TECHNICAL INSTRUCTION
R. 7

Miscellaneous Recording Equipment

BRITISH BROADCASTING CORPORATION
ENGINEERING DIVISION

TECHNICAL INSTRUCTION
R.7

Miscellaneous Recording Apparatus

First Issue, January, 1954

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MARTINDALE VIBROVERTOR

Introduction

The Martindale ' Vibrovertor ' is a transportable d.c./a.c. convertor, comprising a vibrating-reed unit and a step-up transformer. The Type-XM/300 equipment, supplied to the BBC, has a rated output of 300 watts at 230 volts 50 c/s a.c., and is thus suitable for use with portable mains-driven equipment where normal power supplies are not available. The required input supply, at 24 volts d.c., is obtained from four 6-volt batteries in series. For the rated output, the current taken from the batteries is about 16 amps, the efficiency of conversion being therefore of the order of 80 per cent. The load may be increased to 400 watts if desired without greatly altering this efficiency, but since part of the power consumption is independent of the load, the efficiency falls when the unit is underrun.

The vibration frequency under operating conditions is satisfactorily stable, although it rises slightly as the load is increased or the battery voltage falls ; this rise may be balanced to some extent by a tendency for the frequency to fall gradually during a period of use. A disadvantage of the equipment is its rectangular output waveform, the harmonic content of which may cause noise interference on programme circuits unless adequate earthing and screening precautions are taken.

The external appearance of the unit is shown in Fig. 1, and a view with the cover removed is given in Fig. 2. The unit is of solid construction, and tungsten contacts are fitted to ensure a reasonably long life. Precautions are taken to minimise the transmission of noise and vibration through the casing.

The ' Vibrovertor ' is a commercial product, originally developed in Sweden, but now made in this country and modified to meet the requirements of the BBC. Further information concerning the original Swedish apparatus is contained in Designs Department Description No. 45.

Circuit Description

General

A circuit diagram of the unit is given in Fig. A.1, and a wiring diagram in Fig. 3.

The five moving reeds of the 50-c/s vibrator are each provided with two side-contacts, and all are attached to a common armature driven by an electromagnet. One reed interrupts the d.c. supply to the driving electromagnet during a part of each vibration cycle ; the remaining reeds are concerned with polarity switching between the battery and the step-up transformer.

The transformer itself has four secondary tappings, provided to facilitate the maintenance of the correct output voltage at the various stages of battery discharge. A tap-changing switch is fitted, and an output voltmeter is also provided.

Driving Electromagnet Operation (*Fig. A.1*)

The driving electromagnet is controlled by reed contactor M, which is in series with the magnet-energising coil. When the reed is in the neutral position, both its side-contacts are closed, and the magnet is connected directly in series with the battery. When the reed is pulled by the armature in the direction of the magnet, the positive side-contact opens and interrupts the d.c. supply to the coil. The magnet thus ceases to attract the armature, and the vibrating assembly flies back toward its neutral position. The momentum of the armature bar, however, carries it beyond the point of equilibrium. If the battery voltage is high, the overswing is sufficient to cause the negative side-contact of reed M to open, thereby inserting a 25-ohm resistor in series with the magnet coil. The insertion of the resistor reduces the restoring force of the magnet over this part of the vibration cycle, the purpose of the arrangement being to offset the effect on frequency of changes in battery voltage. The side-contacts of reed M are mechanically biased relative to the neutral position.

The capacitor and resistor connected between the positive and the negative side-contacts of reed M are concerned with arcing suppression.

D.C./A.C. Conversion (Fig. A.1)

Conversion from d.c. to a.c. is carried out by the four vibrating-reed contactors connecting the battery to the transformer. The reason for using four reeds to effect conversion, instead of two, is that the normal full-load current is more than one group of comparatively small contacts in each leg of the circuit can satisfactorily handle. To reduce wear on the contacts, the make and break of current is effected in two separate steps for each direction of polarity. The general shape of the waveform produced is shown inset in Fig. A.1.

