INSTRUCTIONS

for

INDUSTRIAL OSCILLOSCOPE

Cat. No. 90915 - Serial No......

JAMES MILLEN MFG. CO., INC.
MALDEN, MASS., U. S. A.

Instructions for

No. 90915 INDUSTRIAL OSCILLOSCOPE

1. DESCRIPTION

The Millen 90915 Industrial Oscilloscope is designed specifically to meet the needs for an industrial type oscilloscope suitable for use in the factory, the laboratory, and the field for design, installation, maintenance, and service. In order to provide the utmost in safety, the oscilloscope has a completely insulated front panel and case so as to permit its use in circuits involving voltages which otherwise would involve a hazard to the operator.

The cathode ray tube has a flat face which increases reading accuracy because of reduced paralax, and it is double shielded against magnetic fields so that it may be used accurately in locations with strong stray magnetic fields. The cathode ray tube is of the new mono-accelerator type where the electron beam is accelerated at the electron gun so that field distortions are minimized and excellent deflection linearity is achieved as well as a very uniform spot size over the entire area which the beam scans.

The vertical and horizontal amplifiers are stable d.c. amplifiers and are identical, thus permitting accurate phase measurements.

The LINE SYNC circuit is designed so that regardless of SYNC AMP setting, the angle at which the sweep starts (referenced to line voltage) does not change.

A choice of seven regulated d.c. voltages permits accurate amplitude calibration of either amplifier. Both the vertical amplifier and the horizontal amplifier are designed with compensation to hold the overall sensitivity of each amplifier within ten per cent with line voltage changes from 105 to 125 volts. The sensitivity of the amplifiers of course can be calibrated accurately at any time.

2. APPLICATION

The 90915 is particularly helpful in such fields as industrial controls, welder controls, motor controls, thickness gauges and controls, relays, and in fact in almost any field involving modern electrical and electronic control of production processes. Some industries in which the 90915 is proving especially valuable are the automobile, refrigeration, air frame, paper processing, industrial regulator, textile, sheet copper and steel mills, silver fabrication, machine tool and many others. Because of the insulated panel and case the 90915 may be used in many industries where a conventional oscilloscope would be valueless as well as creating a severe personal hazard.

The 90915 Industrial Oscilloscope is especially helpful in normal trouble shooting on electronically controlled motor drives such as the Thymotrol, Regulex, Mototrol circuits and their modifications used on large boring mills, lathes, and milling machines.

The 90915 is so versatile that it may be used in the laboratory in designing new controls, in the factory in using and setting-up electronic controls, and in the field for installation, maintenance, and servicing of controls.

The synchronizing circuit input is completely isolated from the chassis so that a synchronizing signal with a d.c. level different from the viewed signal may be used.

The vertical amplifier input, the horizontal amplifier input, and the synchronizing amplifier input terminals for A.C. response are each designed for 1500 volts peak to peak or 500 volts r.m.s. maximum input potential. This allows the use of the oscilloscope directly in high voltage circuits without the need of external isolating circuits.

The 90915 Industrial Oscilloscope may be used to make accurate measurements of voltage, current, and degrees phase shift as well as to observe and study waveshapes. With the proper transducer, the 90915 may be used to measure and study pressure, strain, thickness, width, volume, flow, viscosity, capacity and many other parameters.

3. INSTALLATION

THREE CONNECTOR POWER CABLES WITH A GROUND CONNECTION MAY NOT BE USED WITH THIS OSCILLOSCOPE BECAUSE THE CHASSIS MAY BE ABOVE GROUND POTENTIAL. COMPLETE SAFETY IS PROVIDED BY A COMPLETELY INSULATED PANEL AND CASE.

Since the 90915 is a portable instrument which is completely insulated and shielded from magnetic fields, no special installation is required. The detachable power cable is stowed in the pocket on the inside of the front cover of the oscilloscope, along with the vertical input probe. Plug the cable into the receptacle on the rear of the oscilloscope and into a suitable source of 105-125 volt 50/60 cycle power.

