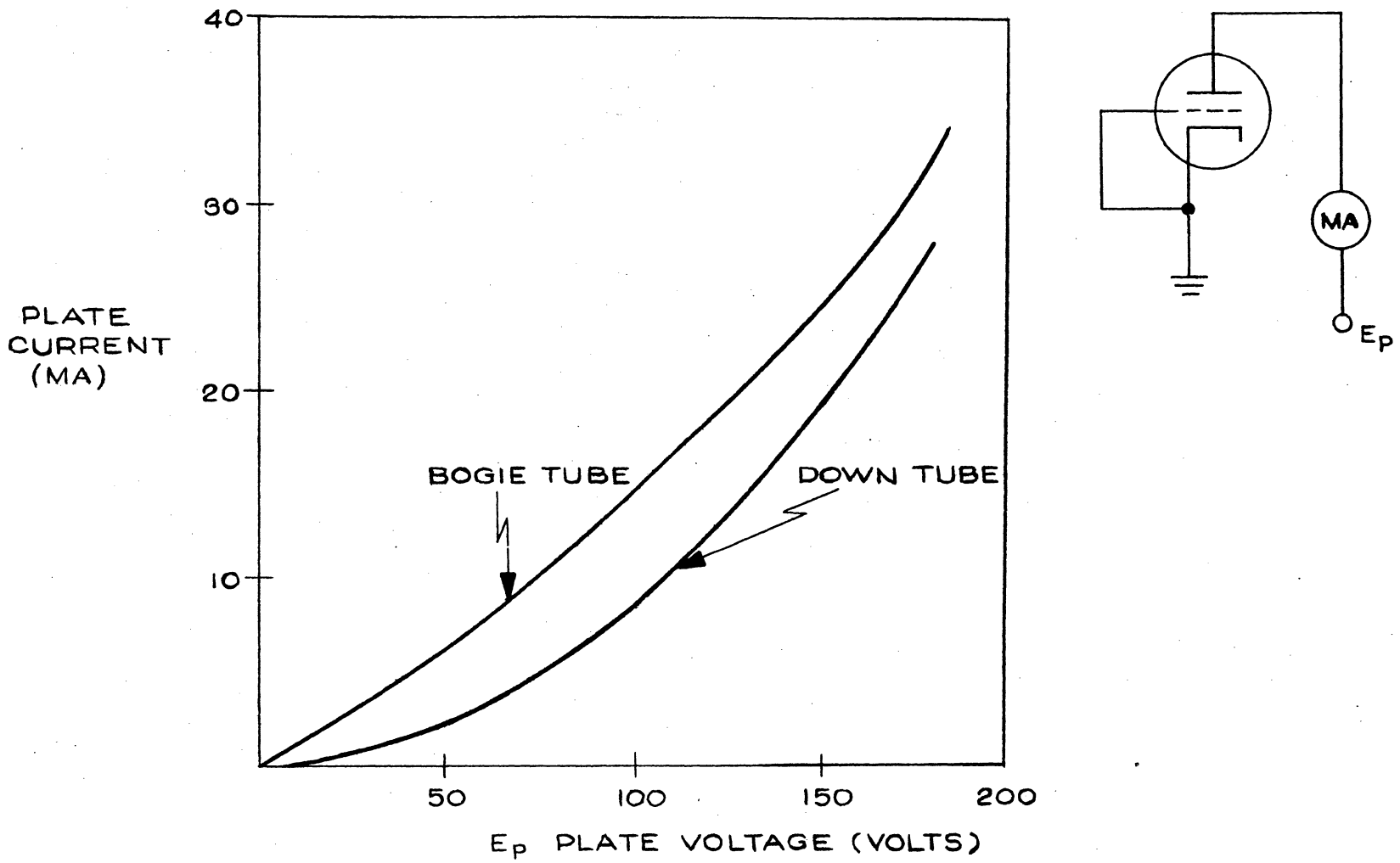


FIG. 11

5965 CHARACTERISTICS

Division 6 - Lincoln Laboratory
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SUBJECT: BLOCKING OSCILLATOR CORE DRIVERS FOR USE IN DISPLAY GENERATOR BUFFER STORAGE.

To: N.H. Taylor

From: E. Anfenger

Date: June 7, 1954

Abstract: This paper lists the corrections on M-2820

Corrections

1. Page 2 under "word driver" item d, should read 20 to 40 volts instead of 10 to 40 volts.

2. Top of Fig. 1 should read 32 bit drivers instead of 16.

3. Fig. 4a return to -300^{V} should be from lower winding of 225T and condenser should go to ground as in Fig. 4b.

4. Fig. 6a cathode return 6293 should read -150^{V} instead of $+150^{V}$.

SIGNED Eli Anfenger
E. Anfenger

APPROVED R L Best

EA:jb

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