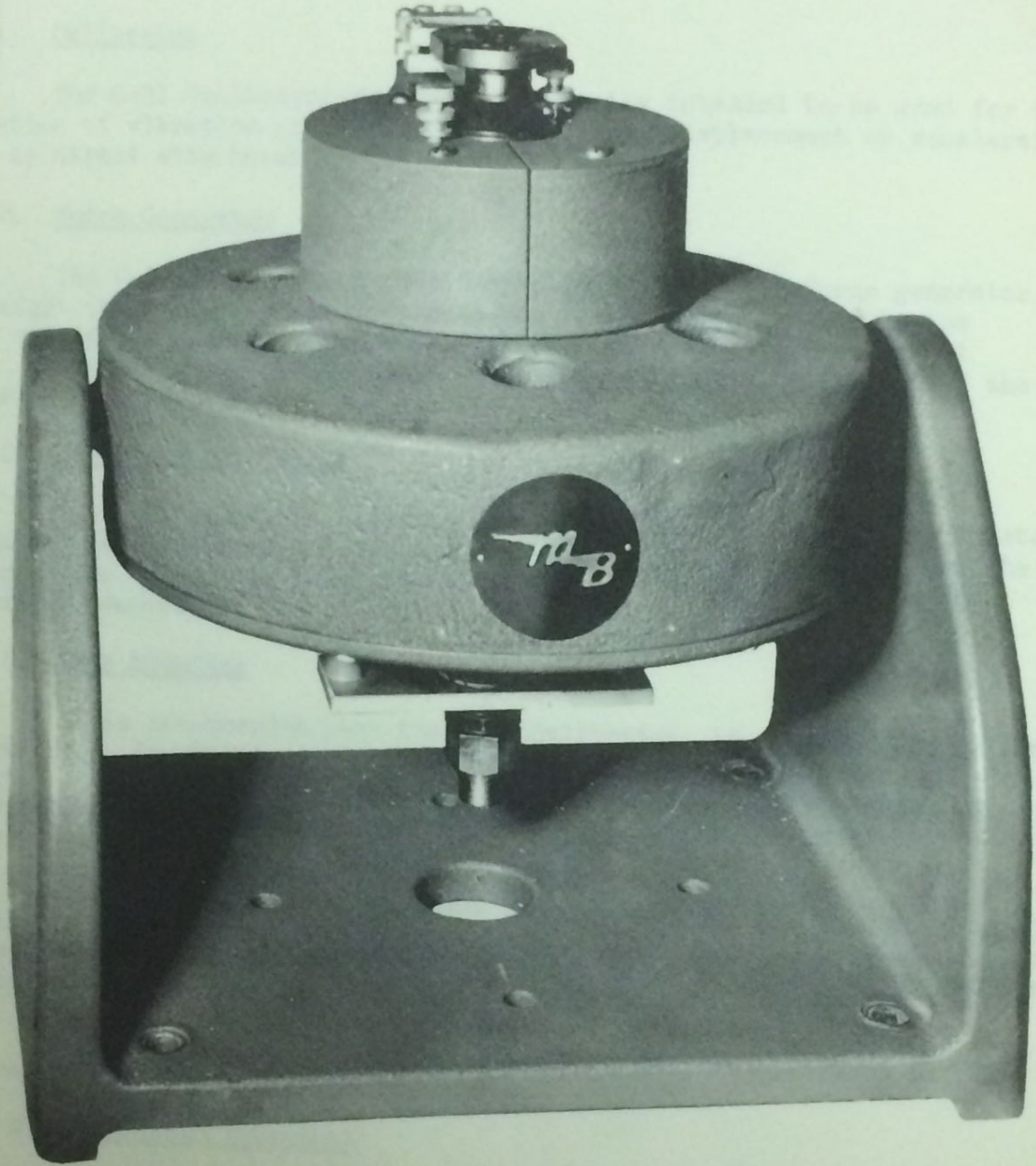
THE MB MANUFACTURING CO., INC.

1060 STATE STREET

NEW HAVEN 11, CONN.



MB MODEL C31
PICKUP CALIBRATOR

12-26-46 KU
Rev. 11-15-50

OPERATING INSTRUCTIONS

MODEL C-31 VIBRATION PICKUP CALIBRATOR AND VIBRATION EXCITER

I. GENERAL

A. Calibrator

The C-31 Calibrator-Exciter is primarily intended to be used for the calibration of vibration pickups, of the velocity, displacement or acceleration types, by direct attachment to the vibration table.

B. Force Generator

The C-31 Calibrator-Exciter may also be used as a force generator. Lightweight (up to 10 ounces) specimens can be attached directly to the pickup calibration table, or an accessory adaptor is provided to permit direct connection of the specimen equipment to the moving element of the exciter.

C. Direction of Motion

The C-31 Calibrator-Exciter is trunnion mounted, and may be rotated for use between the limits of horizontal or vertical. It is important that the two supporting cap screws be tightened completely during all testing and calibration operations.

D. Base Mounting

It is recommended that the C-31 Calibrator, if utilized for calibration purposes, be rigidly mounted on a concrete base, which in turn is supported in the earth for rigidity. It is necessary that the structure of the calibrator be fixed in space particularly for operation in the range of frequency of 50 c.p.s. and lower.

The configuration of the base is optional. It is, however, suggested that if precise optical measurements of amplitudes are to be considered, the calibrator be mounted so that the pickup table is at a convenient height for operator observations.

Four mounting holes for 3/8" diameter bolts are provided in the calibrator base frame.

E. Associated Equipment

1. Driver Coil Supply

The C-31 Calibrator-Exciter is designed to operate at the guaranteed ratings only if the driver coil supply is derived from an MB Mfg. Co. Power Supply Type P11. This equipment provides a sinusoidal wave form current with built-in impedance matching controls.

2. Field Coil Supply

The C-31 Calibrator-Exciter requires a direct-current supply for the operation of the field coil. The MB Mfg. Co. Field Supply (Rectifier) is designed to provide a direct current that will permit operation at the guaranteed ratings.

II. CONSTRUCTION

The Model C-31 Calibrator Exciter consists of a moving assembly including two flat-spring flexures which support a threaded magnesium tube. Mounted on the tube are a driver coil, a signal generator coil and vibration pickup attachment table. Wire leads from the two terminal connectors to the coils are cemented to the spring flexures.

A. Flat-Spring Flexures

The flat-spring flexures support the moving elements, so that the driver coil and the signal generator coil are centered in narrow air gaps.

Adjustments to the flexures or the coils on the magnesium tube should only be undertaken when the elements are rubbing or evidence abnormal restriction of the moving parts. (In general, adjustments should be referred to the MB Mfg. Co. for correct procedure or the instrument returned for repairs at the factory.)

The flat-spring flexures will resonate in the range of 325 to 375 c.p.s. When operating in or near these ranges, it will be necessary to detune the flexure resonant frequency. If the flexures are allowed to resonate, flexure breakage may be expected, as well as slight variations in the calibration of the signal generator coil as compared to actual table motion. Flexure resonance may be recognized by an abrupt increase in the audible sound level at particular frequencies or by an increased amplitude of motion midway between the ends of the flexures. On each flexure is mounted sliding clamps (detuners). These clamps are normally kept positioned against the support bracket. If resonances are developed, the clamps may be loosened, and positioned along the flexures at the point of maximum amplitude of motion.

This will effectively change the resonant frequency of the flexure thereby removing the objectionable condition. The detuner screws need only to be tightened sufficiently to restrain each clamp at the selected position. The detuners "bridge" wires cemented to the flexures. Centering of the clamps on the flexures will prevent damage to the wires when fixing the detuning positions.

B. Air Gap

During operation a strong magnetic field is created by the field coil in the driver coil air gap. Foreign particles (iron fillings, chips, etc.), small tools or instruments must be kept away from this area to prevent damage to the driver coil windings which are partly exposed.

OPERATING INSTRUCTIONS
MODEL C-31 VIBRATION PICKUP CALIBRATOR AND VIBRATION EXCITER

C. Stops

Rubber bumpers are provided (at both limits of travel) to reduce accelerations transmitted to the table when the stops are contacted. However, it is recommended that care in operating the units be used to avoid hitting the stops.

D. Vibration Pickup Attachment Table

The magnesium table is supplied, drilled and tapped with four #6-32 threaded holes, spaced to accommodate the MB Type 124 Pickup. These are located off center so that the center of mass will be over the center of the table. The outline engraved on the table corresponds to the base shape of the MB Pickup and its correct position. Proper orientation of the Pickup may also be determined, if the two mounting holes adjacent to the tapered corners of the (Pickup) cover are kept in alignment with the two tapped (#6-32) holes located nearest to the outer edge of the table surface. Two 8-32 threaded holes are also provided. These may be used to attach adapter plates to the table to accomplish the proper orientation of other types or makes of Pickups for calibration purposes. (See Pickup Calibrations)

CAUTION: The table must not be unthreaded from the magnesium tube, to drill, tap or perform other operations. Special procedure is required, and the MB Electronics Co. should be contacted for instructions, otherwise serious damage may be incurred.

E. Force Take-Off

A steel adaptor and a magnesium nut are provided as accessories to the C-31 Vibration Calibrator. This attachment is to be screwed on the 5/8-16 threaded tube at the driver coil end. When adding or removing this adapter, extreme care should be exercised so as not to damage the magnesium tube, and the use of graphite as a thread lubricant is suggested. (Adaptor MB Part No. 213MB33)

At the opposite end of the adaptor is a 3/8-16 tapped threaded hole to permit connection to necked-down connectors such as are illustrated on the attached sketch SK100103-A. The connectors may be produced from 3/8-16 threaded steel rod.

The body of the exciter may be rotated on its trunion mounts so as to position the force take-off adaptor to permit direct attachment to the specimen. The exciter also is sufficiently portable to be placed adjacent to larger equipment, and directly attached for testing purposes.

F. Signal Generator

Below the pickup table is attached the signal generator coil. This coil moves in a stationary magnetic field derived from permanent magnets. The property of the signal generator is that it produces a voltage proportional to the velocity of table motion. The coil leads are terminated at the two prong receptacle located in the bracket which supports the flat-spring flexures on the side of the exciter.

