CHAPTER IV

RESULTS AND CONCLUSION

4.1 Introduction

From the basic circuits of chapter II, stabilized transistor electronic circuits for standard neutron monitor were constructed. They have been described in Chapter III. Their characteristics concerning stability, particularly the variations with temperature, the gain and leakage current between transistor of the same type; will be presented here. Conslusion will be given in the last section.

Many problems have arised during the construction of the circuits;

1. Inadequate measuring instruments in the early stage of construction,

2. The restriction to components available in Thailand only,

3. The lack of facility to control room temperature to the desired range,

4. Insufficient number of transistors to check the variation of gain and leqkage current among transistors of the same type for the constructed circuits,

5. The problem of choosing transistors,

etc.

4.2 Experiment[1]

Table 4-1 (ambient temperature = 25° C)

pre-preamplifier, preamplifier and amplifier outputs for given inputs

Input X 10^{-5} V	output X 10^{-3} V		
	pre-preamp.	preamp.	amp.
6.28	3.00	2.60	37.50
12.56	5.20	5.20	75.00
18.84	10.40	7.80	112.50
25.12	13.00	10.40	135.00
31.40	15.60	13.00	165.00
37.68	18.20	15.60	188.00
43.96	21.50	18.20	210.00
67.00	35.00	30.00	370.00
100.50	52.00	45.00	550.00
167.50	85.00	75.00	945.00
201.00	104.00	90.00	1130.00

1 Measured by Solartron Oscilloscope Type No. CDIOZ 4.3

V.O.M. Simpson model 260.

Table 4-2 (ambient temperature = 25°C)

Amplification of complete unit
(Pre-preamplifier, preamplifier and amplifier combined)

Input X 10^{-5} V	Output V
1.57	2.20
3.13	4.00
4.70	5.90
6.26	8.30
7.83	10.20
9.39	11.50
10.95	12.80
12.52	13.40
14.09	13.75
15.65	13.90
17.26	13.90

Table 4-3

Temperature effect

Input X 10^{-5} v	Output v	
	at 25°c	at 40°c
1.57	2.20	1.92
3.13	4,00	3.84
4.70	5.90	5.50
6.26	8.65	7.80
7.83	10.50	9.90
9.39	11.70	12.30

Table 4-4 (ambient temperature = 25°c)

Comparison of two sets of the same type transistor

Input X 10^{-5} v	Output v	
	set 1	set 2
1.57	2.20	2.20
3.13	4.00	4.00
4.70	5.90	5.90
6.26	8.65	8.65
7.83	10.50	10.50
9.39	11.70	11.70

Table 4-5 (constant input ≈ 80 microvolts)

Dependence on power supply voltage

Power supply v	output v
12	3.04
13	3.20
14	3.53
15	3.84
16	4.48
17	4.64
18	4.80
19	5.10
20	5.10
21	5.10
22	5.10
23	5.10
	5.20

24	5.20
25	5.25
26	5.60
27	5.75
28	6.15
29	6.40
30	6.50

Table 4-6 (ambient temperature = 25°c)

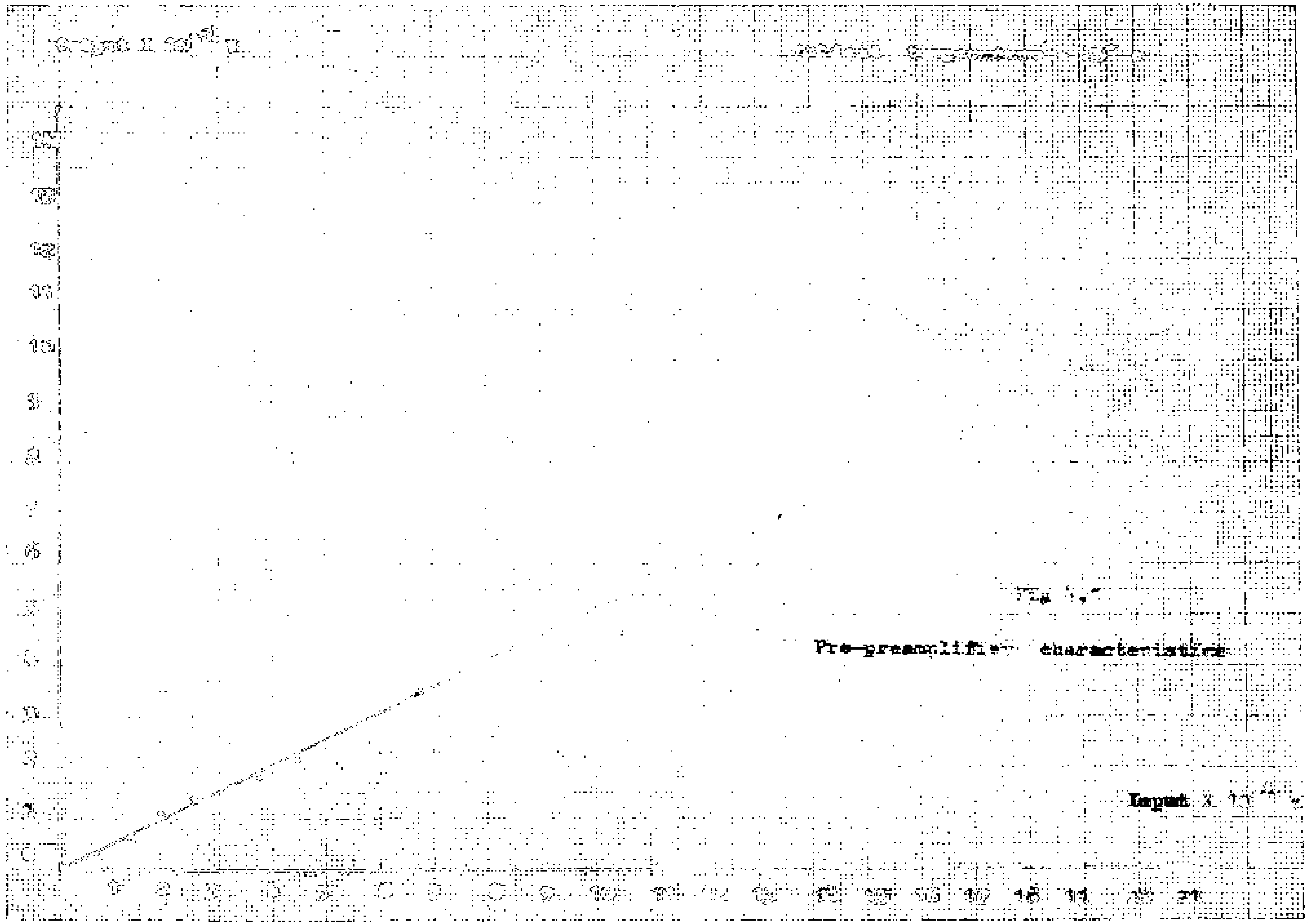
Dependence on power supply voltage of Amplifying part and Discriminator combined

