DU MONT

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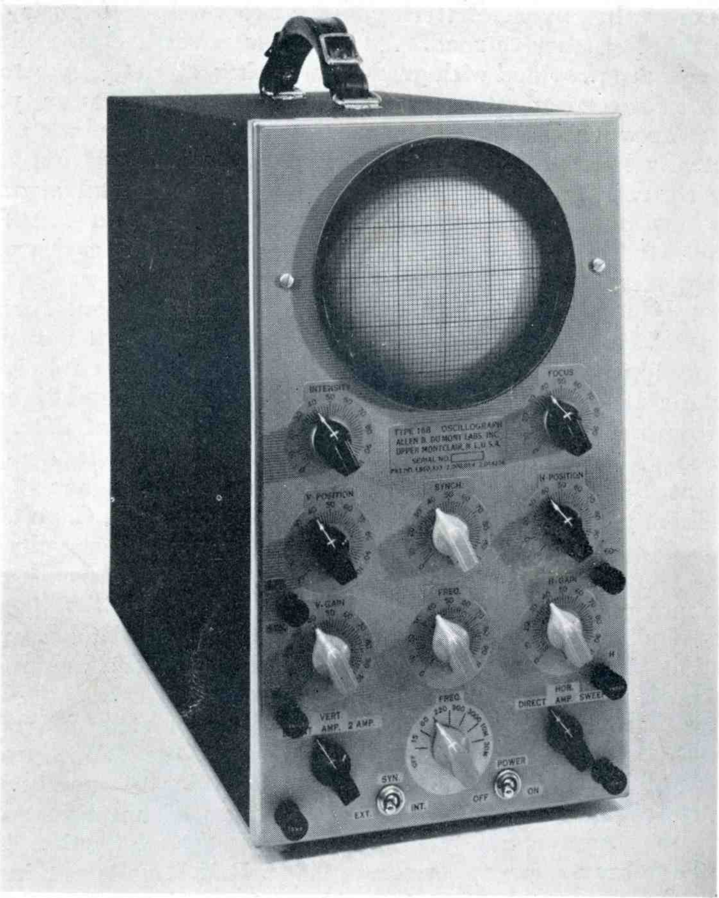
OSCILLOGRAPHER

A NEW FIVE INCH ALL PURPOSE CATHODE RAY OSCILLOGRAPH



A NEW cathode ray oscillograph, employing a type 54-XH Du Mont cathode ray tube, and designated as the Type 168 has recently been developed by our laboratories. The high gain, wide frequency range amplifiers with high input impedance should especially appeal to the engineer and experimenter.

The sweep circuit of this new unit is of the amplified type equipped with a return trace eliminator and expanding amplifier circuit so that all or only a small portion of the wave appears on the screen of the cathode ray tube.

Separate power supplies furnish the voltage for the cathode ray tube and amplifier circuits so that there is no interaction between the controls of the unit. These power supplies deliver sufficient voltage to give good brilliance in ordinary daylight, and the recent improvements in cathode ray tubes provide excellent sharp focus over the entire screen.

The front panel has been arranged with controls conveniently located and with sufficient flexibility for every oscillographic purpose. The panel is of polished chromium with black lettering, making the dials easy to read. All the controls are provided with graduated dials for convenient resetting. The more frequently used controls are centrally located and are supplied with red knobs to unconsciously impress their importance upon the mind of the operator.

The Du Mont Type 54-XH cathode ray tube used in this unit employs an indirectly heated cathode and is equipped with two sets of electrostatic deflection plates. One plate of each pair is connected internally to the second anode. The fluorescent screen is of the high intensity, short persistence type. Due to the high power supply voltage employed for the cathode ray tube, the trace may readily be observed in ordinary daylight, and the spectral distribution is such that photographic work may be easily accomplished with ordinary commercial equipment.

Focus and intensity of the trace are controlled by two controls located on the front panel. These controls have been arranged to control these two factors alone so that when once set they may be left permanently adjusted over any period of time.

