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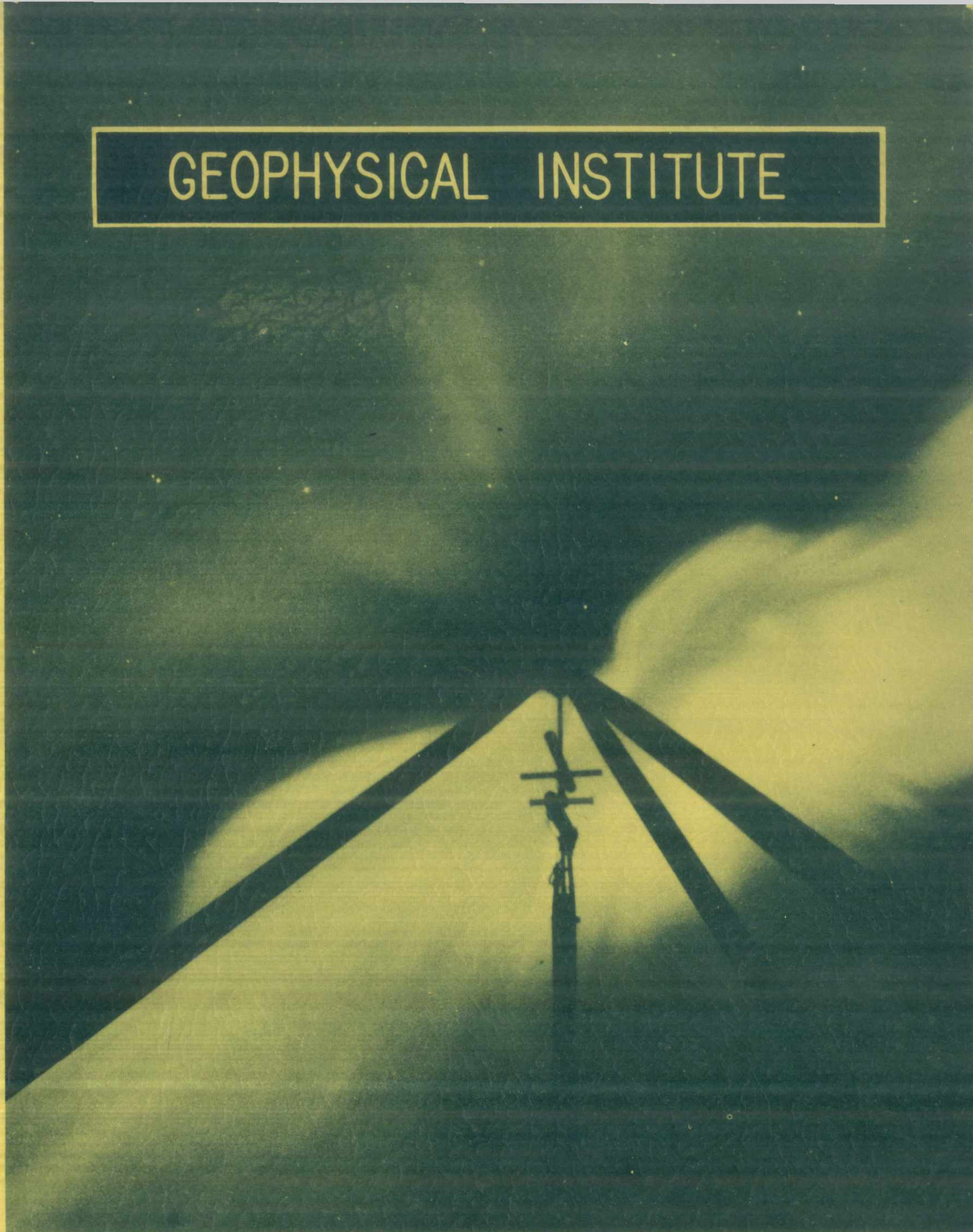

UNIVERSITY
OF ALASKA

COLLEGE
ALASKA

UAG-R111

EXPERIMENT LUXEMBOURG

Scientific Report No. 4
Contract No. AF 19(604)-3880
December 1960

by

G. C. Rumi and R. F. Benson

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AFCRL — 286

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EXPERIMENT LUXEMBOURG

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Prepared
for

GEOPHYSICS RESEARCH DIRECTORATE
AIR FORCE CAMBRIDGE RESEARCH LABORATORIES
AIR FORCE RESEARCH DIVISION (ARDC)
UNITED STATES AIR FORCE
BEDFORD, MASSACHUSETTS

Report prepared by:

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Report approved by:

C. T. Elvey, Director

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ABSTRACT

Experiment Luxembourg was designed to measure the electron density and electron collision-frequency as a function of height in the D region over College, Alaska using the technique of radio-wave interaction. A block diagram, which includes all the equipment necessary for the actual operation of the experiment, is described and illustrated in detail. The major parts of the system are: the disturbing transmitter operating on 17.5 Mc/s and using a 4x4 array of Yagi antennas, the wanted transmitter operating on ~ 5 Mc/s and using a circular polarization unit with 4 dipoles arranged in a quadrangle, a similar circular polarization unit and antenna for 5 Mc/s at the receiving site, and the delicate receiving system which detects a cross-modulation of 1×10^{-4} for a one volt input signal. Some values of electron density and collision-frequency have been obtained and will be discussed in following publications.

INTRODUCTION

This report describes and illustrates the equipment used for the production and detection of radio-wave interaction, the phenomenon which is the basis for Experiment Luxembourg.

The block diagram of Figure 1 is the basic reference for the present description; in order to help the understanding of the ensemble, the mode of operation of Experiment Luxembourg will first be briefly reviewed. Reference can be made to Scientific Report No. 1 of this series if more details are required. A signal from the wanted transmitter is reflected from the ionosphere and is recorded at the receiving site. For each second pulse of the wanted transmitter (which operates at a pulse repetition rate twice that of the disturbing transmitter), the disturbing pulse increases the electron collision frequency and, consequently, changes the absorption coefficient in the D region. Thus alternate pulses from the wanted transmitter are affected in amplitude or, in other words, cross-modulated. If the pulse of the disturbing transmitter is short, one can explore narrow sheets in the D region.

The block diagram in Figure 1 indicates that two sites are used for operation - a transmitting site and a receiving site. The transmitting site is located at the old ACS center, along the road between College and Fairbanks, Alaska; the receiving site is located close to Ballain Lake, along Farmer's loop Road in College and at a distance of about 2 km from ACS. Five pairs of telephone lines are installed between the two sites.

The two transmitters are located in the same room facing each other, so that simultaneous control of both is relatively easy. Since the two operating frequencies are widely separated and voltage regulation is good, no local interaction between wanted and disturbing transmitter affects the performance of the experiment. The regulator used is a "Stabiline - Automatic Voltage Regulator - Type IE - 5105".

The power produced by the disturbing transmitter is transferred to the antenna array by 85.4 m of Heliax HI semiflexible cable. HI cable is used, instead of the more common RG 17, to minimize attenuation. The cable is kept under a 5 psi pressure by means of a nitrogen compressor. The wanted power is transferred to the wanted antenna by about 90 m of RG 8A/Ucable. The disturbing and the wanted antennas are only about 30 m apart, nevertheless no proximity effects have been detected. The 16 Yagis forming the disturbing antenna array are oriented transverse to the geomagnetic meridian plane, whereas the four dipoles that constitute the quadrangle of the wanted wave are oriented 30° and 60° from the geomagnetic meridian plane. The circular polarization unit for the wanted wave is situated at the foot of the wanted antenna.

The receiving site is located at a building called the counterpoise, because a copper wire net, arranged as a counterpoise, is suspended over its roof. Experiment Luxembourg inherited the counterpoise and utilizes it as the ground plane for the wanted receiving antenna. The quadrangle of dipoles that form this antenna is centered around the counterpoise building.

The receiving equipment is distributed on three standard racks, while the scope unit is located on a small cart. Facing the equipment, one sees on the right rack from top to bottom the receiver gate and reference signal generator chassis, the phase sensitive detector and DC amplifier, and the Esterline-Angus recorder. On the central rack are the pulse shaper, the 17.5 Mc/s Collins receiver, the ~ 5 Mc/s Super Pro receiver, the wide band IF strip, the signal gate, and the delay control. The selective amplifier is on the left rack; the power supplies are mounted at the bottom of each rack. The selective amplifier proved to be extremely sensitive and required some spacing from the other equipment. Particular care has been given to the stabilization of all the power supplies. The circular polarization unit, an exact replica of the one at the transmitting site, and therefore rather oversized with respect to its actual requirements, is attached to the wall and is connected to the 75 ohm, Oval Twin-leads that descend directly from the four dipoles of the 5 Mc/s antenna. A single dipole for 17.5 Mc/s operation is located rather far from the counterpoise and is attached to two poles. It is connected to the 17.5 Mc/s receiver through a balun, a quarter wave transformer, and a long length of RG 11 A/U cable.

Starting from the timer, each box that appears in the block diagram depicted in Figure 1 will be described and illustrated in the following pages.

TRANSMITTING SITE

Timer

This unit provides synchronization for all transmitters that are operating at the transmitting site, including the wanted and the disturbing transmitters of Experiment Luxembourg. The fundamental timing frequency is produced by a 3000 c/s temperature-controlled crystal oscillator, whose output is converted into a square wave by a conventional overdriven triode amplifier. A scale-of-two circuit is then utilized to provide a 1500 c/s square wave, which is in turn followed by a scale-of-five circuit to produce a 300 c/s signal. Successive scale-of-two circuits are then used to produce the various pulse repetition frequencies that are needed, namely, for Experiment Luxembourg, 75 c/s and 37.5 c/s. The output takes the form of a square wave of 60 volts peak-to-peak amplitude.

Wanted Transmitter (Figures 2,3,4,5,6,7, and 8)

The wanted transmitter has the following characteristics:

Peak radiated power	0 - 16 kw
Frequency	4503.5 or 4865 or 5290 kc/s
Pulse length	50 or 25 microseconds
Repetition rate	75 or 37.5 pps

It consists of two cabinets which contain the pulse generator (chassis No. 1), the exciter (chassis No. 2), the final amplifier (chassis No. 3) the polarization switch and pulse shaper (chassis No. 4), and six power supplies furnishing plate, screen, bias, and filament voltages. See the wanted transmitter block diagram in Figure 2.

