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OSCILLOGRAPHER

PRODUCTION TEST OF IGNITION COILS
with the
CATHODE-RAY OSCILLOGRAPH

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THE manufacture of induction coils for ignition purposes is a field which has been covered intensively for more than fifty years. It is most likely, then, that any major improvements will be made only as a result of careful investigation of the characteristics of existing coils rather than by any empirical methods. To achieve better performance it is often necessary to make several modifications at one time, no one of which, perhaps, is of great value when considered alone, but all cumulatively showing a considerable improvement. The operating range and the flexibility of the cathode-ray oscillograph make it a highly versatile tool for such observations.

The use of the cathode-ray oscillograph offers many advantages over earlier methods which were employed for production testing of large numbers of ignition coils. These methods consisted essentially of the use of a calibrated spark gap which was affected by several factors, namely, (1) pressure, temperature, and humidity of the surrounding atmosphere; (2) size, shape, and symmetry of the discharge electrodes; (3) the condition of the primary breaker points, the speed of the break, and (4) the power input to the primary of the coil.

The Type 168 Cathode-Ray Oscillograph has been employed to check the output of such coils and effectively eliminates the error due to the first two of the above-mentioned groups, while it provides an excellent means of checking the last two.

In Figure 1 is shown the application of the Type 168 instrument to the production testing of the output voltage of the induction coil. It will be noted that there is no actual discharge, so that the effects of atmospheric temperature, pressure, humidity, and the design of the electrodes are eliminated. The output of the coil is readily clipped into the circuit, and the polarity and peak voltage are quickly read from a calibrated scale mounted over the face of the cathode-ray tube. In Figure 2 is shown a typical highly-damped secondary waveform obtained from an ignition coil by this method. If a spark gap be connected in parallel with the coil, the oscillograph may be employed to indicate the voltage necessary to jump the gap. Also, when no safety gap is provided, this same connection may be used to serve as a maximum insulation test for the coil.

While the above method is highly desirable for production testing of such coils because of its simplicity, it is subject to a certain amount of error because of the frequency-response limitations of an oscillograph amplifier and because of the type of voltage divider employed. When an accurate waveshape plot is desired, it is necessary to use a resistance-capacity compensated voltage divider and to deflect the cathode-ray tube directly as shown in Figure 3.

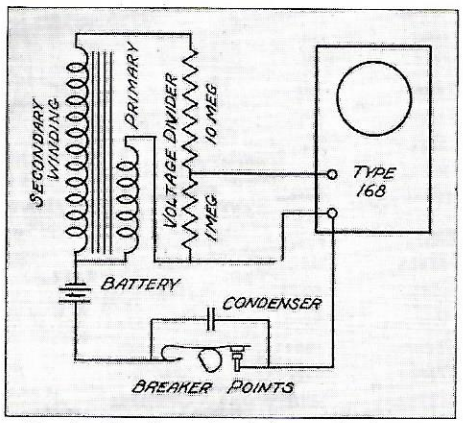


Fig. 1. Circuit employed for production test of ignition coils.

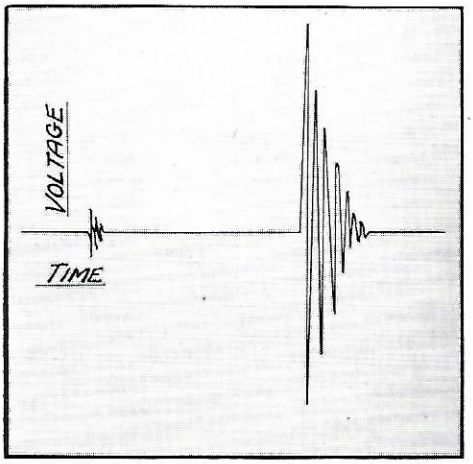


Fig. 2. Typical secondary waveform obtained from method of connection shown in Fig. 1.

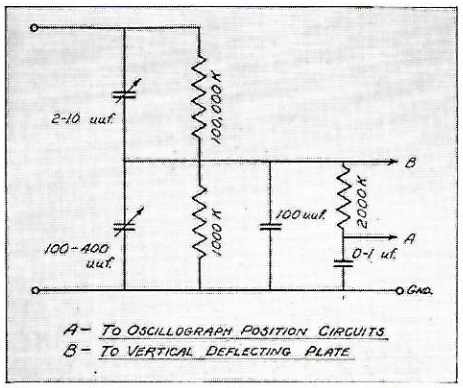


Fig. 3. Resistance-capacitance voltage divider for study of secondary waveform. K = thousand ohms.