The magnetic structure is mounted on small flat-spring flexures which are in turn attached to the body structure. The entire magnetic structure is enclosed in the split cover magnetic shield, protecting it from A.C. and D.C. disturbances of the exciter or external sources. The covers are equipped with adjustable screws and lock nuts for the purpose of restraining the motion of the signal generator magnet structure on its supporting flexures. In order to restrain the motion, it is only necessary to have the magnet structure contact the internal stops, and this is accomplished by cautiously tightening the screws, and then securing each with the lock nut.

The natural resonant frequency of the seismically mounted magnetic structure is approximately 10 c.p.s. In use, it may be desirable to operate with the magnet structure either flexibly mounted or restrained. If the calibrator is mounted on a support or base that moves (Vibrates) below 50 c.p.s., better results may be obtained by using the magnetic structure rigidly attached to the calibrator by grounding out the flexures (using the screws and lock nuts) to avoid exciting the magnet structure at or near its natural frequency. Above 50 c.p.s. the magnet structure should be released by backing out the screws until a few threads hold them in the shields and securing the lock nuts, or completely removing each screw and nut. The release of the structure from the stops isolates it from vibration induced in the base or the calibrator structure itself. If the mounting support or base is rigid up to 50 c.p.s. or higher, then the magnet structure may be left on the flexural supports at all frequencies.

III. OPERATION

The Calibrator is connected electrically via the side receptacle to the AC and DC power sources. The field coil is supplied direct current to produce a fixed magnetic field. In that field the driver coil is suspended and to it is applied a variable-frequency alternating current. Motion of the driver coil results with the control of amplitude and force (or acceleration), by varying the driver coil current, at the frequency desired.

IV. APPLICATION

A. Generated Force

The generated force depends upon the direct current in the field coil, as well as the alternating current in the movable or driver coil. The amplitude of response depends not only on the generated force, but also on the dynamic properties of the system, including both the moving parts of the calibrator (or exciter) and the specimens or pickups attached.

The approximate force ratings of the C-31 Calibrator with 0.70 ampere in the field coil is 9 pounds vector force for each 1.0 ampere r.m.s. of alternating current applied to the driver coil. The maximum continuous a.c. driver coil current is 3.0 amps. rms. in the frequency range at 6 to 500 c.p.s. The maximum driver coil current should be somewhat less than 3 amperes above 500 cps. depending upon length of operation, external cooling, etc.

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B. Motion

The motion of the table (or force takeoff) is limited to plus or minus 1/4 :h travel, giving a total excursion of 1/2 inch, or an acceleration of 100 g, which- :r applies. In general, 100 g cannot be obtained unless the vibration pickup :ibration is connected to a mechanically resonant system, in which case, very high :celerations can be obtained from the available input force if the system has small mping characteristics.

C. Calibration

The signal generator has been individually calibrated and a calibration curve attached. The calibration corresponds to a voltage measured into 20,000 ohms conn- :ed across the coil terminals and with a 0.70 ampere direct current maintained in the ld coil.

D. Pickup Calibrations

1. The direct attachment of pickup devices to the pickup table other than MB locity types, may be accomplished if the following precautions are followed:

a. Proper orientation of the pickup so that the center of mass is located :r the center of the table.

b. In general, if the total weight of the pickup under test is much more than ounces, the flexural supports will deflect excessively and the added weight may affect : dynamics of the moving system, causing undesirable signal generator calibration rors. Write in for information before attempting calibration of heavier equipment.

2. A suggested procedure for calibrating pickups is attached using the :ctrical output of the signal generator coil. *

E. Indications of Amplitude or Acceleration

1. The output of the signal generator if observed with a potential indicator ch as a Vacumn Tube Voltmeter, may be converted to give displacement readings. e following formula will apply:

$$D = \frac{100}{f} \times \frac{E_{mv}}{Sen_{mv}} \times .001$$

Where d = double amplitude of calibrator in inches

f = frequency in c.p.s.

E_{mv} = Output of signal generator coil in millivolts with 20,000 ohms shunting the coil.

Sen_{mv} = Sensitivity in millivolts/.001" double amplitude/100 c.p.s. of the calibrator per the attached curve, at the frequency (f)

* Unholtz Bulletin provided separate from these instructions.

E. Calculation of Amplitude and Acceleration from Signal Generator Output

1. Derived below is a formula for displacement calculation.

In general, velocity = displacement x $2\pi f$; thus, displacement = velocity divided by $2\pi f$. Let d = displacement peak, then

$$\frac{d}{2} = \frac{\text{velocity peak}}{2\pi f} \quad \text{or} \quad d = \frac{\text{velocity rms} \times \sqrt{2}}{\pi f} .$$

Since $Sen_{mv} = \frac{E_{mv}\ \text{rms}}{\text{velocity rms}}$ or velocity rms $= \frac{E_{mv}\ \text{rms}}{Sen_{mv}}$,

$$\boxed{d = \frac{E_{mv}\ \text{rms}}{Sen_{mv}} \times \frac{\sqrt{2}}{\pi f} = 0.45 \times \frac{E_{mv}}{Sen_{mv} \times f}}$$

NOTE: Symbols are defined below acceleration derivation shown below.

2. Formula for acceleration is derived as follows:

$$g = \frac{\text{in./sec}^2\ \text{peak}}{386.1} = \frac{\text{velocity peak} \times 2\pi f}{386.1} = \frac{\text{velocity rms} \times \sqrt{2} \times 2\pi f}{386.1} .$$

Applying definition of Sen_{mv} above, and substituting for velocity rms:

$$\boxed{g = \frac{E_{mv}}{Sen_{mv}} \times \frac{\sqrt{2} \times 2\pi f}{386.1} = 0.23 \times \frac{E_{mv} \times f}{Sen_{mv}}} .$$

where: d = inches double amplitude at frequency f.
f = frequency in cps.
E_{mv} = output of signal generator coil in millivolts rms at frequency f, with 20,000 ohms shunting the coil.
Sen_{mv} = sensitivity of signal generator coil in mv. / in./sec. at frequency f. Note that unit is normalized; see curve.
g = gravity units of acceleration, peak.

V. ELECTRICAL RATINGS

A. Field Coil

1. Rated current: 0.70 ampere
2. D. C. Resistance (at 70°F) = 170 ohms (Nominal)
3. Connected to receptacle pins A (+) & D (-)

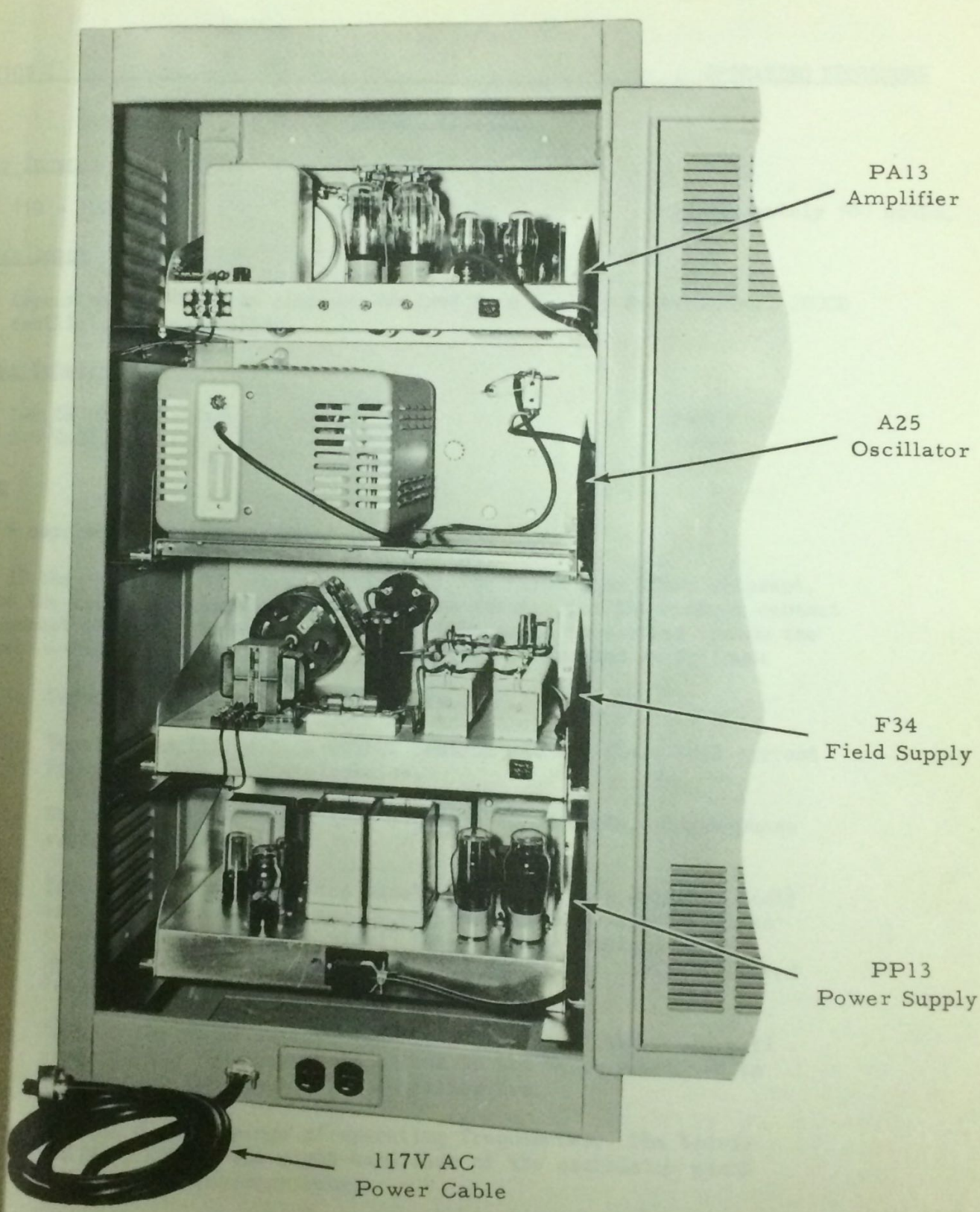
B. Driver Coil

1. Rated current: 3.0 ampere A.C. r.m.s. for continuous operation.
2. D. C. resistance (at 70°F) - 2 ohms (Nominal).
3. Connected to receptacle pins B and C. No polarity required on this coil.

C. Signal Generator Coil

1. D. C. resistance (at 70°F) = 400 ohms (Nominal).
2. Connected to two prong receptacles on fleuxre support arm.
3. No polarity required for the coil.