The oscilloscope as shipped from the factory is wired for operation from a 105-125 volt 50/60 cycle line. If 210-250 volt operation is desired, the wiring of the power transformer must be changed to place the two primary windings in series. For 210-250 volt operation, the brown and yellow lead and the black lead of the power transformer should be joined together and isolated from any other connection. The brown lead should connect to the fuse, and the black and yellow lead should connect to the power input receptacle.

For rewiring from 210-250 volt operation to 105-125 volt operation, the brown lead and the black lead of the power transformer should be connected together and to the fuse. The brown and yellow lead and the black and yellow lead should be connected together and to the power input receptacle.

4. CATHODE RAY TUBE

The 90915 Oscilloscope uses the DuMont type 5AQP— flat face, mono-accelerator five inch cathode ray tube. The persistence of the phosphor of the tube shipped with the oscilloscope is as specified on the purchaser's order.

P1 phosphor writes with a green trace and has medium persistence. This phosphor is generally used where the recurrence rate is above about a hundred cycles per second and where a longer persistence phosphor might cause blurring. A green light filter is supplied to pass the color of the trace but reject room light from the face of the tube.

P7 phosphor fluoresces blue and phosphoresces yellow. The beam writes blue and leaves a yellow long persistence trace. This phosphor is generally used where the recurrence rate is below about a hundred cycles per second and where the full image of the trace would be lost without the long persistence of the yellow phosphor. An amber light filter is supplied to pass the color of the trace but reject room light from the face of the tube. The amber filter makes both the blue fluorescence and the yellow phosphorescence appear yellow.

P11 phosphor writes with a blue trace and has short persistence. This phosphor is generally used for oscillographic recording (photography). No light filter is supplied with the P11 tube.

Both green and amber light filters are supplied with the oscilloscope.

The cathode ray tube is shipped from the factory in its own carton and must be installed by the customer. The oscilloscope must be removed from its case in order to install the cathode ray tube. The case is held on by two bolts on the bottom toward the rear and seven Phillips machine screws around the edge of the front panel.

The cathode ray tube is inserted through the front panel. The camera-mounting bezel is removed by removing the 4 Phillips-head screws near the corners of the bezel.

The tube is inserted through the hole in the front panel and through the magnetic shield. The base of the tube is supported by the clamp at the rear of the shield. Rotate the tube so that the locating pin is at about five o'clock viewed from the rear. Place the socket on the base.

Install the proper light filter.

Reassemble the bezel and engraved graticule.

Push the cathode ray tube forward so that its flat face is in contact with the light filter.

Turn on the oscilloscope.

Adjust for a single horizontal trace.

BEING VERY CAREFUL NOT TO TOUCH THE REAR TERMINAL BOARD WHICH CARRIES VOLTAGE AS HIGH AS 2100 VOLTS, rotate the tube so that the trace is exactly parallel with the engraved lines on the graticule.

Clamp the tube firmly in place by tightening the two large thumb screws on the clamp at the rear of the magnetic shield.

Reassemble the oscilloscope in the insulating case.

5. OPERATION

Plug the detachable power cable into a suitable source of 105-125 volt, 50/60 cycle power.

To turn the unit on, turn the POWER switch clockwise. The DIMMER control is on the same shaft as the POWER switch. Clockwise rotation of the DIMMER control increases the illumination of the engraved graticule. This will serve as a pilot light also.

Turn the BEAM switch clockwise.

Advance the INTENSITY control clockwise to about five o'clock.

After no more than three minutes, a trace should appear and be stabilized sufficiently for use.

If no trace appears, the positioning controls are not centered. If adjustment of the positioning controls does not locate the trace, use the following procedure:

Set VERT. POS. with pointer straight up.

Set HOR. POS. with pointer straight up.

Set TRIG-RECUR to center position.

Set vertical SELECTOR to OFF.

Set horizontal SELECTOR to SWEEP.