power Supply v	Input μv
15	102
16	89
17	78
18	63
19	47
20	34
21	31

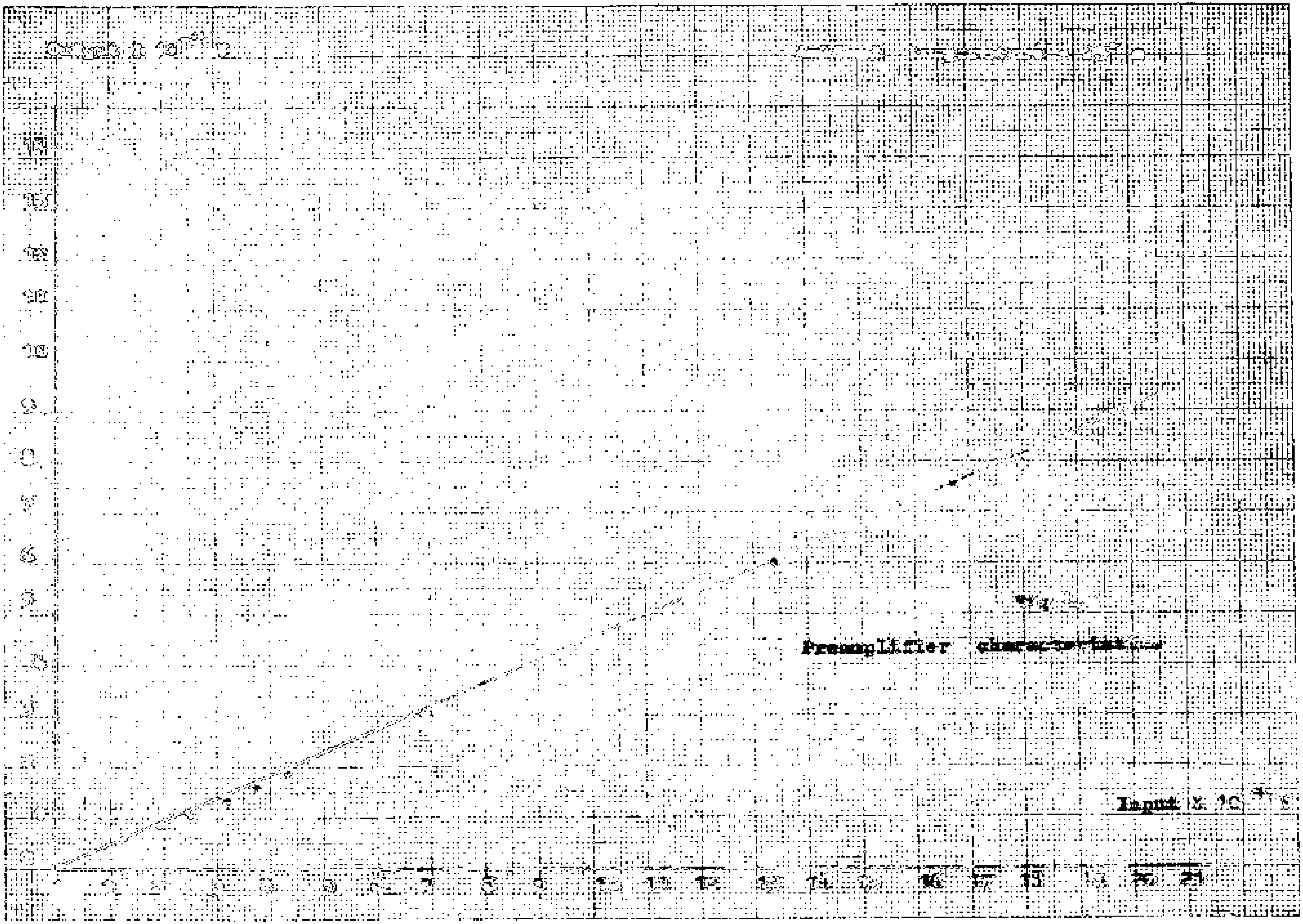
Table 4-7

Discriminator characteristics

Input v	Dial setting (degree)
13.2	190
26.4	220
39.6	240
52.8	260
66.0	270
77.2	280
92.4	290



