DP-63
Instrumentation
39

A REMOTE-INDICATING BF_3 COUNTER SYSTEM

by

L. Cathey
Instrument Development Division

June 1954

E. I. du Pont de Nemours & Co.
Explosives Department — Atomic Energy Division
Technical Division — Savannah River Laboratory

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ABSTRACT

A system is described for operating a BF_3 counter two-hundred cable feet from the indicating scaler.

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A REMOTE INDICATING BF_3 COUNTER SYSTEM

INTRODUCTION

To provide a sensitive, remote-indicating detector for thermal neutrons, a special preamplifier was developed to permit the use of long signal leads.

SUMMARY

Five individual preamplifiers and cable systems were built which operate with a 40-foot cable between the BF_3 counters and the preamplifiers and a 150-foot cable between the preamplifiers and the scalers. All controls and power supplies were located near the scalers. The systems were designed so that standard scalers could be used.

Tests showed that the systems functioned satisfactorily over the desired range and did not saturate completely even at observed counting rates as high as 10^6 counts per minute. There was a counting loss of about 35% at the high counting rates, which may have been caused by insufficient resolution of the scaler.

DISCUSSION

DESIGN

A preamplifier is normally required to amplify the 1 to 5 millivolt output pulses from BF_3 counters in order to trigger a scaler. The standard SRP scaler (Tracerlab CC-10) requires a minimum input pulse of about 50 millivolts so that a preamplifier gain of at least fifty is required if cable losses are neglected.

Since the required 190 feet of cable is much too long to drive with the BF_3 counter directly (the output voltage would be in the microvolt region), the preamplifier is, in practice, placed as close as possible to the BF_3 counter. In the present case, forty feet of cable extends from the counter to the preamplifier. From the preamplifier, 150 feet of cable is provided to reach to the CC-10 scalers. All high voltages for the counter and supply voltages for the preamplifier are taken from the CC-10 scaler except for a filament voltage booster for the preamplifier. All controls are therefore located at the scaler. The system is composed of five complete, independent channels.

The circuit is shown in Figure 1. It will be noticed that the preamplifier is a pulse amplifier with a gain of about 100. It is a feedback type three-tube circuit with amplification relatively independent of variations in supply voltage. The gain changes about 5% when the plate voltage is varied from 100 volts to 250 volts.

The preamplifier receives power from the scaler through the "preamplifier power" plug on the scaler. A three-wire cord delivers the power for filament and plate circuits to the preamplifier. Line losses in the filament circuit make it necessary to add a booster in the filament line to make certain that the voltage drop on the 150 feet of filament line is overcome and that a full 6.3 volts appears on the preamplifier tube filaments. For operating convenience, the line booster is placed near the scaler.

The high voltage for the BF_3 counters is also supplied by the scaler. To minimize the number of cables, the high voltage cable from the scaler to the preamplifier also serves as the signal lead back to the scaler. The combination of preamplifier and BF_3 counter is equivalent to a normal proportional counter so far as the controls of the CC-10 scaler are concerned.

Since the high voltage to the BF_3 counter is fed around the preamplifier through an RC decoupler, there exists a small amount of positive feedback to speed up the pulse edges.

The magnitude of the positive feedback is determined by the lengths of the cables used with the preamplifier. If no cables, or very short cables, are used between the BF_3 counter and the preamplifier and between the preamplifier and scaler, the preamplifier will oscillate due to excessive feedback. With the length of lines specified, this is not possible.

OPERATION AND MAINTENANCE

Directions for operating and maintaining the system are given in the following sections.

Operation To place the system in operation, it should be connected as shown in Figure 1. Before plugging the scaler or line booster into the power, cut all scaler switches off and turn the scaler high voltage control all the way counter-clockwise. Plug the scaler only into the power. Turn on the scaler power switch and allow the scaler to warm up.

Unplug the Jones plug from the preamplifier and test the filament voltage on Pins 2 and 3 with a Simpson 260 meter; the voltage should be about 6.3V AC. Now plug the line booster into the AC power and check the filament voltage again; it should be about 12.6V AC. If the filament voltage drops when the line booster is plugged in, the two primary wires on the filament transformer in the line booster must be reversed. Check between Pins 1 and 3 of the Jones plug to see if 250 volts is present for the preamplifier plate supply.

Plug the Jones plug into the preamplifier and quickly adjust the 6-ohm potentiometer in the line booster until the desired 6.3V AC is present between Pins 2 and 3 of the Jones plug. The filaments of the preamplifier must be connected or an erroneous value will result since the control of the 6-ohm potentiometer depends upon the filament current drawn by the preamplifier. It may be necessary to remove the pre-amplifier cover to make this measurement, but it is possible to make contact with the Jones plug pins by using small wire probes when the plug is inserted into the preamplifier. Allow the preamplifier to warm up.

