NATIONAL RADIO ASTRONOMY OBSERVATORY
Green Bank, West Virginia

Electronics Division Internal Report No. 32

AIL PARAMETRIC AMPLIFIER, MODEL 2877

Dewey Ross

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I. General:

The AIL Model 2877 parametric amplifier is a voltage-tunable, low noise parametric amplifier. A tuning range of 1390 Mc to 1420 Mc is achieved by adjusting the DC bias on the diodes.

II. Measurements:

A. Bandpass

A block diagram of the measurement system is shown in figure 1. Test results are given on page 4.

B. Gain

Two methods of measuring gain were used and are shown in figures 2 and 3. Test results are given on page 4.

C. Noise Figure

Noise figures were measured with an argon source and the AIL Hot-Cold Source. Figure 4 shows the block diagram of the system used and the test results are given on page 4.

In addition to using the argon source (10,000 °K) and the AIL Hot-Cold Source (373 °K hot and 77° cold) we also measured the noise figure using a load whose temperature was 77° K cold and then warmed to 290 °K. A block diagram is shown in figure 4.

Results of the latter measurements are:

System temperature =	107°
Second stage	15°
Paramp temperature =	92°

Noise measurements were computed using the following formula

1. Noise figure = $10 \log (.734 + \frac{1.02}{Y-1})$

   where Y is the Y factor measured.

2. Receiver temperature in °K

$$TR = \frac{T_1 - YT_2}{Y - 1}$$

where T_1 = hot load temperature,

T_2 = cold load temperature, and

Y = the power ratio between receiver output at T_1 and T_2.

D. Noise Figure vs. Temperature

Results are shown in figure 5. These measurements were made as shown in the block diagram (fig. 4).

E. Analog Output as a Function of Thermal Temperature Change

For this measurement the paramp was operated in an environmental diameter while the second stage was kept at room temperature, which was approximately 30 °C. Results are shown in figures 10 and 11.

F. Analog Output as a Function of Change in Line Voltage

For this measurement the paramp line voltage was changed by means of a Variac. Results are shown in figures 12 and 13.

Tested by D. Ross

TEST REPORT
ON
PARAMETRIC AMPLIFIER

Made by Airborne Instruments Laboratory (AIL) Type 2877, SN 1

Frequency 1410 Mc Price $11,330.00

Information from the Manufacturer

Center frequency 1410 Mc

Bandwidth 21.5 Mc

Noise temperature 75 °K

with second stage NF 10 dB

Phase stability ---

Diode manufacturer Micro State Electronics Corporation, Type MS 2506

Capacitance .4 pF ± -- pF at 0 V bias

Cut-off frequency > 190 kMc

β = _____

Diode current _____ μA

Pump frequency 11.9 kMc ± _____ Mc

Klystron type Varian X-13

Frequency range 8.1 - 12.4 kMc

Beam voltage 500 V

Beam current ≈ 48 mA

Repeller voltage ≈ 400 V

Heater voltage 6.3 V V

Heater current --- mA

Isolator type Western Microwave, LNL 116 Ports 4

Test Results

Center frequency 1420 Mc measured with FXR

Bandwidth 3 dB points 26 Mc

Gain 17 dB

Noise Temperature Measured with Hot-Cold Method

System T_e at center frequency 120 °K

System T_e at upper 3 dB point 110 °K

System T_e at lower 3 dB point 140 °K

Second stage bandwidth 8 Mc

Second stage NF 220 °K *

Paramp gain 17 dB °K

Calculated paramp T_e 90 °K

Noise Figure Measurement with Argon Noise Tube

System T_e at center frequency 95 °K

System T_e at upper 3 dB point 130 °K

System T_e at lower 3 dB point 150 °K

Second stage bandwidth 8 Mc

Attenuator between noise source and amplifier

10 dB -- dB

Second stage T_e 220 °K

Paramp gain 17 dB

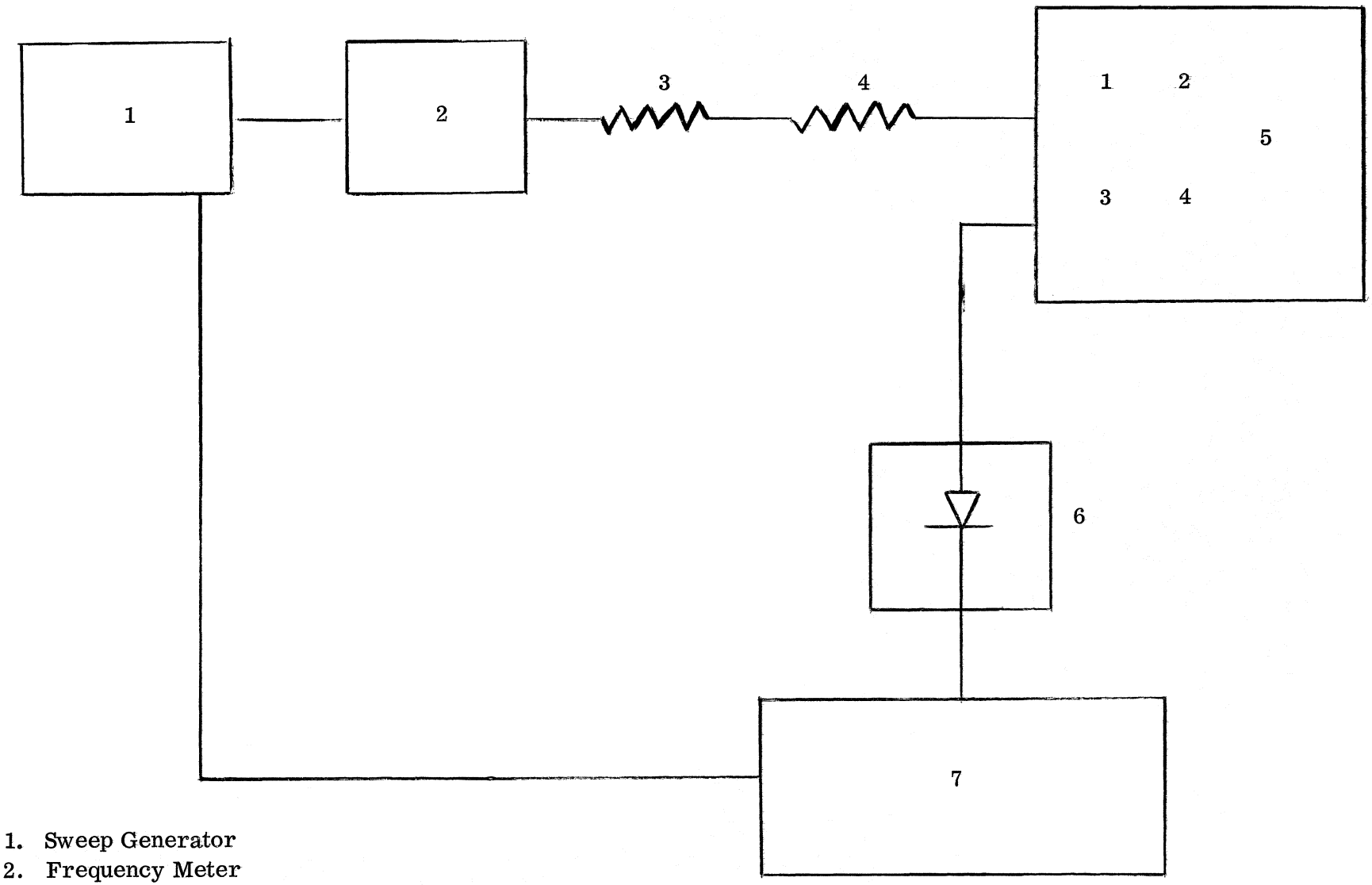
C Calculated paramp T_e 79.6 °K

Phase stability _____

* Using MPC parametric amplifier as second stage.