Pre-preamplifier characteristics


Preamplifier characteristics
Input

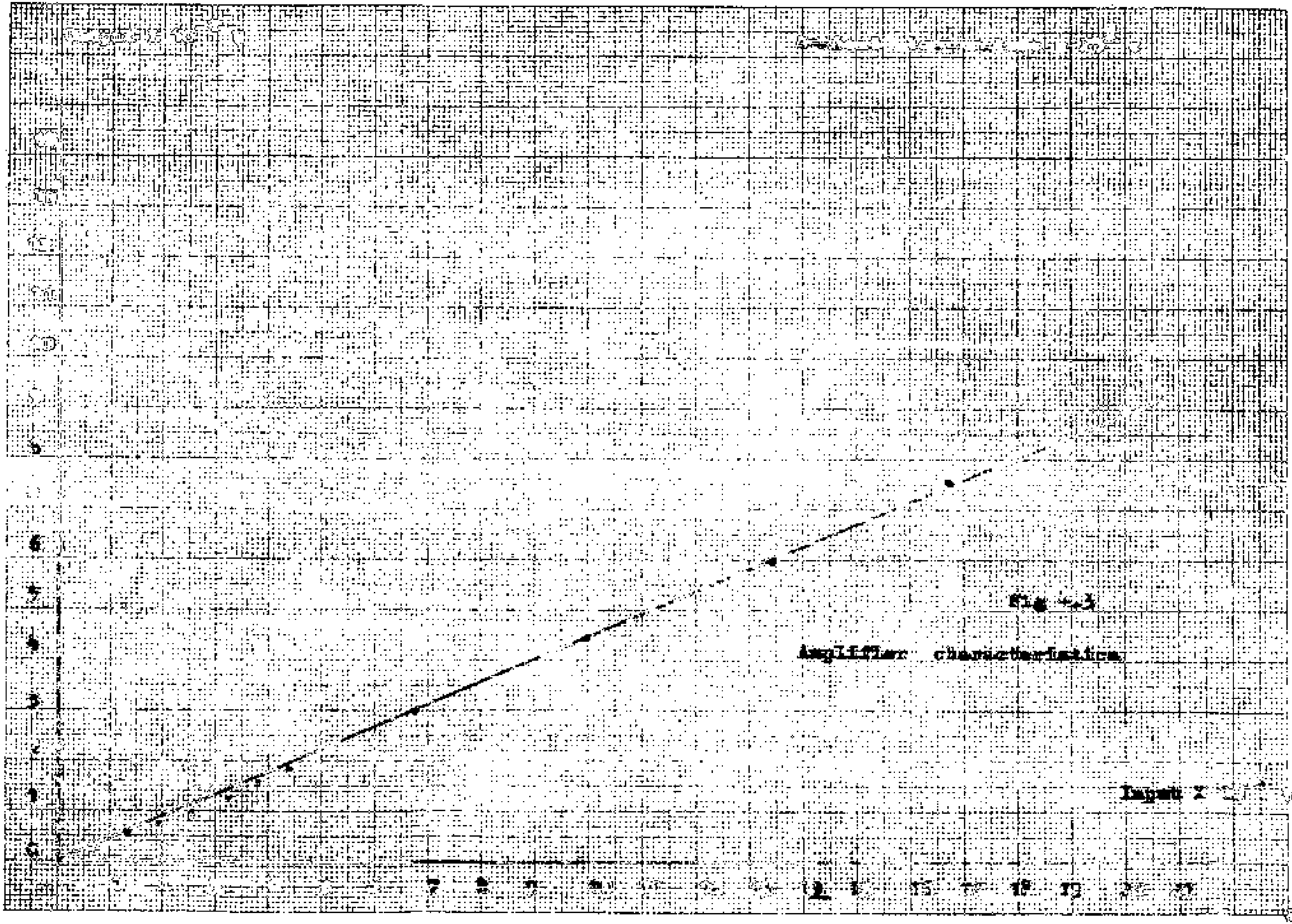


Fig 4.3

Amplifier characteristics