MB MODEL
T132534 POWER AMPLIFIER



Rear View T132534 Power Amplifier

Model T132534

Power Input

110 - 120 volts. 50-60 cps A.C. Approximately 500 watts.

Signal Input

Approximately 10 volts such as obtained from Hwelett Packard Model 200CD oscillator or equivalent.

Vacumn Tubes: PA13-C

1-6 SN7GT	4-807	2-0D3
2-5 R4GY,	2-5Y3GT	1-0B3

Fuses

8 amperes in the input line.

If the equipment is being operated for the first time after shipment, locate the cable that connects the vibration exciter and the control cabinet and connect the cabinet and the exciter. (The cable is shipped inside the cabinet --- lower left-hand side.) The system is operated as follows:

1. Turn the three-on-off switches off.
2. Turn the amplifier A.C. OUTPUT control and the field coil current Powerstat full counterclockwise.
3. Connect the power cable to a 115-volt 50/60 cycle, single-phase supply only.
4. Turn on the amplifier (top panel) and oscillator (middle panel) and permit a suitable warm up period. The amplifier requires 5 to 10 minutes warm-up time. Detailed instructions on the operation of the oscillator are included in the Hewlett Packard instruction book.
5. Turn on the field supply (lower panel); adjust the field coil current with the Powerstat control to the value specified in the instruction manual for the calibrator.
6. Set the desired range of operating frequencies. The decade RANGE switch at the right-hand side of the oscillator panel selects the frequency range.
7. Adjust the AMPLITUDE control located above the range switch on the oscillator panel. This panel is generally set at a dial reading of 80 or 90, i.e., an 80% rotation.

The oscillator AMPLITUDE dial is a gain control and may be used in two ways:

(1) for vernier control of the A.C. OUTPUT (amplifier Panel).

(2) for reproducing settings of the A.C. OUTPUT dial. A.C. OUTPUT settings --- and the table amplitudes which correspond to them --- may be reproduced as follows:

a. Establish the desired input to the vibration exciter by adjusting the A.C. OUTPUT control (top panel) and the AMPLITUDE control (middle panel).

b. Observe the reading on the AMPLITUDE dial.

c. The table amplitude of the exciter may be reduced to zero by turning the AMPLITUDE dial to zero. Provided that the setting of the A.C. OUTPUT control has not been changed, the original A.C. OUTPUT setting can be reproduced by turning up the AMPLITUDE control to the postion observed in (b) above.

8. For general starting procedure, turn the load match seitch marked LOAD MATCH to top No. 1. Turn the amplifier A.C. OUTPUT control fully counterclockwise. Turn the "Variable" load match switch on the right side of the top panel fully counterclockwise.

9. Control the table amplitude with the A.C. OUTPUT control on the amplifier panel. Control the table frequency with the frequency dial (s) on the oscillator panel.

10. To avoid overloading the amplifier, observe the shape of the output current wave on an oscilloscope.* An oscilloscope jack for this purpose is located on the amplifier panel.

To obtain the maximum amplifier output, proceed as follows:

a. Select the proper load match at low power. (See Impedance Matching.)

b. Turn up the A.C. OUTPUT control until the current wave shape begins to distort.

Be careful not to exceed the full-scale reading of the ammeter on the amplifier panel or the maximum current rating of the exciter. When distortion of the current wave form occurs, the audible tone of the exciter will change. Erratic table motion will also be observed if the table amplitude is large.

*Note: If an oscilloscope is not available, severe overloading of the amplifier may be avoided by observing the ammeter on the amplifier panel. Do not increase the A.C. OUTPUT control beyond the point where increases in A.C. OUTPUT Settings are not accompanied by higher-output-current readings.

IMPEDANCE MATCHING

Three positions of output impedance are available as follows on the switch marked LOAD SWITCH: nominal impedance values are 5 ohms, 10 ohms, 29 ohms. Tap #1 (5 ohms) will prove most useful; maximum feedback is derived using this tap. Switching impedance while driver coil current is flowing causes arcing at the impedance selector switch and is to be avoided. In respect the the "Variable" load match switch labelled "Powerfactor," below 200 cps it is not necessary to make use of it. Above 200 cps, this control is used to peak driver-coil current, resulting in macimum power output.

PROTECTIVE MICROSWITCH

The majority of MB electronic cabinet - shaker combinations are equipped with a set of switches which provide for automatic resetting of table over-travel. One switch (reset) is located on the amplifier gain control. The other switch (overtravel) is located remotely on the shaker. In the event of overtravel, the switches de-energize the shaker circuit. To commence operation, the amplifier gain control must be turned fully counterclockwise and then (following at least a 30-second interval) turned clockwise again.

SHUTTING DOWN

To shut down the control cabinet, turn the A.C. OUTPUT knob and the field coil Powerstat full counterclockwise. Turn off all the power switches.

OPERATING PRECAUTIONS

1. Do not exceed maximum value of driver coil current (A.C. OUTPUT).
2. Adjust the field coil Powerstat occasionally to compensate for the change in field-coil resistance as the coil warms up.
3. Connect the exciter to the control cabinet before turning any of the power switches on.
4. Do not disconnect the exciter from the control cabinet until all the on-off power switches have been turned off.
5. Turn off all the power switches before making electrical repairs.

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OPERATING INSTRUCTIONS

MODEL C-31 VIBRATION PICKUP CALIBRATOR AND VIBRATION EXCITER

I. GENERAL

A. Calibrator

The C-31 Calibrator-Exciter is primarily intended to be used for the calibration of vibration pickups, of the velocity, displacement or acceleration types, by direct attachment to the vibration table.

B. Force Generator

The C-31 Calibrator-Exciter may also be used as a force generator. Lightweight (up to 10 ounces) specimens can be attached directly to the pickup calibration table, or an accessory adaptor is provided to permit direct connection of the specimen equipment to the moving element of the exciter.

C. Direction of Motion

The C-31 Calibrator-Exciter is trunnion mounted, and may be rotated for use between the limits of horizontal or vertical. It is important that the two supporting cap screws be tightened completely during all testing and calibration operations.

D. Base Mounting

It is recommended that the C-31 Calibrator, if utilized for calibration purposes, be rigidly mounted on a concrete base, which in turn is supported in the earth for rigidity. It is necessary that the structure of the calibrator be fixed in space particularly for operation in the range of frequency of 50 c.p.s. and lower.

The configuration of the base is optional. It is, however, suggested that if precise optical measurements of amplitudes are to be considered, the calibrator be mounted so that the pickup table is at a convenient height for operator observations.

Four mounting holes for 3/8" diameter bolts are provided in the calibrator base frame.

E. Associated Equipment

1. Driver Coil Supply

The C-31 Calibrator-Exciter is designed to operate at the guaranteed ratings only if the driver coil supply is derived from an MB Mfg. Co. Power Supply Type P11. This equipment provides a sinusoidal wave form current with built-in impedance matching controls.

2. Field Coil Supply

The C-31 Calibrator-Exciter requires a direct-current supply for the operation of the field coil. The MB Mfg. Co. Field Supply (Rectifier) is designed to provide a direct current that will permit operation at the guaranteed ratings.

II. CONSTRUCTION

The Model C-31 Calibrator Exciter consists of a moving assembly including two flat-spring flexures which support a threaded magnesium tube. Mounted on the tube are a driver coil, a signal generator coil and vibration pickup attachment table. Wire leads from the two terminal connectors to the coils are cemented to the spring flexures.

A. Flat-Spring Flexures

The flat-spring flexures support the moving elements, so that the driver coil and the signal generator coil are centered in narrow air gaps.

Adjustments to the flexures or the coils on the magnesium tube should only be undertaken when the elements are rubbing or evidence abnormal restriction of the moving parts. (In general, adjustments should be referred to the MB Mfg. Co. for correct procedure or the instrument returned for repairs at the factory.)

The flat-spring flexures will resonate in the range of 325 to 375 c.p.s. When operating in or near these ranges, it will be necessary to detune the flexure resonant frequency. If the flexures are allowed to resonate, flexure breakage may be expected, as well as slight variations in the calibration of the signal generator coil as compared to actual table motion. Flexure resonance may be recognized by an abrupt increase in the audible sound level at particular frequencies or by an increased amplitude of motion midway between the ends of the flexures. On each flexure is mounted sliding clamps (detuners). These clamps are normally kept positioned against the support bracket. If resonances are developed, the clamps may be loosened, and positioned along the flexures at the point of maximum amplitude of motion.

This will effectively change the resonant frequency of the flexure thereby removing the objectionable condition. The detuner screws need only to be tightened sufficiently to restrain each clamp at the selected position. The detuners "bridge" wires cemented to the flexures. Centering of the clamps on the flexures will prevent damage to the wires when fixing the detuning positions.

B. Air Gap

During operation a strong magnetic field is created by the field coil in the driver coil air gap. Foreign particles (iron fillings, chips, etc.), small tools or instruments must be kept away from this area to prevent damage to the driver coil windings which are partly exposed.

OPERATING INSTRUCTIONS
MODEL C-31 VIBRATION PICKUP CALIBRATOR AND VIBRATION EXCITER

C. Stops

Rubber bumpers are provided (at both limits of travel) to reduce accelerations transmitted to the table when the stops are contacted. However, it is recommended that care in operating the units be used to avoid hitting the stops.

D. Vibration Pickup Attachment Table

The magnesium table is supplied, drilled and tapped with four #6-32 threaded holes, spaced to accommodate the MB Type 124 Pickup. These are located off center so that the center of mass will be over the center of the table. The outline engraved on the table corresponds to the base shape of the MB Pickup and its correct position. Proper orientation of the Pickup may also be determined, if the two mounting holes adjacent to the tapered corners of the (Pickup) cover are kept in alignment with the two tapped (#6-32) holes located nearest to the outer edge of the table surface. Two 8-32 threaded holes are also provided. These may be used to attach adapter plates to the table to accomplish the proper orientation of other types or makes of Pickups for calibration purposes. (See Pickup Calibrations)

CAUTION: The table must not be unthreaded from the magnesium tube, to drill, tap or perform other operations. Special procedure is required, and the MB Electronics Co. should be contacted for instructions, otherwise serious damage may be incurred.

