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A LINEAR CURRENT - FREQUENCY CONVERTER FOR ION PUMP CURRENT READOUT*

by

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In simple vacuum systems employing a single ion pump, it is common to use the linear pump current - pressure relationship to advantage, eliminating the need for a separate vacuum gauge by reading the ion pump power supply current. In large systems it becomes prohibitively expensive to install a power supply for each pump and in such systems one or more central supplies are usually used with a distribution scheme for the high voltage. Then, however, the power supply current is the sum of the currents of the pumps connected to the supply and one loses the "gauge" facility unless he is willing to measure currents at the high voltage end of the pump. This note describes a simple way of doing this at a reasonable cost.

The problem is illustrated in Fig. 1, which shows a block diagram of a distributed power supply vacuum system. The anode end of the pumps is the pump body, which is at ground in most systems, so that one cannot measure the pump current there. On the other hand, the other end of the pump is at high voltage, and current measuring devices placed there must pass signals

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across the high voltage interface. The circuit described here does this by converting the current to a train of narrow pulses, which can be passed through a transformer. The transformer then provides the high voltage insulation required. The frequency of the pulse train is proportional to the current passing through the device. The circuit diagram is given in Fig. 2. Circuit operation is as follows:

The pump current charges the capacitor until the voltage across it reaches the triggering voltage of the four-layer diode (for the IN5158, this is 10 volts). Then provided that the current exceeds the triggering current of the diode, it will switch to the low state, dumping the capacitor into the pulse transformer primary (through the gate-to-cathode junction of the SCR). This turns on the SCR, which has a sufficient low forward voltage drop to extinguish the four-layer diode. Then the SCR continues to dump the capacitor into the primary of the pulse transformer. The current through the SCR drops exponentially toward the pump current, and provided that the pump current is less than the holding current of the SCR, the SCR will turn off and the circuit is ready to begin again.

The underlined sentences above point out the operating range for the circuit; for the components indicated in Fig. 2 the range of current is about 5μA to 15 mA, or a little over three decades. The 10 volt trigging voltage coupled with the 0.1μf capacitor produces an output from 5-Hz to 15-KHz over this current range. The pulse width is about 25μs when the output is terminated in 100Ω.

Of course, the SCR is not needed for circuit operation but does two things. First, it increases the operating range because its holding current is higher than that of the four-layer diode. Secondly, should a fault occur (such as a pump short), the discharge device must take the full short-circuit current of the power supply. The SCR can do this, while the four-layer diode can handle only 150 mA dc maximum. Other devices can be used for triggering; the author has used an npn-pnp transistor pair and also a neon bulb in place of the four-layer diode. The former increases the component count while the latter increases the ripple on the pump because of its higher triggering voltage. Both increase the range of the circuit by lowering the trigger current, however.