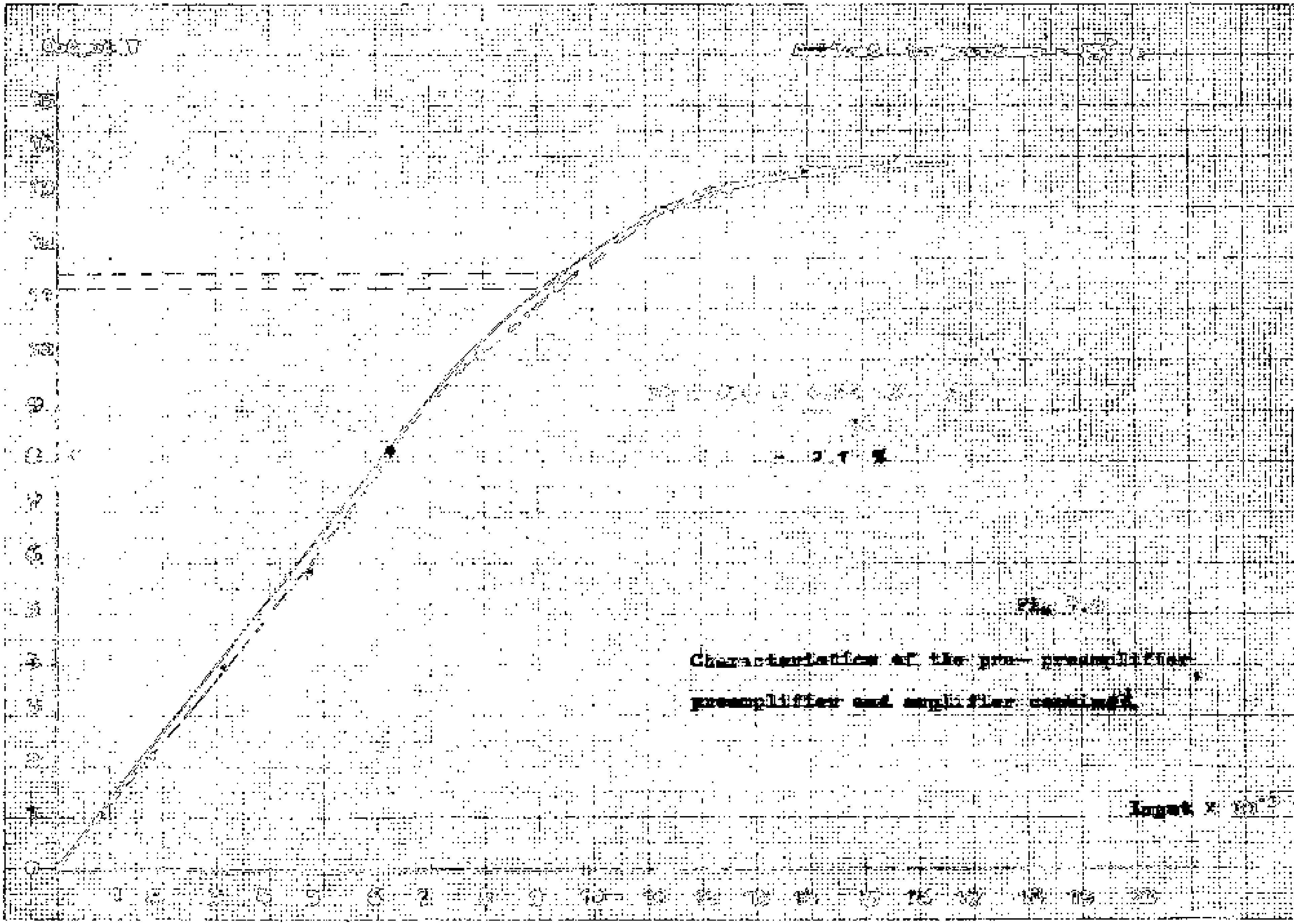


Fig. 7.2

Characteristics of the pre- preamplifier preamplifier and amplifier combined.