E. Force Take-Off

A steel adaptor and a magnesium nut are provided as accessories to the C-31 Vibration Calibrator. This attachment is to be screwed on the 5/8-16 threaded tube at the driver coil end. When adding or removing this adapter, extreme care should be exercised so as not to damage the magnesium tube, and the use of graphite as a thread lubricant is suggested. (Adaptor MB Part No. 213MB33)

At the opposite end of the adaptor is a 3/8-16 tapped threaded hole to permit connection to necked-down connectors such as are illustrated on the attached sketch SK100103-A. The connectors may be produced from 3/8-16 threaded steel rod.

The body of the exciter may be rotated on its trunion mounts so as to position the force take-off adaptor to permit direct attachment to the specimen. The exciter also is sufficiently portable to be placed adjacent to larger equipment, and directly attached for testing purposes.

F. Signal Generator

Below the pickup table is attached the signal generator coil. This coil moves in a stationary magnetic field derived from permanent magnets. The property of the signal generator is that it produces a voltage proportional to the velocity of table motion. The coil leads are terminated at the two prong receptacle located in the bracket which supports the flat-spring flexures on the side of the exciter.

The magnetic structure is mounted on small flat-spring flexures which are in turn attached to the body structure. The entire magnetic structure is enclosed in the split cover magnetic shield, protecting it from A.C. and D.C. disturbances of the exciter or external sources. The covers are equipped with adjustable screws and lock nuts for the purpose of restraining the motion of the signal generator magnet structure on its supporting flexures. In order to restrain the motion, it is only necessary to have the magnet structure contact the internal stops, and this is accomplished by cautiously tightening the screws, and then securing each with the lock nut.

The natural resonant frequency of the seismically mounted magnetic structure is approximately 10 c.p.s. In use, it may be desirable to operate with the magnet structure either flexibly mounted or restrained. If the calibrator is mounted on a support or base that moves (Vibrates) below 50 c.p.s., better results may be obtained by using the magnetic structure rigidly attached to the calibrator by grounding out the flexures (using the screws and lock nuts) to avoid exciting the magnet structure at or near its natural frequency. Above 50 c.p.s. the magnet structure should be released by backing out the screws until a few threads hold them in the shields and securing the lock nuts, or completely removing each screw and nut. The release of the structure from the stops isolates it from vibration induced in the base or the calibrator structure itself. If the mounting support or base is rigid up to 50 c.p.s. or higher, then the magnet structure may be left on the flexural supports at all frequencies.

III. OPERATION

The Calibrator is connected electrically via the side receptacle to the AC and DC power sources. The field coil is supplied direct current to produce a fixed magnetic field. In that field the driver coil is suspended and to it is applied a variable-frequency alternating current. Motion of the driver coil results with the control of amplitude and force (or acceleration), by varying the driver coil current, at the frequency desired.

IV. APPLICATION

A. Generated Force

The generated force depends upon the direct current in the field coil, as well as the alternating current in the movable or driver coil. The amplitude of response depends not only on the generated force, but also on the dynamic properties of the system, including both the moving parts of the calibrator (or exciter) and the specimens or pickups attached.

The approximate force ratings of the C-31 Calibrator with 0.70 ampere in the field coil is 9 pounds vector force for each 1.0 ampere r.m.s. of alternating current applied to the driver coil. The maximum continuous a.c. driver coil current is 3.0 amps. rms. in the frequency range at 6 to 500 c.p.s. The maximum driver coil current should be somewhat less than 3 amperes above 500 cps. depending upon length of operation, external cooling, etc.

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B. Motion

The motion of the table (or force takeoff) is limited to plus or minus 1/4 inch travel, giving a total excursion of 1/2 inch, or an acceleration of 100 g, whichever applies. In general, 100 g cannot be obtained unless the vibration pickup calibration is connected to a mechanically resonant system, in which case, very high accelerations can be obtained from the available input force if the system has small damping characteristics.

C. Calibration

The signal generator has been individually calibrated and a calibration curve is attached. The calibration corresponds to a voltage measured into 20,000 ohms connected across the coil terminals and with a 0.70 ampere direct current maintained in the field coil.

D. Pickup Calibrations

1. The direct attachment of pickup devices to the pickup table other than MB velocity types, may be accomplished if the following precautions are followed:

a. Proper orientation of the pickup so that the center of mass is located over the center of the table.

b. In general, if the total weight of the pickup under test is much more than 12 ounces, the flexural supports will deflect excessively and the added weight may affect the dynamics of the moving system, causing undesirable signal generator calibration errors. Write in for information before attempting calibration of heavier equipment.

2. A suggested procedure for calibrating pickups is attached using the electrical output of the signal generator coil. *

E. Indications of Amplitude or Acceleration

1. The output of the signal generator if observed with a potential indicator such as a Vacumn Tube Voltmeter, may be converted to give displacement readings. The following formula will apply:

$$D = \frac{100}{f} \times \frac{E_{mv}}{Sen_{mv}} \times .001$$

Where d = double amplitude of calibrator in inches

f = frequency in c.p.s.

E_{mv} = Output of signal generator coil in millivolts with 20,000 ohms shunting the coil.

Sen_{mv} = Sensitivity in millivolts/.001" double amplitude/100 c.p.s. of the calibrator per the attached curve, at the frequency (f)

* See Unholtz Bulletin provided separate from these instructions.

E. Calculation of Amplitude and Acceleration from Signal Generator Output

1. Derived below is a formula for displacement calculation.

In general, velocity = displacement x $2\pi f$; thus, displacement = velocity divided by $2\pi f$. Let d = displacement peak, then

$$\frac{d}{2} = \frac{\text{velocity peak}}{2\pi f} \quad \text{or} \quad d = \frac{\text{velocity rms} \times \sqrt{2}}{\pi f} .$$

Since $Sen_{mv} = \frac{E_{mv}\ \text{rms}}{\text{velocity rms}}$ or velocity rms $= \frac{E_{mv}\ \text{rms}}{Sen_{mv}}$,

$$\boxed{d = \frac{E_{mv}\ \text{rms}}{Sen_{mv}} \times \frac{\sqrt{2}}{\pi f} = 0.45 \times \frac{E_{mv}}{Sen_{mv} \times f}}$$

NOTE: Symbols are defined below acceleration derivation shown below.

2. Formula for acceleration is derived as follows:

$$g = \frac{\text{in./sec}^2\ \text{peak}}{386.1} = \frac{\text{velocity peak} \times 2\pi f}{386.1} = \frac{\text{velocity rms} \times \sqrt{2} \times 2\pi f}{386.1} .$$

Applying definition of Sen_{mv} above, and substituting for velocity rms:

$$\boxed{g = \frac{E_{mv}}{Sen_{mv}} \times \frac{\sqrt{2} \times 2\pi f}{386.1} = 0.23 \times \frac{E_{mv} \times f}{Sen_{mv}}} .$$

where: d = inches double amplitude at frequency f.
f = frequency in cps.
E_{mv} = output of signal generator coil in millivolts rms at frequency f, with 20,000 ohms shunting the coil.
Sen_{mv} = sensitivity of signal generator coil in mv. / in./sec. at frequency f. Note that unit is normalized; see curve.
g = gravity units of acceleration, peak.

V. ELECTRICAL RATINGS

A. Field Coil

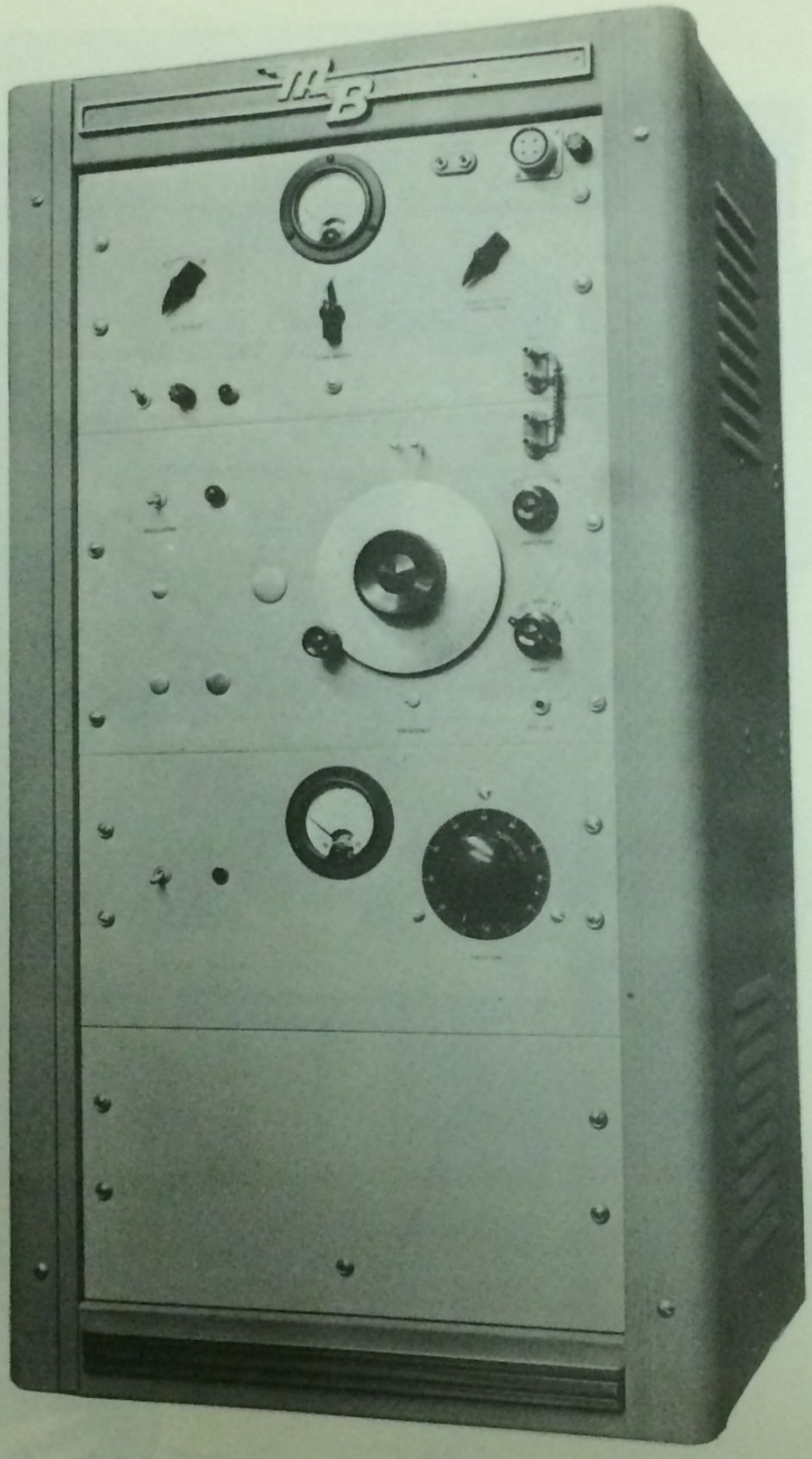
1. Rated current: 0.70 ampere
2. D. C. Resistance (at 70°F) = 170 ohms (Nominal)
3. Connected to receptacle pins A (+) & D (-)