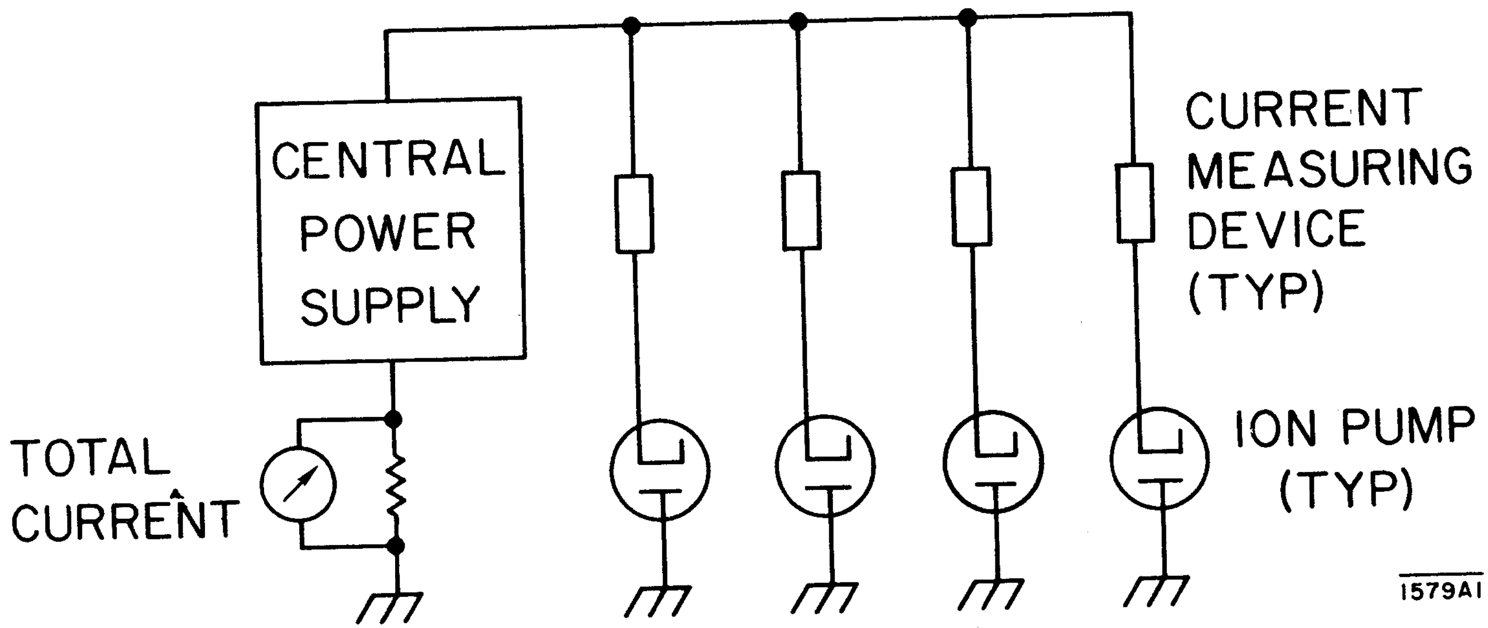
CENTRAL
POWER
SUPPLY
CURRENT
MEASURING
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Fig. 1

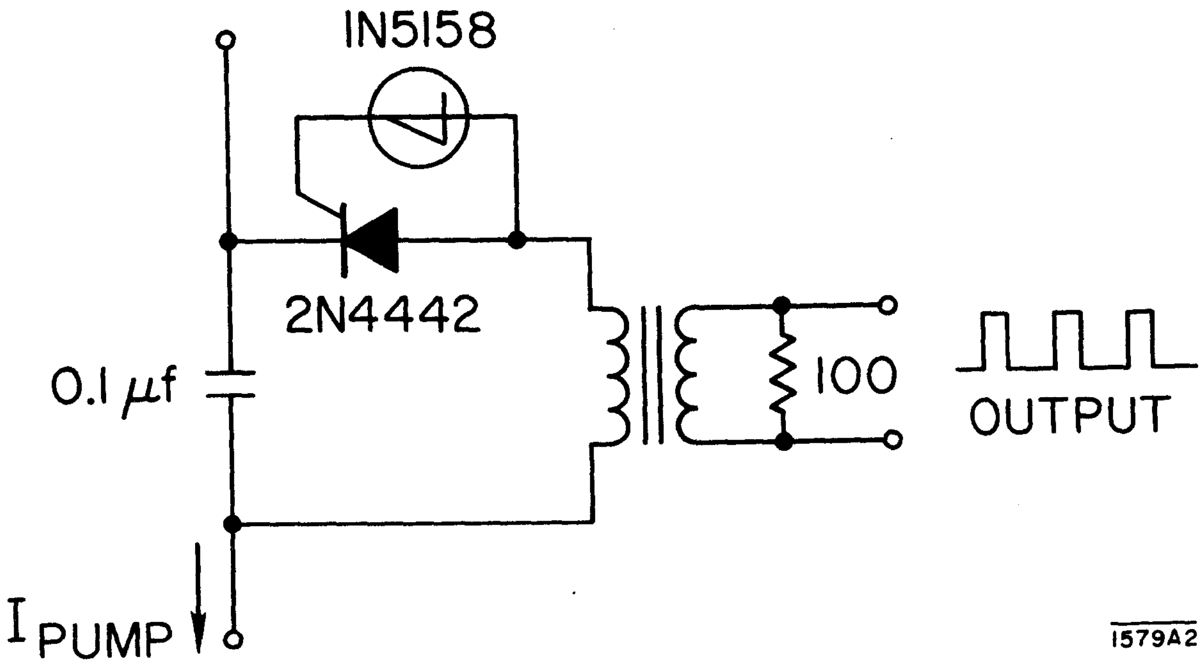

Fig. 2