Set horizontal ATTEN. to 1/10.

Set horizontal vernier gain control to center position.

By slight movement of the positioning controls, the trace can be centered.

6. CONTROLS

1. CATHODE RAY TUBE CONTROLS

A. INTENSITY. Clockwise rotation produces maximum intensity. Never leave a small stationary bright spot or trace on the face of the tube as this will burn the fluorescent material on the inside of the tube face.

B. FOCUS. This potentiometer controls the amount of voltage on anode No. 1. Adjustment of this voltage results in a sharp trace.

C. ASTIG. The Astigmatism control focuses the spot over the entire screen. This control actually sets the voltage on anode No. 2 to a mean value between the potentials of the horizontal deflection plates.

D. BEAM ON-OFF. In the OFF position, this switch biases the cathode ray tube off. This is useful for photography or "standby".

E. RED WHITE. This switch determines the color of the lights which illuminate the engraved graticule. White is for normal visual use, and red for photography.

F. DIMMER and POWER. The dimmer controls the voltage on the pilot bulbs that are used to illuminate the engraved graticule. In the extreme counter clockwise position the power on-off switch is actuated and power is removed from the oscilloscope.

2. SWEEP CIRCUIT CONTROLS

A. SWEEP FREQ. The large outside knob is the coarse frequency selector switch which selects the value of capacity across the sweep generator tube and hence selects the sweep frequency range indicated on the panel. The center knob is the fine frequency control. This is a potentiometer which controls the amount of resistance in the sweep generator circuit and hence serves as a vernier sweep frequency control covering the frequency range selected by the outside knob and indicated on the panel.

B. TRIG-RECUR. The center knob controls a potentiometer in the cathode of the sweep generator gas tube to control bias and hence determines whether the sweep is free running or must be triggered.

Turning the control in the clockwise direction causes the sweep to free run. Normally for free running the control should be set a few degrees further clockwise than that just necessary to cause free running. This adjustment is made with the SYNC AMP control at extreme counter clockwise position. The best triggered operation is obtained when the control is set to the point where the sweep will just not quite free run. Again, this adjustment must be made with the SYNC AMP control at extreme counter clockwise position.

C. SYNC SELECT. The large outside knob controls the switch which selects the source of the sweep synchronizing voltage. The following sources are available:

+INT is positive internal synchronizing voltage taken from the vertical amplifier.

—INT is negative internal synchronizing voltage taken from the vertical amplifier.

+LINE is positive synchronizing voltage taken from the power transformer.

—LINE is negative synchronizing voltage taken from the power transformer.

EXT In this position of the SYNC SELECT switch, the EXT SYNC binding posts are connected to the synchronizing voltage amplifier. The EXT SYNC binding posts are completely isolated from the chassis, therefore, the external synchronizing voltage need not have a terminal common with the signal applied to the vertical amplifier. Also, the polarity of synchronization may be reversed by reversing the connections to the EXT SYNC terminals.

KEYED In this position of the SYNC SELECT switch, provision is made for manually keying the sweep. Ground the upper EXT SYNC binding post to the lower HORIZONTAL INPUT binding post each time it is desired to trigger the sweep.

D. SYNC AMP. The center knob controls the amount of sweep synchronizing voltage. The circuit contains a synchronizing voltage limiter, hence there is no danger of overloading the sweep generator.

3. VERTICAL AMPLIFIER CONTROLS

A. ATTEN. The large outside knob controls a four step compensated decade attenuator for selecting the appropriate level of attenuation of vertical input signal. The attenuator is made of precision resistors.

The inside center knob controls a vernier gain control. This is a potentiometer with a ten to one range to operate between the attenuator steps.

B. SELECTOR. This switch selects the input to the vertical amplifier.

AC POST In this position, the signal applied to the VERTICAL INPUT binding posts is applied to the vertical attenuator and amplifier through a 0.1 mfd. 1500 volt condenser.

DC POST In this position, the signal applied to the VERTICAL INPUT binding posts is applied directly to the vertical attenuator and amplifier.

