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NOTES ON POWER AND TIMING EQUIPMENT FOR MANAM AND ESA'ALA VULCANOLOGICAL STATIONS.

by

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SUMMARY

The effectiveness of a seismo-vulcanological observatory depends largely on continuity of instrument operation and on timing accuracy. To achieve these qualities in isolated tropical environments with unskilled operators presents difficulties. This report details the specifications of equipment with which we hope to achieve good results. Mains power from diesal generators is fed into constant potential chargers which maintain nickel-cadmium batteries and at the same time take up any fluctuating loads without voltage variation. All instruments derive their power from this charger-battery assemblage which has sufficient reserve capacity to operate them during a mains failure of about 12 hours, and to safeguard the rate of the crystal clock for not less than two weeks. A 24 volt rectifier parallel inverter supplies frequency controlled 240 volt 50 cps power for the synchronous motors of recorders and is itself controlled in frequency by the output from a crystal clock. The 24 hour digital readout clock is operated from 12 volts DC. It has no mechanical parts and is specified to have an accuracy of one second in three months. It provides contact closures for marking the seismic records at minute, hour and six hour intervals. A programming device attached to the clock provides switching facilities during any part of twenty four hours. A time signal receiver, crystal locked and fully transistorized, is used in conjunction with a chronoscope for accurate time checks. The chronoscope which consists of a 3 inch cathode ray tube receives signals for comparative purposes from the receiver and the clock. Pips on the circular time base can be read to yield a checking accuracy of better than 10 milliseconds. All equipment is designed for reliable performance under severe tropical conditions: silicon transistors have been used wherever practicable.

INTRODUCTION

In 1955 the Administrator of the Territory of Papua and New Guinea approved in principle a submission to establish permanent Vulcanological stations on Manam and on Normanby Islands: the object being to improve surveillance work of the central observatory at Rabaul by studying both the vulcanicity of volcanic centres adjacent to these stations and the seismicity of the region as a whole. Manam is one of the most active of the Territory volcanoes and northern Normanby Island is close to a series of long dormant volcanic vents which appear to have a potential for reactivation. The proposed station locations form with the central observatory at Rabaul a roughly equilateral triangle with sides of about 500 miles. This disposition of recording centres offers good prospects of yielding useful data for the pinpointing of regional seismic disturbances.

Construction of the two stations was held up chiefly by commitments associated with an unusually powerful and prolonged eruption from Manam which began in December 1956. However, work began on the stations this year, and it is expected that installation of equipment will be completed early 1965. On Manam Island the site is near Tabele at lat. 04°07' long. 145°04': on Normanby Island the site is near Esa'ala at lat. 9°44' long. 150°49'.

The equipment for the stations has been designed to ensure that the basic instruments are isolated from the uncertainties of short term mains power failures and from the effects of voltage and frequency fluctuations. All timing and recording gear is run from batteries. Every effort has been made to obtain equipment which will function reliably under severe tropical conditions.

The attached schematic block diagram illustrates the layout of the circuitry (Fig.1). The mains power is connected to 12 volt trickle chargers which maintain three alkaline batteries. The batteries supply 12 volts for recorder lighting and for operating a crystal clock with its associated programmer. They also supply 24 volts to an inverter which provides frequency controlled 240v 50c/s power for recorder motors.

CHARGERS

The chargers are Westat constant potential units which will trickle charge the batteries at approximately 1.42 volts per cell. These units will automatically take up loads to 23 amperes without appreciable voltage change. Their output is smoothed to P.M.G. communication standards and provision is made for "gas charging". Care must be taken to adjust the chargers to the rate of charge specified above. Lower rates will ultimately damage the batteries and higher rates boil off the electrolyte. A circuit diagram of the battery charger is shown in Figure 2.