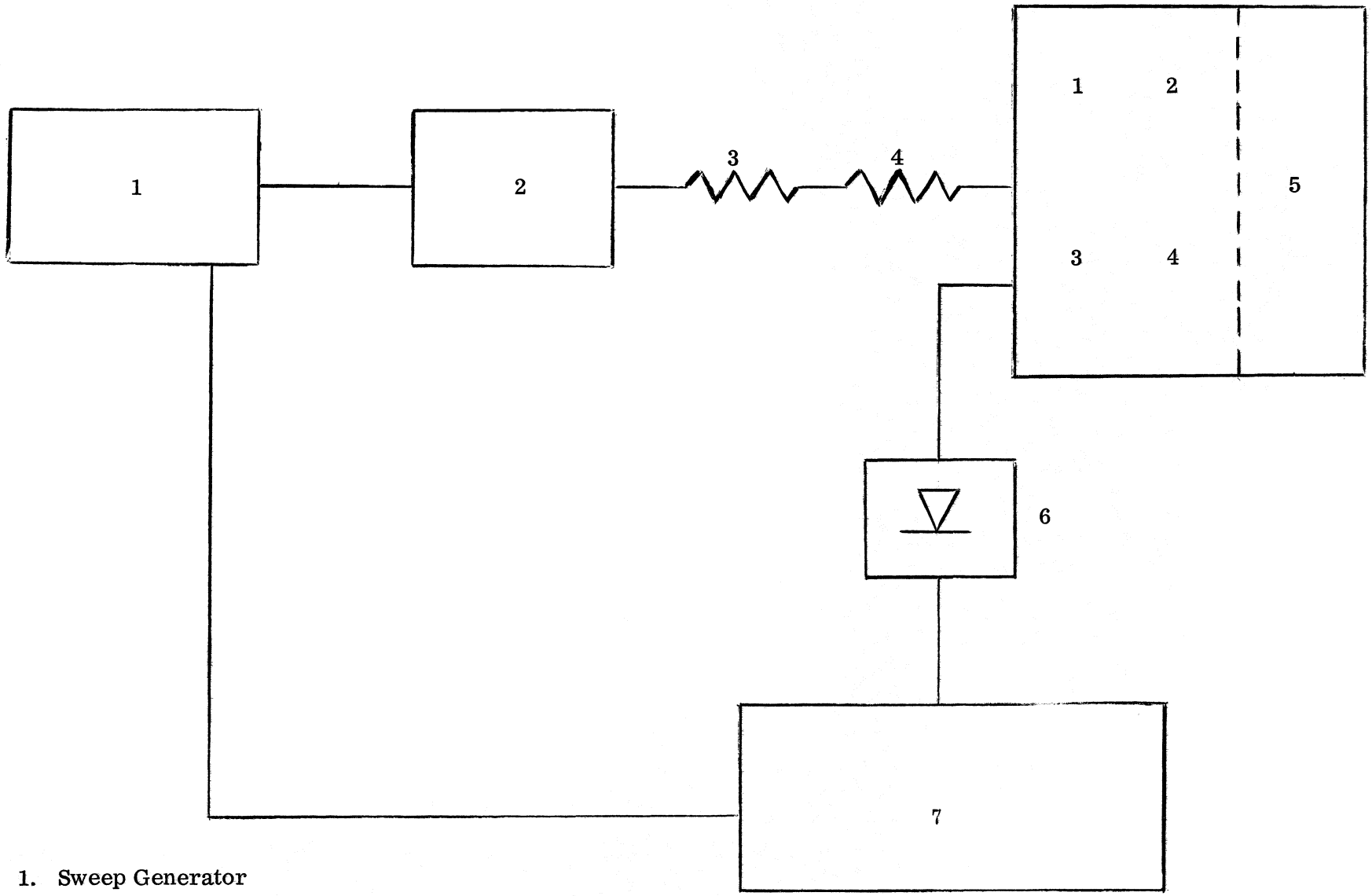
LIST OF RECORDS FROM NRAO STANDARD RECEIVER WITH PARAMP FRONT END

Fig.	
6A	Switched receiver ---- two 300° loads
6B	Total power record --- two 300° loads
7A	Switched receiver ---- 77° and 300° loads
7B	Total power record --- 77° and 300° loads
8A	Switched receiver ---- two 300° loads with paramp in constant temp. 28 °C $\pm$ .2 °C
8B	Total power record --- two 300° loads with paramp in constant temp. 28 °C $\pm$ .2 °C
9A	Switched receiver ---- 77° and 300° loads with paramp in constant temp. 28 °C $\pm$ .2 °C
9B	Total power record --- 77° and 300° loads with paramp in constant temp. 28 °C $\pm$ .2 °C
10A	Switched receiver ---- two 300° loads ambient temp. varied from 0 °C to 40 °C
10B	Total power record --- two 300° loads ambient temp. varied from 0 °C to 40 °C
11A	Switched receiver ---- 77° and 300° loads ambient temp. varied from 0 °C to 40 °C
11B	Total power record --- 77° and 300° loads ambient temp. varied from 0 °C to 40 °C
12A	Switched receiver ---- 300° loads and line voltage changed in 10 V steps from 100 to 130 V
12B	Total power record--- 300° loads and line voltage changed in 10 V steps from 100 to 130 V
13A	Switched receiver ---- 77° and 300° loads and line voltage changed in 10 V steps from 100 V to 130 V
13B	Total power record --- 77° and 300° loads and line-voltage changed in 10 V steps from 100 V to 130 V



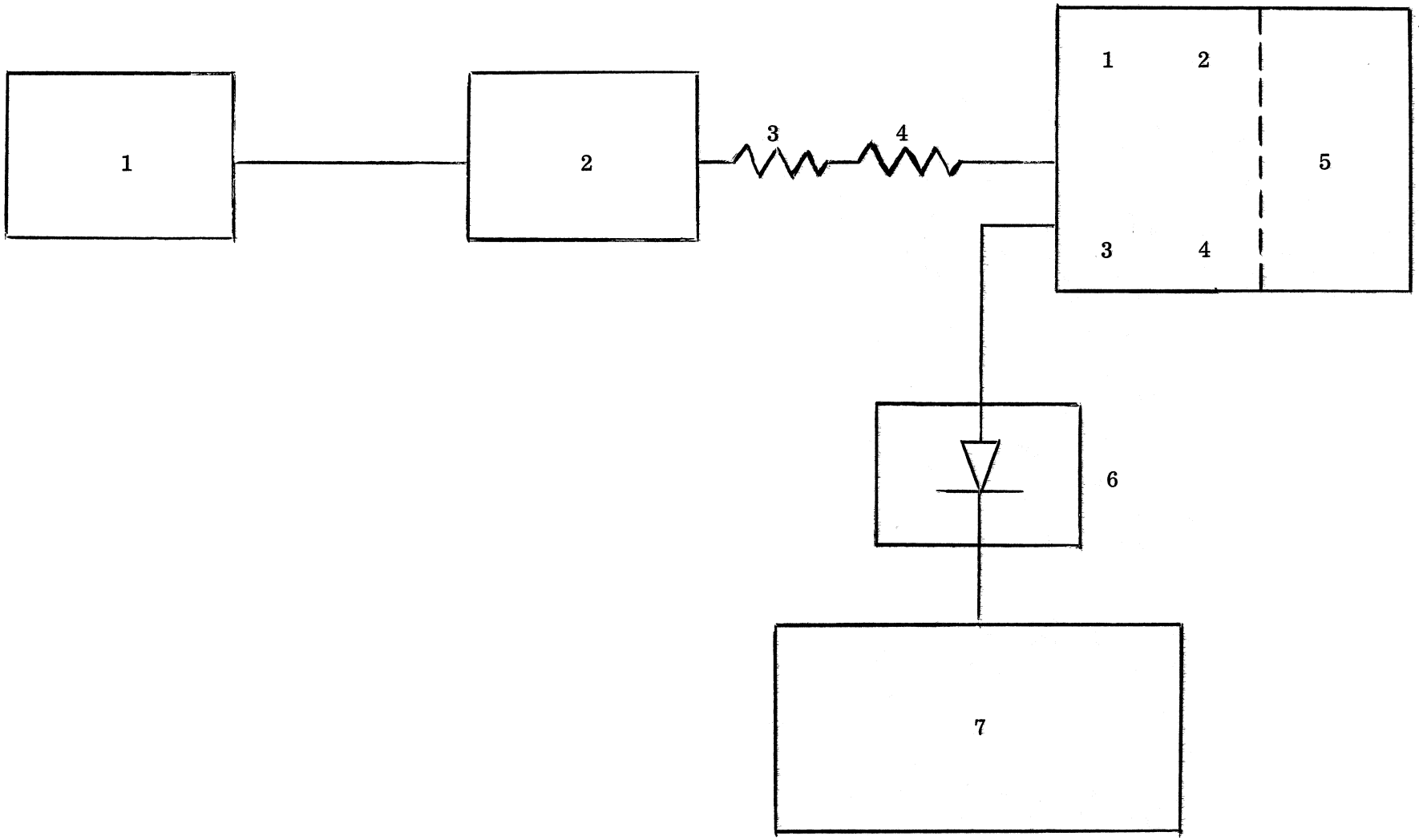
1. Sweep Generator
2. Frequency Meter
3. Attenuator - 10 dB
4. Attenuator - 20 dB
5. AIL Parametric
6. Detector (Hewlett Packard 420A)
7. Oscilloscope

