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AEROSPACE RECOMMENDED PRACTICE

ARP 846

LOW TENSION SPARK IGNITER SPARKING VOLTAGE TEST

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Revised

1. **PURPOSE** - The purpose of these specifications is to provide a standard procedure and standard equipment for the evaluation of a measurement of the ionization voltage (sparking voltage) of shunted surface gap spark igniter designs.
2. **SCOPE** - These specifications contain general information pertaining to the sparking voltage parameter of shunted surface gap spark igniters; test equipment circuitry; bill of materials for test equipment; test equipment operation.
3. **GENERAL CONSIDERATIONS CONCERNING SPARKING VOLTAGE MEASUREMENTS AS A SHUNTED SURFACE SPARK IGNITER PARAMETER**
 - 3.1 **Spark Igniter Configuration** - The low tension type of spark igniter utilizes a material classified as a semi-conductor to bridge the gap from the center electrode to the outer or ground shell. Thus, this design is referred to as the shunted surface gap spark igniter as well as the low tension spark igniter. When the shunted surface material is in good condition and in intimate contact with the electrodes, the spark igniter gap can be forced to break down (ionize gases between electrodes) at a lower voltage than would occur if the shunt were removed. The voltage required to break down the gap increases with deterioration of the shunted gap material and the deterioration of the material's contact with the igniter electrodes.
 - 3.2 **Sparking Voltage** - By definition, the sparking voltage of a particular shunted surface gap spark igniter design is the lowest voltage applied to an igniter which will initiate a spark. The term "initiate" is used since the maintenance of the sparking conditions and energy dissipation is a function of the igniter gap itself and the applied voltage. Sparking voltages may be used as a measure of the condition of shunted surfaces and of contact conditions between electrodes and surface. It is also conceivable that sparking voltages may be used as an indicator of life expectancy of new and used spark igniters providing that all use-conditions are taken into account.
 - 3.3 **New Spark Igniter Limit** - It has been established that for new spark igniters the sparking voltage should be less than 1000 volts under room conditions. This test value assures that the spark igniter life will be a function of engine environment and use and that the unit has been properly assembled. It must be noted here that sparking voltages of a very low magnitude (below 200 volts) may indicate abnormal semi-conductor material conditions. Consideration should therefore be given to establishing a minimum as well as a maximum sparking voltage for a given igniter design.
4. **TEST EQUIPMENT FOR MEASURING LOW TENSION SPARK IGNITER SPARKING VOLTAGES**
 - 4.1 **General Test Procedure**

Section 8.3 of the SAE Technical Board rules provides that: "All technical reports, including standards approved and practices recommended, are advisory only. Their use by anyone engaged in industry or trade is entirely voluntary. There is no agreement to adhere to any SAE standard or recommended practice, and no commitment to conform to or be guided by any technical report. In formulating and approving technical reports, the Board and its Committees will not investigate or consider patents which may apply to the subject matter. Prospective users of the report are responsible for protecting themselves against infringement of patents."

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- 4.1.1 New Spark Igniters - A new spark igniter, when connected to a power source consisting of a previously charged 0.5 microfarad capacitor at 1000 volts maximum, shall produce a readily visible spark between the two metal electrodes. It is recommended that a minimum of five (5) successive sparks be used to establish compliance to the maximum voltage requirements.
- 4.1.2 Old Spark Igniters - The test equipment must be capable of applying voltages adjusted between 1000 volts (for new spark igniters) and 5000 volts. The test operator shall use his experience to determine the voltage level that the 0.5 microfarad capacitor is to be charged to for the test. Repetitive tests parallel to that for new spark igniters may be used to determine the actual sparking voltage or the test may be confined to determining if the sparking voltage is less than a specified limit.