Turn on the high voltage switch on the scaler and advance the voltage control knob until the required voltage specified for the particular BF_3 counter is reached. At this voltage setting on the BF_3 counters, a few noise pulses will be registered on the scaler. Reset the scaler register and timer and take a one-minute count to determine the noise value for this particular channel. No neutrons should be hitting the counter during this measurement.

Place the counter in a thermal neutron beam of known value and determine the counting plateau. A curve of such a test is shown in Figure 2. It will be noticed that any voltage from 1900 to 2200 will give essentially the correct count. The curve of Figure 2 was taken with a scaler input sensitivity of about 50 millivolts.

Maintenance

Preamplifier The tubes are the most likely source of trouble in the preamplifier. They should be checked before the system is put in use. A quick check of the operability of the preamplifier is to hook up all the required cables and the scaler and introduce a 2 millivolt signal into the cable at the BF_3 counter. The pulse should be of short duration. The scaler should count very reliably on this input signal.

Normal care accorded electronics equipment should be employed with the preamplifiers. They should be maintained free of dust and jarred as little as possible. The phase of the line booster filament transformer must be right before the tube filaments will light.

Cables The cables should be kept coiled in rolls not less than 1 foot in diameter when not in use.

Line Booster This unit should be protected from dust and mechanical shock.