CAL In this position, the signal selected by the CAL DC VOLTS control is applied directly to the vertical attenuator and amplifier.

OFF In this position, the input to the vertical attenuator and amplifier is short circuited. This position is particularly convenient when calibrating.

DC PRB In this position, the signal applied to the probe is applied directly to the vertical attenuator and amplifier. There is a ten to one attenuation in the probe.

AC PRB In this position, the signal applied to the probe is applied to the vertical attenuator and amplifier through a 0.1 mfd 1500 volt condenser. There is a ten to one attenuation in the probe.

C. V. BAL. This is a potentiometer adjusted by screwdriver at the front panel. Occasionally it is necessary to adjust the balance of the input stage so that changing the vertical gain control will not change the vertical positioning. Because of the design of the gain control and positioning circuits and because stable ruggedized 5 star tubes are used, the 90915 Industrial Oscilloscope has unusually stable DC amplifiers. Therefore the need for readjusting the balance occurs very rarely.

The balance adjustment is made as follows:

Turn the VERTICAL SELECTOR to OFF.

Set the vertical vernier gain control full counter-clockwise.

Center the spot by adjusting VERT. POS.

Set the vertical vernier gain control full clockwise.

If the spot moves, it should be recentered by the V.BAL adjustment. If a few minutes warmup time is allowed, this adjustment will need be made rarely.

Should it be impossible to adjust V.BAL so that changing the vertical vernier gain control does not change the vertical positioning, V1 should be replaced by a new General Electric 5 star 5814-A tube.

4. HORIZONTAL AMPLIFIER CONTROLS

A. ATTEN. The large outside knob controls a four step compensated decade attenuator for selecting the appropriate level of attenuation of horizontal input signal or sweep voltage. The attenuator is made of precision resistors.

The inside center knob controls a vernier gain control. This is a potentiometer with a ten to one range to operate between the attenuator steps.

B. SELECTOR. This switch selects the input to the horizontal amplifier.

AC In this position, the signal applied to the HORIZONTAL INPUT binding posts is applied to the horizontal attenuator and amplifier through a 0.1 mfd. 1500 volt condenser. The sweep is turned off.

DC In this position, the signal applied to the HORIZONTAL INPUT binding posts is applied directly to the horizontal attenuator and amplifier. The sweep is turned off.

CAL. In this position, the signal selected by the CAL DC VOLTS switch is applied directly to the horizontal attenuator and amplifier. The sweep is turned off.

OFF In this position, the input to the horizontal attenuator and amplifier is short circuited. This position is particularly convenient when calibrating. The sweep is turned off.

SWEEP In this position, the sweep is turned on and fed into the horizontal attenuator and amplifier. Normally, the ATTEN. should be set in the 1/10 position for a normal sweep length.

SET This position is used only when aligning the compensation of the horizontal attenuator or if for some reason it is desired to put the sweep on the vertical amplifier only.

The following conditions exist when the HORIZONTAL SELECTOR switch is in the SET position:

Sweep is turned on.

Sweep is fed to the CAL DC VOLTS switch only.

The horizontal amplifier and attenuator is connected to the HORIZONTAL INPUT binding posts.

If the CAL DC VOLTS switch is set to SW SIG. the sweep may be fed into the vertical attenuator and amplifier by setting the VERTICAL SELECTOR switch to CAL.

To synchronize the sweep in this position it is necessary to use external synchronization.

C. H. BAL. This is a potentiometer adjusted by screwdriver at the front panel. Occasionally it is necessary to adjust the balance of the input stage so that changing the horizontal gain control will not change the horizontal positioning.

Because of the design of the gain control and positioning circuits and because stable ruggedized 5 star tubes are used, the 90915 Industrial Oscilloscope has unusually stable d.c. amplifiers. Therefore the need for readjusting the balance occurs rarely.

The balance adjustment is made as follows:

Turn the HORIZONTAL SELECTOR to OFF.