FIGURE 1 — BANDPASS MEASUREMENTS



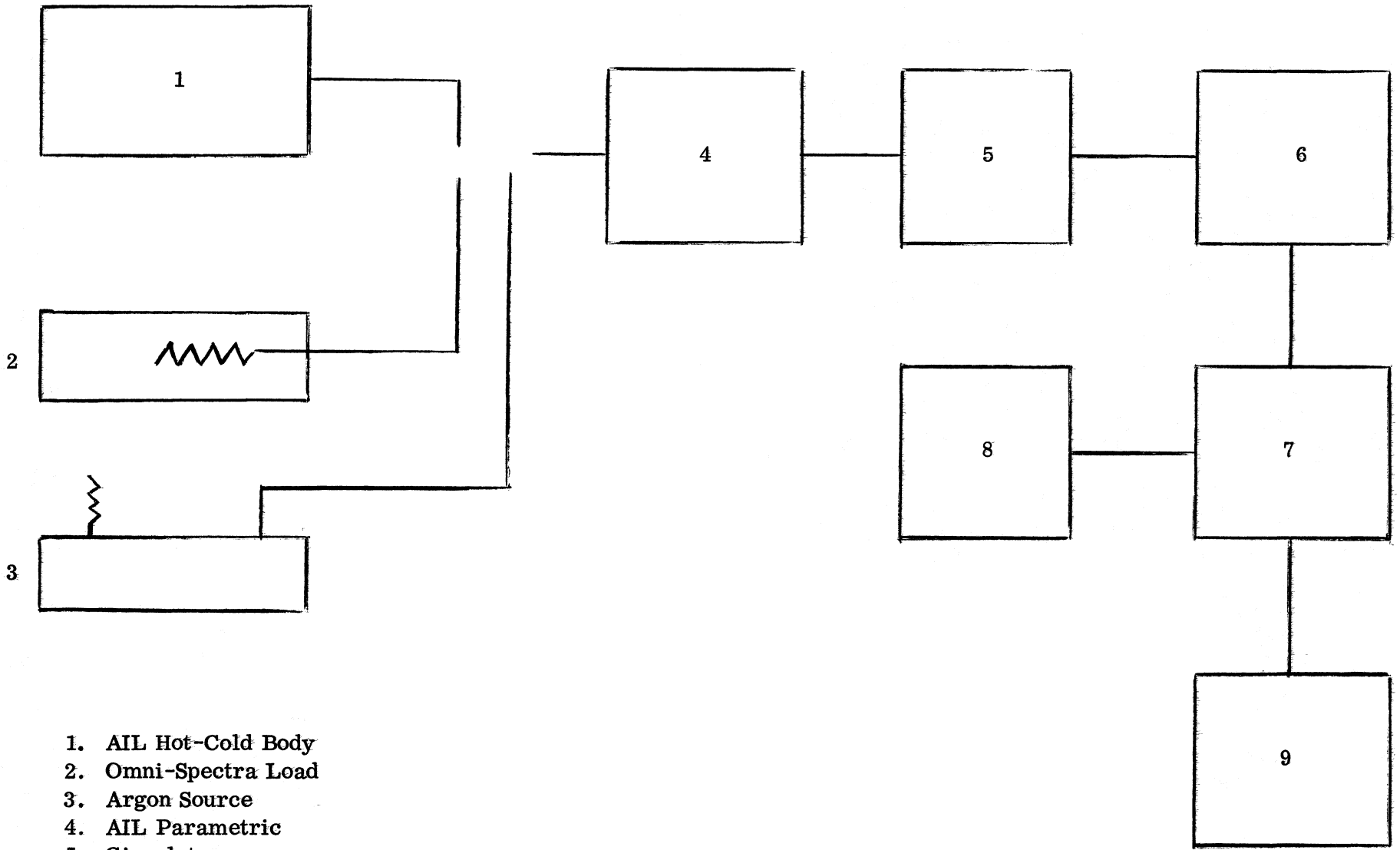
1. Sweep Generator
2. Frequency Meter
3. Attenuator - 10 dB
4. Attenuator - 20 dB
5. AIL Paramp
6. Detector (Hewlett-Packard 420A)
7. Oscilloscope

FIGURE 2 — GAIN MEASUREMENTS



1. Signal Generator
2. Frequency Meter
3. Attenuator - 10 dB
4. Attenuator - 20 dB
5. AIL Parametric Amplifier
6. Detector (Hewlett-Packard 420A)
7. Microammeter

FIGURE 3 — GAIN MEASUREMENTS



1. AIL Hot-Cold Body
2. Omni-Spectra Load
3. Argon Source
4. AIL Parametric
5. Circulator
6. MPC Paramp
7. LEL Mixer-Preamp
8. Local Oscillator
9. AIL Test Receiver