BATTERIES

The DEAC nickel-cadmium alkaline batteries, type AC1816H, are 9 cell units with a capacity of 180AH at a 10 hour rate. Cells of a similar type are to be used at all instrument stations in the Territory in order to facilitate maintenance and replacement. Trickle charging at a rate which avoids excessive loss of electrolyte makes available approximately 70% of the battery's nominal capacity. This will cover normal instrument-power requirements during a mains failure of several hours.

A separate battery is provided for the critical components included with the oven circuitry of the clock. This is to ensure that in the event of a major power failure the clock rate will not change if power is restored within two weeks. This battery is isolated from other loads by a mercury tube relay using a tilting beam and a solenoid with a vertical plunger. Contact with other parts of circuit is broken when the mains power fails.

INVERTER

A silicon controlled rectifier inverter supplies frequency controlled power, for synchronous motors of the recorders. Its characteristics are:-

Imput - 24 volts DC $\pm$ 2 volts
Output - 240 V $\pm$ 2%: no load to full load,
power factor 0.65 lagging to unity
50 c/s
1 phase
150 v.a.
output voltage waveform sinusoidal
with an harmonic content of 3%
maximum.

Facilities - will accept synchronising pulses from a 50 c/s crystal clock. If free running it operates at 50c/s ± 1 c/s/ For operation under extreme humidity conditions a heater element is included.

"The static inverters comprise basically, an SCR parallel inverter, followed by a power regulator and band-pass filter.

The parallel inverter contains, in addition to the S.C.R.'s, circuits which protect the devices against normal transient voltages and currents. A small pulse generator, the frequency of which is carefully stabilised, provides the necessary drive pulses for the S.C.R.'s; a frequency trimmer control, giving ± 5% adjustment, is usually provided.

The power regulator is fed with a pulse signal from the voltage regulator; this, in turn, compares the output of the equipment, with a stable reference, and controls the power regulator in such a manner as to maintain the equipments output voltage constant, irrespective of load changes. The voltage regulator includes a voltage trim control, giving ± 5% voltage trim, a gain control and a stability control, (the last two items being pre-set during manufacture of the equipment).

The band-pass filter accepts the output of the power regulator, and produces a sine wave which is maintained sinusoidal with usually less than 3% R.S.S. total harmonic content.

The equipment is usually fed by an appropriate D.C. input voltage, although circuits can be added enabling the equipment to be operated from normal A.C. mains supplies. In addition to this facility, circuits can be provided to float charge a suitable accumulator which would, in turn, be used to supply the inverters.

The output of the inverter is protected by a suitable fuse, although the equipment is designed so that a short circuit load condition would not cause damage to the inverter. Approximately twice full load current is available during short circuit conditions, in order to clear the output fuses.

The pulse generator previously mentioned, can also accept a specified synchronising signal, which enables the frequency to be locked to another frequency source."

CRYSTAL CLOCK

The crystal clocks used in the stations will be manufactured by Labtronics of Brisbane and will have the following basic specifications:-

24 hour digital readout down to 0.1 secs., comprising seven indicators in all, each of which can be advanced or re-set to zero individually. The tube type used here to be Philips Z550N. To include an additional advance button for 20 m.s. advance increments. Full proportional crystal oven temperature control 10-14 volt D.C. imput.

Accuracy - approximately 10 m.s./day.

Outputs: 50 c/s square wave 2 V 600 chms (or as arranged with Electrodynamic & Hewitt Electrons Ltd.)

Seconds pulse output of 100 m.s. duration capable of driving small relays or recorder coils.

Contact closures: - 2 seconds duration at beginning of each minute except -
4 seconds duration at beginning of each hour, except -
6 seconds duration at beginning of each six hours.

Power Consumption : 12 watts (oven - 200 ma)

Crystal oscillator and oven circuits to be arranged to operate from a separate 12 volt battery for prolonged emergency operation.

Labtronics Programmer unit to work with the clock, fully solid state with no moving parts. Unit to start and stop two programmes at any selected time with durations from one minute to approximately 24 hours.

Both units to be suitable for operation in a tropical climate.

All connectors to be of the Cannon M.S. type.