4.2 Test Equipment

- 4.2.1 General - The output characteristics of the spark igniter tester shall be such, that when it imposes a positive pulse across a 0.3 ohm resistor (inductance rating 0.35 to 0.375 microhenry at 10 kc) from a 0.5 microfarad capacitor charged to 2000 v, the voltage rise across the resistor shall exceed 200 v within a time period of 1.5 microseconds. (Reference: Tektronic Scope No. 531 or equivalent may be used to measure the voltage rise or if the voltage rise is too high for this equipment a Tektronic High Voltage Probe No. P6002, Part Number 010-024 or equivalent may be used.)

NOTE: A negative pulse may be used instead of a positive pulse; however, one polarity must be chosen, as it is felt that difference may exist and an igniter measured as satisfactory on one may be unsatisfactory on the other.

The test equipment circuit described in this document is one of many possible circuit designs which would satisfy the above requirements.

- 4.2.2 Circuit Description - The test equipment designed to accomplish the general test functions has three major circuit elements: input circuit, power circuit and oscillator circuit. These circuit elements are connected to charge and/or discharge a 0.5 microfarad capacitor to voltage levels from 0 to 5000 v d-c at a discharge rate of approximately two (2) sparks per second. The detailed circuit schematic is shown in Figure 1.

The tester consists of a main housing which contains the circuitry shown on the schematic diagram and an adapter box which provides for enclosure of the test piece. S-3 is an interlock switch that is incorporated in the cover of the main housing and S-4, also an interlock switch, is mounted in the enclosure for the test piece. The cover of both the tester and adapter box has to be closed in order to energize the high voltage supply located in the tester.

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The front panel of the tester contains two toggle switches (S-1, S-2), two pilot lamps (DS-1, DS-2), a variac for voltage adjustment (T-1), a calibrated voltmeter (M-1), and selector switch (S-6) for full scale meter readings of 2.5 and 5.0 kilovolts. The push button switch (S-5) when depressed, will cause M-1 to indicate the voltage that the tank capacitor C-1 is charged to.

4.2.3 Detailed Circuit Description

- 4.2.3.1 Input Circuit - When S-1 is closed, voltage is applied to DS-1, the primary of T-4 and the filaments of K1, V-1, V-2 and V-3. DS-1 will light and d-c voltage will exist on C-2 and C-3 of the d-c power supply circuit. The time delay relay K-1 will close in approximately 60 seconds.

S-2 and S-3 are mechanical interlocks with the lid of the tester and the lid of the adapter box respectively. With both lids closed, S-2 may be closed applying power to DS-2 and the coil of K-2. Thus, the variac T-1 is energized, the charging circuit is energized and the charge readout meter interlock circuit is armed. T-1 determines the voltage to be applied to T-2 and thus determines the charge voltage on the tank capacitor C-1.

- 4.2.3.2 Power Circuit - The power circuit consists mainly of T-1, T-2, V-1, R-1, C-1 and is such that C-1 will charge to a peak value within 0.2 seconds. This assures that the tank capacitor (C-1) will always be charged to the peak value at the time that the igniter is connected to the test circuit.

When S-5 of the meter interlock circuit is depressed, K-4 will energize and K-6 will de-energize. K-4 will connect the meter M-1 across C-1 and K-6 will short C-4 removing the B+ from V-3. V-3 will cease to oscillate and M-1 will indicate the voltage across C-1 allowing the voltage across the tank capacitor (C-1) to be adjusted. When S-5 is released, the meter is removed from the circuit and the oscillator circuit will start to function. The pre-set voltage will then be impressed on the spark igniter connected at the output terminals at a rate of approximately two times a second.

Switch S-4 is located in the adapter box containing the spark igniter under test. When the cover of the adapter box is opened, S-4 would be in a normally open position de-energizing K-2. This in turn would remove the high voltage from C-1, and K-3 would de-energize shorting C-1 through R-2 and R-3. Thus, the high voltage is removed from the spark igniter to provide for operator protection.

- 4.2.3.3 Oscillator Circuit - The oscillator determines the firing rate of the test circuit by momentarily energizing K-5 and thus connecting the test spark igniter to the test circuitry. The oscillator circuit consists of a power supply containing T-4, V-2, R-6, R-7, C-2 and C-3 and a grid bias circuit element containing CR-1, R-12,