FIGURE 4 — NOISE FIGURE MEASUREMENTS

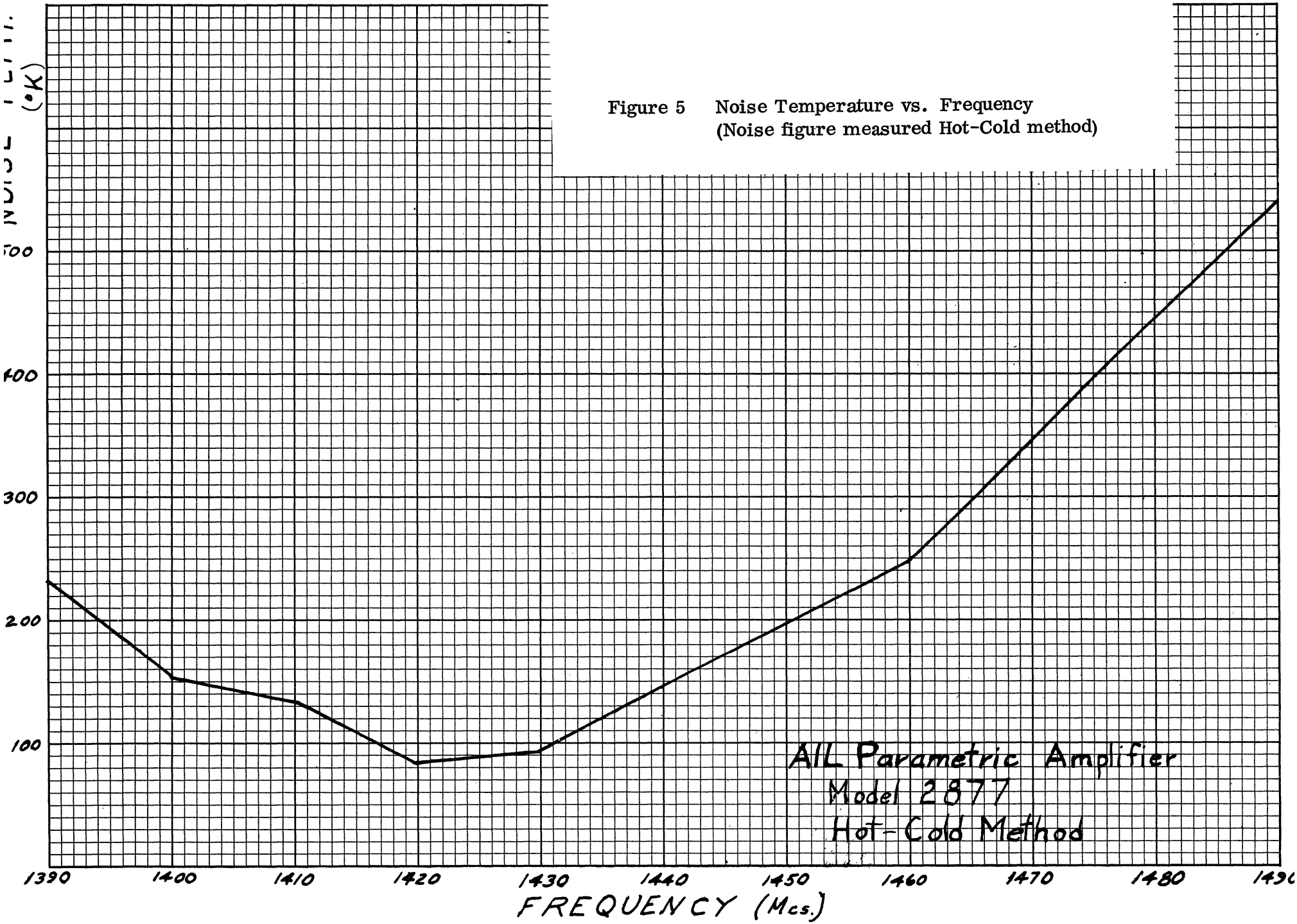


Figure 5 Noise Temperature vs. Frequency
(Noise figure measured Hot-Cold method)