Set the horizontal vernier gain control full counter clockwise.

If the spot moves, it should be recentered by the H.BAL. adjustment. If a few minutes warm-up time is allowed, this adjustment will need be made rarely.

Should it be impossible to obtain balance by adjusting H.BAL. so that changing the horizontal vernier gain control does not change the horizontal positioning, V4 should be replaced by a new General Electric 5 star 5814-A tube.

5. ADDITIONAL CONTROLS

A. CAL DC VOLTS. This switch selects accurate DC calibrating voltages which may be applied to either attenuator and amplifier and which is also supplied to the CAL OUT jack. This switch may also select a sweep voltage sample or a line voltage sample.

a. SW SIG. In this position a sample of the sweep signal is applied to the CAL position of the VERTICAL SELECTOR and the CAL OUT jack, provided the sweep is turned on by setting the HORIZONTAL SELECTOR to SWEEP or SET.

b. .3, 1, 3, 10, 30 and 100. In these positions an accurate D.C. voltage of the value selected is applied to both SELECTOR switches and to the CAL OUT jack.

c. 60 Cycle. In this position a sample of the heater voltage as a source of line frequency is applied to both SELECTOR switches and to the CAL OUT jack.

CALIBRATION:

Set CAL DC VOLTS to the desired calibrating D.C. voltage.

Set the SELECTOR (either vertical or horizontal as required) to OFF.

Set beam to a reference point on the graticule. (Such as one inch below center for vertical calibration or one inch to the left of center for horizontal calibration.)

Set SELECTOR to CAL.

Adjust the vernier gain to move the beam to a convenient point above center for vertical calibration or to the right of center for horizontal calibration—say, one inch.

The calibration is the calibrate voltage divided by the inches deflection. If one volt had originally been selected, this would now mean the oscilloscope is calibrated for 0.5 volts per inch since two inches of deflection was used.

THE V. BAL (or H. BAL) ADJUSTMENT MUST BE SET CORRECTLY BEFORE ATTEMPTING TO CALIBRATE.

B. DEFLECTION PLATES. The terminals on the deflection plate terminal board are +300 volts above chassis. Behind the door on the left side of the oscilloscope case is a terminal board for connecting directly to the deflection plates. Remove the jumpers and connect to the indicated terminals. No centering or positioning voltages are normally available when the jumpers are removed. A large resistance of five megohms or so may be used in place of the jumpers, thus restoring centering voltages but also CAUSING THE PLATES TO RUN +300 VOLTS D.C. ABOVE CHASSIS. Of course an external source of D.C. centering voltage may be used.

7. CIRCUIT DESCRIPTION

A. The horizontal and vertical amplifiers are essentially identical; therefore the description of one also describes the other.

Each amplifier consists of a cathode follower gain control stage and a differential two-stage D.C. amplifier.

One grid of the input stage is grounded and the other has the input signal applied to it. Thus the cathode whose grid has signal applied to it reproduces the input signal while the cathode whose grid is grounded has essentially no signal. Hence, a potentiometer placed between these two cathodes acts as a gain control. Since direct coupling is used throughout the amplifiers, it is necessary that the two cathodes be at the same D.C. level with no signal, otherwise the beam would shift with gain control setting. A balance adjusting potentiometer, V. BAL or H. BAL, is used for the purpose of adjusting the two cathodes of the input stage to the same level.

The second stage of each amplifier is a conventional differential D.C. amplifier with certain additions. Positive feedback in the form of a small capacitor connected from the second plate to the first grid is introduced to reduce the apparent input capacity; thus decreasing the amount of phase shift that occurs as the vernier gain setting is changed. The cathode of the second stage derives its bias not only from self bias but also from a resistor connected to the unregulated B+. As the line voltage varies, the gain of the amplifier is changed to counteract the change in the sensitivity of the cathode ray tube deflection plates.

The final stage of each amplifier is a conventional differential D.C. amplifier with the addition of negative feedback in the form of plate to grid resistors to improve linearity, to aid in gain compensation, and to improve frequency response.