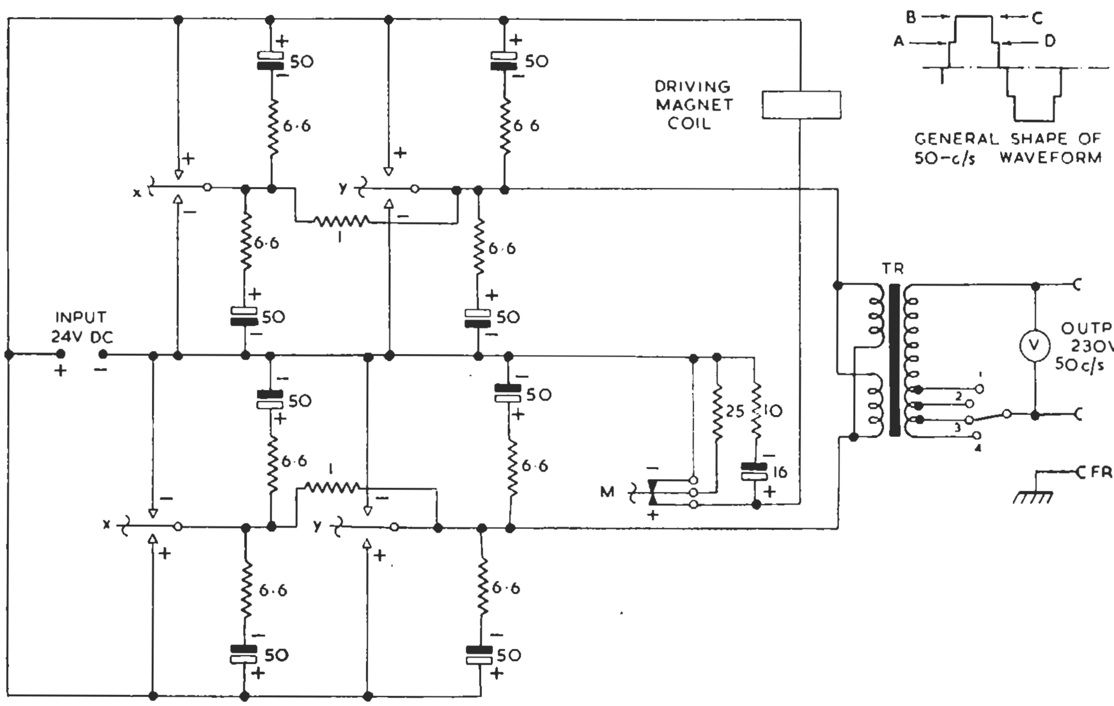


Fig. A.1. Martindale Vibrovertor: Circuit

All the reeds operate in series, but the pair marked *x* in Fig. A.1 have smaller contact gaps than those marked *y*, and the *x* contacts therefore close earlier and open later than the *y* contacts. Connected in series with the *x* reeds are 1-ohm wire-wound resistors; these limit the current passed by the *x* contacts to approximately half that required on the full rated load. The *y* contacts, when they operate, bridge the resistors and *x* contacts, and thus make or break the remainder of the total current; as soon as the *y* contacts are made, the current flow through the *x* contacts is diverted to the path of lower resistance. In the interests of efficiency, the time-separation between the action of the *x* and the *y* contacts is made as short as practicable without rendering adjustment of the contact gap-widths unduly critical.

The functioning of the circuit can best be understood by tracing the waveform through a complete vibration cycle. Suppose at first the reeds are moving upwards through their mean positions, and are approaching the side-contacts shown above them on the diagram. Since all these contacts are open, the voltage applied between the two ends of the transformer primary winding is momentarily zero. As the reeds continue to move, the *x* contacts close while the *y* contacts are still open. One *x* contact, on closing, connects the positive pole of the d.c. supply to the upper end of the transformer winding via the 1-ohm resistor, and the other *x* contact similarly connects the lower end of the winding to d.c. negative. These operations bring the transformer input to point *A* on the waveform diagram. The *y* contacts now close almost immediately and short-circuit the current-limiting resistors, thus bringing the waveform to point *B*.

Since the mountings of the side-contacts include springs, the reeds continue to move upwards, with the battery still directly across the transformer, as the side-contact springs are compressed. The reeds eventually reach the limit of their travel, and commence to return, the *y* contacts opening first, at point *C*, followed by the *x* contacts at point *D*.

The reeds now move downwards through their mean positions towards the lower side-contacts; when these are reached the sequence of operations is repeated, but with the polarities of the two ends of the transformer primary winding reversed.

(a) Reduction of contact wear.
(b) Reduction of interference with neighbouring programme circuits.
(c) Improvement of the output waveform, and thus of the conversion efficiency.

Mechanical Construction

General (Figs. 1 and 2)

The unit is housed in a substantial cast-aluminium case, specially adapted to exclude dust and moisture and to minimise the transmission of vibration and noise. The overall dimensions are 15 in. by 12 in. by 9¼ in., and the total weight is 46¼ lb.