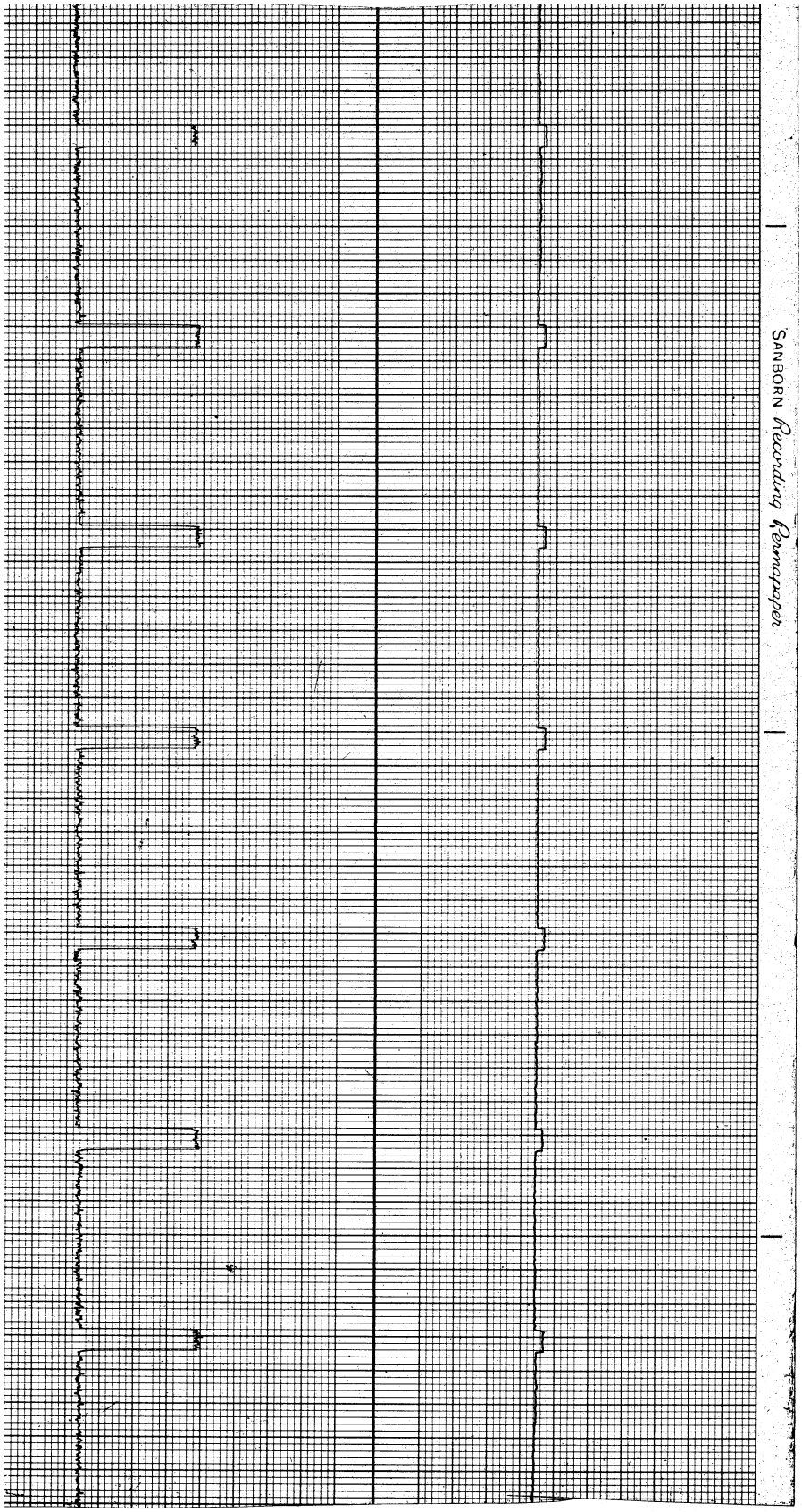


Figure 6

Receiver Output
Frontend Switched Between
300° and 300°

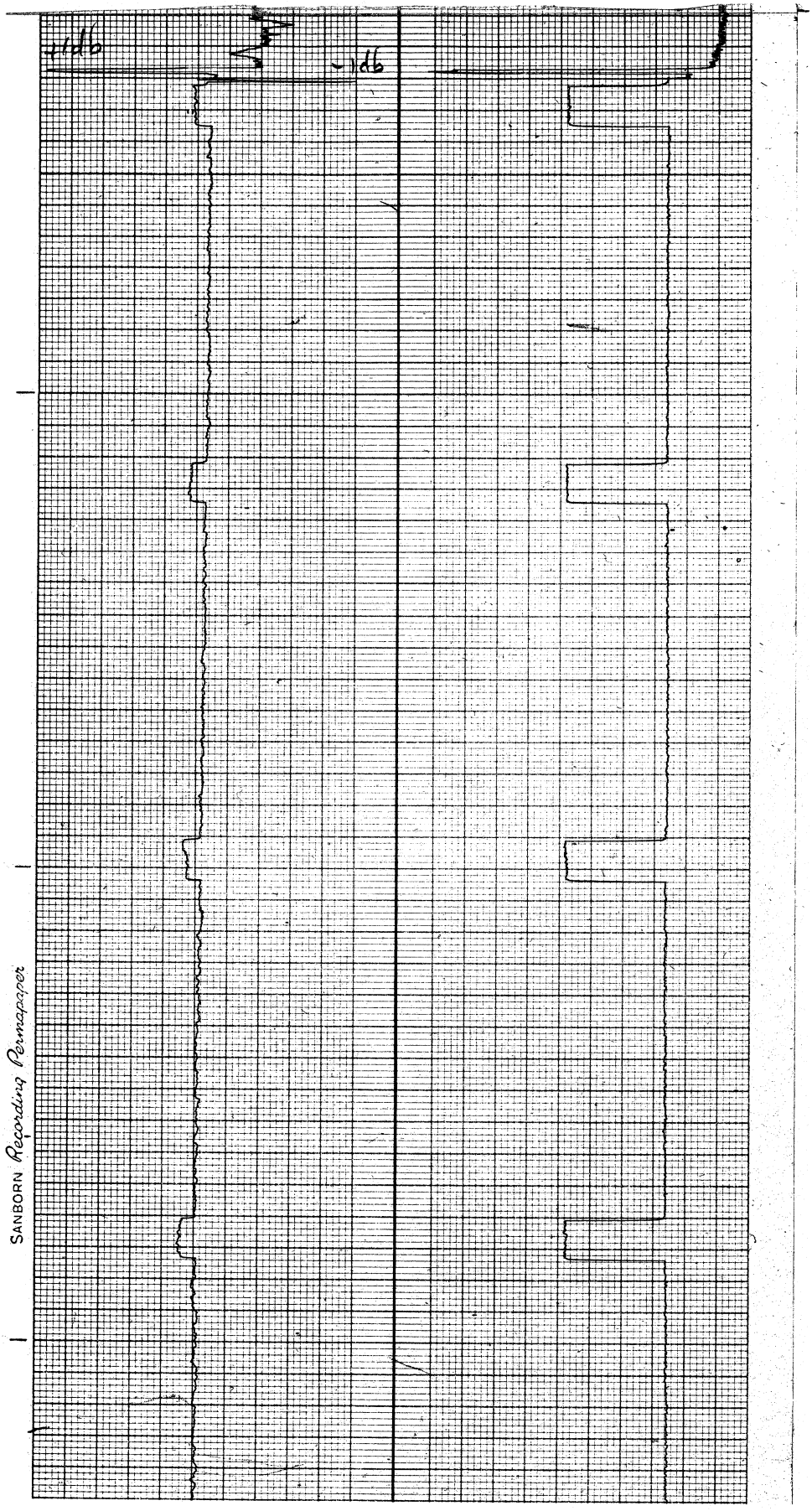
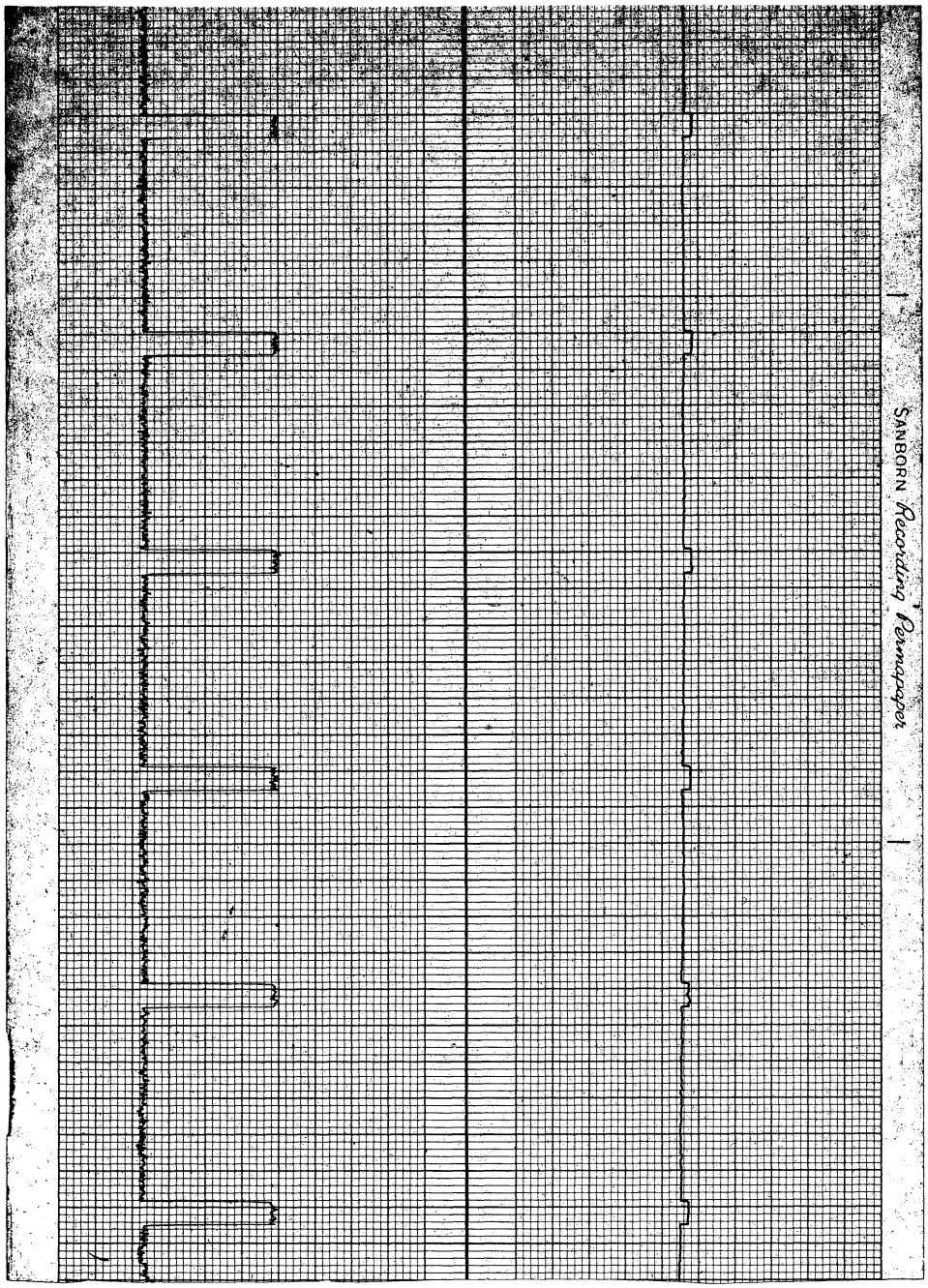