A factory set gain control is across the plates of the second stage. This is set at the factory to give the vertical amplifier a maximum sensitivity of exactly 0.3 volts D.C. per inch of deflection and the horizontal amplifier a maximum sensitivity of exactly 0.375 volts D.C. per inch of deflection (0.3 volts D.C. per 0.8 inches of deflection).

B. SWEEP AND SYNCHRONIZING CIRCUIT

The sweep synchronizing circuit has a single stage of amplification followed by a synchronizing voltage limiter (diodes back to back) which feeds the 6Q5-G gas sweep generator tube. The sweep generator is the conventional gas tube type with a clamp circuit added to hold the plate voltage at the desired level when the sweep is being operated in the triggered mode. This is followed by a cathode follower. In the cathode of the cathode follower is a potentiometer (SWEEP BALANCE) which is factory adjusted to set the sweep voltage to a zero average value to prevent horizontal shifting of the beam as the horizontal gain is varied. The SWEEP BALANCE control is mounted on the chassis and is pre-set at the factory. To provide blanking of the return trace, the sawtooth sweep voltage is differentiated, amplified, and applied to the cathode of the cathode ray tube.

The voltage for synchronizing the sweep generator may be obtained from the vertical amplifier, line, external binding posts, or manual keying. The LINE synchronizing voltage is derived from a clipped, differentiated signal originating at the power transformer. The resultant pulses correspond to zero degrees or 180 degrees relative to the line voltage. Hence, when using LINE SYNC., the sweep will start at zero or 180 degrees relative to the line voltage, depending on the polarity selected. Thus the synchronized sweep may be used to make measurements of phase or time relative to the incoming line sine wave. There is a very slight delay of not much over two degrees in the start of the sweep; however, this is constant.

An external signal of one half volt peak is needed to synchronize the sweep generator. There is an isolation transformer between the EXT SYNC binding posts and the synchronizing circuit so that synchronizing signals which do not have a common bus with the signal under observation may be used. If both binding posts are not needed, the one not used should be grounded to a ground binding post on the oscilloscope.

The KEYED position of the SYNC SELECT switch provides a means of manually keying the sweep. All that is necessary is to ground one of the EXT SYNC binding posts each time it is desired to trigger the sweep.

C. POWER SUPPLIES

1. HIGH VOLTAGE Approximately minus 2100 volts is provided for the cathode ray tube. It has a conventional half wave rectifier with an RC filter.

2. LOW VOLTAGE — UNREGULATED Approximately +460 volts is supplied by a full wave rectified, L—C filter arrangement. This is arranged to provide minus thirty volts below chassis and plus 430 volts above chassis.

3. LOW VOLTAGE — REGULATED A conventional electronic regulator is used to supply plus 195 volts; this appears as minus thirty volts below chassis and plus 165 volts above chassis. A potentiometer (REG ADJUST) for setting the output of the regulated power supply to plus 165 volts above chassis is provided on the chassis. This control is pre-set at the factory.

8. TECHNICAL SUMMARY

A. FREQUENCY RESPONSE

Vertical Amplifier or Horizontal Amplifier

D.C. Amplifier using either the terminals or the probe and at any gain setting.

0 to 100 KC. +0 —10%
0 to 200 KC. +0 —30%
0 to 400 KC. +0 —50%

Square Wave response 0 to 10 KC.

A.C. Amplifier using either the terminals or the probe and at any gain setting. Same as D.C. Amplifier except low frequency 3 db. point is 0.3 cycles.

Square Wave response 30 cycles to 10 KC.

B. SENSITIVITY

Vertical Amplifier

Terminals

D.C.—0.3 volts D.C. per inch deflection.

A.C.—0.3 volts peak to peak per inch deflection
0.106 volts r.m.s. per inch deflection.

Probe

D.C.—3.0 volts D.C. per inch deflection.