L. Cathey
Instrument Development Division

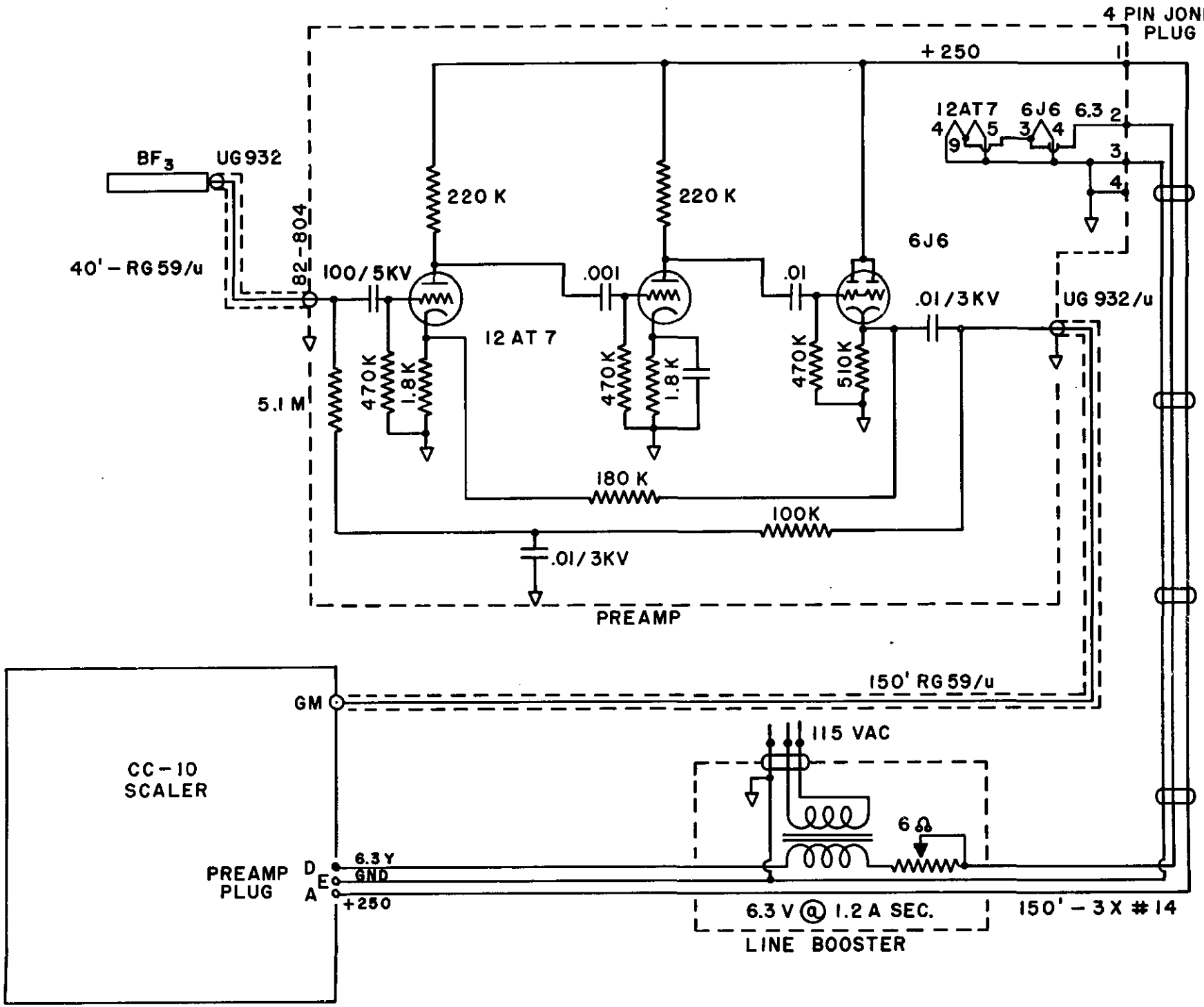
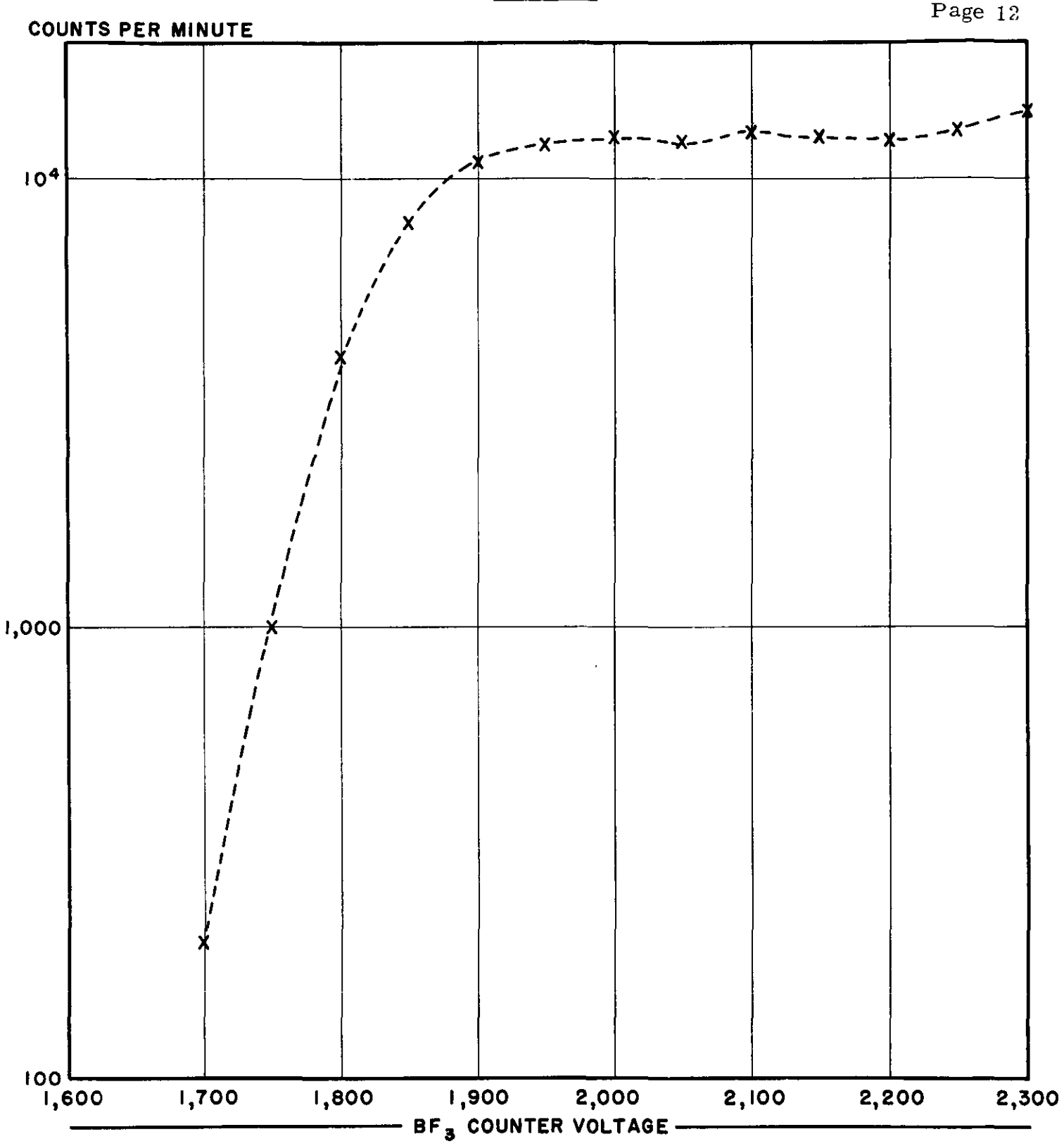