B. Driver Coil

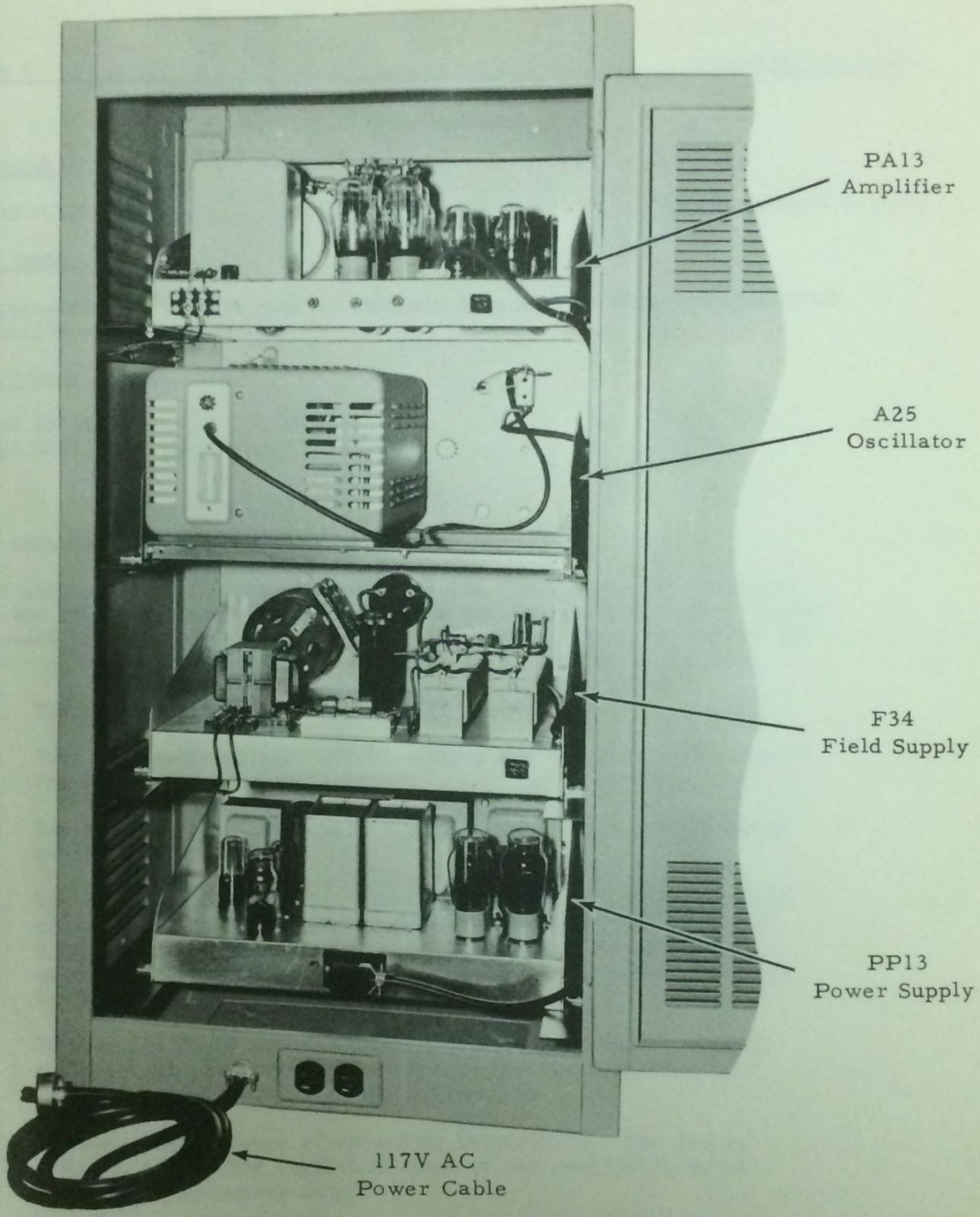
1. Rated current: 3.0 ampere A.C. r.m.s. for continuous operation.
2. D. C. resistance (at 70°F) - 2 ohms (Nominal).
3. Connected to receptacle pins B and C. No polarity required on this coil.

C. Signal Generator Coil

1. D. C. resistance (at 70°F) = 400 ohms (Nominal).
2. Connected to two prong receptacles on fleuxre support arm.
3. No polarity required for the coil.



MB MODEL
T132534 POWER AMPLIFIER



Rear View T132534 Power Amplifier

Model T132534

Power Input

110 - 120 volts.	50-60 cps A.C.	Approximately 500 watts.

Signal Input

Approximately 10 volts such as obtained from Hewlett Packard Model 200CD oscillator or equivalent.

Vacuum Tubes: PA13-C

1-6 SN7GT	4-807	2-0D3
2-5 R4GY,	2-5Y3GT	1-0D3

Fuses

8 amperes in the input line.

If the equipment is being operated for the first time after shipment, locate the cable that connects the vibration exciter and the control cabinet and connect the cabinet and the exciter. (The cable is shipped inside the cabinet --- lower left-hand side.) The system is operated as follows:

1. Turn the three-on-off switches off.
2. Turn the amplifier A.C. OUTPUT control and the field coil current Powerstat full counterclockwise.
3. Connect the power cable to a 115-volt 50/60 cycle, single-phase supply only.
4. Turn on the amplifier (top panel) and oscillator (middle panel) and permit a suitable warm up period. The amplifier requires 5 to 10 minutes warm-up time. Detailed instructions on the operation of the oscillator are included in the Hewlett Packard instruction book.
5. Turn on the field supply (lower panel); adjust the field coil current with the Powerstat control to the value specified in the instruction manual for the calibrator.
6. Set the desired range of operating frequencies. The decade RANGE switch at the right-hand side of the oscillator panel selects the frequency range.
7. Adjust the AMPLITUDE control located above the range switch on the oscillator panel. This panel is generally set at a dial reading of 80 or 90, i.e., an 80% rotation.

The oscillator AMPLITUDE dial is a gain control and may be used in two ways:

(1) for vernier control of the A.C. OUTPUT (amplifier Panel).

(2) for reproducing settings of the A.C. OUTPUT dial. A.C. OUTPUT settings --- and the table amplitudes which correspond to them --- may be reproduced as follows:

a. Establish the desired input to the vibration exciter by adjusting the A.C. OUTPUT control (top panel) and the AMPLITUDE control (middle panel).

b. Observe the reading on the AMPLITUDE dial.

c. The table amplitude of the exciter may be reduced to zero by turning the AMPLITUDE dial to zero. Provided that the setting of the A.C. OUTPUT control has not been changed, the original A.C. OUTPUT setting can be reproduced by turning up the AMPLITUDE control to the postion observed in (b) above.

8. For general starting procedure, turn the load match seitch marked LOAD MATCH to top No. 1. Turn the amplifier A.C. OUTPUT control fully counterclockwise. Turn the "Variable" load match switch on the right side of the top panel fully counterclockwise.

9. Control the table amplitude with the A.C. OUTPUT control on the amplifier panel. Control the table frequency with the frequency dial (s) on the oscillator panel.

10. To avoid overloading the amplifier, observe the shape of the output current wave on an oscilloscope.* An oscilloscope jack for this purpose is located on the amplifier panel.

To obtain the maximum amplifier output, proceed as follows:

a. Select the proper load match at low power. (See Impedance Matching.)

b. Turn up the A.C. OUTPUT control until the current wave shape begins to distort.

Be careful not to exceed the full-scale reading of the ammeter on the amplifier panel or the maximum current rating of the exciter. When distortion of the current wave form occurs, the audible tone of the exciter will change. Erratic table motion will also be observed if the table amplitude is large.

*Note: If an oscilloscope is not available, severe overloading of the amplifier may be avoided by observing the ammeter on the amplifier panel. Do not increase the A.C. OUTPUT control beyond the point where increases in A.C. OUTPUT Settings are not accompanied by higher-output-current readings.

IMPEDANCE MATCHING

Three positions of output impedance are available as follows on the switch marked LOAD SWITCH: nominal impedance values are 5 ohms, 10 ohms, 29 ohms. Tap #1 (5 ohms) will prove most useful; maximum feedback is derived using this tap. Switching impedance while driver coil current is flowing causes arcing at the impedance selector switch and is to be avoided. In respect the the "Variable" load match switch labelled "Powerfactor," below 200 cps it is not necessary to make use of it. Above 200 cps, this control is used to peak driver-coil current, resulting in macimum power output.

PROTECTIVE MICROSWITCH

The majority of MB electronic cabinet - shaker combinations are equipped with a set of switches which provide for automatic resetting of table over-travel. One switch (reset) is located on the amplifier gain control. The other switch (overtravel) is located remotely on the shaker. In the event of overtravel, the switches de-energize the shaker circuit. To commence operation, the amplifier gain control must be turned fully counterclockwise and then (following at least a 30-second interval) turned clockwise again.

SHUTTING DOWN

To shut down the control cabinet, turn the A.C. OUTPUT knob and the field coil Powerstat full counterclockwise. Turn off all the power switches.

OPERATING PRECAUTIONS

1. Do not exceed maximum value of driver coil current (A.C. OUTPUT).
2. Adjust the field coil Powerstat occasionally to compensate for the change in field-coil resistance as the coil warms up.
3. Connect the exciter to the control cabinet before turning any of the power switches on.
4. Do not disconnect the exciter from the control cabinet until all the on-off power switches have been turned off.
5. Turn off all the power switches before making electrical repairs.