The pulse generator (Figures 3 and 4) provides the keying voltage for the exciter. First a multivibrator (6SN7) determines the repetition rate - 75 or 37.5 pps. It is followed by a pulse amplifier (6SN7) which supplies a -100V synchronizing pulse. A cathode follower ($\frac{1}{2}$ 6SN7) leads to a second multivibrator (6BL7), which determines the pulse length of either 50 or 25 microseconds. A second cathode follower (6CD6) produces the keying pulse of about 100V amplitude. An internal power supply provides the voltages that are needed.

The exciter (Figure 5) generates and amplifies the radio frequency. It includes a 70 E-15 Collins variable frequency oscillator, followed by a doubler (12AU7), an amplifier (5763), a buffer (6146), and a driver (4-125A). A meter, in conjunction with a switch, provides a means for the measurement of various currents, and a relay protects the driver tube. In order to facilitate the initial tuning of the exciter, a cw mode of operation, at relatively low voltages, has been provided. A switch controlled relay shifts from the tune to operate condition.

The final amplifier (Figure 6) consits of two 4-250A tetrodes connected in push-pull. In operation, these tubes are characterized by the following voltages: bias -200V, screen 750V, and plate 8000V. Arrangements for cw tuning are also present. For such operation, shunts by-pass the meters so that the larger currents can be monitored.

The pulse shaper (Figure 7), essentially a multivibrator and a cathode follower, shapes the synchronizing signal, which is transferred to the receiving site by phone lines. On the same chassis, the polarization switch shifts the polarization of the wanted antenna. The polarization may be controlled from the receiving site as well as from the transmitting site.

The six power supplies shown in Figure 8 must be turned on in succession, according to the order that is properly indicated on the front of each panel. The circuit diagram of this transmitter has been derived from the diagram kindly furnished by Budelman Radio Corporation, Stamford, Conn.

Circular Polarization Unit (Figure 9)

The circular polarization unit provides an efficient means for discriminating between the ordinary and the extraordinary component of the radio wave and it offers an improvement over similar systems previously used (see Gardner and Pawsey - JATP 3, 321, 1953). Special care has been devoted to preserve the symmetry of the two parts into which the cirucit can be divided, since this symmetry is of utmost importance for correct performance. The 90 degree phase shifter has been designed to introduce no mismatch; furthermore, in order to minimize the consequences of mismatch elsewhere, the length of the twin leads going to the two pairs of dipoles has been taken as a multiple of a half wave length.

In particular, the phase shifter consists of two parallel sections of RG 8A/U cable, $\lambda/4$ or 10.4 m long. The characteristic impedance of the two parallel cables is 25 ohms. Since the impedance of the grounded side of the antenna transformers is also 25 ohms, the shifter produces a 1 to 1 impedance ratio as desired.

Two large variable condensers compensate for the self-inductance of the transformers; the circular polarization unit is properly tuned only if these condensers are adjusted at the same position, everything else being the same for the two pairs of dipoles. The primary and the secondary windings of the transformers are very efficiently shielded by a special Faraday shield woven ad hoc by Mrs. Ava Hessler.

5 Mc/s Antenna

This antenna consists of 4 dipoles arranged in a quadrangle and held 16.5 m above ground by four aluminum towers. The dipoles are fed through 1/2 wave length sections of 75 ohm Oval twin-lead, each pair of opposite dipoles being connected in parallel.

Disturbing Transmitter (Figure 10)

The disturbing transmitter has the following characteristics:

Peak radiated power	0-200 kW (at present 0-100 kW)
Frequency	17.5 Mc/s
Pulse length	50 or 25 microseconds
Repetition rate	75 or 37.5 pps

Its circuit diagram has been derived, as in the case of the wanted transmitter, from the diagrams kindly furnished by Budelman Radio Corporation, Stamford, Conn. In fact, up to the level of the two 4-250A stage (which acts as the final in the wanted transmitter and acts as the driver in the disturbing transmitter) the two transmitters are alike. The final stage for the disturbing transmitter, which utilizes four 4-100A tubes, is illustrated in Figure 10. The tubes operate in parallel push-pull under the following voltages: bias -1000V, screen 2500V(max), and plate 18000V(max).

This transmitter also has provisions for cw operation for tuning. In normal pulse operation the grid current should be about +1 mA, the plate voltage should be about 13 kV, and the plate current should be about 30 mA, with a duty factor of 0.2. The correct reading of the grid meter is obtained after subtraction of the negative current that circulates through the meter and the voltage divider, as indicated in the diagram.

The cabinet that houses the disturbing transmitter contains a Tektronix pulse generator, type 161, and a Tektronix waveform generator, type 162, that are used as a count down device to reduce the repetition frequency from 75 c/s to 37.5 c/s. The latter frequency is the desired value for operation of the disturbing transmitter.

Duplexer

The duplexer has been constructed along the lines of the prototype illustrated in Cornell University Research Report EE 219, 1954. Essentially, it is a standard duplexer with supplementary transformers, intended to increase the discrimination between firing and non-firing conditions. It is constructed with RG 17A/U cable and makes use of 1B32 tubes as spark gaps. All the "homemade" T junctions are separated by a distance corresponding to a quarter wave length (2.87)m; the spark gap tubes are located 2 m from the closest T junctions.

17.5 Mc/s Receiver

This receiver monitors the output of the disturbing transmitter and is used in connection with a lower D region backscatter experiment.

17.5 Mc/s Antenna

The 17.5 Mc/s antenna is an array of 4x4 Yagis of three elements, commercially built and connected starwise by sections of RG-34A/U cables so that they are cophased. The distance between Yagis is a wave length. They are supported by cylindrical masts which in turn are held vertically, 4 m above ground, by a wooden platform and by three guys. The beamwidth should be of the order of 12 degrees.

RECEIVING SITE

5 Mc/s Antenna

This antenna is a duplicate of the 5 Mc/s antenna at the transmitting site, except for the ground plane which in the present case is the counterpoise wire net instead of the natural ground.

Circular Polarization Unit (Figure 9)

This unit is a replica of the circular polarization unit at the transmitting site which has been described above.

5 Mc/s Super-Pro Receiver

The RF portion of this receiver is used for the reception of the wanted wave; a special wide-band circuit has been constructed for IF and audio amplification. Specifications for this receiver can be found in the manual for the Super-Pro Radio Receiver.

Wide Band IF Amplifier (Figure 11)

This amplifier is used in connection with the Super-Pro receiver and has a bandwidth sufficient for 50 or 25 microsecond pulse operation. Four standard stages (using 6BA6 tubes) amplify the intermediate frequency of 450 kc/s, which is available at the IF output. A rectifying diode produces an audio signal. A supplementary circuit (1/2 6U8) for an optional AVC is built in, and a power supply is included.

Pulse Shaper and Delay Control

The pulse shaper is a General Radio Unit Pulser type No. 1217-A, with unit power supply type 1203B. The shaper receives the 75 pps synchronizing signal from the transmitting site via one pair of phone lines and provides a 20 volt pulse which is supplied to the receiver gate and reference signal generator chassis.

The delay control for the disturbing transmitter is also a General Radio Unit Pulser type No. 1217-A with power supply type 1201-B. Its output is differentiated and sent to the disturbing transmitter via a second pair of phone lines.

Receiver Gate and Reference Signal Generator (Figure 12)

This chassis is divided into two parts as indicated by the title. The gate consists of a series of multivibrators that produce the negative pulse for the Super-Pro receiver. The reference signal generator is a count-down circuit that produces a 37.5 c/s sinusoid used in the phase sensitive detector. The same chassis furnishes the trigger pulse for the signal gate.

The input pulses (50 microseconds at a 75 pps repetition rate) are amplified by a 12AU7 stage, whose output is used as a switching voltage for the signal gate. A 12AU7 multivibrator produces a fixed delay of these pulses, which successively pass through a variable delay control (12AU7) and a width control (12AU7). The final stage of the channel is an amplifier (12AU7), whose output signal is a negative pulse that is applied to the input of the Super-Pro receiver in correspondence with the transmitter's main bang.

Another connection from the first multivibrator, mentioned above, is fed to a 12AU7 stage that provides a transformation from 50 microsecond pulses to a square wave. Filtering and amplification follow, so that a sinusoid at 37.5 c/s is available at the output of this portion of the circuit. A power supply is included.

Signal Gate (Figure 13)

The signal gate is a balanced gate, with no pedestal, which opens only in correspondence with the protion of the echo that is to be examined. The gate itself is preceded by a signal inverter required for the functioning of the gate; the position of the gate can be selected over the full range of interest. Supplementary useful information about the functioning of the circuit can be obtained from Millman, J. and T. H. Puckett - Proc. IRE, 43, 29, 1955.

A 75 pps input triggers a multivibrator (12AU7) which provides a variable delay. It is followed by a second multivibrator (12AU7) which provides the required width (a 35 microsecond width is being used at present) for the pulsed switching signal. A 6J5 that follows is concerned with the generation of two similar signals of opposite phase; each of these signals are fed into a cathode follower. The outputs of the cathode followers are connected through a biasing battery to two opposite vertices of the bridge that constitutes the gate. The four 1/2 6AL5 diodes that operate in the four branches of the bridge can be regarded as switches; they are normally kept closed by two batteries connected diagonally. A current that is proportional to the signal input may then flow through the other diagonal and generate the signal output across an appropriate resistor. The switching signals from the two cathode followers can open the four diodes of the bridge, since under their influence the bridge itself can be isolated from the direct influence of the diagonally connected batteries. The input signal voltage is clipped at a level of 8 volts. The battery voltages are 67.5 volts; an electronic power supply is included.

Selective Amplifier (Figure 14)

The output from the signal gate is a succession of 35 microsecond pulses at a repetition rate of 75 pps, alternate pulses being modulated. It is this modulation that represents the desired information. The selective amplifier has the function of detecting the modulation of the pulses. These requirements are rather strict: Linearity, extremely high selectivity, and high gain must be simultaneously achieved. Furthermore, 60 c/s voltages must be removed. The problem has been solved by integration techniques, filtering of 75 and 60 c/s with a series of resonant circuits, and selecting the 37.5 c/s signals with a series of resonant circuits. Compromises had to be adopted between the need for high Q circuits and the necessity of suppressing ringing. The tendency to ring is supported by the rather high fading rate that affects the reflected signals in auroral latitudes. Linearity, extremely high selectivity, and gain must be sufficient to produce an output of at least 0.5 V, nearly sinusoidal and unaffected by phase modulation. The input pulse at 75 pps repetition rate has an amplitude of about 1 V.