A.C.—3.0 volts peak to peak per inch deflection.
1.06 volts r.m.s. per inch deflection.

Horizontal Amplifier

D.C.—0.375 volts D.C. per inch deflection.

A.C.—0.375 volts peak to peak per inch deflection.
0.133 volts r.m.s. per inch deflection.

C. MAXIMUM INPUT POTENTIAL

Horizontal Amplifier or Vertical Amplifier

550 Volts r.m.s.
1500 Volts peak to peak

D. INPUT IMPEDANCE

Horizontal Amplifier or Vertical Amplifier

Terminals—5 megohms and 45 mmf.
Probe—10 megohms and 13 mmf.

E. LINEARITY

Horizontal Amplifier or Vertical Amplifier

Less than 5% non-linearity.

F. POSITIONING

Vertical Amplifier—At least 2.7 tube diameters.

Horizontal Amplifier—At least 1.7 tube diameters.

G. PHASE SHIFT BETWEEN AMPLIFIERS

With like gain and attenuator settings, there is no appreciable phase shift at frequencies up to one megacycle.

With one amplifier adjusted with vernier gain at ½ and the other at maximum (worst possible condition) phase shifts are:

1.3 degrees at 30 KC.
2.8 degrees at 100 KC.
14 degrees at 500 KC.

H. AMPLITUDE CALIBRATION

0.3, 1.0, 3.0, 10, 30, and 100 volts D.C. ±4% (regardless of line voltage) available to either amplifier through panel switch and also available at a jack on the panel.

I. SAMPLE LINE VOLTAGE

Available to both vertical and horizontal amplifiers through panel switching.

J. SWEEP

Type: 6Q5-G gas tube.
Triggered or recurrent.

Range: 2 cycles per second to 30KC. per second with provisions for adding external capacity for slower sweeps.

Synchronization: Plus Internal
Minus Internal
Plus Line
Minus Line
Plus External
Minus External
Keyed

Synchronizing voltage is applied through a limiter.

K. CATHODE RAY TUBE ACCELERATING VOLTAGE

2100 volts, permits use of P1, P7, or P11 screens.

L. BLANKING

Input Impedance: 3.3 megohms and 70 mmf.
Input Voltage: Minus 20 volts peak to peak to blank.
Blanking Input Terminal: Front Panel.

M. DEFLECTION PLATES

Available for direct connection.
Capacity 15 mmf. each plate to ground.
Sensitivity:

Vertical 26½ to 32½ volts D.C. per inch deflection.

Horizontal 33½ to 42 volts D.C. per inch deflection.

N. PHYSICAL SPECIFICATIONS

Height: 15¼ inches including handle.
Width: 10 inches.
Depth: 22⅛ inches overall.
Weight: 40 pounds.

O. AMBIENT TEMPERATURE RANGE

0 to 50 degrees centigrade.