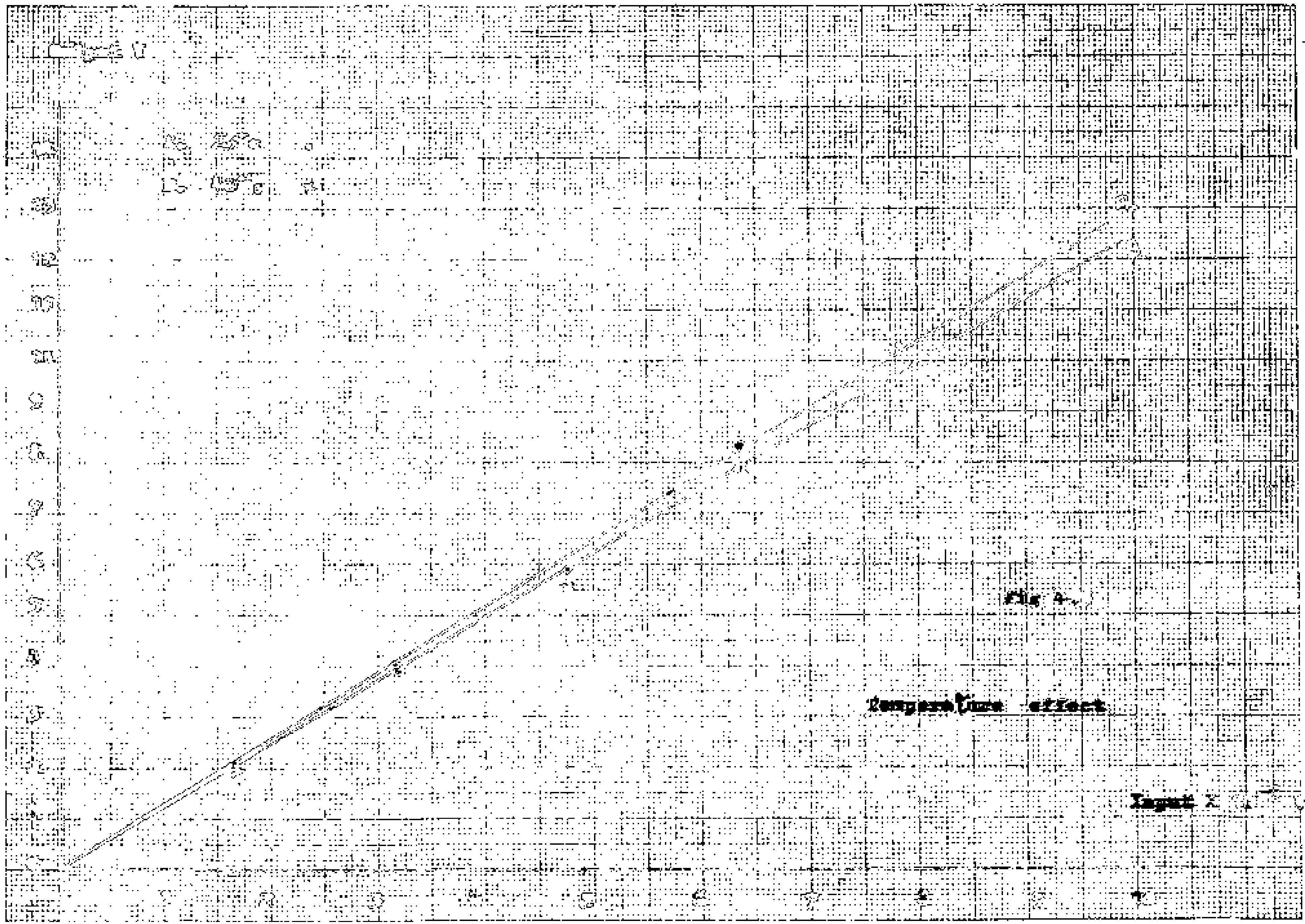


Fig 4.
temperature effect
Input X

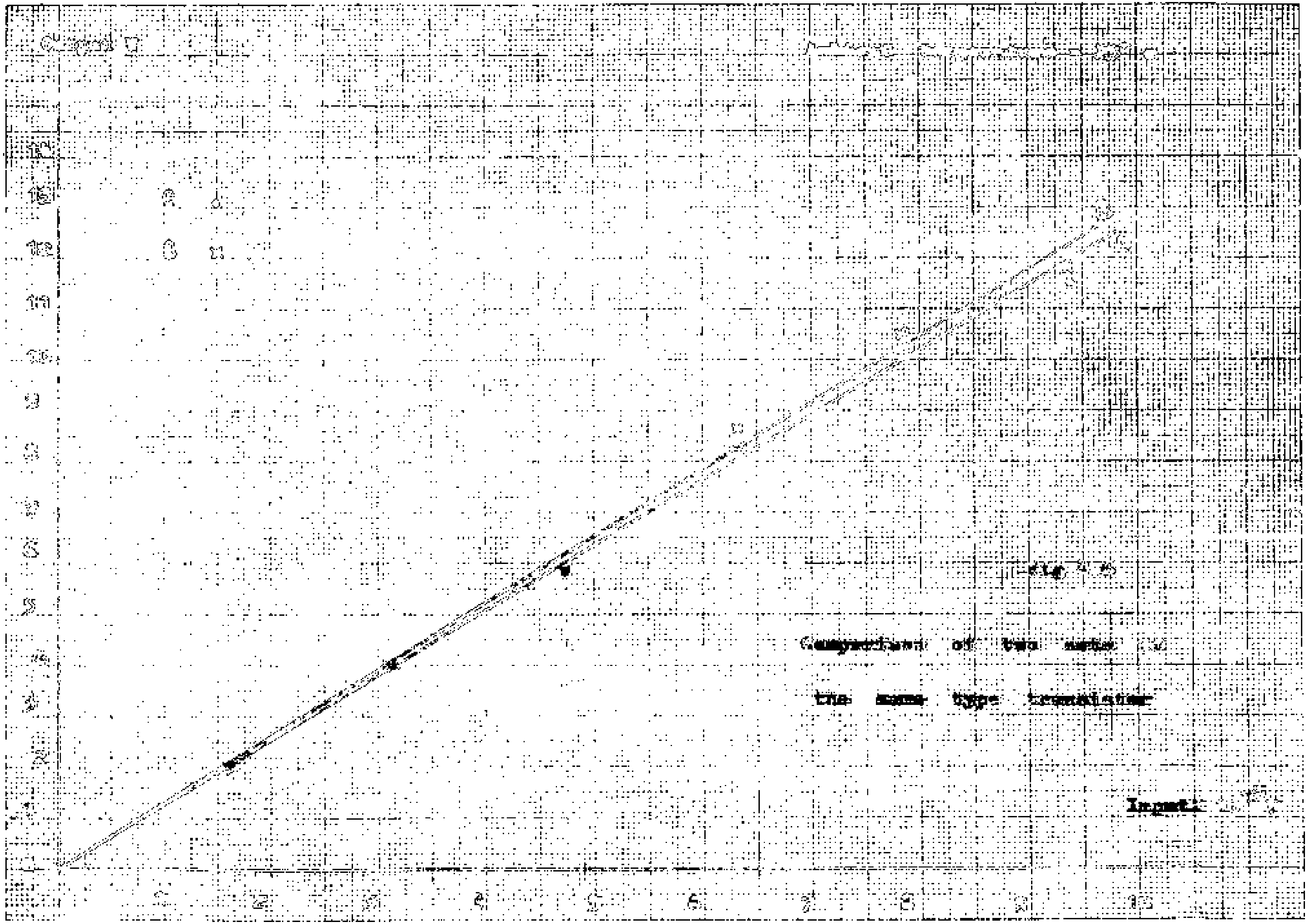


Fig 4.5

Comparison of two units of

the same type transistor

Input: [illegible]