All relays to be of the sealed dry reed type.

The clocks will be supplied in two sections - a power module and an indicator module. This is to give more flexibility in the use of the spare clock which will be held in case of breakdowns.

The clock rate of 10 milliseconds a day has been specified to make allowances for the fact that the stations will be operated by unskilled personnel. If this rate is realized the usefulness of the stations in recording tectonic disturbances will be greatly enhanced.

RADIO TIME SIGNAL RECEIVER

A Labtronics receiver type 21 with the following specifications has been chosen.

Frequency coverage	- 10 and 15 Mc/s
Sensitivity	- 0.5 microvolts at antenna terminals will produce A.G.C. action.
Selectivity	- Approx. ± 1.5 kc/s at - 3 db without audio filters.
Audio filter	- 5 positions, wide, 440, 600, 1000, 1200 c/s. Initial slope typically 70 db/octave. Selectivity at - 3 db approx. 50 c/s.

	- Selectivity at - 6 db approx. 100 c/s. Typical ratio between tones far off selected tone, typically 30 db.
Output Impedance	- Approx. 100 ohms. Maximum unterminated voltage 3V peak to peak.
Image Rejection	- Approx. 50 db.
Antenna Inputs	- Single ended/balanced (75 ohms).
Power Input	- Internal 9 volt battery Ext. 12 V battery + reearthed Ext. 240V A.C. 50c/s } Automatic switching.
Audio Output	- Maximum 1 watt.
Semiconductor complement	- 22 transistors 8 diodes 2 zeners.
Outside Dimensions	- 5" high x 17" wide x 5" deep.

The radio is a fully transistorized high performance crystal controlled dual conversion superhet. First I.F. frequency of 1.6 Mc/s for high image rejection, and second I.F. frequency of 85 kc/s, stagger tuned for optimum band pass characteristics. Variable threshold noise limiter. Amplified A.G.C., emitter follower output and built in speaker. Beat frequency oscillator for C.W. receiption (e.g. VHP).

For ease of operation all controls are front panel mounted. Either frequency may be selected by means of a single front panel switch without the necessity of changing coil assemblies, crystals, etc. Audio filters are readily selected in the same manner. R.F. gain, audio gain, fine tune, limiter threshold, output level and A.G.C. and B.F.O. controls are conveniently positioned.

Power supply design utilises diode logic to switch to highest available supply. Thus if receiver is connected to 12 volt battery and 240 volt mains, receiver will choose mains power. If mains fail receiver will switch to 12 volt battery. If battery fails receiver will switch to internal battery. A stabilized supply is provided for the second local oscillator and for the audio filter circuit.

The set includes a relay driving unit which has its own level control and will drive any 12 volt relay with coil current up to 0.5 amps. When used in conjunction with audio filters this unit can drive chronographs, recorders etc. directly from any tones or second pips.

CHRONOSCOPE

For accurate checking of the clock against a standard time signal a labtronics chronoscope has been included. This unit consists of a 3" cathode ray tube on which a circular time base of one seconds duration is displayed. This time base is synchronised by the closing of a contact on a clock.

The intensity of the circle is made just visible and the WWV seconds pips are applied as a brightening pulse to the cathode ray tube. The pips are then visible as a bright spot. The synchronising pulses appear as a short li.e normal to the circular trace. A calibrated circular graticule enables the difference between the clock and WWV to be read off to an accuracy of better than 10 milliseconss. The major graticle calibrations are in tenths, with minor divisions of 20 milliseconds. A two inch diameter circle is used giving a circumference of some six inches, so that 20 milliseconds is approximately 0.1 inches.

The WWV and WWVH pips are received through 1000 c/s and 1200 c/s filters which are incorporated in the type 21 receiver.

SUPPLIERS OF MAIN EQUIPMENT

DEAC Batteries & Taper Charger

H.H. Green Electronics Pty Ltd,
181 Wells Street,
P.O. Box 92,
SOUTH MELBOURNE, Vic.