A 6BF6 tube at the input of the selective amplifier provides some amplification and is followed by an RC smoothing circuit. A 6BF6 cathode follower serves as a buffer, and a third 6BF6 operates as another amplifier. A series of integrating circuits then alternate with amplifier stages (1/2 12AU7, 6C4, 1/2 12AU7). Included here is a trap for 60 c/s which also works for 75 c/s.

From this point one notices a cathode follower (6BF6); a series resonant system operating at 37.5 c/s, an RC integrator, an amplifier, a cathode follower, a second series resonant system at 37.5 c/s, a filter for the low frequencies of the fading component, and a final amplifier (6AQ5). Special items used in the circuit are the low frequency high Q coils employed in the series resonant circuits: namely UTC - MQL - 3 - 200 H coils. A separate commercial power supply is used.

Phase Sensitive Dector (Figure 15)

The phase sensitive detector uses a bridge circuit in which the reference signal is applied to one diagonal and the input signal is applied to the other diagonal. It is provided with a continuous phase control and a phase switch, so that signals of any phase may be detected. The same chassis has a dc amplifier that increases the level of the integrated dc signal.

The incoming reference signal is amplified (1/2 12AU7) and passes through a phase shifter (1/2 12AU7) and a final amplifier (6AQ5). The bridge uses four 1/2 6AL5 diodes. The dc amplifier utilizes a 12AU7 tube. Five different time constants are available: 2 sec, 4 sec, 10 sec, 20 sec, and 40 sec.

E. A. Recorder

The recorder used is a one milliamp Esterline-Angus chart recorder, operated with a paper speed of 12 inches per hour.

17.5 Mc/s Collins Receiver

For the purpose of detecting the ground wave of the disturbing transmitter at the receiving site, a simple dipole antenna and a 51J Collins receiver have been installed. The ground wave is utilized in connection with measurements of the height of the interaction.

Scope Unit

The oscilloscope is a standard Tektronix Double-beam oscilloscope, type 454A. Two signals are fed into it: the ground wave from the distrubing transmitter and the output of the signal gate. The delay between the two is proportional to the height of interaction, if any, between the two radio waves. It is possible to operate on a scale with 1/5 cm divisions which are equivalent to three kilometers.

Calibration

Calibration of the equipment has been obtained by two different approaches. First, a modulation has been applied to the last stage of the wanted transmitter, the modulating voltage being furnished to the screens of the two 4-250A tubes via a transformer. The amount of modulation that is produced is measured by observing the output signal of the transmitter on an oscilloscope. The ground wave transfers this modulation to the receiving site and the ratio

$$\frac{\text{deflection of the Esterline-Angus pen}}{\text{amplitude of the pulse entering the selective amplifier}}$$

is then measured.

A second approach to the calibration has been followed. Accordingly, the ratio

$$\frac{\text{deflection of the Esterline-Angus pen expressed in No. of chart divisions}}{\text{amplitude of pulses entering the selective amplifier at } \underline{37.5} \text{ pps}}$$

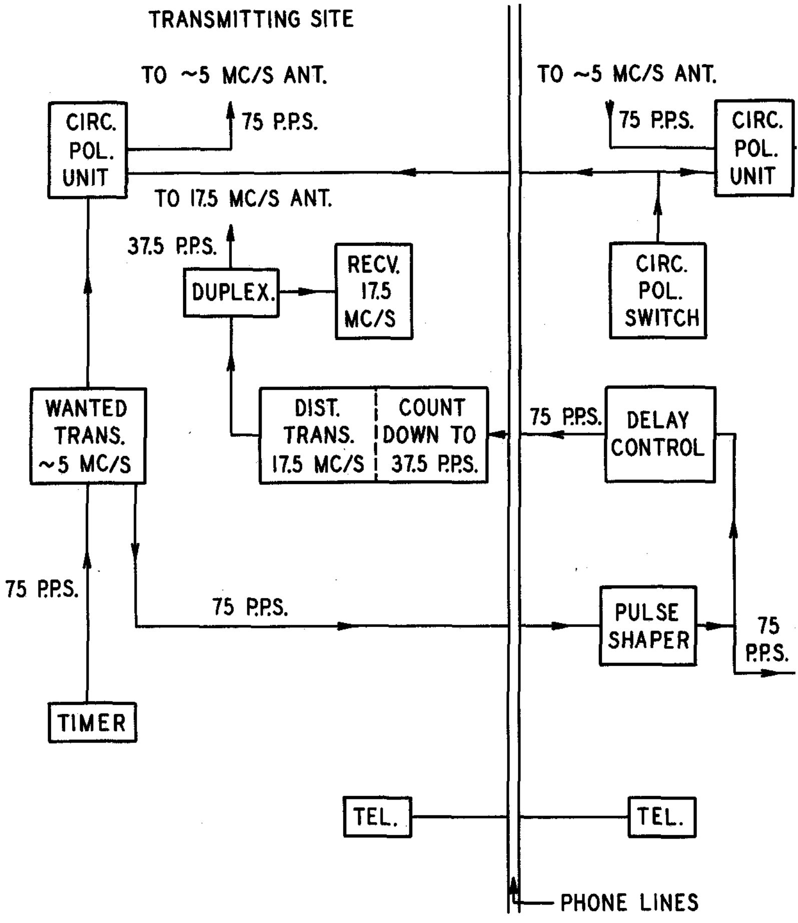
is measured. Then any deflection of the pen can be translated into a definite amplitude of the modulating signal at the input of the selective amplifier. In actual operation an oscilloscope connected to the input of the selective amplifier reads the amplitude of the unmodulated signal at 75 pps, the modulation being so small that it is insignificant from this point of view. The ratio of the modulating signal amplitude, measured in terms of the pen's deflection and translated into volts at the input of the selected amplifier, to the amplitude of the input pulses, observed on the oscilloscope, is the amount of cross-modulation. For a one volt input to the selective amplifier, the minimum detectable cross-modulation is approximately 1×10^{-4}. It is absolutely necessary to operate in the linear range of the equipment when this approach to the calibration is followed.

Results

Some values of electron density and collision frequency have been obtained and will be discussed in following publications.

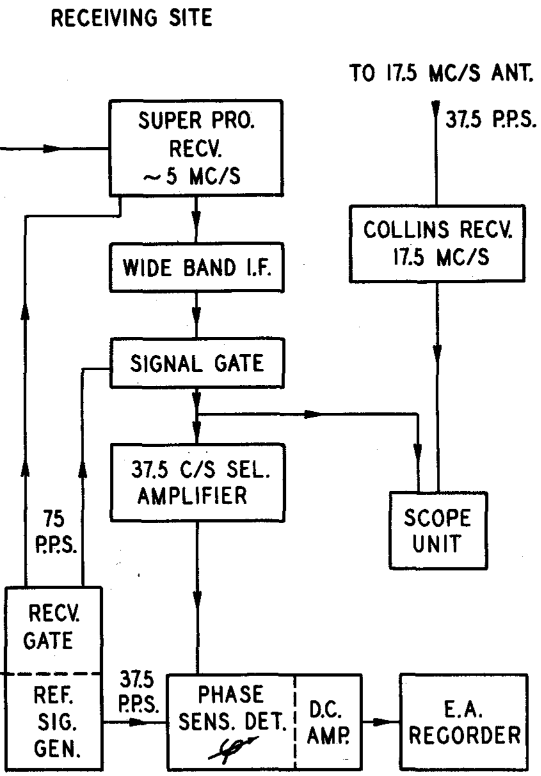
Acknowledgements

The substantial contribution of Mr. Peter Michalow in developing, adjusting, and testing a great part of the equipment described in this report is gladly acknowledged.



TRANSMITTING SITE
TO ~5 MC/S ANT.
75 P.P.S.
CIRC. POL. UNIT
TO 17.5 MC/S ANT.
37.5 P.P.S.
DUPLEX.
RECV. 17.5 MC/S
WANTED TRANS. ~5 MC/S
DIST. TRANS. 17.5 MC/S
COUNT DOWN TO 37.5 P.P.S.
75 P.P.S.
75 P.P.S.
TIMER
TEL.
TO ~5 MC/S ANT.
75 P.P.S.
CIRC. POL. UNIT
CIRC. POL. SWITCH
75 P.P.S.
DELAY CONTROL
PULSE SHAPER
75 P.P.S.
TEL.
PHONE LINES