Figure 7

Receiver Output
Frontend Switched Between
77° and 300°



A B

Figure 8

Receiver Output
Frontend Switched Between
300° and 300°

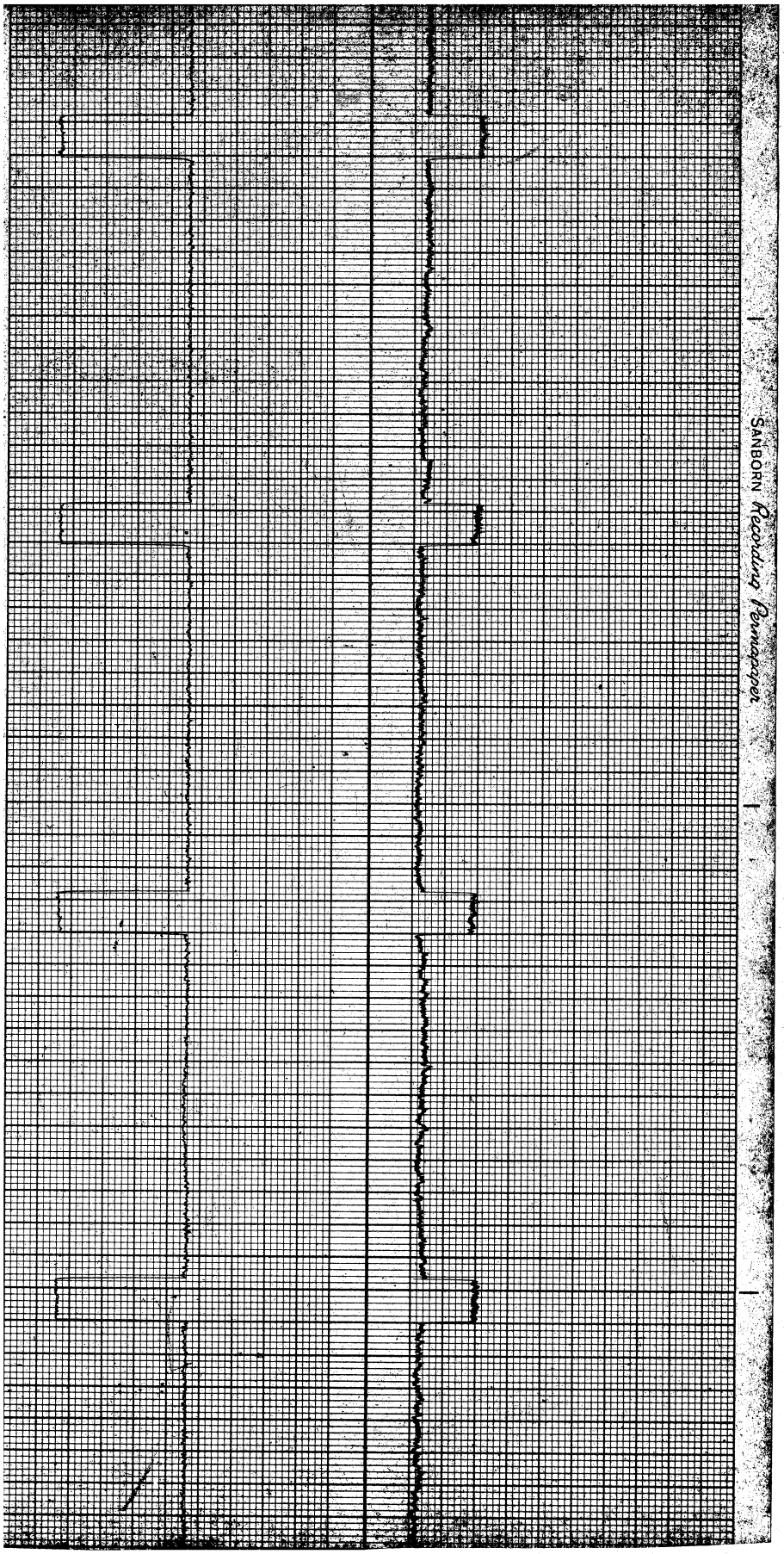
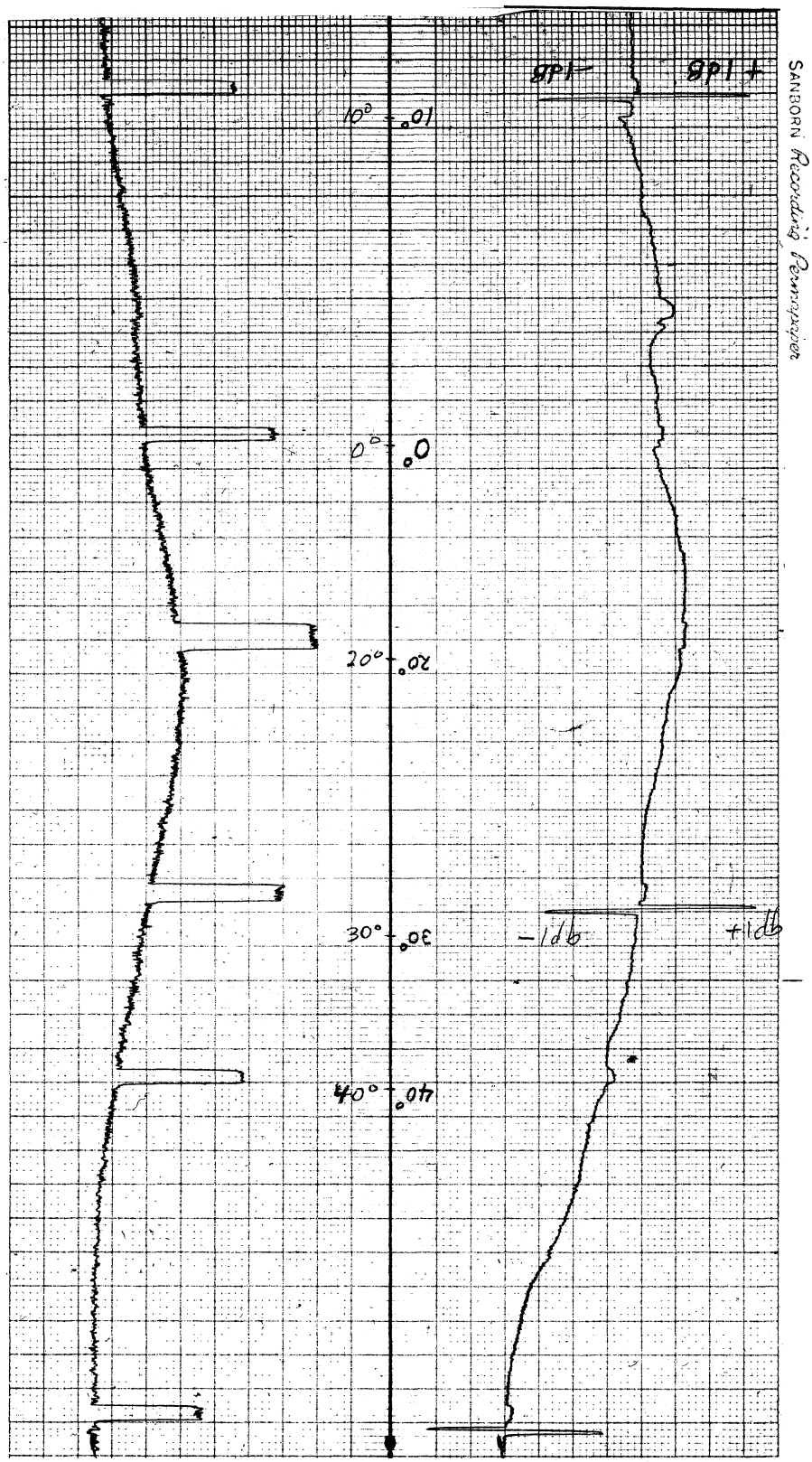