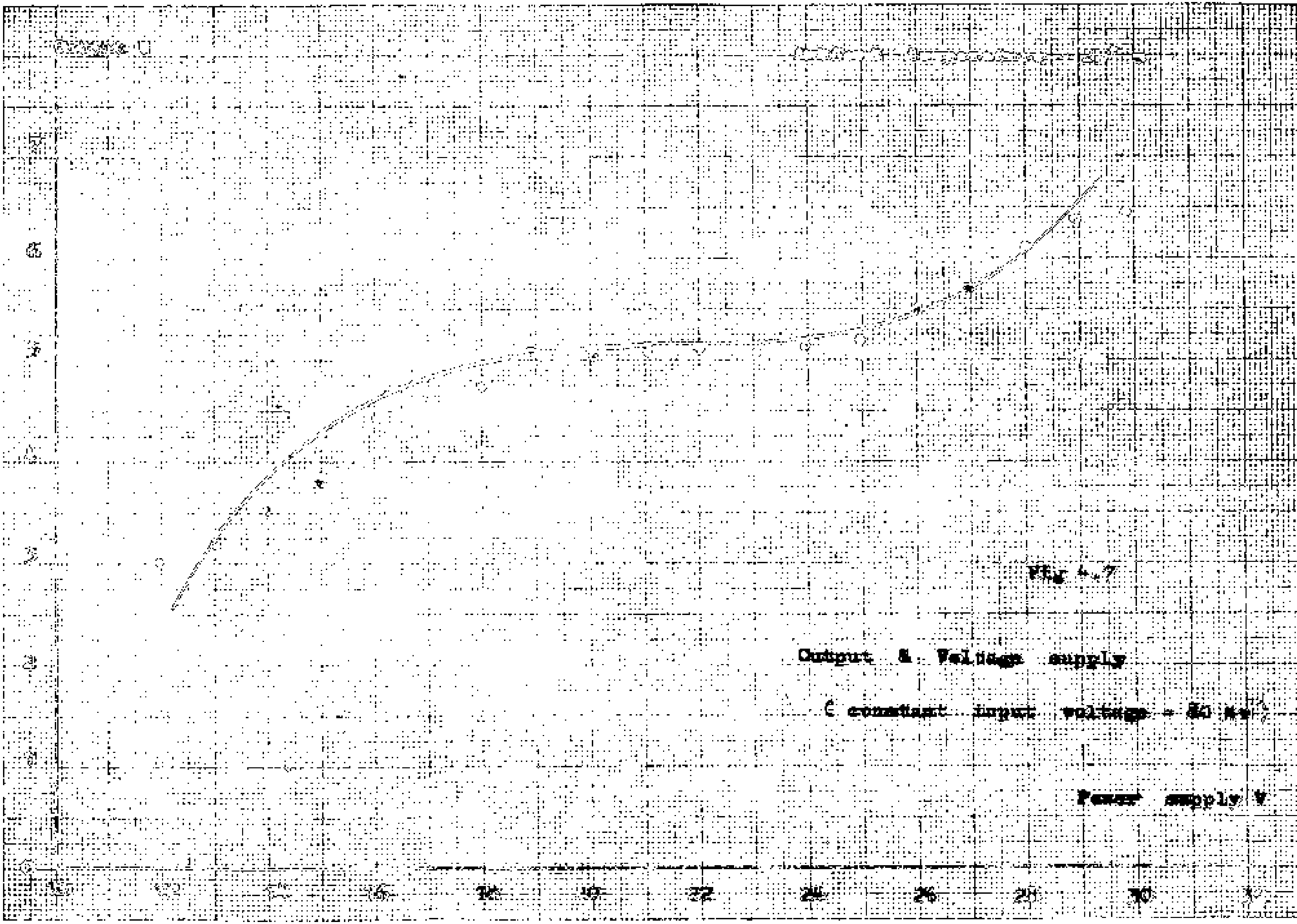
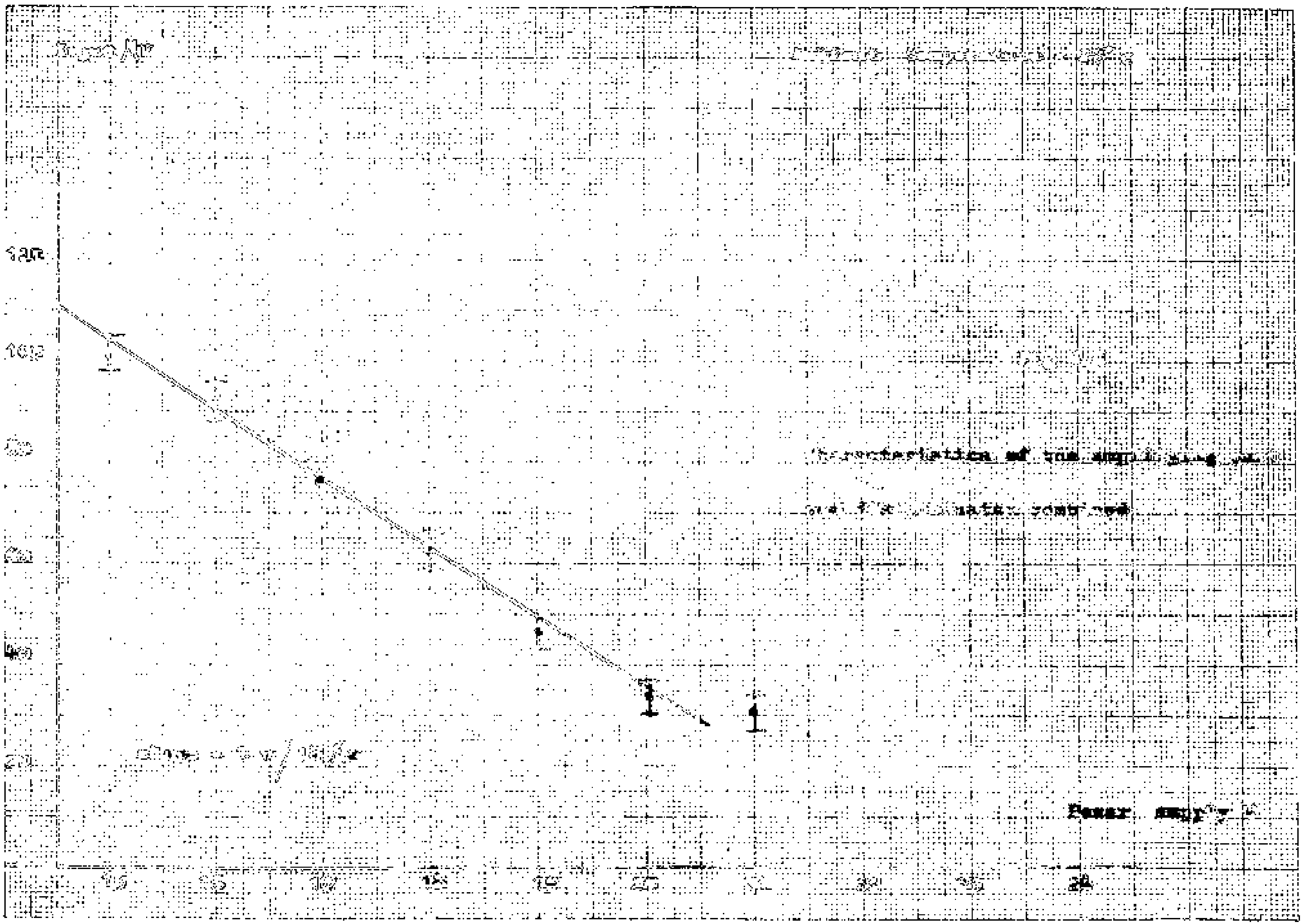