Figure 1

BF_3 NEUTRON FLUX MONITOR

Figure 2

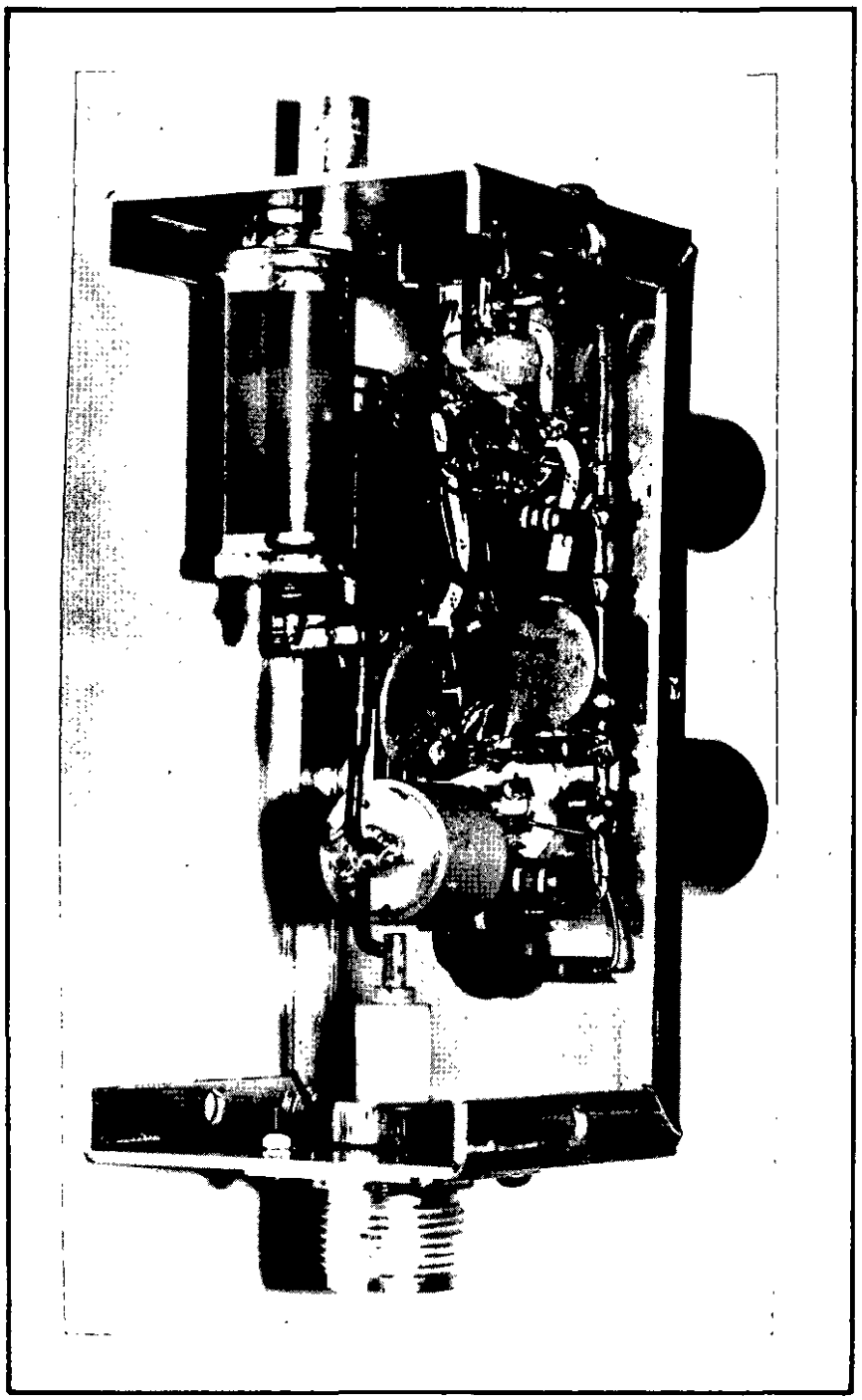


COUNTING PLATEAU - BF_3 COUNTER

N. WOODS 1" DIA. X 6" LONG

C.C. - 10 SCALER
~ 50 MV SENS. } + PREAMP

Po Be NEUTRON SOURCE



PREAMPLIFIER - BF_3 NEUTRON FLUX MONITOR

ONE-CHANNEL BF_3 NEUTRON FLUX MONITOR