The case is constructed in two parts, a shallow base-tray and a cover, the latter secured by nuts

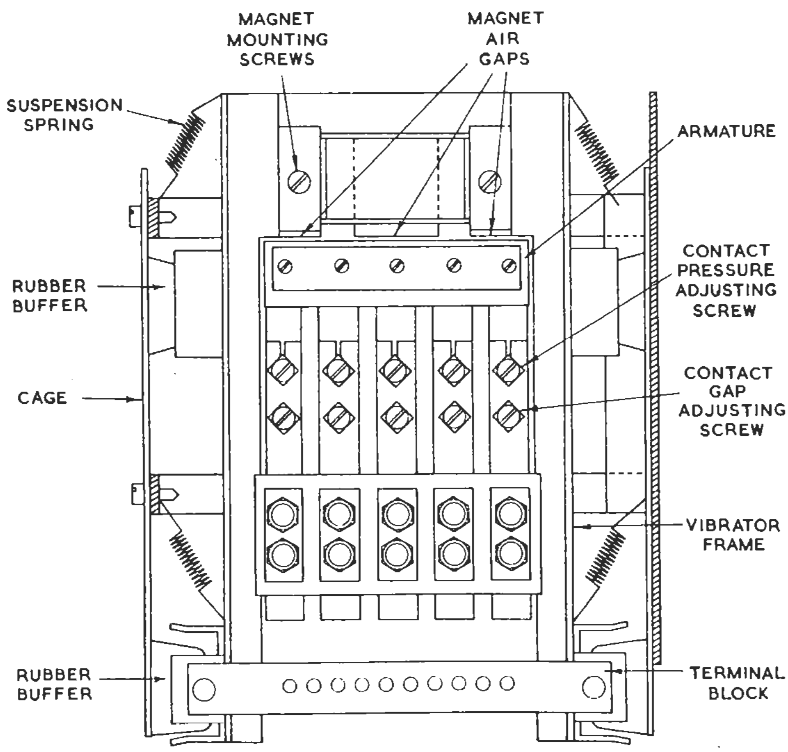


Fig. A.2. Front View of Vibrator

The negative half-cycle of the waveform shown in the sketch is thus described.

Between every *x* or *y* reed and each of its side-contacts is a 50-μF capacitor and a 6·6-ohm resistor. The values of these components are carefully selected with reference to the transformer leakage inductance, and they are fitted with the following objects in view:

engaging with pillars rising from the bottom of the tray and projecting through holes in the top. The unit is supported on four feet; these are mounted in rubber and attached to brackets projecting to front and rear of the tray. Two collapsible carrying handles are fitted to the cover. These details are visible in Fig. 1.

Mounted accessibly at the front edge of the base-tray are the transformer tap-changing switch and a standard 3-pin 5-amp output socket; a 4-pin input plug, with the pins connected in parallel pairs to minimise contact resistance, is recessed into the left-hand edge of the tray. The tray carries all components other than the output voltmeter, and is divided centrally by a paxolin sheet between the vibrator and the transformer, as shown in Fig. 2. The 0-300 voltmeter is a flush-mounting fixture on the front of the cover; the leads attached to this instrument are of sufficient length to enable the cover to be lifted well clear of the tray.

Vibrator

The vibrator itself (Fig. A.2) is a small unit mounted on a framework suspended by eight helical springs inside a rigid cage. Motion of the suspended framework is limited by stops, which normally have a small clearance with rubber buffers attached to the cage. The purpose of the suspension system is to isolate the vibrator mechanically from the rest of the apparatus by allowing it relatively free movement inside the cage.

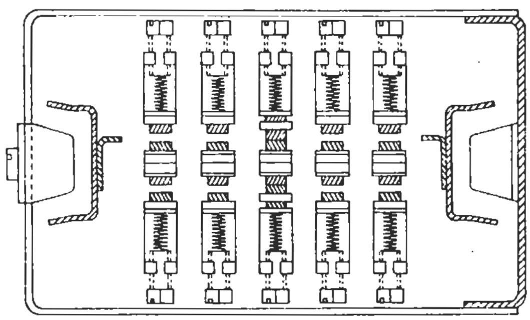


Fig. A.3. Contact Assemblies

Contact Assemblies

The arrangement of the contact assemblies is shown in Figs. A.3 and A.4. Each side-contact is riveted to a leaf-spring and passes through a locating hole in a guide-strip situated between the leaf-spring and the reed. A helical compression spring behind each leaf-spring bears on the contact with a pressure which is adjustable by means of a screw carried by a rigid support-strip spaced off from the leaf-spring and guide-strip.