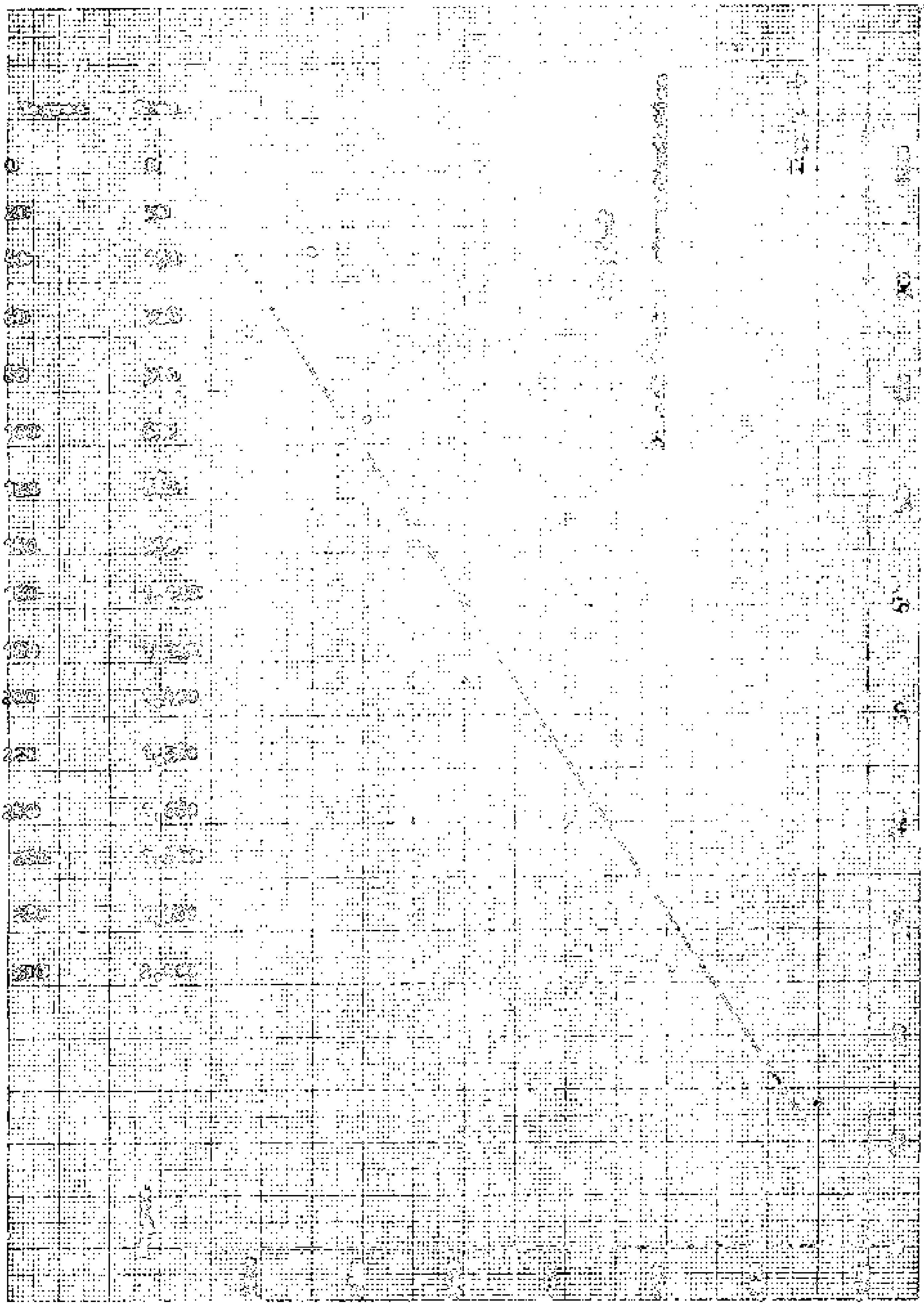