DUAL-OPERATION MODELS

DT112537, DT112531, DT11253434, and DT132531

GENERAL DESCRIPTION

The respective exciter control cabinets associated with the types DT112537, DT112531, DT11253434, and DT132531 provide for dual operation of such MB exciters as the C11, C31 and S31-1 series. The Model DT11253434 is unique by comparison in that it consists of two F34 field supplies for dual operation of the types C31 and S31-1 shakers. The Model DT132531 is also worth noting in that it is equipped with a special dual control adapter mounted on the upper right hand side of the cabinet; see MB drawing No. 213MBE21. Plug-in receptacles are provided at the base of the adapter for connecting either one or two types C31-H exciters for single or dual operation. The exciter selector switch as well as an in-phase and out-of-phase toggle switch are located on the dual control adapter; see MB drawing No. 255MBE05. In comparison the Models DT112537, DT112531, and DT11253434 are equipped with front-panel phasing and exciter selector controls.

The output receptacles are wired so that the exciter field coils are in parallel and the driver coils are in series. Either exciter receptacle may be used for single operation. The D.C. meter in the lower panel reads the total current supplied to either one or both exciters. Since the driver coil current is common to both exciters, each unit will deliver the same force largely independent of mass load conditions. (This is generally not true, however, under resonant load conditions).

OPERATING PROCEDURE

1. Changing Phase

To change the phase relationship, reduce the A.C. OUTPUT control on the amplifier (top panel) to zero, then switch to the desired phase relationship. Increase A.C. OUTPUT to obtain the desired operating conditions. (Within the operating limits of the amplifier and/or vibration exciter).

CAUTION: Do not change phase while exciters are in operation, since it is possible to present a momentary open circuit to the amplifier at the time of switching.

2. Exciter Selection

Reduce the A.C. OUTPUT control to zero. This procedure should close the time delay relay in the amplifier power supply. Set the exciter Selector switch. Turn up the A.C. OUTPUT control.

OPERATING PRECAUTIONS

Do not connect or disconnect an exciter to the receptacles on the panel front unless the A.C. OUTPUT and Field-Coil controls have been turned full counterclockwise.

PA13-C POWER AMPLIFIER

D.C. BALANCING

D.C. balancing is performed primarily to balance the output impedance of the amplifier at low frequencies and thereby secure symetrical damping as seen by the shaker. The following steps are recommended:

1. Connect the shaker to the control cabinet and connect the console to 115V 60 cps A.C.
2. Turn all gain controls and the field powerstat full counterclockwise.
3. Turn the "variable" load match switch labelled powerfactor full counter-clockwise.
4. Turn the feedback control (screw driver adjustment) full counterclockwise.
5. Connect a 500 m.a. ammeter between the red lead and the transformer center tap.
6. Turn on all three decks of the control console.
7. No signal-plate current should be of the order of 120-130 m.a.
8. Adjust the oscillator to a frequency of 4 or 5 cps.
9. Increase the oscillator gain to about 80% rotation.
10. Increase the amplifier gain carefully until approximately full travel is apparent in the shaker table motion.
11. Adjust the D.C. balance controls (screw driver adjustment) until the shaker motion is apparently continuous and sinusoidal.
12. Reduce the gain and recheck zero signal plate current which should not exceed 120 m.a.
13. If plate current is high, reduce it by turning both D.C. balance controls to minimize plate current and repeat steps 11 and 12.
14. Upon completing D.C. balancing operation, advance the feedback control full clockwise.

Optimum balance has been set at the factory - occasional readjustment may be necessary.

FEED BACK CONTROL

A screw driver adjustment on the back of the chassis has been provided which permits operation with and without feedback. Nothing is to be gained by operating without feedback as the wave form will be somewhat more distorted. Under operating conditions where it appears that marginal power is available, elimination of feedback may provide slight additional gain.

OSCILLOSCOPE

The oscilloscope terminals are provided for monitoring driver coil current waveform. A sudden change in ammeter reading indicates improper connection to the oscilloscope. The oscilloscope should not be grounded to the amplifier in any case.

OPERATING INSTRUCTIONS

Model F31, 34, 36, and 37 FIELD SUPPLIES

A. PRINCIPLES OF OPERATION

The D.C. Field Supply for these models consists in each instance of a powerstat, full wave selenium rectifier, and filter unit. Each Field Supply is designed to deliver a designated value of amperage to the field coil of an associated Calibrator or Exciter. Current control is provided by means of a meter and powerstat in the load circuit; see the attached wiring diagram.

B. CURRENT ADJUSTMENT

The powerstat is used for adjustment of load voltage which may be required in order to supply rated current to a field coil. Fine adjustment of field coil current is not critical for general shake-test applications of the exciter. Adjustment may be critical, however, where quantitative values of vibration-exciter force are desired or when the signal generator is being calibrated.

C. AMPERAGE RATINGS

The Model F31, 34, 36, and 37 Field Supplies are rated to operate designated equipment as follows:

Field Supply	Rated Amperage	Equipment Operated
F31	1.75	C11 or C31 Dual
F34	1.00	C31
F36	4.00	C5
F37	4.00	C11 Dual

PARTS LIST FOR PA13-C POWER AMPLIFIER

DIAGRAM REFERENCE: 213MBE20

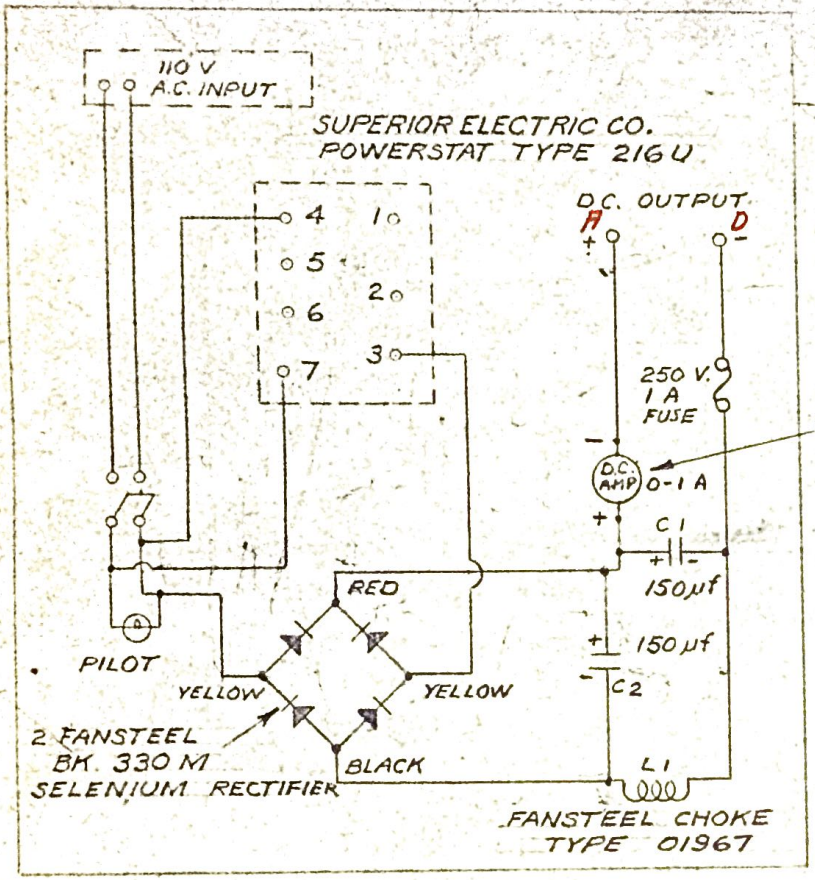
ITEM	DESCRIPTION	QUANTITY
C1	Capacitor 2MF 400 V	1
C2	" 470 MMF 500 V	1
C3, C4	" 5 MF 600 V	2
C5, C6	" Dual 40/40 MF 150 V	1
C7, C8	" " 20/20 MF 450 V	1
C9	" 2 MF 330 V AC	1
CP1	Cannon Receptacle (MB #: CP 4)	1
F1	Fuse 3AG 8A	1
F2	" 3AG 1/2A	1
F3	" 3AG 3A	1
JP 1	Jones Plug S2406 C6E	1
M1	3A RF Ammeter	1
P1	Binding Post - National FWH	1
P2	Banana Jack " FWJ	1
R1	Pot 500 k. ohmite CA 5041	1
R2	Resistor 68 k, 1 w, 10%	1
R3	" 2700Ω 1 w, 10%	1
R4	Pot, 2500Ω ohmite CLU 2520	1
R5, R6	Resistor, 68 k, 1 w, 5%	2
R7, R8	" 100 k, 1, w, 5%	2
R9	" 1500Ω 1, w, 10%	1
R10, R11	Pot. 1000Ω ohmite CLU 1021	2
R12	Resistor 3300Ω 2 w, 10%	1

ITEM	DESCRIPTION	QUANTITY
R13	Resistor 2500 10w. 10%	1
R14, R16, R18, R20	" 100 1/2 w. 10%	4
R22	" 4700 1 w.	1
R15, R17, R19, R21	" 68 1 w. 10%	4
PL-1	Pilot Lamp 6-3V	1
SW-1	Switch DPST	1
SW-2	"] Pole 3 Pos. (MB #: SW 5)	1
SW-3	Microswitch (MB #: SW 26, 28)	1
TR-1	Output Transformer Triad HSM 94	1
TR-2	Filament " Stancor P4089	1
V1	Tube 6SN7GT	1
V2, V3, V4, V5	Tube 807	4
V6, V7	Tube OD3	2

PARTS LIST FOR PP13-C
POWER SUPPLY

DIAGRAM REFERENCE: 213MBE19

ITEM	DESCRIPTION	QUANTITY
C1, C2	Capacitor, 15 MF 1000V	2
C3, C4	" Dual 20/20 MF 450 V	1
C5, C6	" Dual 40/40 MF 150 V	1
CH1	Choke Triad C33A	1
CH2	" " C18A	1
CH3	" Stancor C1708	1
JP 1	Jones Receptacle P2406 DB	1
R1, R2	Resistor 1.2ohm 2.w.	2
R3	" 10 k. 20 W.	1
R4, R5	" 100 k. 2 w.	2
TR 1	Transformer Triad P11A	1
TR 2	" Stancor P5000	1
TR 3	" Triad R11A	1
V1, V2	Tube 5R4GY	2
V3	" 5Y3GT	1
V4	" 5Y3GT	1
V5	" OB3	1



9292805

MB MANUFACTURING COMPANY, INC.
NEW HAVEN, CONN.