Below the tensioning screw, each support-strip carries a second screw. This passes through a hole in the leaf-spring, and bears on the semi-flexible guide-strip, which bends slightly in the direction of the reed. The extent of this bending controls the position assumed by the leaf-spring and attached side-contact relative to the reed-contact, since the leaf-spring tends to be forced in the direction of the reed by the helical compression spring. Thus, the position of the side-contact can be controlled by the pressure of the lower screw on the guide-strip, and the screw can be used to adjust the width of the contact gap.

The reeds at their lower ends are clamped between insulators and spacers and at their upper (moving) ends are bolted to the armature bar, which links all five reeds together. The driving electromagnet is mounted above the armature bar and is slightly offset, so that when the magnet is energised, the armature is attracted into alignment, bringing the reeds against one set of side-contacts. All connections to the vibrator are made via a 10-point screw-terminal block at the front.

Referring to Fig. A.3, the central reed and pair of side-contacts, corresponding to contactor M of Fig. A.1, are associated with the driving electromagnet; this contact group is drawn to a larger scale in Fig. A.4, at (a). The remaining reeds, representing the x and y contactors, are connected in the load circuit; one such reed, together with its side-contacts, is shown enlarged in Fig. A.4, at (b).

When the reeds occupy their neutral positions, the driving-magnet reed touches both its side-contacts, this arrangement imparting a form of make-before-break action, but all the other contacts have a slight separation as shown.

Driving-magnet Reed

The mechanical details of the make-before-break action of the driving-magnet reed deserve some explanation. Referring to Fig. A.4(a), when the reed moves upwards on the diagram, the movement of the reed-contact is followed by its upper and lower side-contacts until the motion of the leaf-spring to which the lower side-contact is attached is arrested by the lower guide-strip. At this point, the lower ' negative ' gap is reduced to zero, and the result of further motion of the reed is to separate the moving reed-contact from the lower side-contact, this separation constituting an actual or ' positive ' gap.

The clearance space between leaf-spring and guide-strip, which has been termed a ' negative ' gap, is produced by bending of the guide-strip, caused by the application of pressure from the gap-

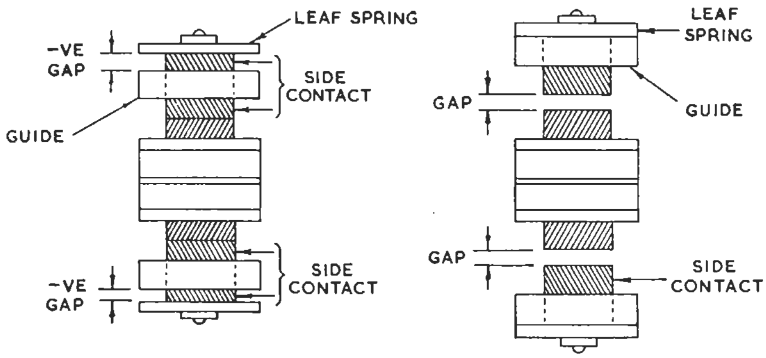


Fig. A.4. Enlarged Views of Contacts

adjusting screw. This bending is similar in nature but greater in magnitude compared to that produced in the other guide-strips by identical means.

The maximum distance moved by the reed from its equilibrial position, *less* the lost motion due to the negative gap, decides the final maximum separation between the reed-contact and the opening side-contact, i.e., the maximum positive gap.

Operating Instructions

Mounting Position

The unit is intended for upright mounting, with the feet resting on a horizontal surface.

External Connections

The method of connecting the batteries can be seen from Fig. 3, on which the external or ' pin ' side of the input connector is shown. **The observance of correct battery polarity is essential, since wrong polarity will destroy the electrolytic capacitors.**

To minimise interference with programme circuits, care must also be taken to ensure a satisfactory connection between the earth-pin of the ' Vibrovertor ' output socket and the power-circuit earth of the apparatus supplied. Where this apparatus embodies microphone transformers, the ' Vibrovertor ' should not be operated in its immediate vicinity, or electro-magnetic pickup may be severe ; in such curcumstances a long connecting cable should be used, fitted with an earthed screen as a precaution against electrostatic induction.

Battery Voltage

The battery voltage should be maintained within 20 per cent of the nominal value, and must on no account be allowed to fall more than 25 per cent below nominal, i.e., below 18 volts for a 24-volt system. Any variation beyond these limits will not merely make it impossible to regulate the output voltage satisfactorily by means of the transformer tap-changing switch, but will also seriously affect the frequency.