Fig 4.7
Output & Voltage supply
(constant input voltage = 20 mv)
Power supply V
22
24
26
28
30





4.3 Conclusion

The parallel-connected proportional counters in neutron pile were coupled to an electronic circuit. Pulses from the amplifier output were selected by a discriminator circuit and were shaped to the correct pulse shape for the scaling circuit by the amplifier shaper.

Circuit used for neutron monitor possesses the following characteristics;

1 It must have high input impedance and low output impedance in order to match the BF_3-counters and the cable line respectively.

2 It can be used at frequencies that range right down to zero, where as the noise level must be kept low.

3 Its stability on variations in ambient temperature and variations of gain and leakage-current between transistors of the same type must be sufficiently high enough.

4 The gain of the amplifying part must be high enough.

5 The output pulse to scaler must be of regular shape and constant pulse height.

6 It must be stable from oscillating.

High input impedance is obtained by applying negative feedback to the input common-emitter stage and the low output impedance by using the output emitter-follower stage.

Direct-coupled stage is necessary for the second requirement though the third one is made worse, particularly if many such stages are used by this method. Though the transistor circuit, compared to the vacuum-tube one, is highly dependent on temperature, it has many advantage, particularly the fact that it has a long life time of the order of 100,000 hours or more. This is suitable for neutron monitor work.

In general the precautions taken to reduce drift of operating point also tend to give low noise (7). Stabilizing methods used for the circuit constructed are mainly negative feedback loops and bias compensations. The negative feedback reduces the gain of the whole circuit, but on the other hand it reduces the distortion, increases the useful frequency band, and makes the amplifier operation more independent of the characteristics of the particular transistors incorporated in the circuit. More amplifier stages are required because of the gain decreasing. So the phase-shift considerations become particularly important. This may result in oscillation or burn-out of the amplifier. Thus, precautions should be taken.

From Fig 4.4 the amplifying part constructed has a linearity of about 2.1 %. This is not so good. From Fig 4.5 and Fig 4.6 it can be seen that the gain is decreased by about 3.2 % by the temperature effect from 25° c to 40° c and increased by about 2.6 % by the effect of changing to the other set of the same type of transistors respectively. The ambient temperature could not be controlled at a constant value throughout the experiment.

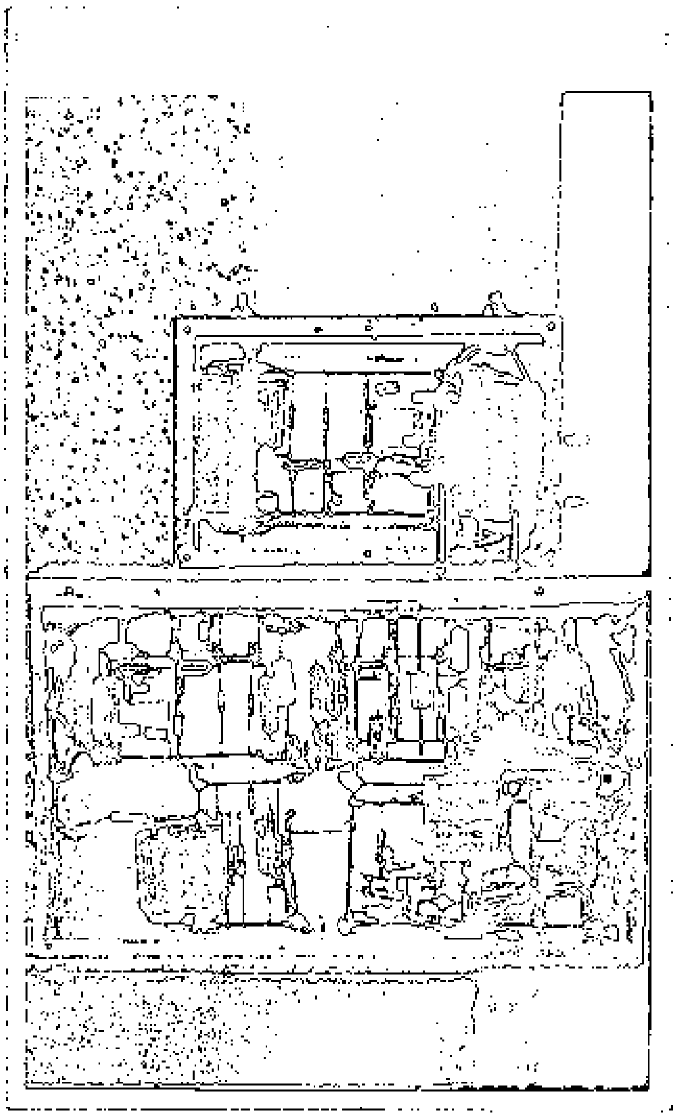
Input signal from the BF_3-counter to the circuit is about 100 microvolts in practice and such pulse high was experimented. However, the signal to noise ratio was small and the noise could be separated by the discriminator constructed.

Fig 4.9 shows the gain stability of the amplifying part as a function of power supply voltage. The gain is almost constant only in the range of 19 to 23 volts. However, the regulated power supply used can ensure this range.

By combining the amplifier with the discriminator, the lower limit of the input pulse height scarcely varies with the variation of the power supply voltage with the length of time it is used, because the variation of the discriminating voltage compensates for the amplifier gain (Fig 4.8).

The linearity of the discriminator as well as the volume used are shown in Fig 4.9.

The steps of design which were made were simple, but to do the experiment it required techniques in solving problems that cannot be found in any text or handbook, e.g. the problem of choosing transistors, arrangement of the circuit to keep the noise low. The procedures of amplifier design were omitted, because they can easily be found in any standard handbook. However, the most important thing in designing amplifier that must be kept in mind is the collector dissipation that will damage the transistor if it is in excess.



Photograph of the Pre-preamplifier, Preamplifier, Amplifier,

Discriminator and Amplifier shaper combined