FIG. 1



EXPERIMENT LUXEMBOURG	
BLOCK DIAGRAM	COLLEGE NOV. 1960

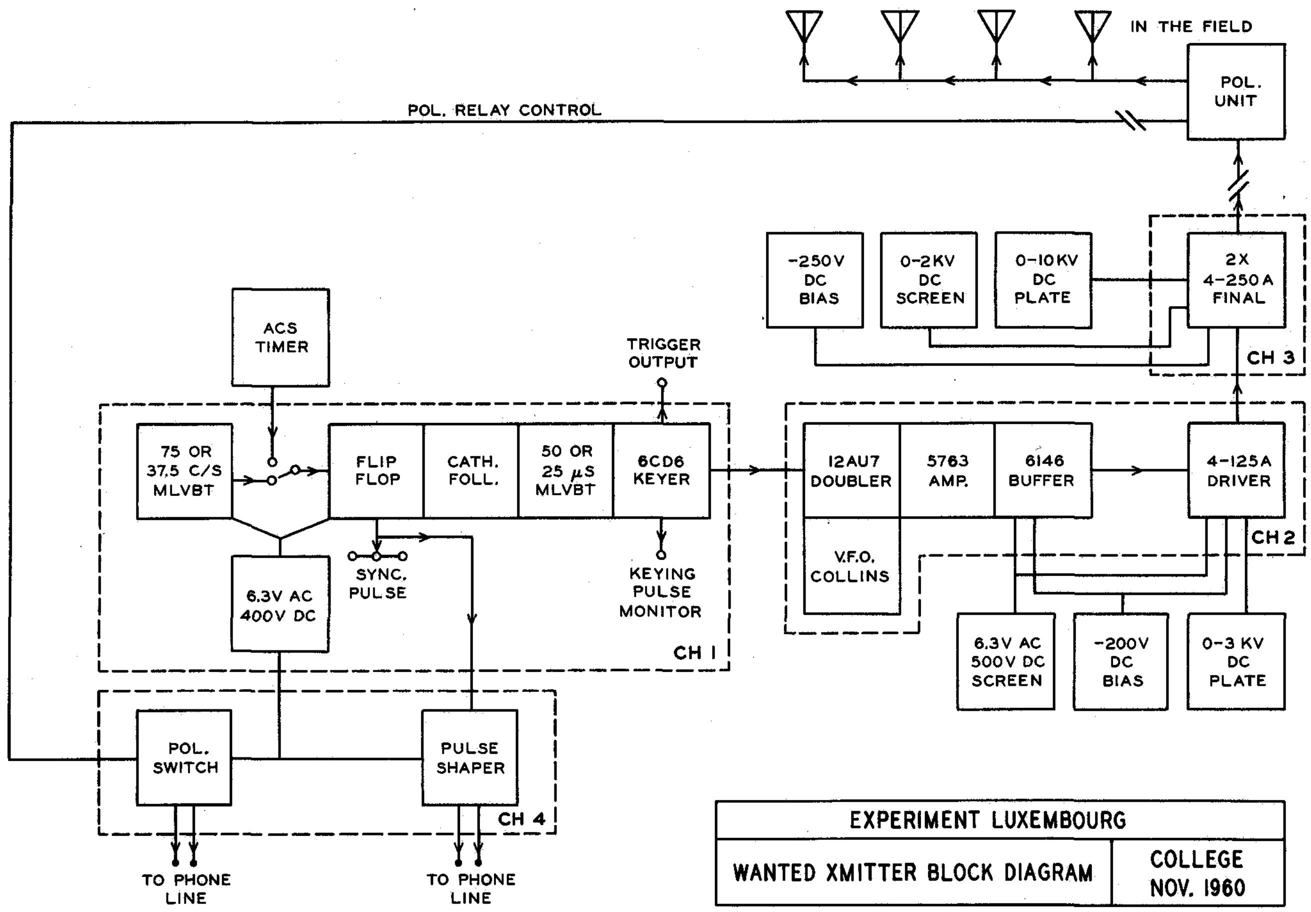

IN THE FIELD
POL. UNIT
POL. RELAY CONTROL
-250V DC BIAS
0-2KV DC SCREEN
0-10KV DC PLATE
2X 4-250A FINAL
CH 3
ACS TIMER
TRIGGER OUTPUT
75 OR 37.5 C/S MLVBT
FLIP FLOP
CATH. FOLL.
50 OR 25 μS MLVBT
6CD6 KEYER
12AU7 DOUBLER
5763 AMP.
6146 BUFFER
4-125A DRIVER
CH 2
V.F.O. COLLINS
SYNC. PULSE
6.3V AC 400V DC
KEYING PULSE MONITOR
CH 1
6.3V AC 500V DC SCREEN
-200V DC BIAS
0-3 KV DC PLATE
POL. SWITCH
PULSE SHAPER
CH 4
TO PHONE LINE
TO PHONE LINE
EXPERIMENT LUXEMBOURG
WANTED XMITTER BLOCK DIAGRAM
COLLEGE NOV. 1960

FIG. 2

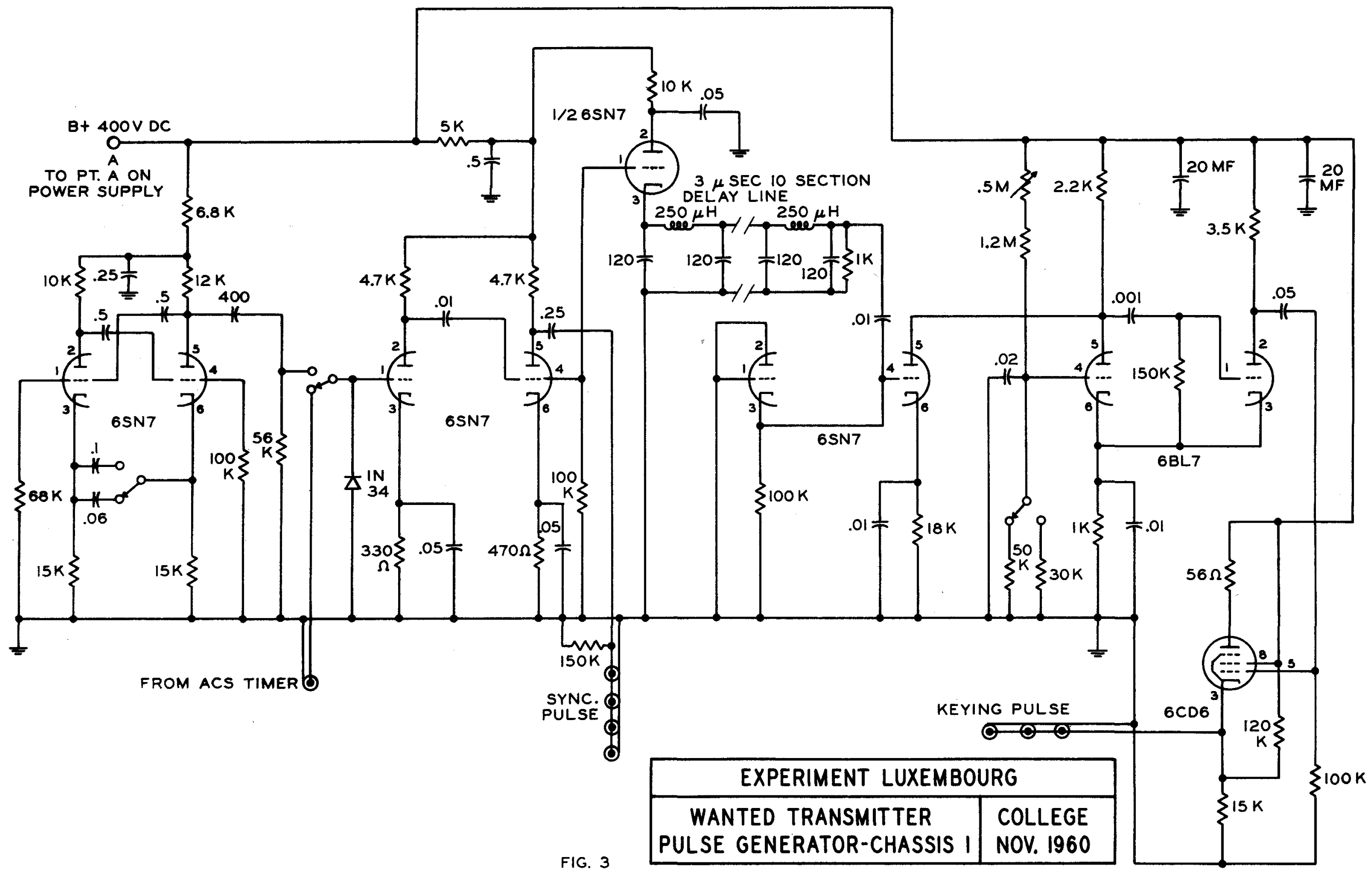

B+ 400V DC
A
TO PT. A ON
POWER SUPPLY
5K
.5
6.8K
10K
.25
12K
.5
400
6SN7
.1
.06
68K
15K
15K
100 K
56 K
FROM ACS TIMER
IN 34
4.7K
.01
4.7K
.25
6SN7
330 Ω
.05
470Ω
.05
100 K
150K
SYNC. PULSE
10 K
.05
1/2 6SN7
3 μ SEC 10 SECTION DELAY LINE
250 μH
250 μH
120
120
120
120
1K
.01
6SN7
100 K
.01
18K
.5M
1.2M
2.2K
20 MF
20 MF
3.5K
.001
.05
.02
150K
6BL7
50 K
30K
1K
.01
56Ω
6CD6
120 K
15 K
100 K
KEYING PULSE
EXPERIMENT LUXEMBOURG
WANTED TRANSMITTER
PULSE GENERATOR-CHASSIS I
COLLEGE
NOV. 1960

