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Letters to the Editor

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AN INVERTER

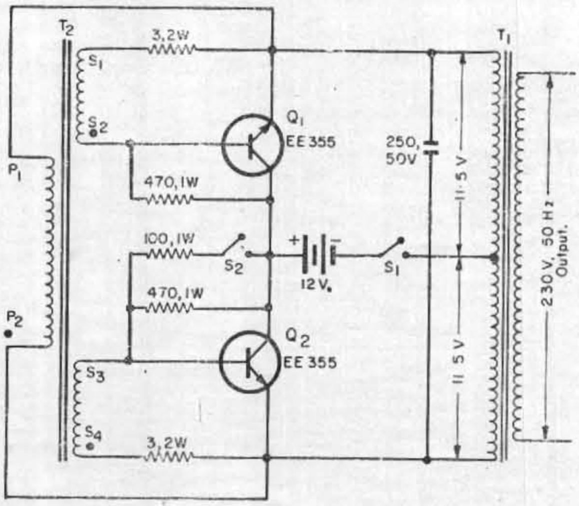
1. To work a Honeywell potentiometric recorder on board an aircraft for special radiation measurements, an inverter has been constructed in the Central Radiation Laboratory, Poona. The inverter provides the 220V, 50 Hz power supply for the recorder from a 12 V accumulator.

2. The circuit diagram of the inverter is given in Fig. 1. The instrument does not start functioning when switch S_1, is put on. On activating the 'press momentarily to start' switch S_2, transistor Q_2 gets a positive base voltage drive enabling its conduction. The positive voltage induced at S_3 and the base of Q_2 with respect to its emitter due to the fast changing magnetic fields also aids the conduction of Q_2. As a result Q_2 is driven very fast to saturation and acts as a short circuit. Current flows through the lower half of the primary of transformer T_1. The negative voltage induced at the base of Q_1 with respect to its emitter keeps Q_1 cut off. No current flows through the upper half of the primary of T_1. Once the steady state is reached, voltage at S_3 starts falling and at S_2 starts rising. The capacitor in the circuit makes the change slow. When Q_1 is able to conduct, the induced voltage at S_2 drives it quickly to saturation while the induced voltage at S_3 cuts off Q_2. The current flows through the upper half of the primary of T_1. The cycle repeats. The battery voltage, thus made alternating at the primary of transformer T_1 is stepped up at its secondary to feed the load.

3. The components are described below.

3·1. The transistors used are EE 355 manufactured by the Electronic Corporation. It can handle a maximum collector current of 17 amp, a base current of 7 amp and can dissipate 117 watts of power. The transistors are mounted on a large heat sink. The common collector configuration chosen for the inverter permits the transistors to be mounted directly to the common heat sink without insulation.

3·2. The battery should have a large capacity like rechargeable lead acid accumulators as more than 5 amperes of current is continuously drained from the battery to work the recorder.



Resistances in Ohms, and
Condensers in Microfarad

Fig. 1. Block diagram of the Inverter

3·3. The switch S_1 used here is rated for 10 amperes.

3·4. The power transformer (T_1) has to be large to reduce the losses and increase the efficiency. The transformer used here is heavy and can handle 500 watts of power. The voltage ratings are given in the circuit. The d.c. resistance across 11·5 volt terminals are about 0·1 ohm and across the 230 volt terminals is about 2 ohms.

3·5. The feedback transformer (T_2) had to be specially wound. The core is iron and the former dimension is 3×3 cm. The primary turns (P_1 to P_2) are made up of 320 turns of 26 swg copper wire. The secondary windings are over the primary, each winding (S_1, S_2 and S_3, S_4) made up of 80 turns of 26 swg copper wire. The polarity of the transformer windings are indicated by dots in figure.

3·6. The condenser was selected to clamp the resonant frequency to 50 Hz. The frequency is more critical than the voltage to work the recorder. The synchronous chart drive motor in the recorder keeps time depending on the frequency of the power supply. The safe operating voltage can vary even by 70 volts as prescribed by the manufacturer.

TABLE 1

Performance test of the inverter

Load (Phillips lamps)	Input (d.c.)			Frequency (Hewlett-Packard frequency counter)	Output (a.c.)		Efficiency
	Voltage (Simpson multimeter)	Current (Cambridge ammeter)	Power		Voltage (Avometer)	Power	
(watt)	(volts)	(amp.)	(watt)	(Hz)	(volt)	(watt)	(%)
Nil	11·1	2·8	31·1	50/51	215	0	0
15	10·9	3·7	40·3	50	200	12·4	31
25	10·7	4·2	44·9	50	195	19·6	44
40	10·6	5·3	56·2	50	193	30·7	55
60	10·5	6·2	65·1	49/50	190	44·7	69

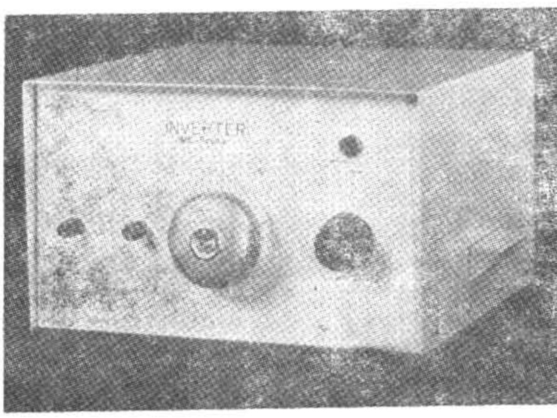


Fig. 2. Photograph of the Inverter

Fig. 3. Wave shapes

3·7. 3/·029 cables have been used to make connections to the battery and to input of transformer T_1 because of large current drainage.

A photograph of the completed instrument is given in Fig. 2.

4. The circuit has been tested in the Laboratory for continuous operation. A Hewlett Packard frequency counter with an accuracy of $\pm$ 1 Hz was reading 49 or 50 Hz. The chart time varied only by a minute in 200 which shows that the frequency was maintained within 0·5 per cent during the test. The output voltage obtained was around 200 volts throughout the period.

A fully charged 80 amp-hr car battery can work the recorder continuously for at least 8 hours.

5. The inverter was constructed in 1973 and was put into use immediately after initial testing with a Honeywell recorder. Global and reflected radiation measurements were made on board two different DC-3 aircrafts hired by the Indian Institute of Tropical Meteorology for cloud seeding. The total number of flights were more than 30. The

inverter performance was good without any attendance during all the flights. The inverter was further tested with different loads in the laboratory and the results are presented in Table 1. The output a.c. power was computed assuming the lamps to be pure resistive loads. It failed to operate at higher load (100 watt) due to poor condition of the battery.

The waveforms at the emitters of the two transistors and the output monitored on a BEL Oscilloscope are presented in Fig. 3. Those at the bases of the transistors were identical to those at the emitters. No significant changes in the waveforms could be observed with and without load. However these waveforms do not generally affect the performance of most of the instruments. (*see* Ref.).

The inverter can be used to operate a wide variety of recorders which operate at 220 volts and draws less than 60 watts of power.

6. The author wishes to thank Sri George Alexander, Director (Instruments) and Shri O. Chacko for their interest in the work and encouragement

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REFERENCE

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