Faults

Should a fault develop on the vibrator, the matter should be referred to Recording Maintenance Unit at once. Adjustment of the contacts requires special tools and considerable skill, and should not be attempted on stations.

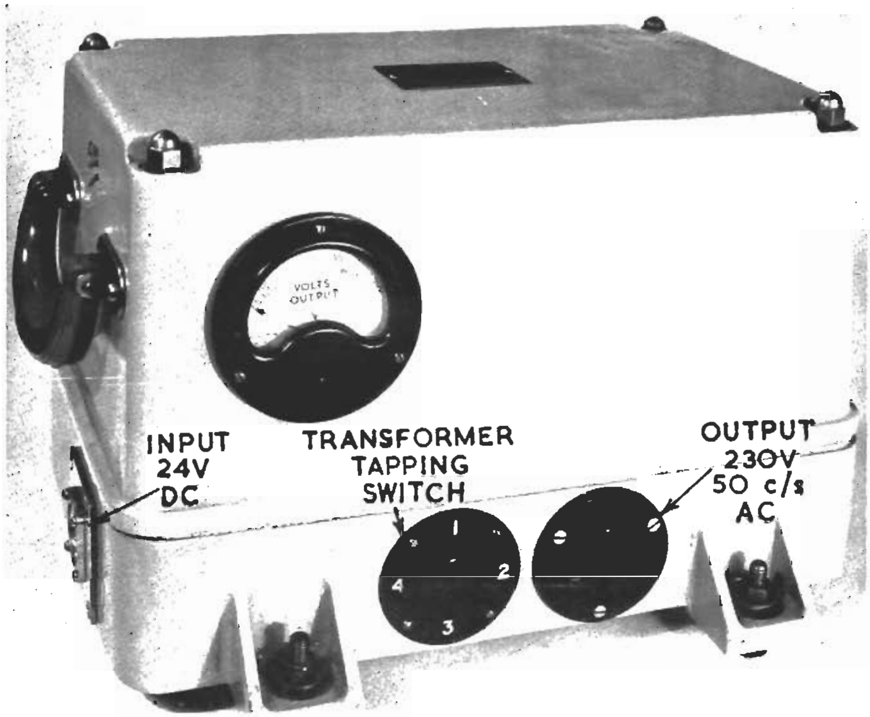


Fig. 1. Martindale Vibrovertor : External View

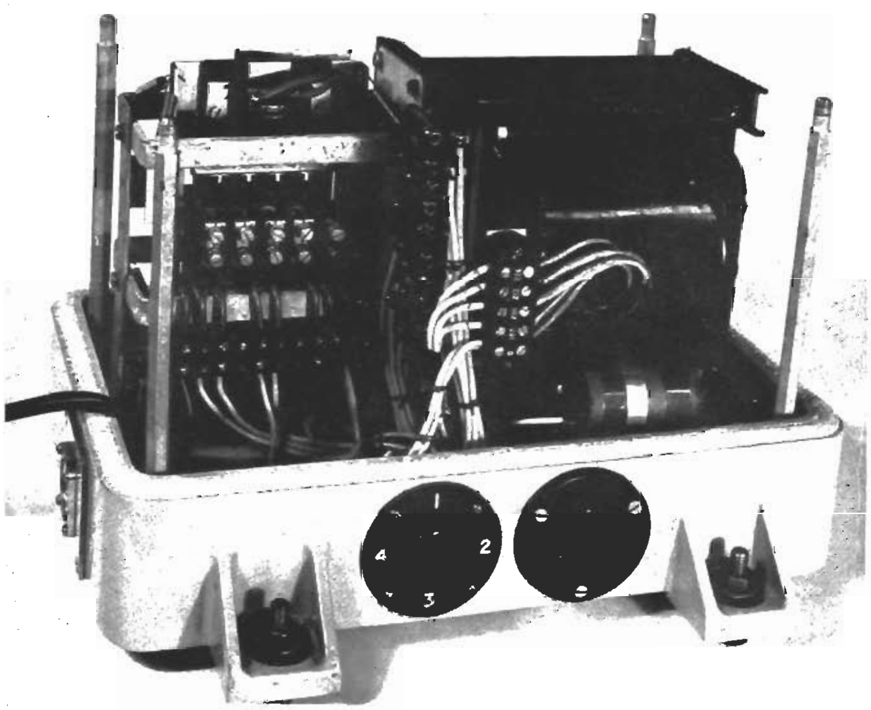
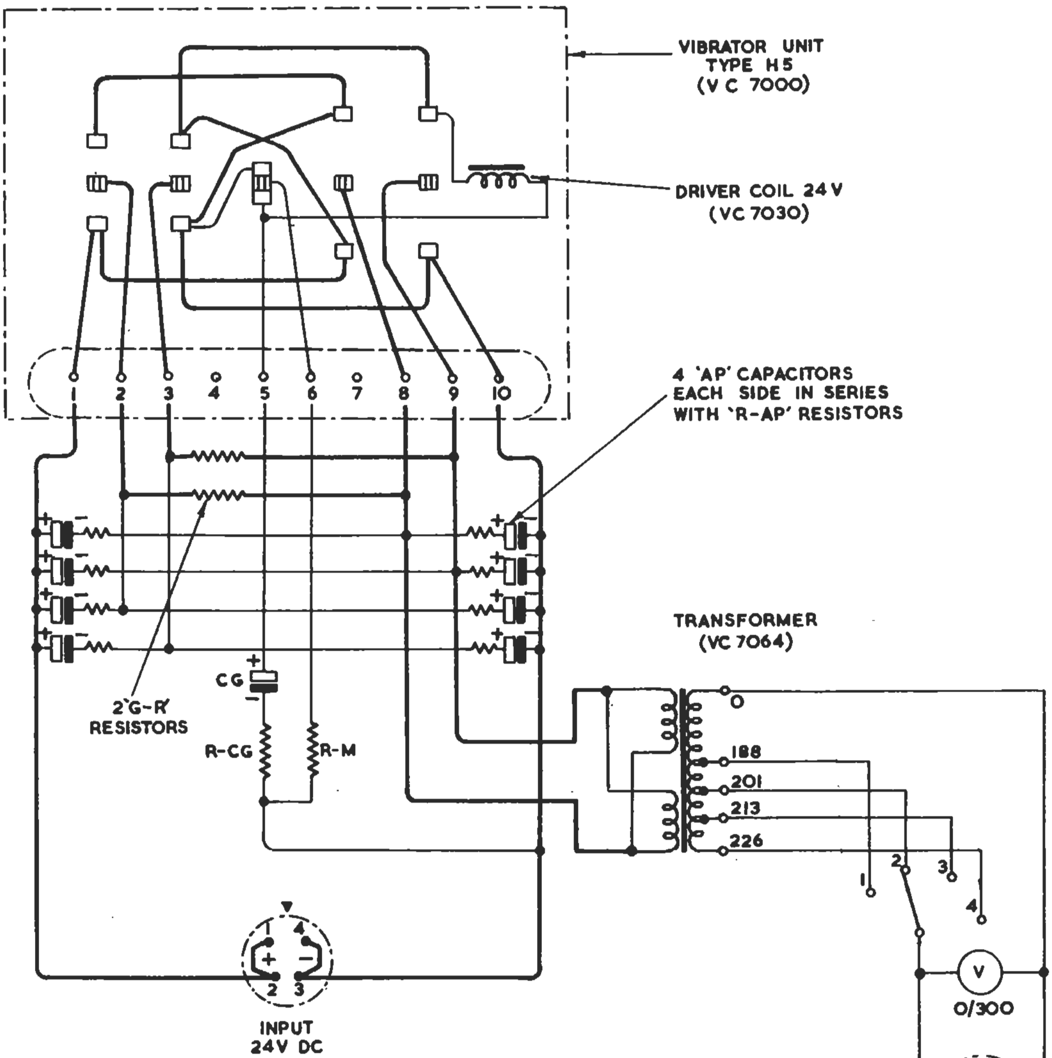


Fig. 2. Martindale Vibrovertor : Component Layout

53/GWH/157/AJP
MARTINDALE
DRG No VC110

FIG 3 R7



COMP	VALUE	TYPE	PART No
CG	16μF	ELECTROLYTIC	V.C7082
R-CG	10Ω	6W	VC7093
R-M	25Ω	6W	VC7103
AP	50μF	ELECTROLYTIC	VC7137
R-AP	6·6Ω	6W	VC7116
G-R	1Ω	WIRE COIL	

TABLE OF COMPONENTS

MARTINDALE VIBROVERTOR: WIRING

ERRATA

To Editor,

Technical Instructions,

305, *St. Hilda's, Maida Vale.*

The following errors have been noted in **Instruction**

Station.............................. *Date*........................... *Signature*.........................

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