This type of voltage divider eliminates the errors due to stray circuit capacities, and it attenuates the high-frequency components as well as the low-frequency components of the signal in equal proportion for indication on the cathode-ray tube. The elimination of the deflection amplifiers eliminates all frequency discrimination of the indicating circuit since the cathode-ray tube is free from all such effects at frequencies below 100 megacycles.*

The values for the voltage divider indicated in Figure 3 are indicative of representative values which are usually required. In practice the ratio of the two arms of the divider will depend upon the input voltage available and upon the voltage necessary for approximately full-scale deflection of the cathode-ray oscillograph which is being used. The divider shown here has an attenuation ratio of approximately 50 to 1. It is designed for an input voltage maximum of 30,000 with a deflecting potential output of approximately 600 volts.

For investigation of the primary current of the induction coil, the drop across a short length of lead wire may be fed into the amplifiers of the cathode-ray oscillograph. In Figure 4, the primary current may be seen increasing logarithmically from the "make" at point A to the saturation point, B. The break occurs at point C and the oscillatory discharge is indicated from C to D

By adjustment of the horizontal gain control, which determines the amplitude of the sweep-circuit deflection, the base line may be adjusted until it covers exactly thirty-six divisions on the calibrated scale

** This figure of 100 megacycles is variable, depending upon a number of factors, but it is representative of the limit which is obtained with present-day commercial cathode-ray oscillographs.*

over the face of the cathode-ray tube. This method of operation then permits direct readings of cam angle, indicating the time during which the breaker points are closed, the time of saturation, and the timing of the internal combustion engine. Although the sweep-frequency control markings do not amount to a frequency calibration of this circuit, they will give a fairly accurate indication of the engine speed. Weak spring tension, or resilience in the contact support arms is indicated by a flutter when closing as indicated at point A, Figure 4.

At low engine speeds, the primary current will reach saturation as shown at B in Figure 4. At higher engine speeds the break may occur previous to saturation and poor ignition will result. The oscillatory discharge shown from C to D in Figure 4 will assume the form shown in Figure 5 when there is a defective condenser connected across the breaker points.

Figure 6 is an indication of the method used for locating the keyway for a new magneto. A reference line, A, is supplied by the discharge from an auxiliary induction coil. Since the location of this reference line is known from the space phase of the breaker points, the location of the keyway is determined from the location of the maximum output point of the magneto as indicated with reference to the discharge of the induction coil on the cathode-ray oscillograph.

The use of the cathode-ray oscillograph in the production testing of ignition coils has effectively eliminated many errors present in previous methods. The simplicity of the test allows for its being carried on by personnel who have had very little experience, and it may be accomplished at production speeds with equipment involving a minimum investment.

The editor wishes to express his appreciation to Mr. C. Toben of the Nathan R. Smith Manufacturing Company for his kind preparation of the above article. Our experience indicates that there has been much interest in this application of the cathode-ray oscillograph; and this organization has consented to disclose their method of operation for the benefit of our subscribers.

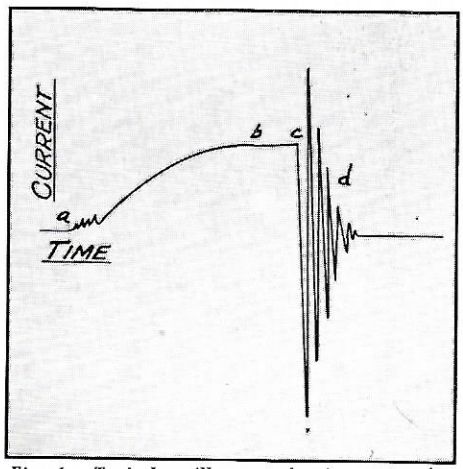


Fig. 4. Typical oscillogram of primary waveform of ignition coil.

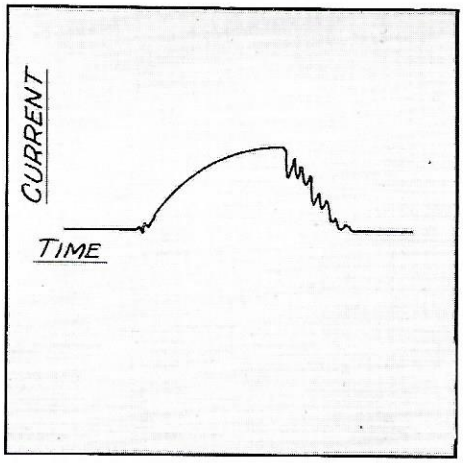


Fig. 5. Type of discharge obtained when a defective condenser is connected across the breaker points.