FIG. 3

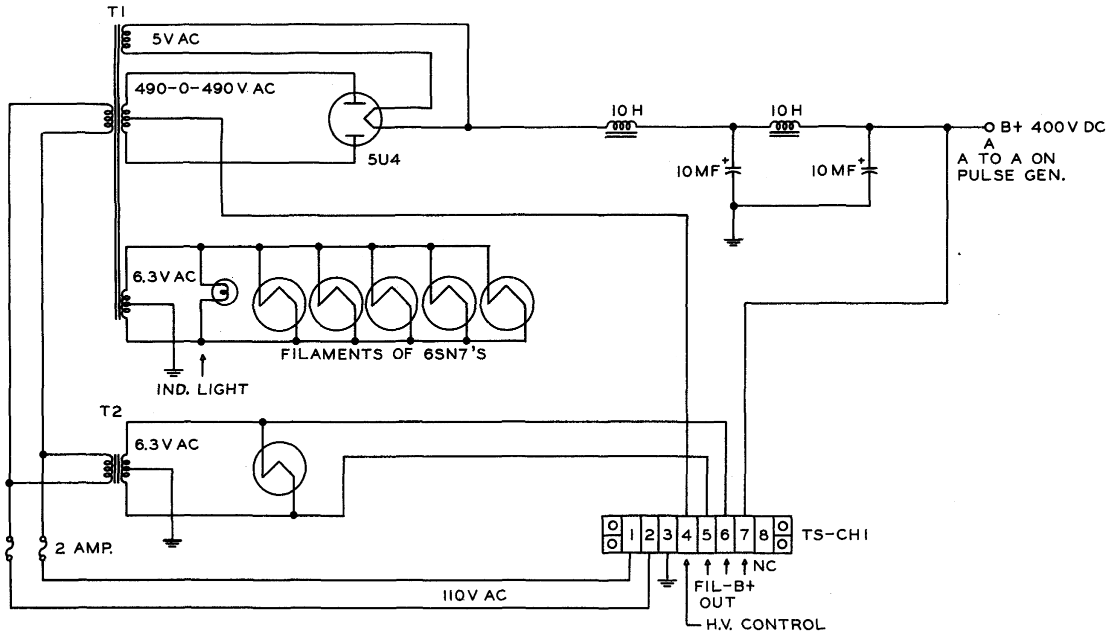
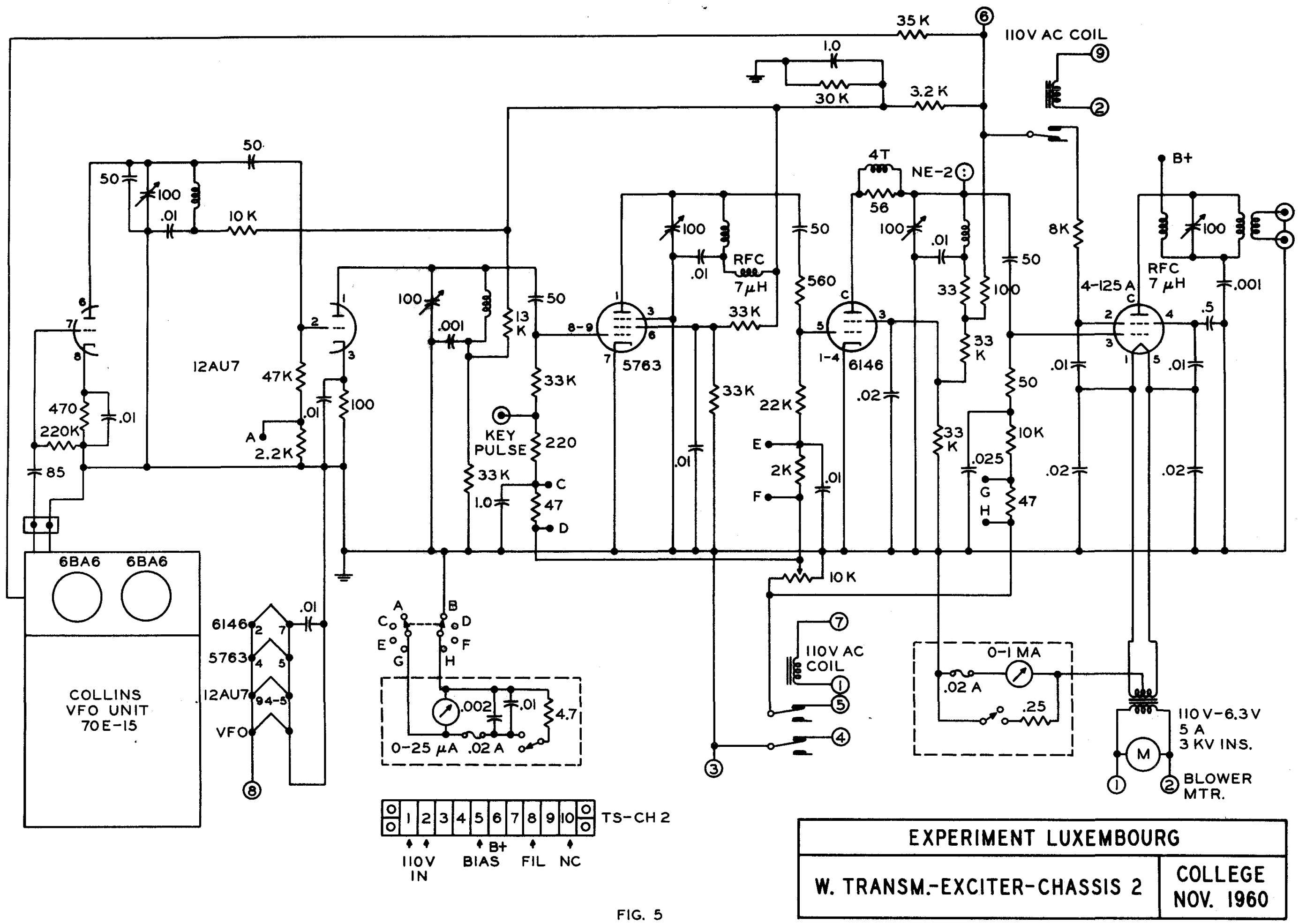


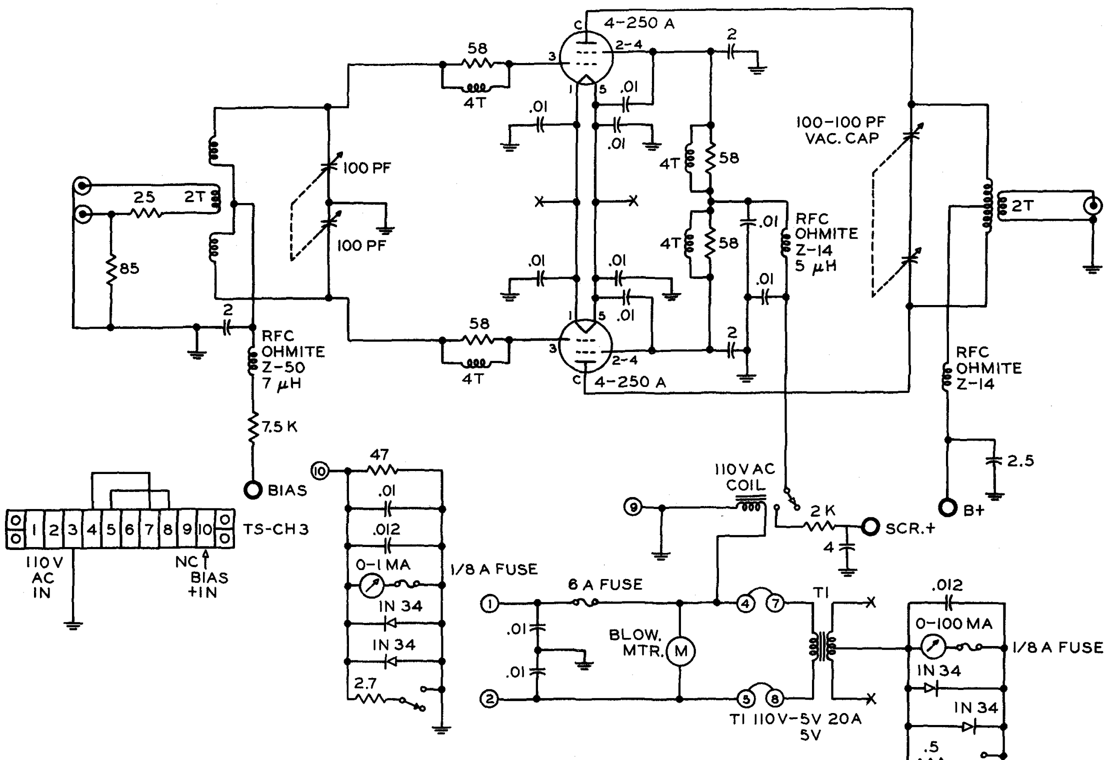
FIG. 4

EXPERIMENT LUXEMBOURG	
WANTED TRANSMITTER PULSE GEN. POWER SUPPLY-CHASSIS I	COLLEGE NOV. 1960



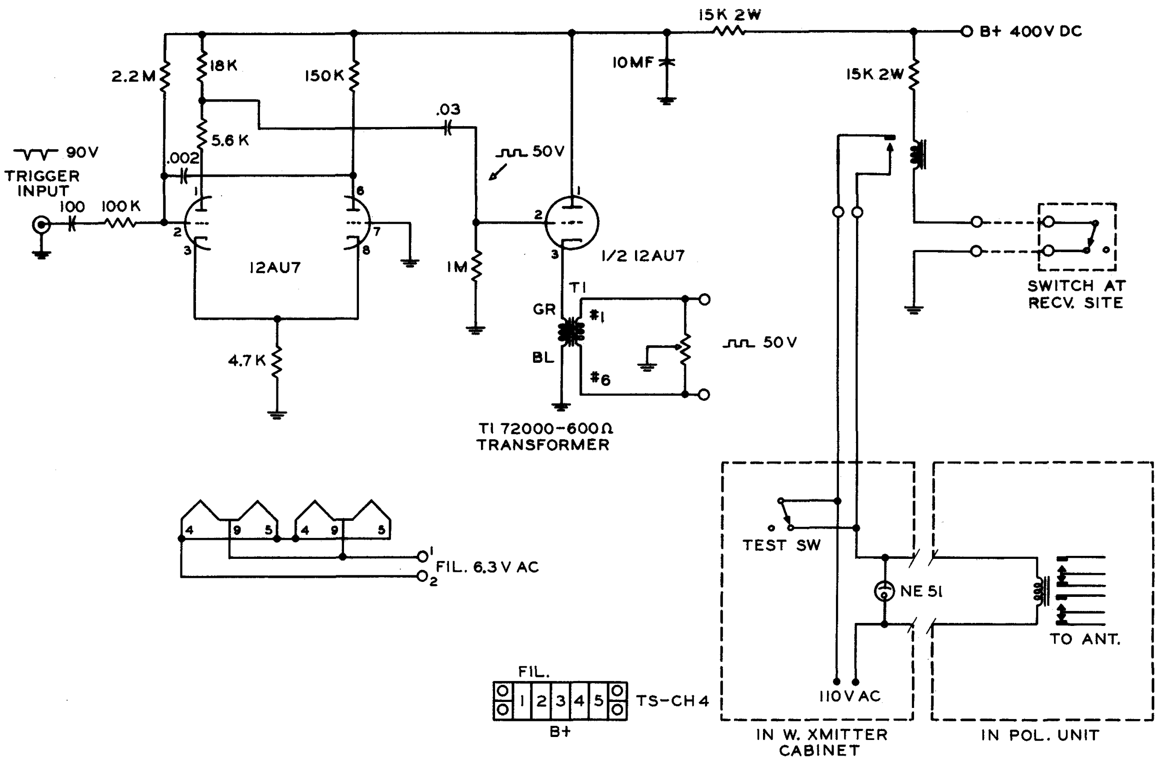
35 K
110V AC COIL
1.0
30 K
3.2 K
50
50
100
.01
10 K
12AU7
47K
A
2.2K
.01
100
470
220K
.01
85
100
.001
13 K
50
KEY PULSE
33K
220
33K
1.0
C
47
D
8-9
5763
100
.01
RFC 7μH
33K
.01
33K
50
560
22K
E
2K
F
.01
10 K
4T
56
NE-2
6146
1-4
.02
100
.01
33
100
33 K
50
33 K
.025
10K
G
H
47
8K
4-125 A
B+
RFC 7 μH
100
.001
.5
.01
.02
.01
.02
6BA6
6BA6
COLLINS VFO UNIT 70E-15
6146
5763
12AU7
VFO
.01
0-25 μA
.02 A
.002
.01
4.7
110V AC COIL
0-1 MA
.02 A
.25
110V-6.3V 5 A 3 KV INS.
BLOWER MTR.
TS-CH 2
110V IN
BIAS
B+
FIL
NC
EXPERIMENT LUXEMBOURG
W. TRANSM.-EXCITER-CHASSIS 2
COLLEGE NOV. 1960