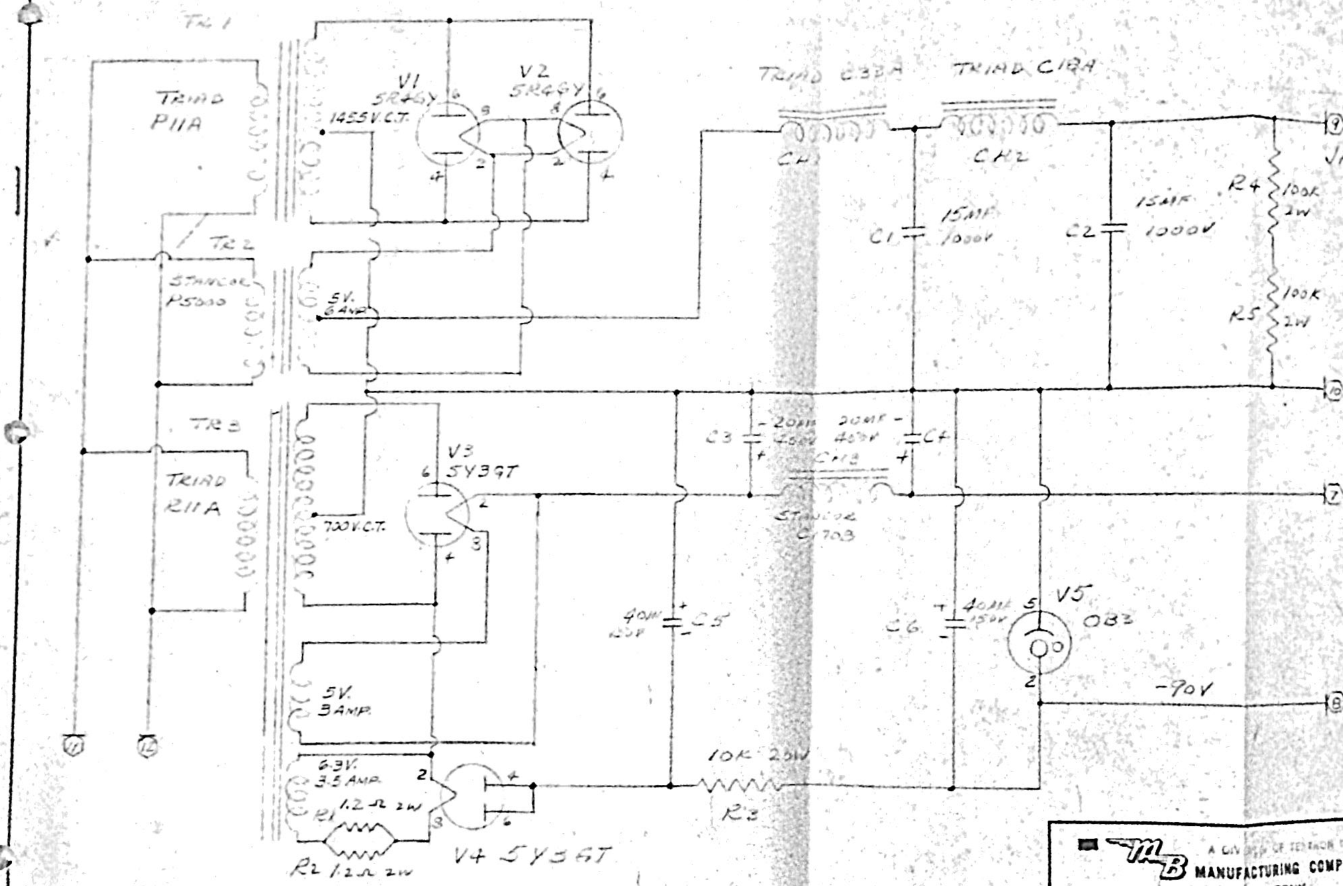
WIRING DIAGRAM MODEL F-34
D.C. FIELD SUPPLY

DRAWN	PL	8-22-51
CHKD.		
APPR.	J.F.K	8-22-51
NEXT ASSY. NO.		
SCALE:		

9213503

REF. 213MBE03

A CHG DWG PER R-2090



JUN 12 1962

A DIVISION OF TEXTRON INC.
MB MANUFACTURING COMPANY, INC.
NEW HAVEN, CONN.