Amplifiers are provided for both horizontal and vertical deflection, with switching such that the vertical plates may be connected directly, through one stage, or through two stages of amplification. The horizontal switching is arranged to connect the deflection plates directly, through the single stage horizontal amplifier, or to the linear sweep circuit. The input impedance for horizontal or vertical circuits, either direct or amplified, is one megohm. This high impedance, therefore, does not disturb the majority of circuits which are usually investigated with the oscillograph. The gain through the single stage vertical amplifier is seventy, and with the two vertical stages is 450. The two stage vertical amplifier and its switching circuits operate only on the vertical deflection plates and the resultant isolation provides complete freedom from interaction with the horizontal signals. The amplifiers have a flat frequency response from 15 cycles per second well up into the radio frequency range. The horizontal amplifier is a single stage which may be used either for an external signal or to amplify the internal linear sweep, and it has a gain of fifty.

The deflection factor, which is the reciprocal of sensitivity, may be expressed as D. C. volts per inch or root mean square volts per inch. For the Type 168 oscillograph this factor is 57 D.C. volts per inch direct, or 20 R.M.S. volts per inch direct. This holds for either horizontal or vertical deflection. Through one stage of vertical amplification, the deflection factor is 0.28 R.M.S. volts per inch. Using two stages of amplification on the vertical the deflection factor is 0.046 R.M.S. volts per inch. With one stage of amplification on the horizontal the deflection factor is 0.40 R.M.S. volts per inch. The slightly reduced gain of the horizontal amplifier is necessary in order to raise the overload point and allow expansion of the waves applied to the sweep circuit while at the same time providing more faithful amplification of the saw tooth pulse.

The amplified sweep circuit provided in the Type 168 oscillograph has a frequency range from 15 to 30,000 cycles per second and is so adjusted that the amplifier may cause a spreading of this sweep sufficient to observe waves up to 500,000 cycles per second. This amplified sweep is of great advantage over other types of sweep circuits in that the pattern width may be altered without upsetting in any way the frequencies involved. A standard type 885 discharge tube is employed as a sweep oscillator. The front panel is provided with an approximate frequency calibration for the sweep.

Internal or external positive synchronization is provided and may be selected by a switch on the front panel. The circuit employs capacity-resistance coupling which operates positively over a much wider frequency range than the old style transformer coupled synchronization.

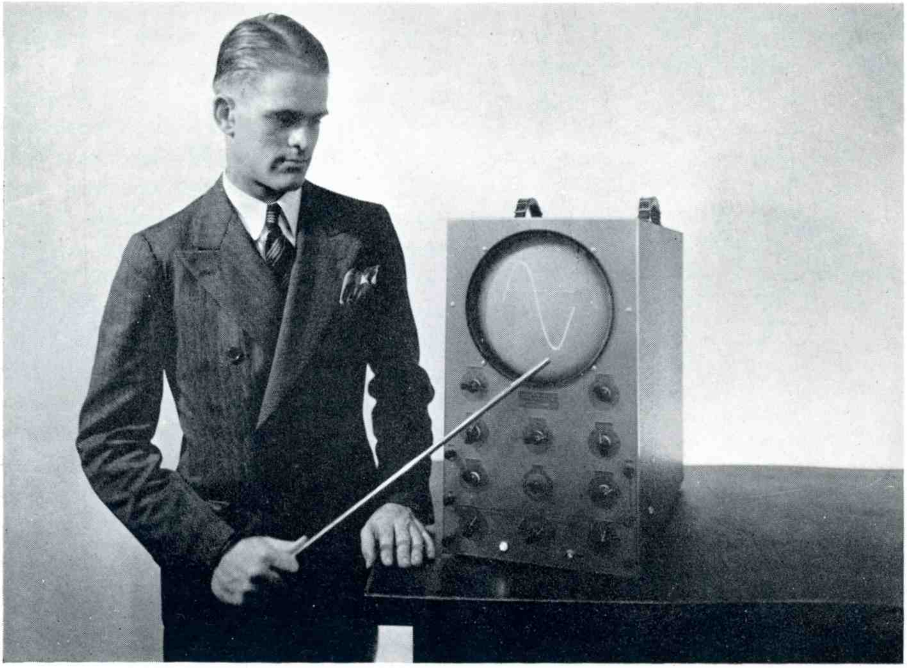
The standard television principal of grid modulation has been employed in this unit to eliminate the return trace of the sweep circuit. This is accomplished by application of a pulse to the grid to turn off the beam during the fly-back time of the sweep circuit.