FIG. 5



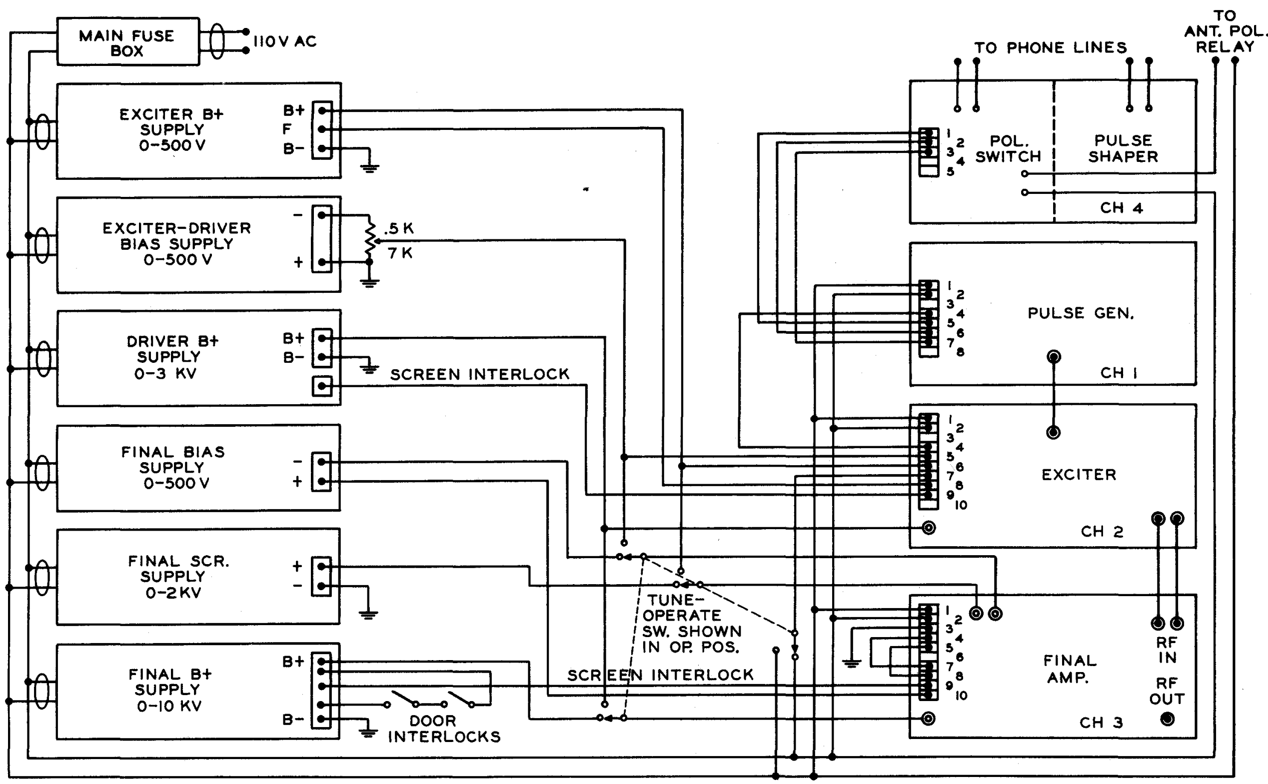
EXPERIMENT LUXEMBOURG	
WANTED XMITTER FINAL AMPLIFIER - CHASSIS 3	COLLEGE NOV. 1960