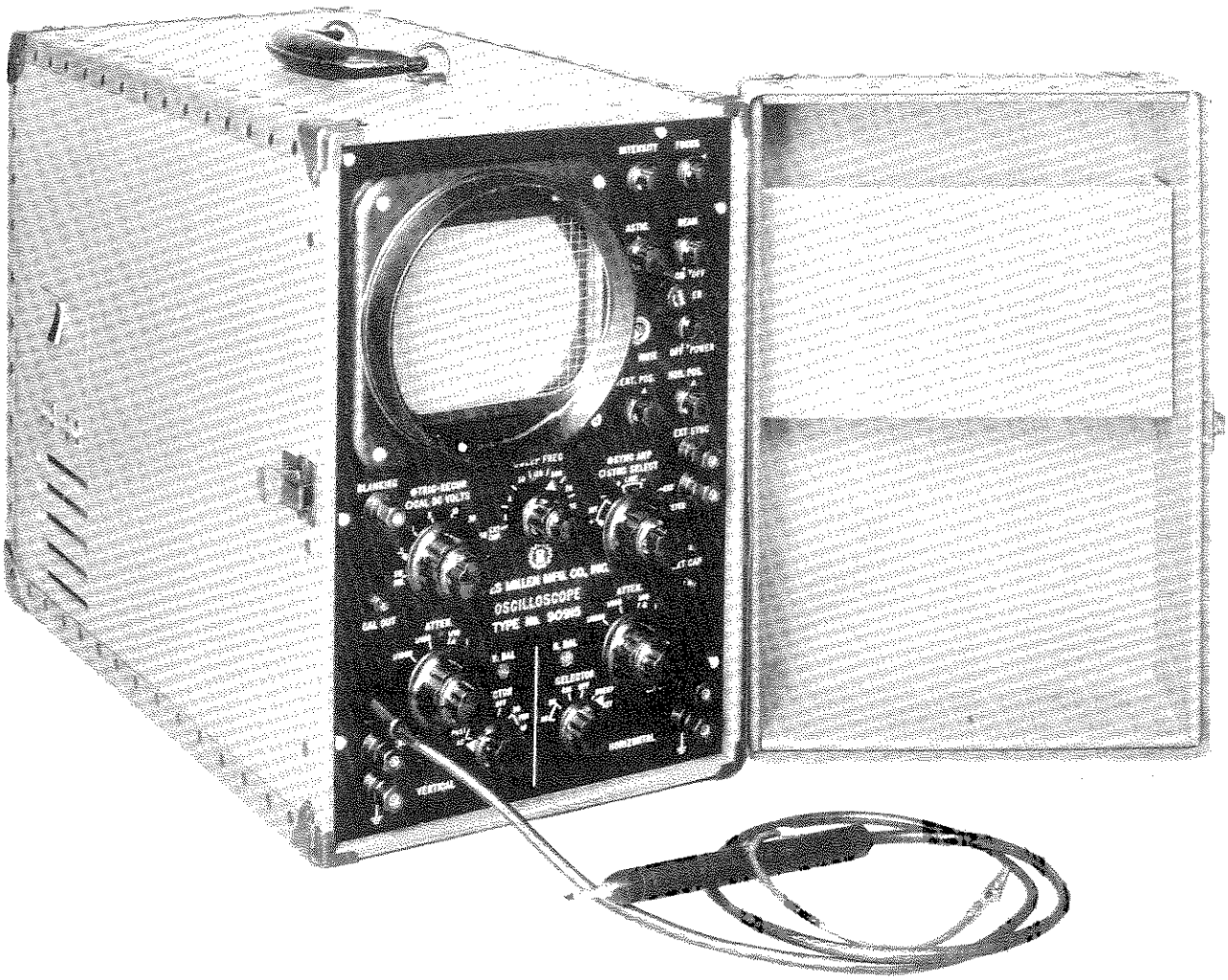
P. POWER REQUIREMENTS

105 to 125 volts 50/60 cycles, or
210 to 250 volts 50/60 cycles.
105 watts power consumption.

Q. TUBE COMPLEMENT

2—5814-A—Amplifier Input—General Electric 5 Star.
2—6201—Differential Amplifiers — General Electric 5 Star.
2—6BK7-A—Amplifier Output.
1—12AT7—Synchronizing Voltage Amplifier and Sweep Voltage Clamp.
2—1N48—Crystal Rectifiers. Synchronizing Voltage Limiters.
2—1N91—Crystal Rectifiers—Line Frequency Synchronizing Voltage Limiters.
1—6Q5-G—Sweep Oscillator—Dumont.
1—12AU7-A—Sweep Cathode Follower and Blanking Amplifier for Return Trace.
1—5AQP—Cathode Ray Tube—Dumont, P1, P7 or P11.
1—1B3-GT—High Voltage Rectifier.
1—5Y3-GT—Low Voltage Rectifier.
1—6AQ5—Series Voltage Regulator.
1—6AU6—Voltage Regulator Control.
1—OA2—Voltage Reference.

R. W. C. 2/2/56


OSCILLOSCOPE