Charging Sets, Westat

McKenzie & Holland (Aust.) Pty Ltd,
P.O. Box 21,
BURWOOD. N.S.W.

Inverter

Electrodynamics & Hewitt Electronics Ltd,
St. Mary Crag,
Orpington, Kent,
UNITED KINGDOM.

Radio receiver, crystal clock & chronostat.

Laboratory Electronics,
96 Osborne Road,
Mitchelton,
BRISBANE, Qld.

Instrumentation

Initial instruments for the two stations will consist of seismic and tiltmeter equipment. Three Benioff seismometers will be installed at Esa'ala with a 35 millimetre film recorder for short period and a photographic paper recorder for long period data. One vertical Benioff seismometer with a hot pen recorder for short period and a photographic paper recorder for long period events will be installed at Manam. Both stations will contain two component water tube tiltmeters which will be set up on 5 metre legs.

Acknowledgements

In drawing up the specification and finding suppliers of the power and timing equipment assistance has been received from many quarters outside the Department. In particular I would like to acknowledge helpful discussions with Professor G. Newstead of the University of Tasmania, Dr J.P. Webb of University of Queensland and Mr E Penekis of the Australian National University.

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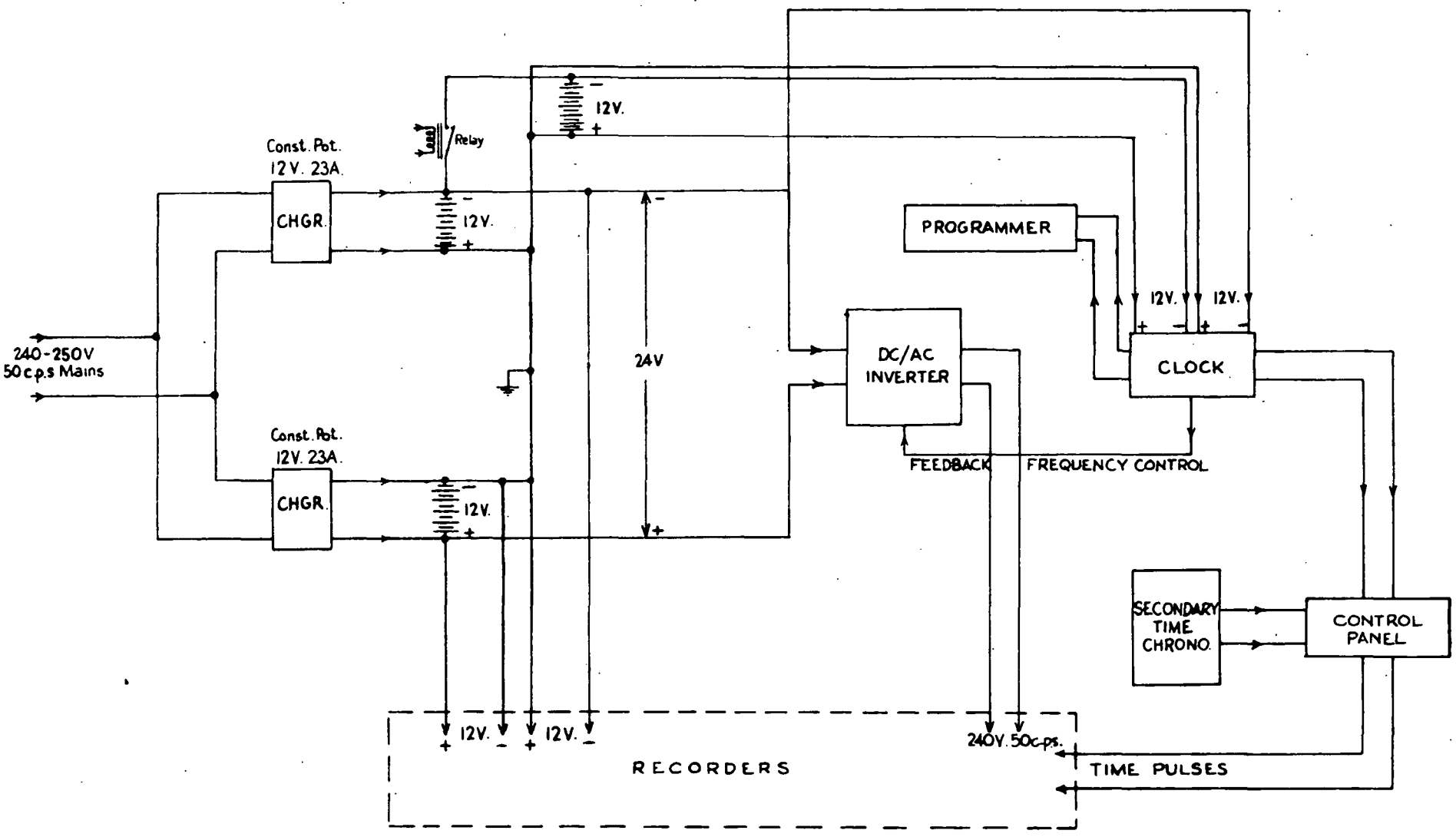