FIG. 6



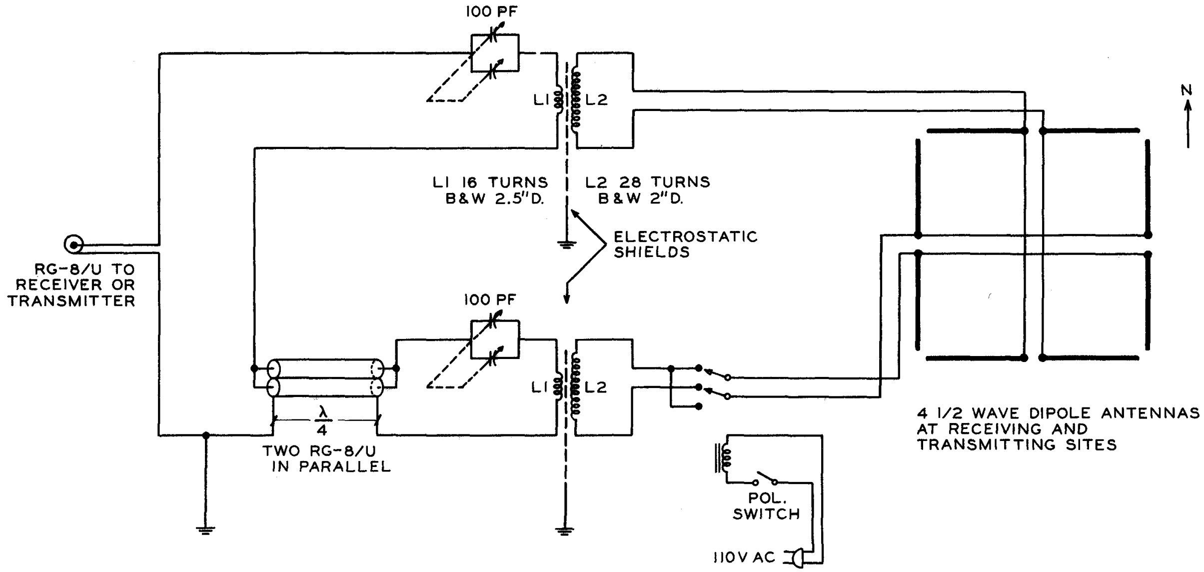
EXPERIMENT LUXEMBOURG	
W.T.-POL. SWITCH AND PULSE SHAPER-CH 4	COLLEGE NOV. 1960

FIG. 7



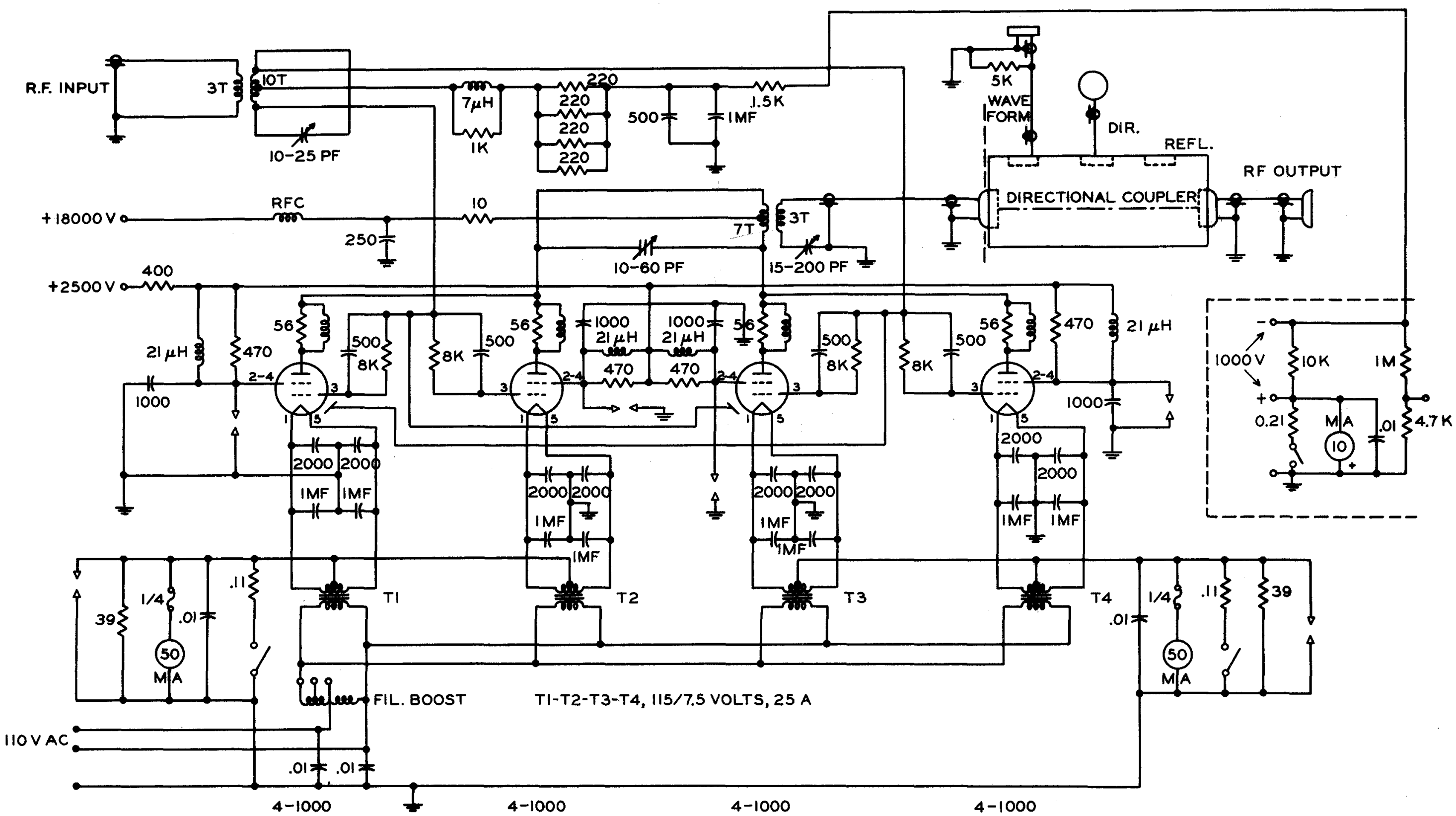
EXPERIMENT LUXEMBOURG	
W. XMITTER-INTERCONNECTIONS	COLLEGE NOV. 1960

FIG. 8



EXPERIMENT LUXEMBOURG	
CIRCULAR POLARIZATION UNITS	COLLEGE NOV. 1960

FIG. 9



EXPERIMENT LUXEMBOURG	
DIST. XMITTER-FINAL	COLLEGE NOV. 1960

FIG. 10

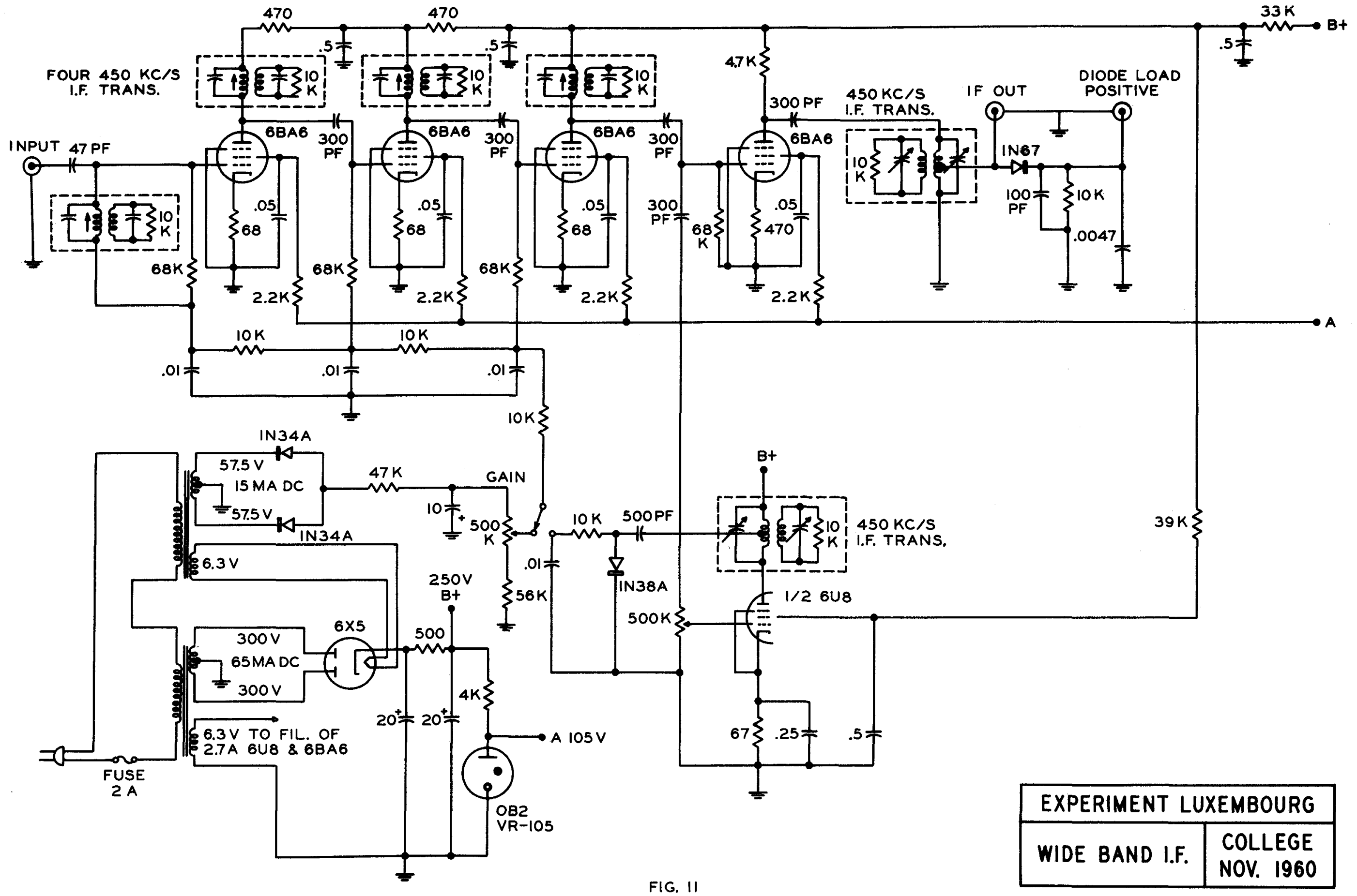


FIG. 11

EXPERIMENT LUXEMBOURG	
WIDE BAND I.F.	COLLEGE NOV. 1960

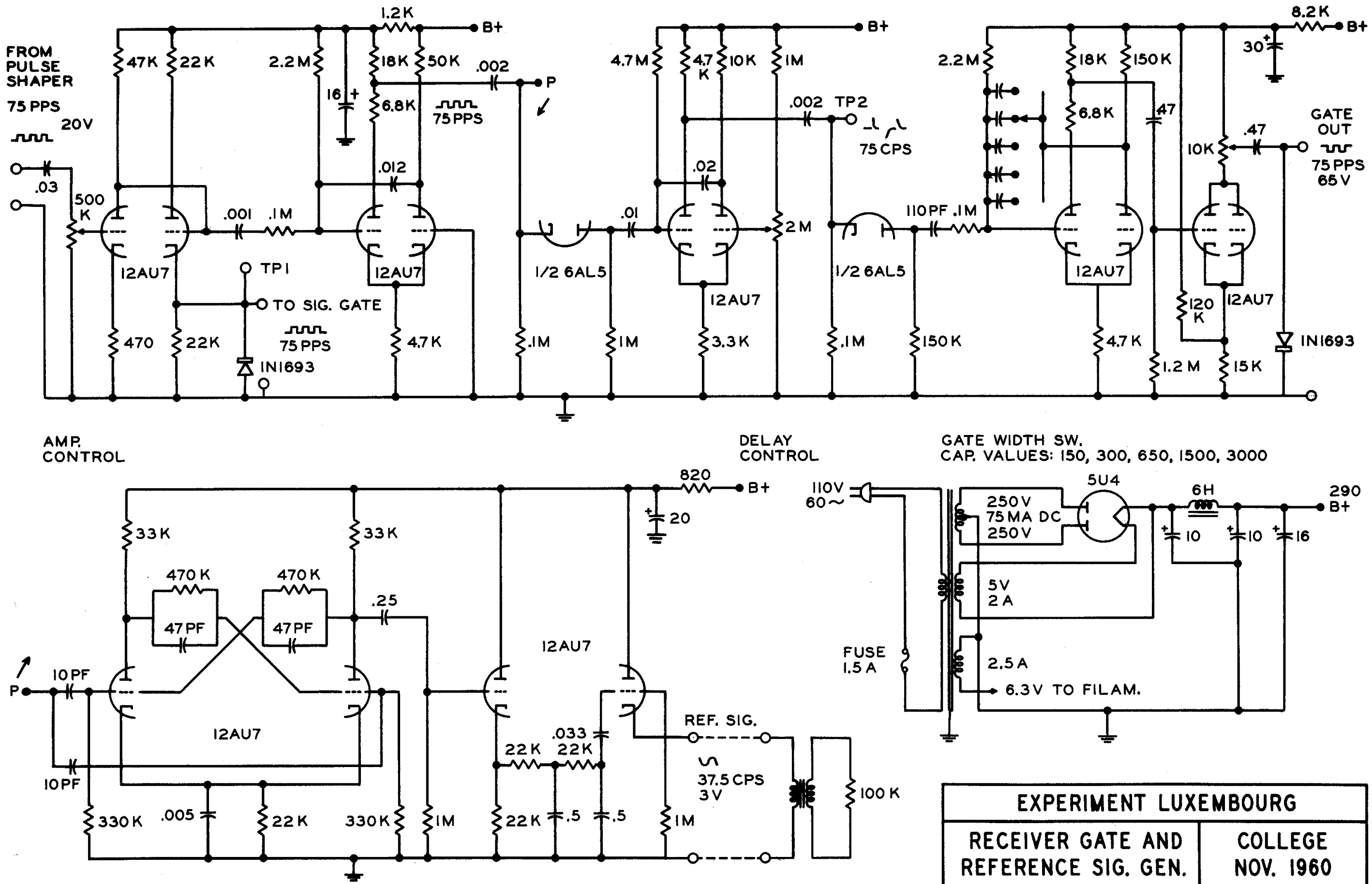

FROM PULSE SHAPER
75 PPS
20V
.03
500 K
47K
22K
12AU7
470
22K
AMP. CONTROL
.001
.1M
TP1
TO SIG. GATE
75 PPS
1N1693
2.2M
16
1.2K
B+
18K
50K
6.8K
.002
P
75 PPS
.012
12AU7
4.7K
1/2 6AL5
.1M
1M
.01
4.7M
4.7 K
10K
1M
.02
12AU7
3.3K
2M
DELAY CONTROL
.002
TP2
75 CPS
1/2 6AL5
.1M
110PF
150K
2.2M
18K
150K
6.8K
.47
12AU7
4.7K
1.2 M
GATE WIDTH SW.
CAP. VALUES: 150, 300, 650, 1500, 3000
8.2K
30
10K
GATE OUT
75 PPS
65 V
120 K
15K
1N1693
33K
470K
47PF
.25
10PF
12AU7
330K
.005
22K
820
20
.033
.5
REF. SIG.
37.5 CPS
3 V
100 K
110V
60~
FUSE
1.5 A
250V
75 MA DC
5V
2 A
2.5 A
6.3V TO FILAM.
5U4
6H
10
16
290
EXPERIMENT LUXEMBOURG
RECEIVER GATE AND
REFERENCE SIG. GEN.
COLLEGE
NOV. 1960