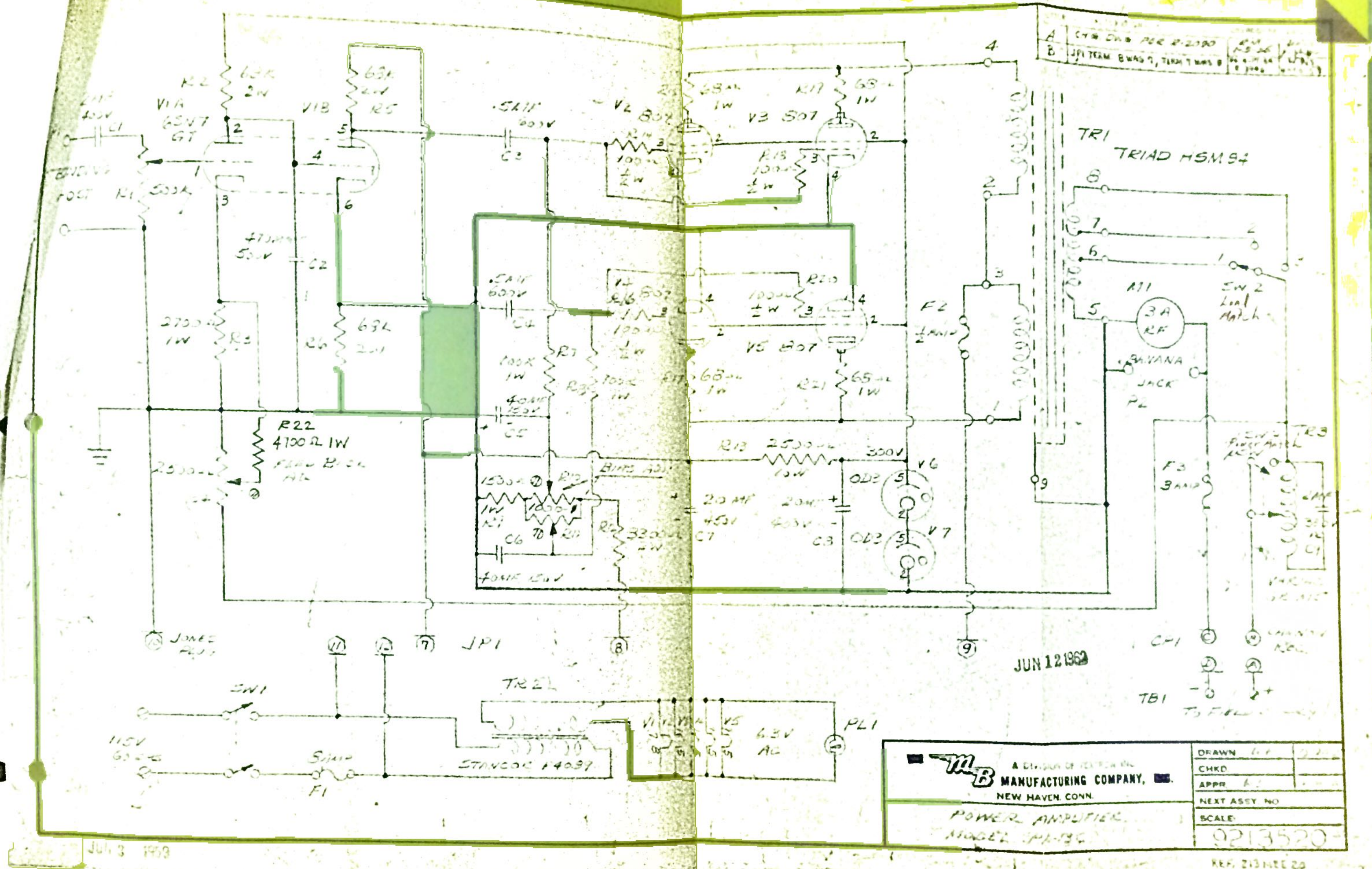
POWER SUPPLY
MODEL PP150

DRAWN	
CHKD.	
APPR	
NEXT ASSY. NO	
SCALE	

9213519

JUL 3 1959

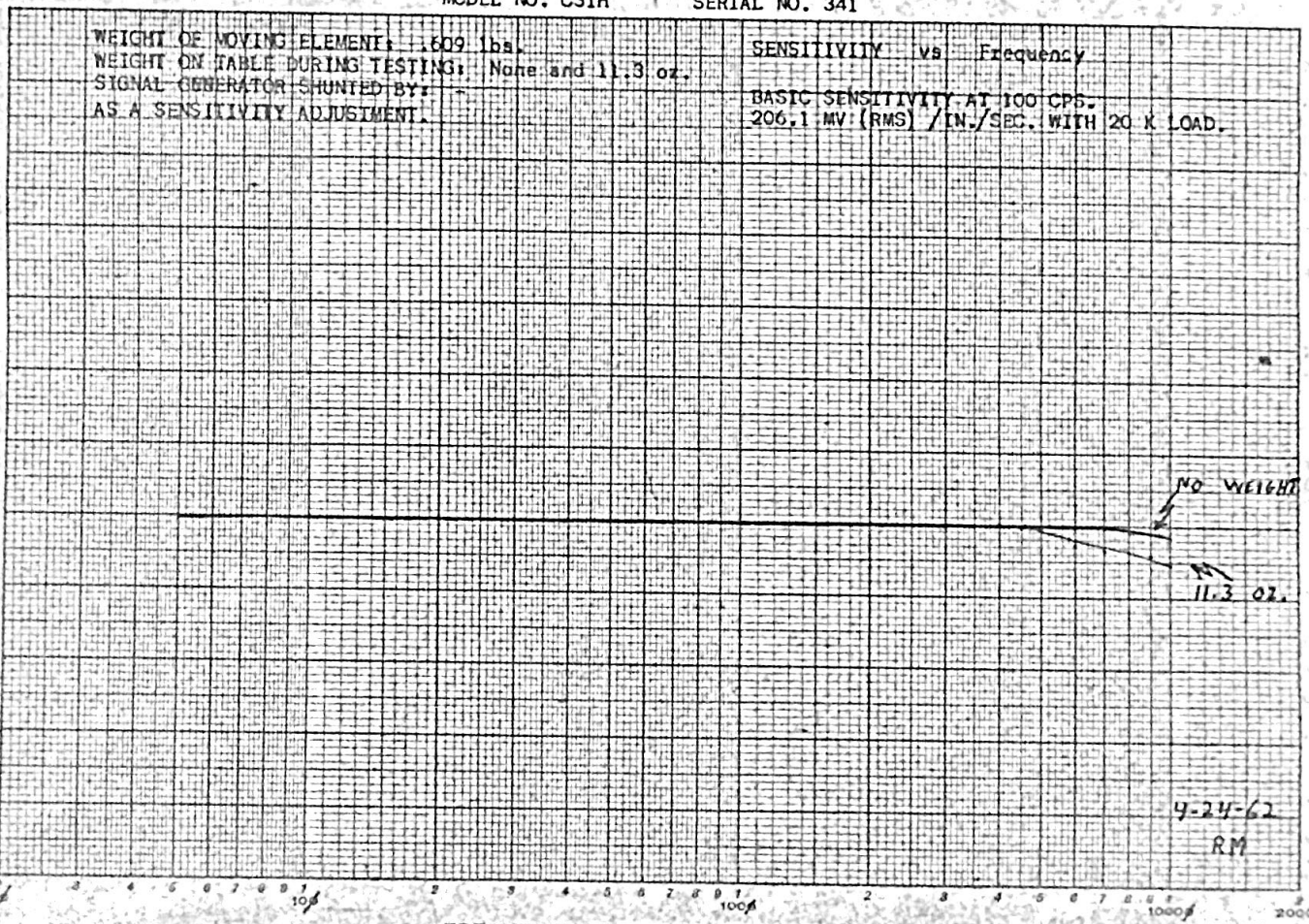
REF. 213 MBE 19



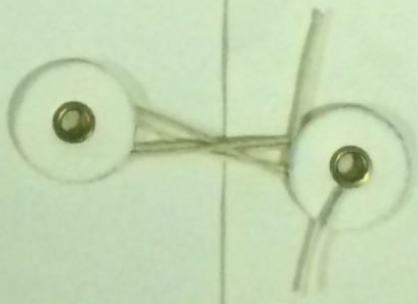
V1A
V1B
V2 807
V3 807
V5 807
TR1
TRIAD HSM 94
R22
4700 Ω 1W
V6
V7
OD3
JP1
CP1
TB1
SW1
TR2
F1
PL1
6.3V AC
JUN 12 1962
MANUFACTURING COMPANY, INC.
NEW HAVEN, CONN.
POWER AMPLIFIER
DRAWN
CHKD
APPR
NEXT ASSY NO
SCALE
9213520

MB ELECTRONICS
DIVISION OF TEXTRON ELECTRONICS, INC.

CALIBRATION OF MB VIBRATION EXCITER
MODEL NO. C31H SERIAL NO. 341



T-5843



DEL T-112531-F3
ILLATOR IS
A MODEL AC13-B
CLING UNIT

NOTE:

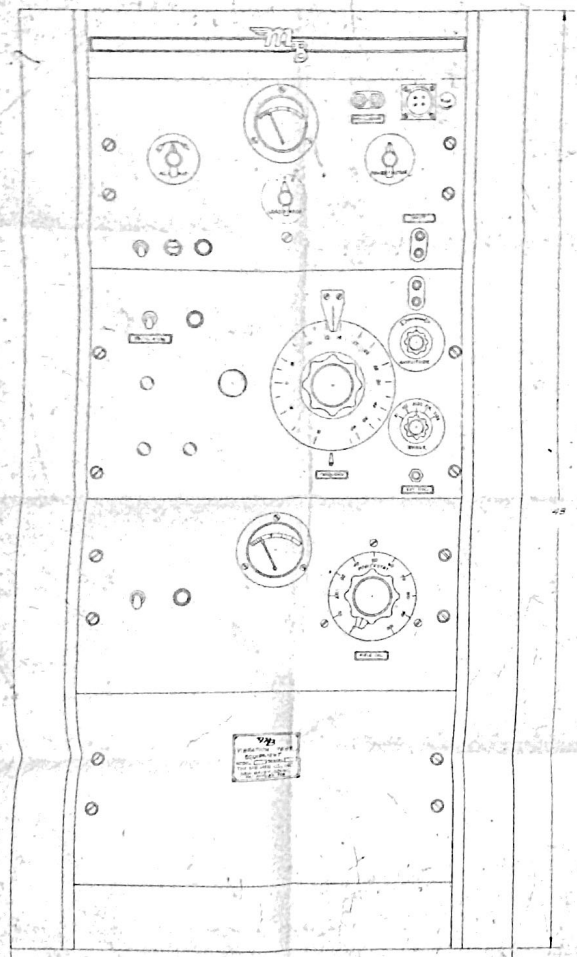
DETAIL	SCHEMATIC WIRING
PP-13C	213MBE19
PA-13C	213MBE20
F-34	213MBE03
A-25	REFER TO I
	FOR H.P. M
AC-13A	280MBE0
AGC11-E	264MBE

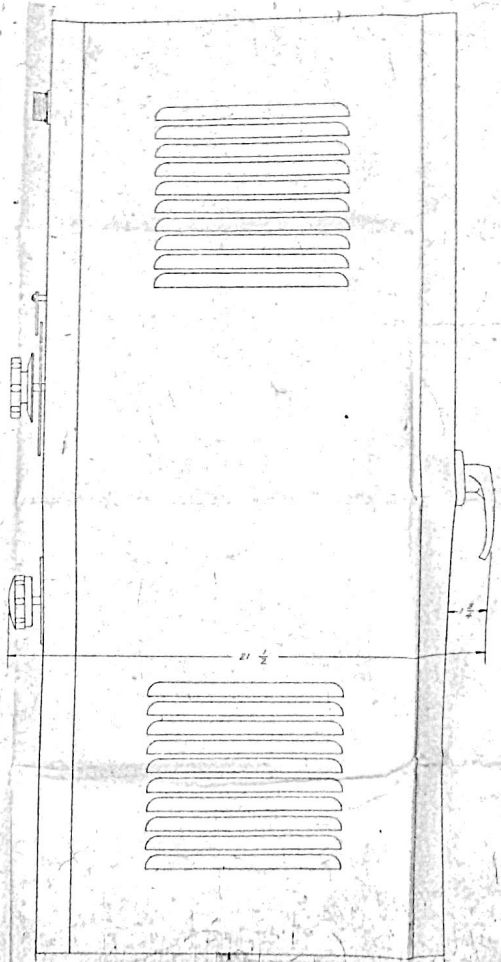
JUN 12 1942

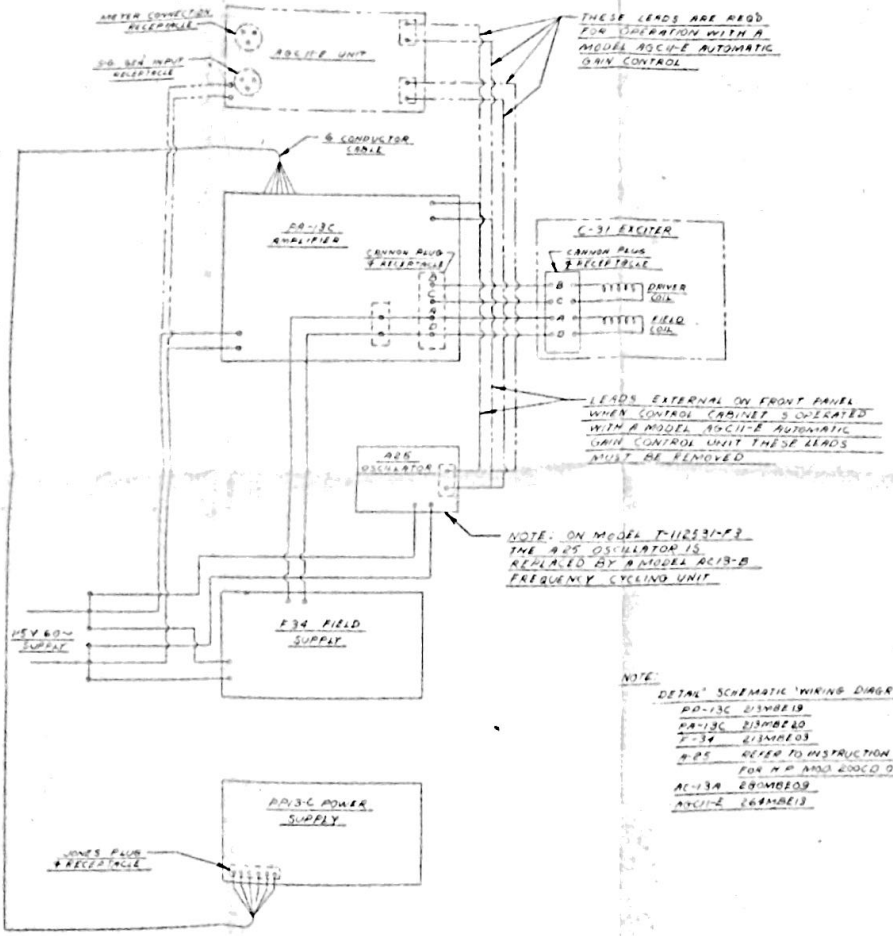
THE MB MANUFACTURING COMPANY, INC.
NEW HAVEN CONN

CONTROL CONSOLE COMPLETE
MODEL T-152534

DRAWN AP 5-12
CHKD. JCD
APPR.
NEXT ASSY. NO
SCALE: 1/2" SIZE
213MBE12







NOTE

DETAIL SCHEMATIC WIRING DIAGRAMS

PA-13C	213MBE19
PA-13C	213MBE20
F-3A	213MBE09
A-2S	REFER TO INSTRUCTION BOOK FOR H.P. MOD. 200CD OSCILLATOR
AC-13A	280MBE09
AGC-E	264MBE13

9213514

JUN 12 1964

UNLESS OTHERWISE SPECIFIED
BREAK ALL SHARP EDGES
TOLERANCES ON DIMENSIONS
FRACTIONS ± DECIMALS ±
ANGLE TOL ± DRILLS ~ .007-.008

USED ON

NEW HAVEN, CONN.

INSTALLATION WIRING DIAGRAM
MOD. T-11253-F2 & T-11253-F3 CONTROL CAB.

SCALE: —

9213514