DIAGRAM OF INSTRUMENT LAYOUT
MANAM & ESA'ALA VULCANOLOGICAL . STATIONS

Fig 1

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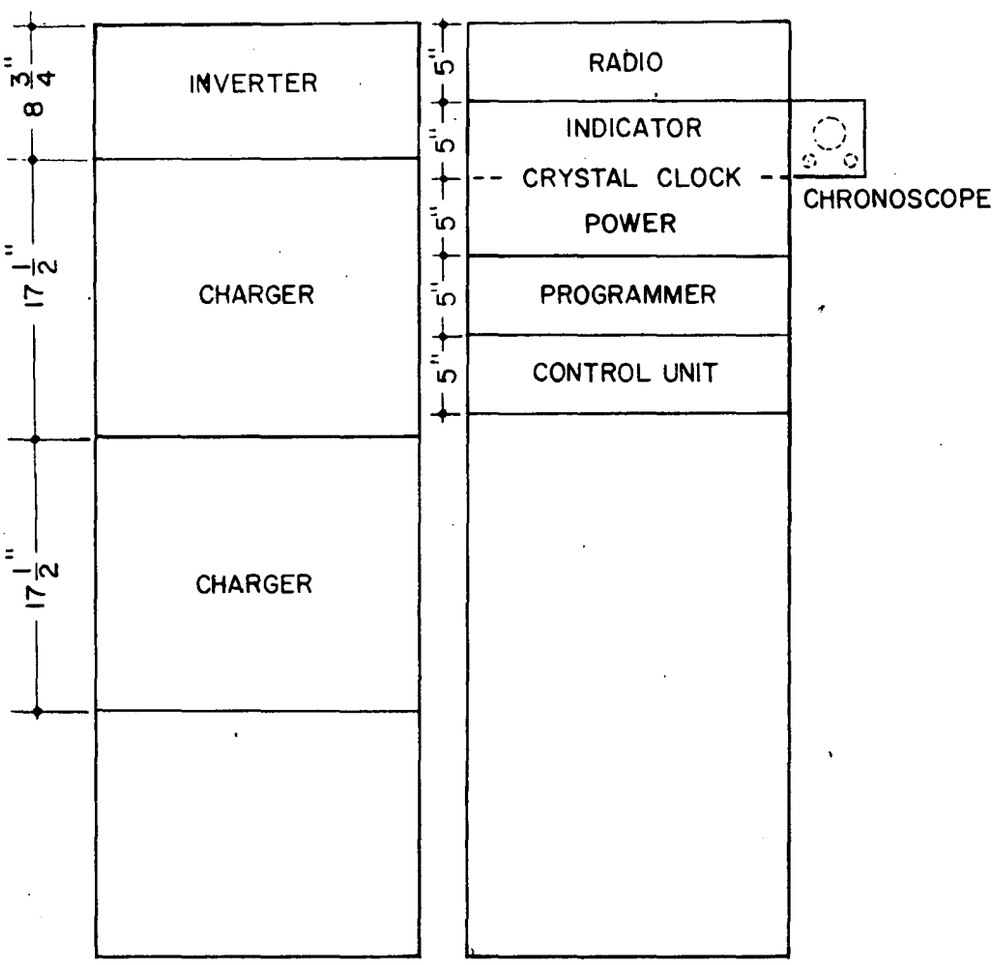
FIG 2.