FIG. 12

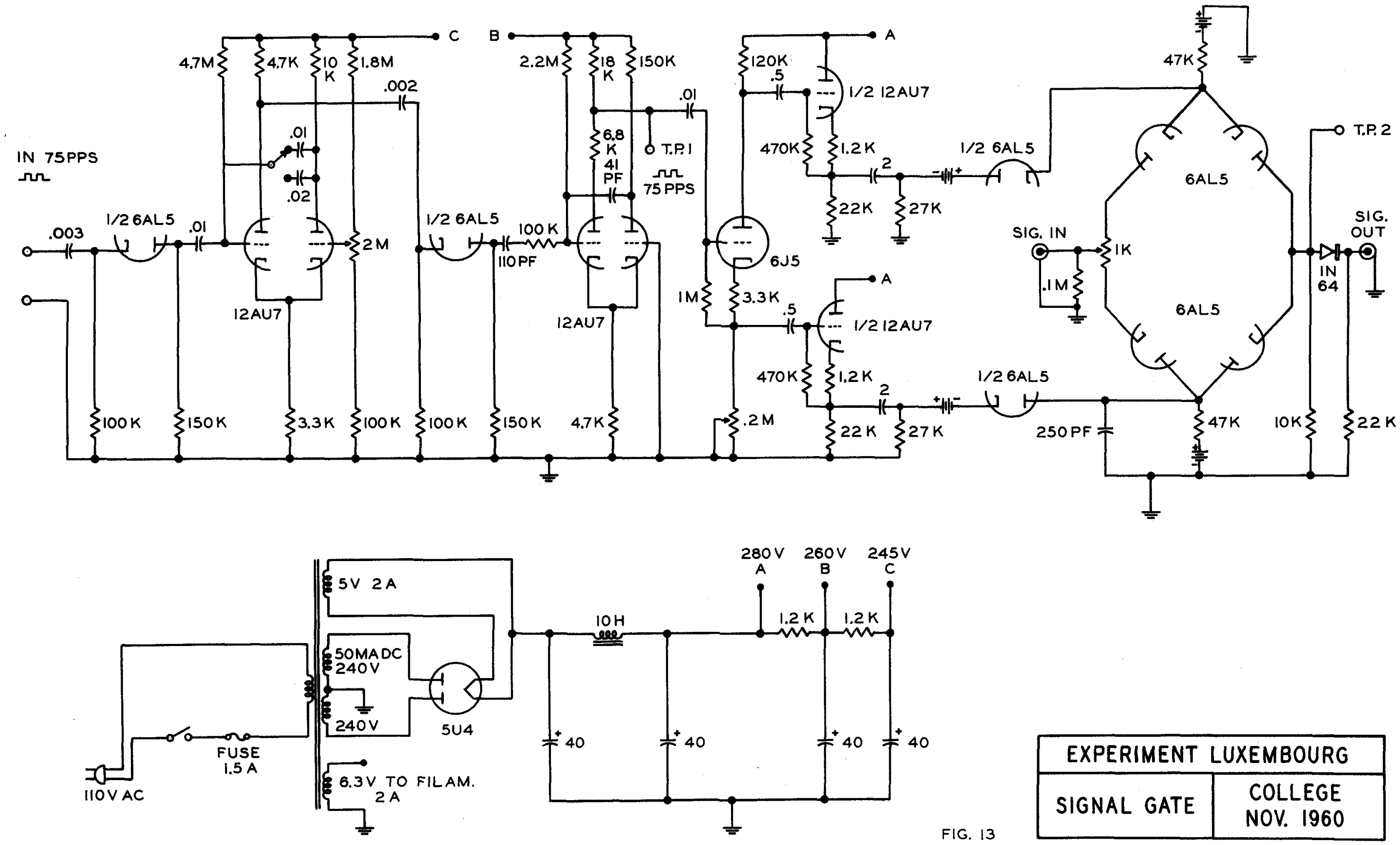


FIG. 13

EXPERIMENT LUXEMBOURG	
SIGNAL GATE	COLLEGE NOV. 1960

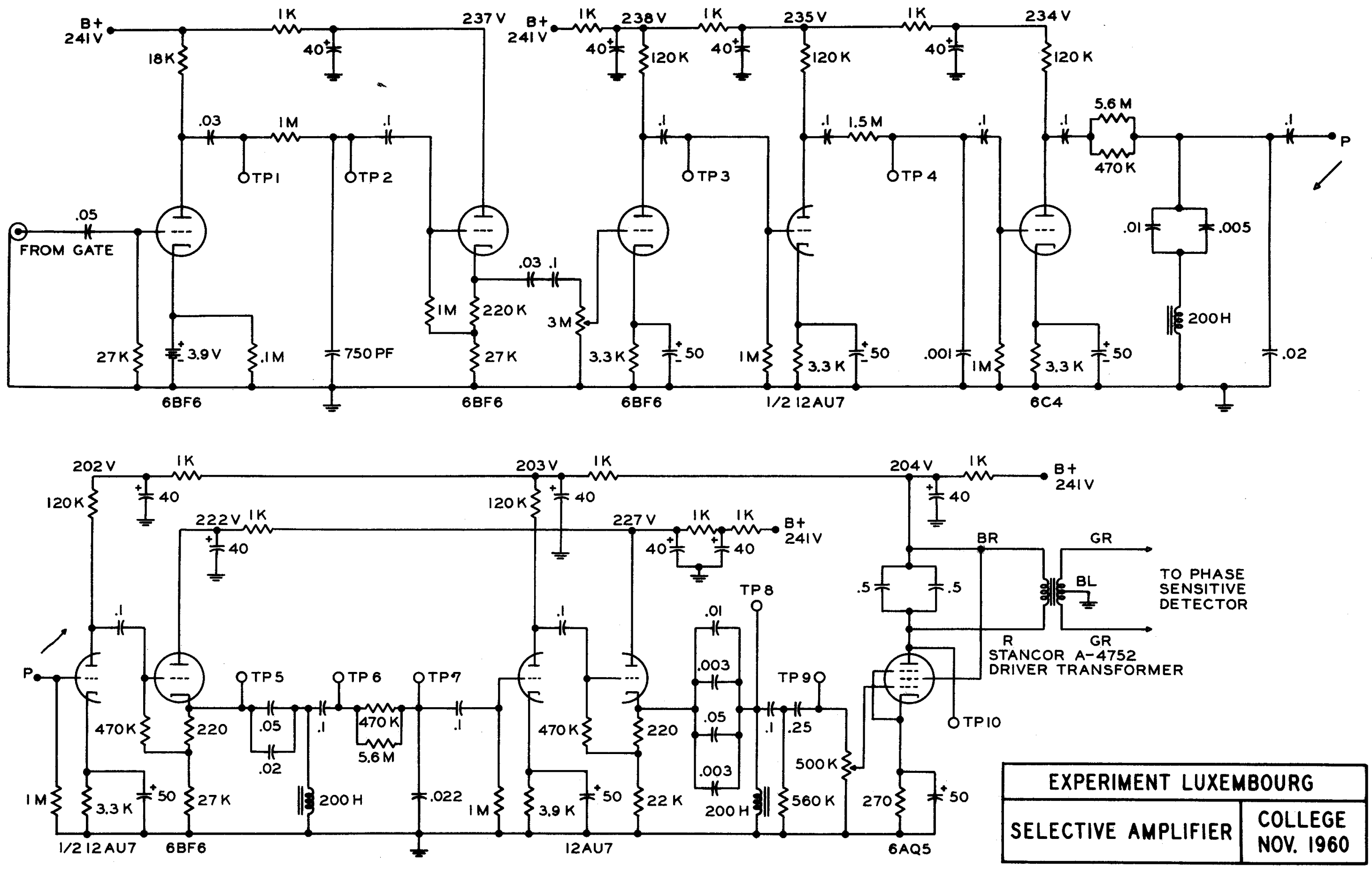

B+ 241V
1K
18K
40
237V
238V
235V
234V
120K
.03
1M
.1
TP1
TP2
TP3
TP4
1.5M
5.6M
470K
P
.05
FROM GATE
27K
3.9V
.1M
750PF
220K
3M
3.3K
.50
.001
.01
.005
200H
.02
6BF6
1/2 12AU7
6C4
202V
203V
204V
222V
227V
TP5
TP6
TP7
TP8
TP9
TP10
.25
.003
.022
220
22K
3.9K
560K
500K
270
12AU7
6AQ5
BR
GR
BL
R
TO PHASE SENSITIVE DETECTOR
STANCOR A-4752 DRIVER TRANSFORMER
EXPERIMENT LUXEMBOURG
SELECTIVE AMPLIFIER
COLLEGE NOV. 1960

FIG. 14

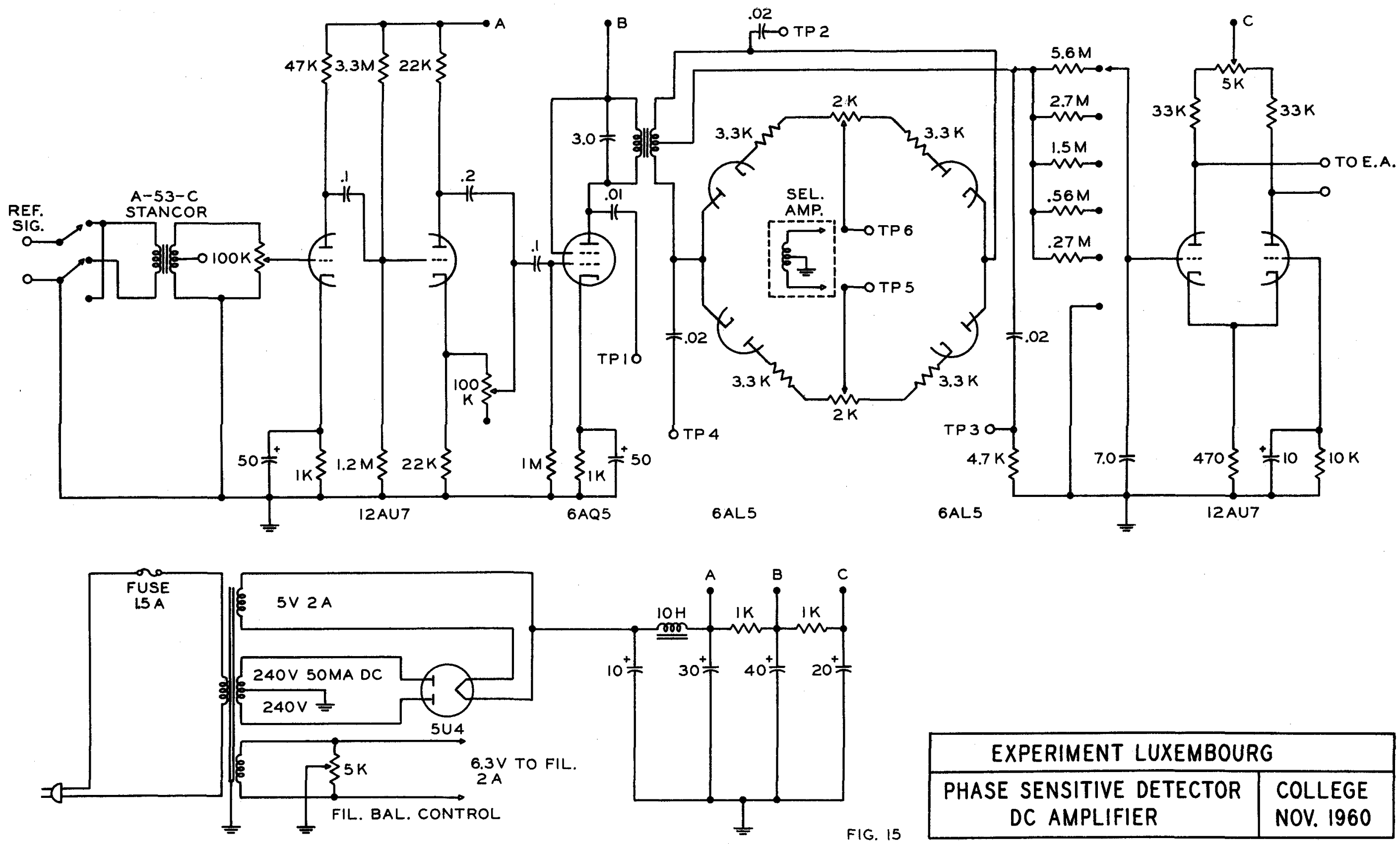


FIG. 15

EXPERIMENT LUXEMBOURG	
PHASE SENSITIVE DETECTOR DC AMPLIFIER	COLLEGE NOV. 1960