Both horizontal and vertical positioning controls have been placed on the front panel. The convenient location of these controls has been found to be of definite advantage in the study of many complicated wave forms. A procedure quite often found convenient in such a study is to spread the signal as far as possible with the horizontal amplifier and then to position the trace on the screen for convenient observation of the portion of the trace desired. To facilitate quantitative measurements a removable celluloid calibrated scale has been provided.

A bakelite plate located at the rear of the oscillograph directly at the socket of the cathode ray tube carries the deflection plate terminals of the tube. Jumpers are conveniently provided at this plate connecting the deflection plates to all the internal deflection and control circuits of the oscillograph. By the removal of these jumpers the deflection plates are free to be used either for D.C. measurements or for very high-frequency observations. The location of the terminals on this plate also makes it convenient to connect decoupling resistors so that the internal positioning controls of the units may be utilized while the deflection plates are externally connected. This bakelite strip has been located so that it is available for connection thereto without removing the oscillograph from its shielding case.

The two independent power supplies of the Type 168 oscillograph provide complete freedom from interaction of the controls. One rectifier with a heavy filter provides 400 volts for the amplifiers and the linear sweep circuit. Decoupling devices are used in the plate circuits of the various stages to insure isolation. The other rectifier with a light filter circuit, and utilizing an additional high voltage winding on the power transformer, supplies 1100 volts for the cathode ray tube and allows the second anode to remain at ground potential. This high voltage provides excellent brilliance of the pattern. The unit is completely A.C. operated from 115 volt, 60 cycle lines. Power consumption is 50 watts. The dimensions of this oscillograph are as follows: Height—14″, Width—8″, Length—15¼″. The weight is 31 pounds.

THE OSCILLOGRAPH IN THE LECTURE ROOM



THE DUMONT TYPE 158 OSCILLOGRAPH
ON THE LECTURE PLATFORM

THE Cathode Ray Oscillograph originated in the experimental laboratory and in the lecture room, but now it has become such an important tool in the research field that great strides have been made in the past few years in perfecting the instrument for precision work. In the course of its development and application to industry, it has been rather at a standstill with regard to lecture applications. However the instrument is so useful in lecture demonstrations that it is of interest to describe some practical circuits and procedures for lectures with the oscillograph.

If the interest proves sufficient, a short series of articles is contemplated on this subject, and the author will be more than glad to hear from anyone who has devised demonstrations which would be of value to others. These descriptive articles will necessarily be brief, but references will be given to more voluminous articles on the various topics considered. A historical sketch of the oscillograph and the general theory of the instrument will be in keeping. This will be followed by specific details regarding use of the instrument for lectures in General Science, General Physics, Biology, Mechanics, Electricity and Magnetism, Applied Electricity, Sound, Radio Programs and Servicing, and Principles of Television. In so far as it is possible, strict attention to simplicity of the necessary equipment will be maintained in order that the average school laboratory and lecture equipment may prove adequate without additional expensive outlays. Certainly with better equipment, the user may prepare more striking and instructive performances, but it is deemed wiser to base the plans on simple equipment and then let the user elaborate the experiments as he sees fit.

This series is being prepared with lectures particularly in mind, but it is hoped that its wide scope of subjects may also suggest profitable laboratory and research uses to those of its readers who are not yet familiar with the oscillograph in its broadest scope.

Historical Sketch of the Oscillograph

The Cathode Ray Oscillograph came into being as a practical commercial instrument following the experiments of J. J. Thompson in 1897 when he first discovered the nature of the electron, and the work of Braun in the same year. At first the tubes were quite crude and inefficient, but they have been developed to the point where they compete successfully in the field of precision instruments. Today they take several forms for many different purposes. Among outstanding contributors to the development of the oscillograph may be mentioned Wehnelt, Von Ardenne, Dufour and Wood in Europe, and in this country Johnson, Bedell and Du Mont.

A multitude of articles have been written on the subject of the cathode ray oscillograph in the last few years and many of them are exceptionally good for parallel reading. The development of the cathode ray tube is described by MacGregor-Morris and Henley in their book entitled Cathode Ray Oscillography, Pittsburgh Instruments Publishing Company, England, 1936. An excellent book for general information has been written by G. Parr, "The Low Voltage Cathode Ray Tube and its Applications," Chapman and Hall Ltd., London, 1937. A current series of technical articles by R. R. Batcher on the application of the oscillograph is being published in Instruments, beginning in the May 1935 issue and running to the present. John Rider's book, "The Cathode Ray Tube at Work," 1935 gives many helpful suggestions in radio applications. This book may be obtained from the Allen B. Du Mont Laboratories.