Figure 9

Receiver Output
Frontend Switched Between
77° and 300°

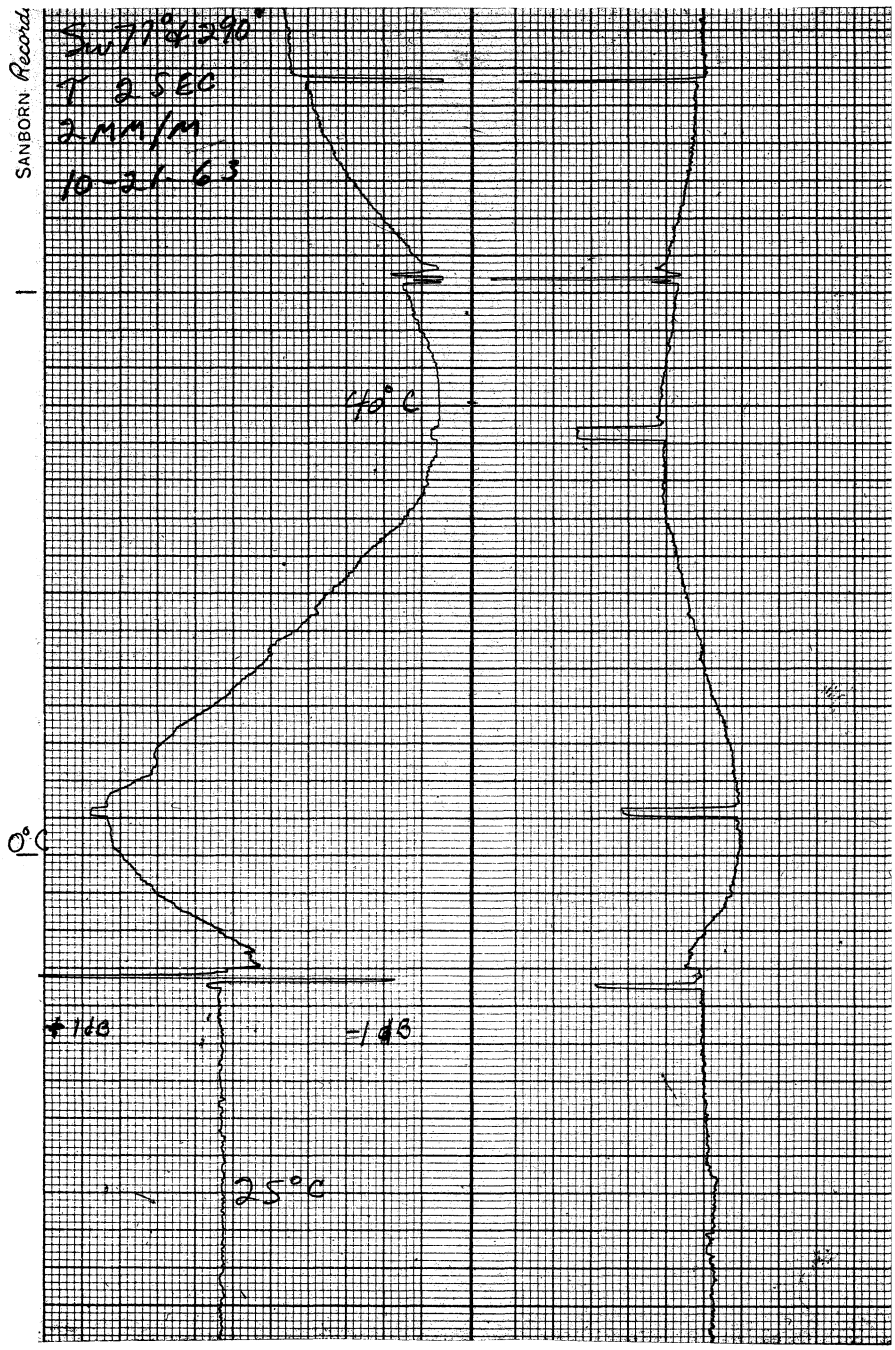


A

B

Figure 10

Receiver Output vs. Thermal Temperature Change
Frontend Switched Between
300° and 300°



A B

Figure 11

Receiver Output vs. Thermal Temperature Change Frontend Switched Between 77° and 300°

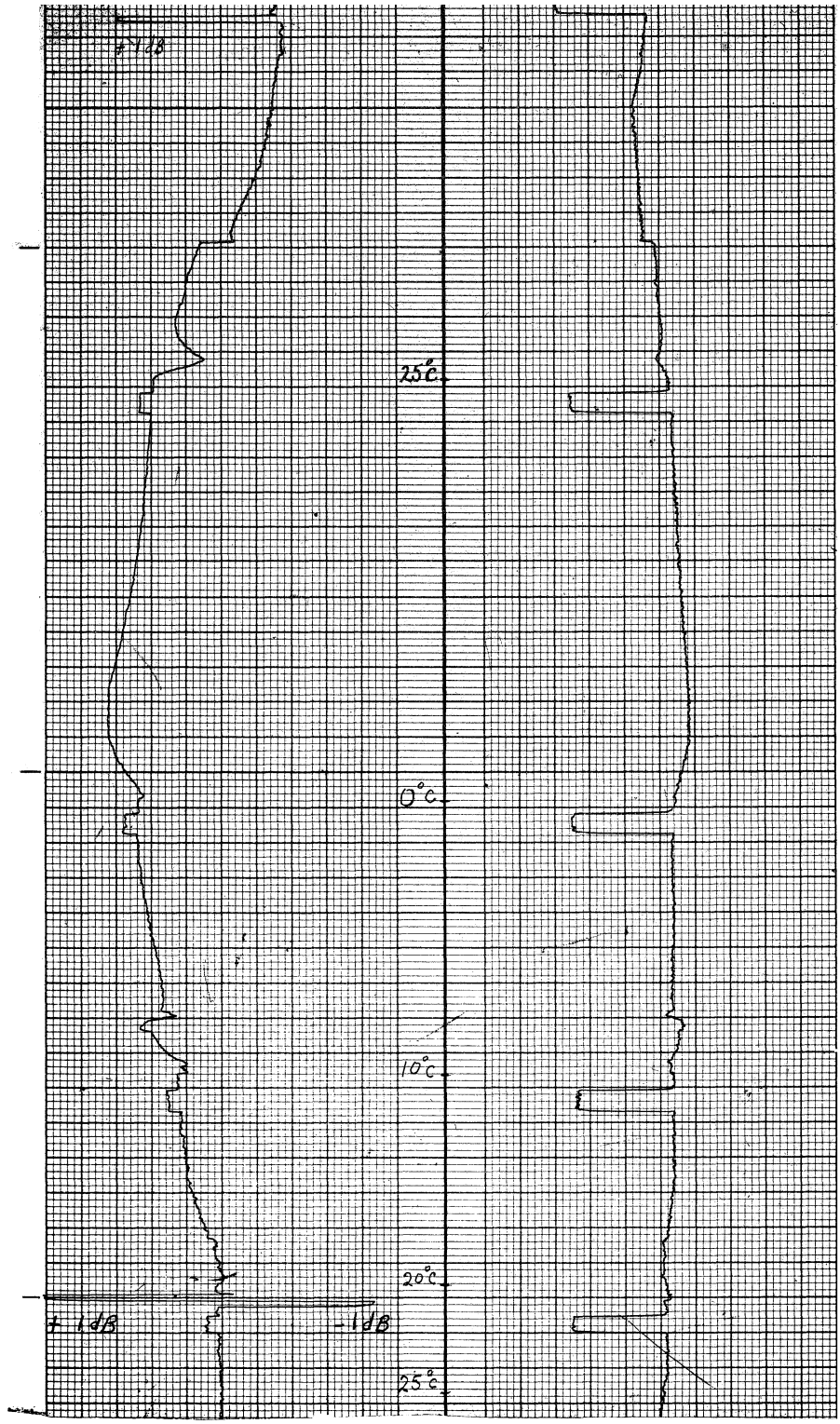


Figure 11
Receiver Output vs. Thermal Temperature Change
Frontend Switched Between
77° and 300°