LAYOUT OF MOUNTING RACKS

VULCANOLOGICAL STATIONS.

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FIG 3

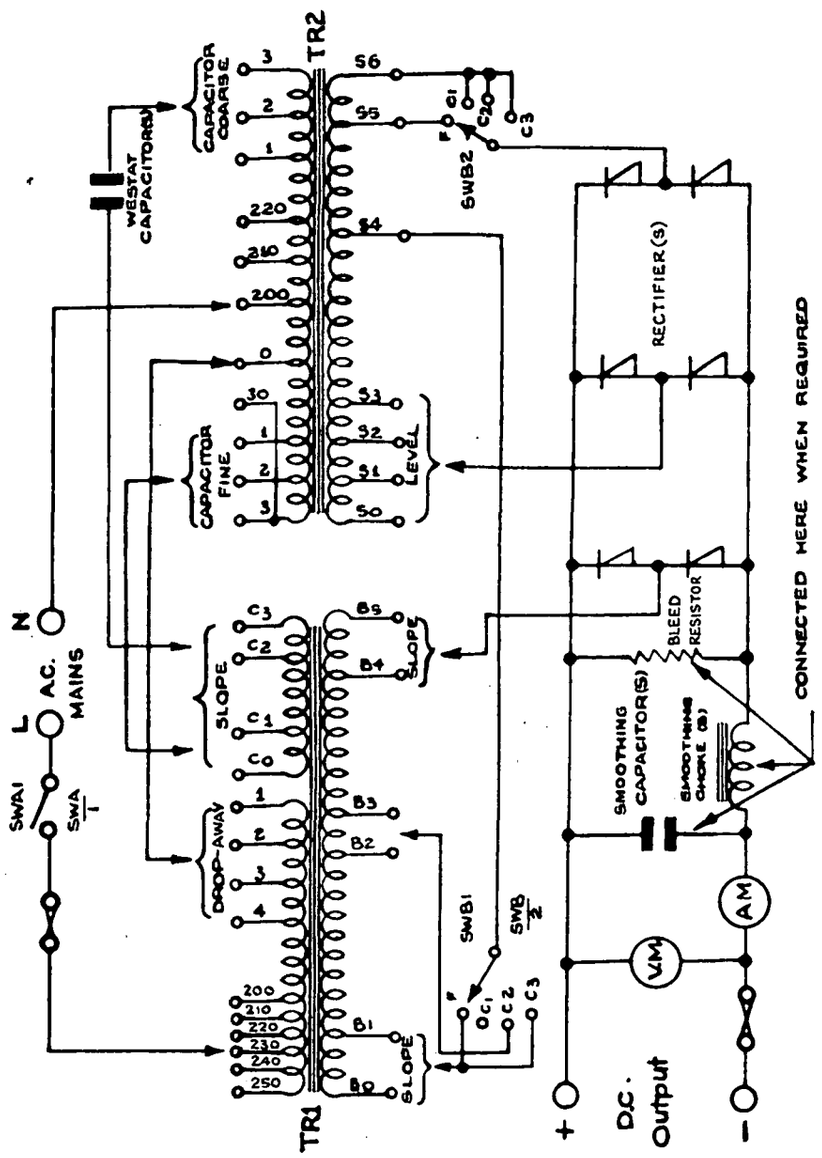