Theory of the Tube

As the present series of articles will deal primarily with the use of the low voltage cathode ray tube with electrostatic deflection plates, discussion will be limited to this type of tube.

An electron gun produces and focuses a beam of electrons into a fine pencil which, upon impinging against the screen, produces a spot of fluorescent light. Deflection plates are provided along the path of this beam such that any voltages applied to these plates cause displacement of the beam. Two pairs of plates, at right angles to each other, allow the beam to be deflected independently in two dimensions. Thus two dimensional graphs of quantities may be observed directly on the screen of the tube.

Two outstanding advantages are provided by using electrons as the moving pointer. First a very small amount of energy is required to move such a pointer, and thus the oscillograph can be used on equipment without upsetting its electrical circuits. Second the beam has practically no inertia and accordingly can respond instantaneously to changes, in contrast to slow moving mechanical pointers.

The fluorescent trace is visible in ordinary light, and when a nine inch tube is employed, such as that provided in the Du Mont Type 158 oscillograph, the patterns are easily visible to an entire group of students. For small groups either the three inch or five inch tubes as provided in the Du Mont Type 164 or Du Mont Type 148 or Du Mont Type 168 units should prove quite satisfactory.

Preliminary Study of the Unit

It will prove quite advantageous for any user of the oscillograph to become thoroughly familiar with the instruction books furnished for the particular unit which he decides to use. The best way to become adept in handling the oscillograph is to carry out some of the simple standard tests prescribed in the book of instructions.

With a group of students who never before have seen an oscillograph, the following introductory demonstrations will prove valuable. These introductory suggestions will terminate this first article of the series, and then future articles will deal with specific fields of study as outlined above.

(1) It is very important for a student to comprehend that the indicator is a single point of light. Turn each amplifier gain control back to zero. Then bring the beam to proper focus and intensity. A single point of light is produced. This light appears where the electrons strike the fluorescent screen.

(2) Controls on the left side of the panel affect vertical motion. Move the left positioning control slowly. The spot moves up and down in a straight line, but still can be distinguished as a single spot. Move it rapidly. The spot now begins to appear as a continuous line.

(3) Controls on the right side of the panel affect horizontal motion. Move the right positioning control slowly, then rapidly.

(4) Simultaneous deflection along each axis results in placement of spot in all possible positions in any quadrant of the face of the tube. Turn both positioning controls simultaneously so as to produce displacement at forty-five degrees.

(5) The most general use of the oscillograph employs displacement along the horizontal in proportion to time. A device for producing such displacement is termed a linear sweep circuit, and the rate of this sweep can be adjusted quite critically to simplify the observations being made. Adjust the controls for the internal sweep. Set the frequency controls for the lowest sweep frequency. Even then the moving spot, due to persistence of vision of the eye, appears as a continuous line. Adjust the length or amplitude of this line to full screen deflection by means of the horizontal amplitude control.

(6) An electrical input voltage proportional to the quantity we wish to measure, either mechanical or electrical, must be applied at the vertical input terminals. Connect a low voltage sixty cycle signal to the vertical input posts, either from

the terminal provided to give sixty cycles on the front panel or from a small transformer. For a moment turn off the sweep, and turn on only the vertical amplifier so that the input signal gives a convenient length vertical line. Show that the position of the input control determines the amplitude of this line. Now turn on the sweep circuit again and thus spread out this series of sixty cycle waves. Adjust the sweep frequency controls until the pattern stands approximately stationary.

(7) Synchronization of the sweep circuit with the vertical signal facilitates observation. Adjust the synchronization control and the fine frequency control until the pattern locks definitely in a stationary position. Show, by turning back the synchronizing control, that it is responsible for the sweep circuit keeping in step with the signal under investigation.

(8) A variety of patterns may be produced by altering the sweep speed. With the synchronization turned all the way off, vary the frequency controls and study the way in which the waves are split up into more and more small segments as the sweep frequency is raised.

