3. DISCUSSION OF RESULTS

Comparison between the curve plotted automatically by the recorder and the curves manually plotted are shown in Fig. R11 to R13. It is obvious that the error produced by the recorder is greater in the lower negative grid voltage region. This error is a combination of individual circuit error including an error produced by mechanical parts. To locate the source of error consideration on the individual test results has to be made.

From the test result in Fig. R7 and R8 which show the relation between plate supply voltage and chart displacement, it is cleared that the error resulting from this part is relatively small. The overall error resulting from y-axis plotting device as shown in Fig. R1 to R4 is not so large, however, the previously mentioned errors do not affect only in the low grid voltage region. Thus, it should be the grid voltage supply unit that contributed major part of the error.

The positive return of the grid voltage supply is referenced back to the output terminal of the buffer amplifier instead of referenced back to the cathode of the tube being tested. The reasons for using this circuit is stated in section 2.3-15.

Since the voltage different between cathode and output terminal of the buffer amplifier is not constant, as shown in Fig. R9. The effect of which is the same as the pre-set grid voltage is changed by the same amount as the incremental change of that voltage difference, see Fig. 19 and Fig. 20.

Furthermore incremental change of bias base current of the two buffer amplifiers due to the variation of plate current causes the voltage drop across R_4 to vary, resulting in varying of the pre-set grid voltage of the same magnitude. That is the pre-set grid voltage would be slightly changed as

plate current was changed. Thus, strictly speaking the recorded curve is the curve of slightly varying grid voltage instead of the one of constant grid voltage. The effects of which is relatively large in the lower grid voltage region.

In order to reduce the error, input and output voltage tracking of the buffer amplifier must be kept as close to each other as possible. Furthermore high input impedance of the amplifier is also required in order that the change in bias current is reduced.

Another solution is to connect the positive return of the grid voltage supply unit to the cathode of the tube directly. Such circuit arrangement requires the cathode terminal to be grounded to avoid the effect of hum and noises from entering into the comparator circuit. Consequently the current sensing resistor has to be moved to connect between ground and the negative return of the plate voltage supply unit. This circuit arrangement also leads to some minor change in the other circuits. On the other hand, this circuit modification simplifies the problem of using the recorder for recording characteristics of vacuum-tubes pentode. Nevertheless, screen voltage source must be isolated from ground to avoid common screen current flowing through the same current sensing resistor.

Some other minor sources of error are:-

a) Stylus driving motor, a shaded pole motor was used in this experiment, its speed characteristics depends largely on load and line voltage. Motor speed variation caused the same variation in percentage to the y-axis defl tion sensitivity. This part of error can be minimized by using a synchronous motor.

b) Transverse displacement of the paper, it was caused by transportation of the paper in the x-direction. The effect of which is similar to

shifting of x-axis at the same magnitude. This error can be minimized by using a paper edge-sensing device instead of the light triggering circuit to trig the ramp function generator. In this method marking end of the stylus is used as an arm to detect the paper edge. Operation of which is as described in section 4.2

c) Belt vibration. Owing to high speed of the belt, belt vibration is unavoidable. This vibration causes some error in sweep start-up, triggering point. Its effect and solution are the same as described in (b).

d) Paper slip. In this experiment paper was driven by means of the pressure between the paper driving drum and the rubber rollers. Therefore, slipping of the paper can occur, resulting in error in the plate voltage scale. It can be improved by using a sprocket driving drum, but this must be ensured that the perimeter of the driving drum is exactly the multiple value of the sprocket teeth spacing.

e) Plate voltage supply unit. It is evident from the plot of voltage scale on Fig. R8 that the error from the plate voltage supply unit is quite small. However, the final accuracy of the plate voltage scale is also affected by the voltage drop across current sensing resistor Rk. Therefore, the actual plate to cathode voltage is less than the voltage which read from the plate voltage scale by the same amount as the voltage drop across Rk.

This error can be minimized by decreasing the maximum voltage drop across Rk to a relatively low value comparing to the operating plate voltage. Another solution may be done by feeding the voltage drop across Rk back into the voltage control circuit which has been rearranged so that the output voltage is increased by the same amount as that voltage drop.

As previously discussed, the y-axis plotting device also produced some error. These error should be investigated in order that they may

be minimized or eliminated. Unfortunately, suitable test instruments were not available. So the error as seen from Fig. R1 to Fig. R4 is the combination error resulting from the ramp-function generator, belt speed variation, and the voltage comparator. In order to test individual circuit, special test instruments such as sweep linearity tester and high accuracy stroboscope for measuring instantaneous belt speed are required.