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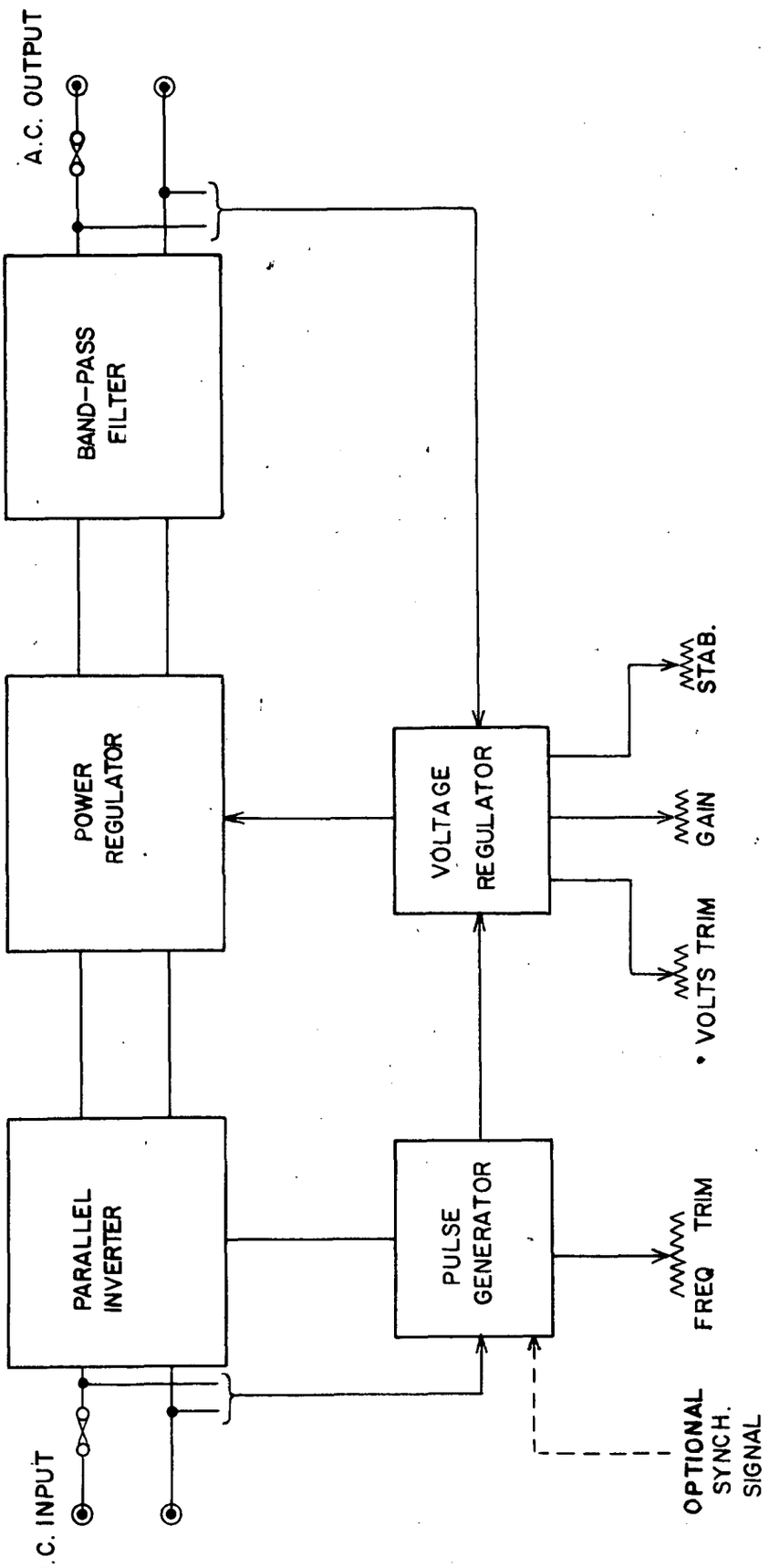
FIG 4

CIRCUIT DIAGRAM OF STATIC INVERTER



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