(9) The alternating current light mains produce a very smooth pattern called a sine wave. Adjust the sweep again for a low speed such that two complete waves are produced. The waves are smooth and show definitely their alternating character, with both positive and negative portions.

(10) Average patterns to be observed are much more complicated than a sine wave. Disconnect the signal from the vertical input post, and turn up the amplifier. Then grasp this terminal with the hand, remaining away from other metallic objects. In the average laboratory or lecture room there are sufficient stray electric fields to allow a person to act as a capacitance which will pick up enough energy to give a deflection on the oscillograph with use of the amplifiers. Notice that this wave form is more complicated than the pure sine wave, due to the presence of additional higher frequencies.

Place a block of dry wood on the floor and stand on it. The signal is much reduced, depending on the type of floor. Connect and disconnect a ground wire from the unit to a water pipe and note the changes as the vertical post is touched by the hand. Now it may be of interest to allow the students to touch the vertical input post and study the effect of rubber heels, a chain of several students touching each other, and the like.

Now to summarize, remember that the oscillograph makes it possible to study variations in electrical quantities. Future articles will explain how quantities entirely non-electrical may nevertheless be transformed into proportional electrical energy and studied in detail with the cathode ray oscillograph.

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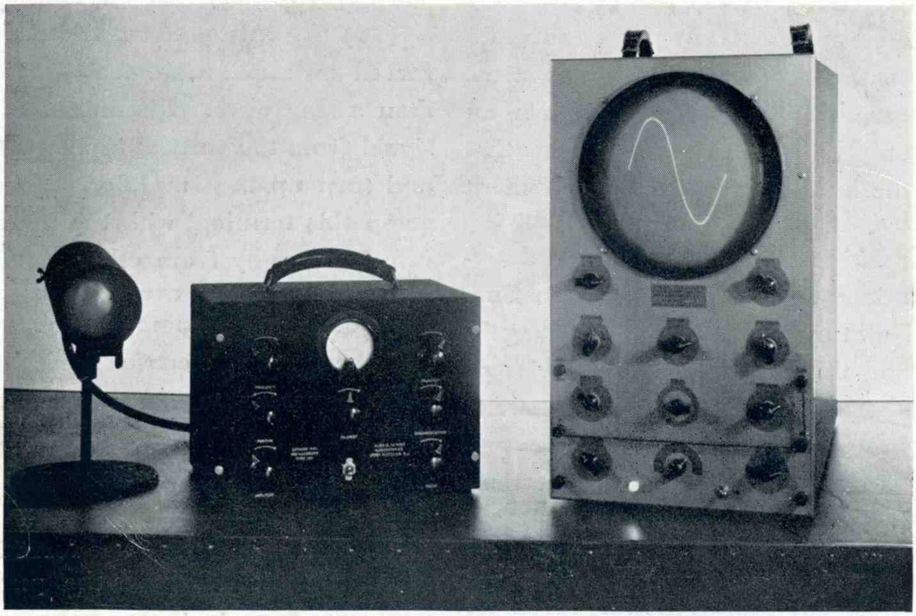

SEVEN YEARS OF PROGRESS IN OSCILLOGRAPH DESIGN

THE difference in appearance between the Du Mont old type 130 and the new type 158 pictured above truly represents seven years of experience in building quality cathode ray oscillographs.

At the time the type 130 was introduced to the engineering world it was the best portable three inch oscillograph available. Since that time Du Mont Oscillographs have been able to maintain this distinction of quality and have lead the field through the wide acceptance received among the leading laboratories, colleges and industrials all over the world.

Du Mont Laboratories has a distinct advantage when confronted with the various problems of cathode ray tube and oscillograph design due to the fact that its organization is of moderate size and therefore more flexible and efficient. Every oscillograph manufactured by Du Mont is equipped with a cathode ray tube designed, engineered and manufactured by Du Mont.

Du Mont tubes and instruments are many months in the experimental laboratory. During this period they are submitted to the most severe tests and not until the Du Mont life test has proven the product to the satisfaction of the Du Mont engineering staff, is a tube or instrument allowed to leave the laboratory.

There is no substitute for Du Mont care and efficiency of design, quality workmanship and material and the experience of seven years of specialization in a comparatively new yet rapidly growing industry.

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