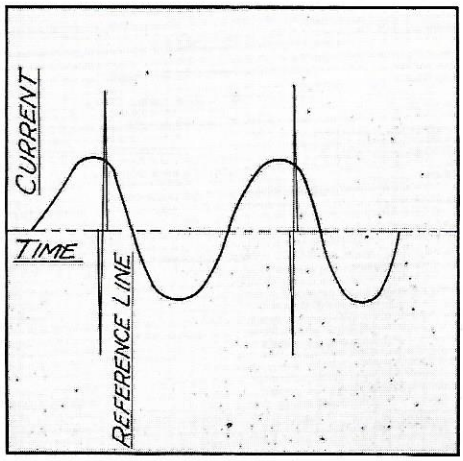
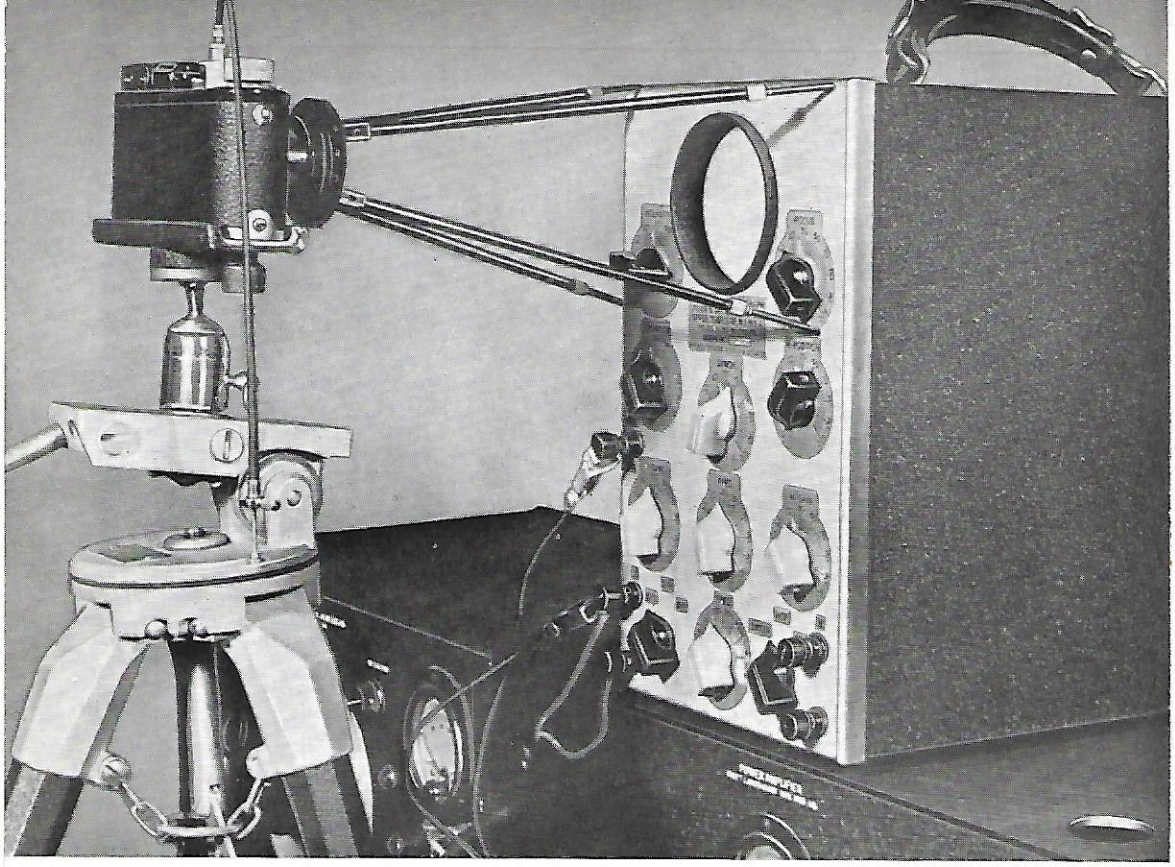


Fig. 6. Method employed for location of keyway in a new magneto.



The cathode-ray oscillograph may be simply employed for making permanent records with ordinary commercial photographic equipment. Photograph Courtesy Paul H. Donaldson, Cruft Laboratory, Harvard University, and "Leica Photography"

ENGINEERING reports are seldom complete without illustrations showing, graphically, the exact relationships of the phenomena under discussion. In like manner specifications are often best established by a line representation properly defining certain desired characteristics of the equipment.

The cathode-ray oscillograph, in addition to its ready adaptability to routine investigation, is often useful in illustrating such reports and specifications because of its ability to show the exact relationships of various phenomena. Since it lends itself so readily to photographic recording, the tedious preparation of such drawings is often eliminated by the use of ordinary commercial photographic equipment.

In the photograph above, a standard Leica camera is illustrated with a Du Mont Type 164 Cathode-Ray Oscillograph as exemplary of the type of commercial equipment which may be used for this type of recording. Depending upon the phenomenon to be recorded, inexpensive cameras with slow lenses and simple shutter equipment, or cameras equipped with extremely fast lenses and sensitive emulsions may be required. The writing rate of the phenomenon and the type of cathode-ray oscillograph employed are the main determining factors in the selection of photographic equipment.

Du Mont cathode-ray oscillographs have become widely accepted as a standard method for many engineering studies because of their dependability and uniformity. We shall be pleased to cooperate with you in regard to the application of cathode-ray equipment to your particular problem.

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