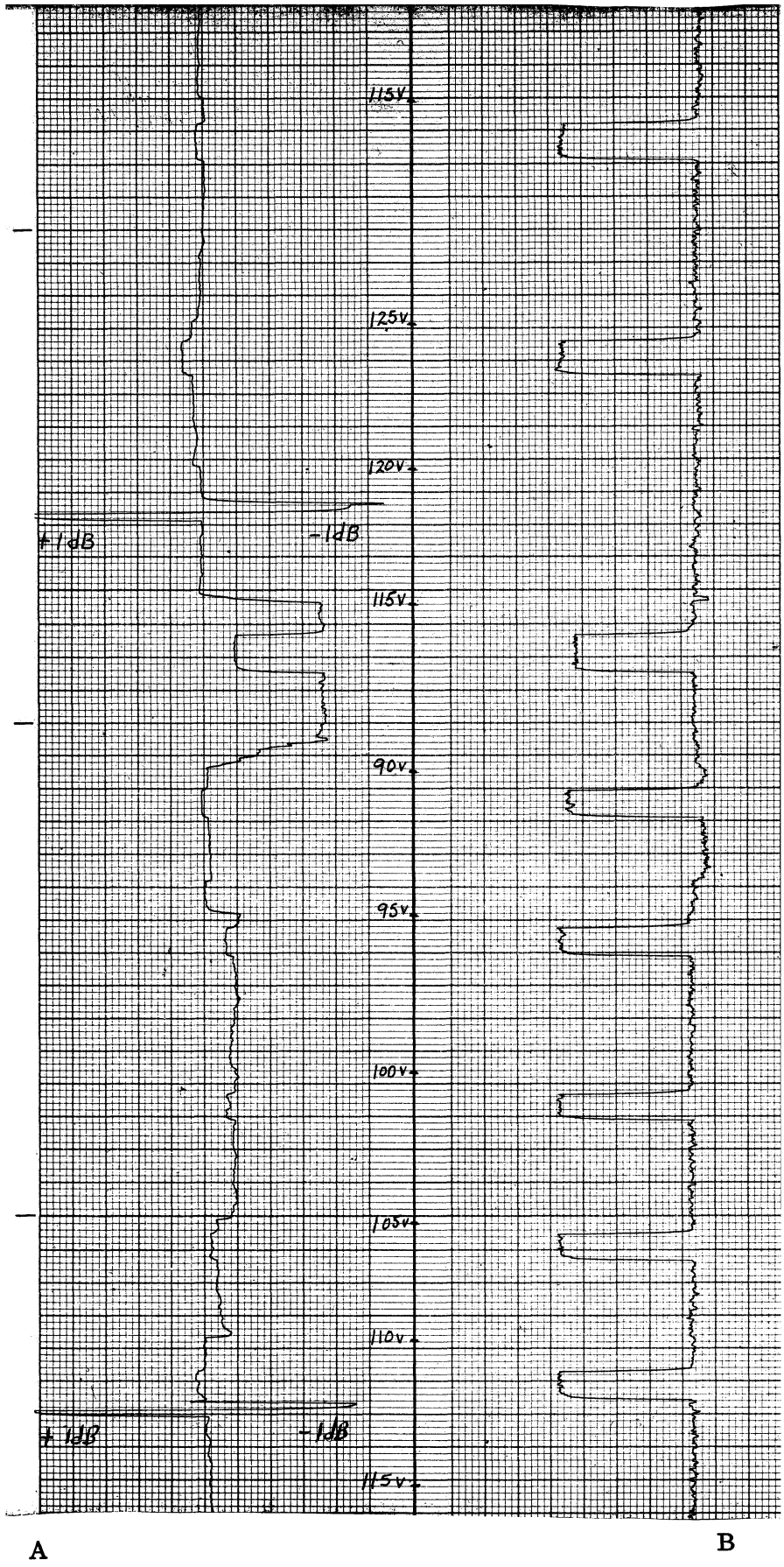


Figure 12

Receiver Output vs. Line Voltage Change
Frontend Switched Between
300° and 300°

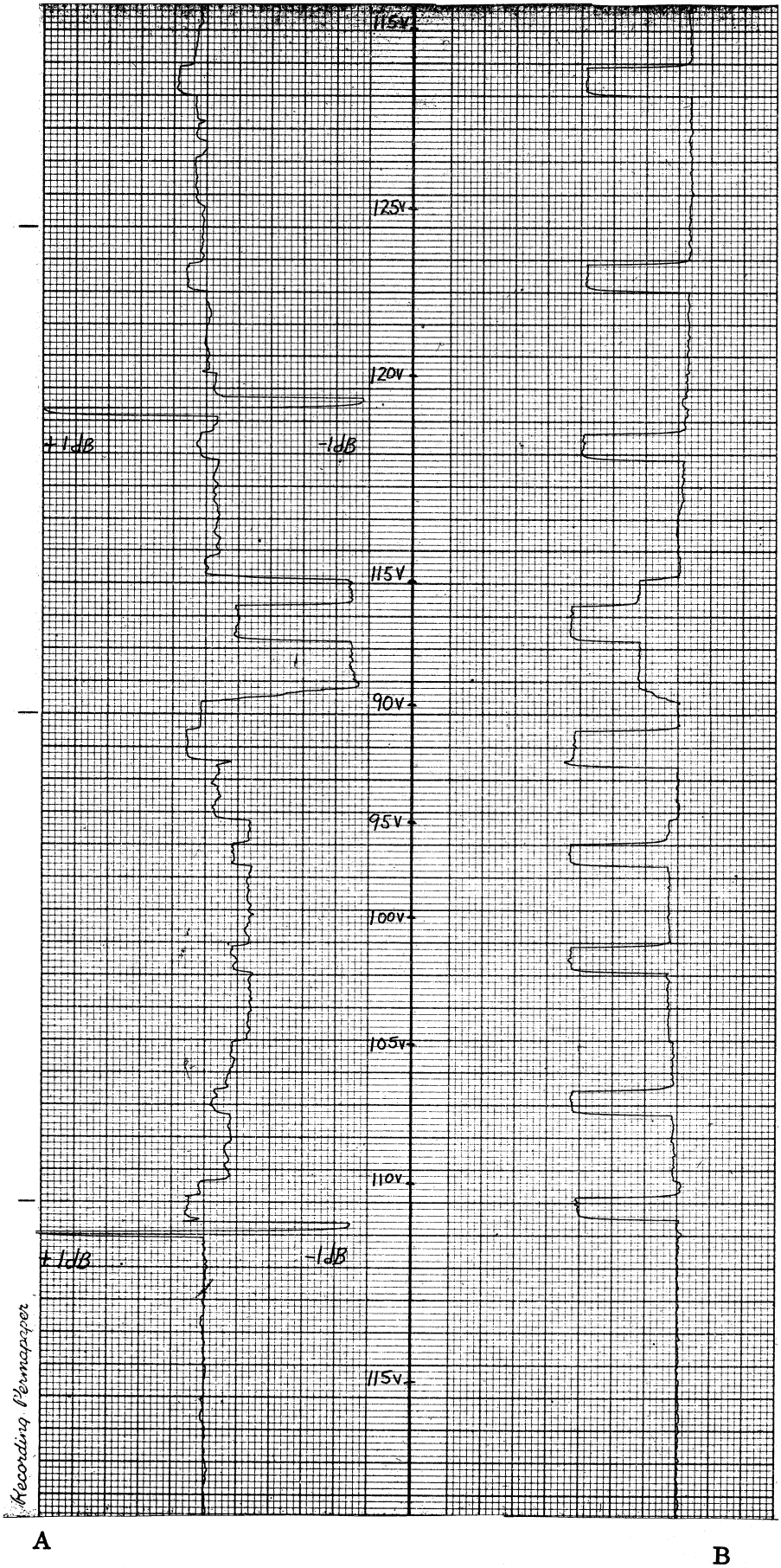


Figure 13

Receiver Output vs. Line Voltage Change
Frontend Switched Between
77° and 300°