PART 1 : SECTION 2

CHAPTER 2

IGNITION SYSTEMS

Purpose

1. The aircraft engine ignition system is required to provide a rapid series of sparks of an intensity sufficient to ignite the weakest fuel/air mixtures normally used, correctly timed in relation to each compression stroke, and arranged to fire each cylinder in the desired sequence.

Implementation

2. The sparks take place between the points of sparking plugs screwed into the cylinder heads. Of the two points, one is attached to the body of the plug and so is in metallic contact with the mass of the engine ; hence it is usually referred to as being earthed. The second point is insulated from the body of the plug by a mica or ceramic insulator designed to withstand the high temperatures and voltages to which it is exposed.

3. The plug points are usually set to a gap of about ·012 inch to ·015 inch, and the voltage necessary to make the spark jump this gap varies from about 5,000 to 12,000, depending on the setting of the plug gap, the engine compression ratio, location of the plug in the head, timing (the point in the compression stroke at which the spark is arranged to occur), and other factors. Current is fed to the sparking plugs through heavily rubber-insulated high tension (high voltage) wires from the source of supply—a magneto.

Magneto

4. The magneto is a special type of electric generator driven by the engine. It is designed to supply a desired high-voltage current to the plugs in the sequence, and at the precise time in the compression stroke. It is independent of the aircraft battery or electrical system and, like all electric generators, works on the principle that a current will be caused to flow in any closed conductor, such as a coil of wire, when passed between the poles of a magnet, and so *cutting* the lines of magnetic force (see Fig. 1).

5. In the magneto a coil of wire is rotated between the poles of a fixed permanent magnet, or, as in later-type magnetos, a permanent magnet (or soft-iron polar inductor which picks up magnetism from a fixed permanent magnet) is rotated within the gap in a soft-iron U-shaped ring. The coil of wire is wound upon this ring and forms the primary winding (see Fig. 2). The voltage generated in this winding is too low for the requirements, and so, to increase it, a second coil—the secondary winding—having many more turns than the primary, is also wound upon the "U" ring. When the current flowing in the primary winding is suddenly interrupted, a very high voltage is immediately induced in the secondary winding.

6. Interruption of the primary current is effected by a contact breaker driven from the main driving spindle carrying the rotating magnet or polar inductor. This contact breaker consists of a fixed point which is earthed, and an insulated spring-loaded point to which one end of the primary winding is connected. These points are normally in contact and complete the circuit through the primary winding. A cam, driven from the main spindle, is arranged so as to force these contacts apart as it rotates, thus interrupting the flow of current in the primary winding, and inducing a high voltage in the secondary winding at the instant a spark at the plug points is required. Pitting of the contact points or the presence of dirt on them reduces the primary voltage, and so the induced secondary voltage when the circuit is broken. For this reason the points must be kept clean and in proper adjustment. To ensure that the secondary high-tension

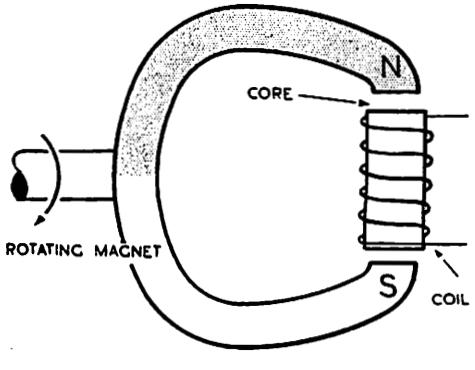

Fig. 1. Simple Generator.

voltage builds up to its full strength instantaneously, it is necessary to make certain that the primary circuit is broken cleanly by preventing arcing or sparking across the breaker contact points as they separate. This is achieved by fitting a condenser in parallel with (across) the points.

7. While piston speed varies with r.p.m., the rate of flame propagation through the compressed mixture in the combustion chamber remains substantially constant, and to ensure that the maximum combustion pressure develops at the correct stage in the power stroke at all r.p.m., it is necessary on some engines to provide means of varying the instant in the cycle at which the spark at the plug point occurs. This is done by varying the point at which the contact breaker points open, either automatically by means of a small governor, or, in some installations, mechanically by interconnection with the throttle control.

8. To put the ignition system out of action, the end of the primary winding connected to the insulated point of the contact breaker is earthed, so that the primary circuit cannot be broken by the opening of the points; a high voltagy, therefore, cannot be induced in the secondare winding, and no spark can occur at the plug points.

9. From the secondary winding of the magneto, current is led to the centre brush (the rotor) of the distributor. This rotor is fixed to a spindle either integral with or geared to the main magneto spindle, and as it rotates it comes opposite to (but does not actually make contact with) each of a number of segments in turn. These segments, which are insulated from each other and from the body of the magneto, are connected one to each of the plug leads. As the contact breaker opens, the secondary current jumps, as a spark, from the rotor to the segment opposite to it, and so to the appropriate plug.

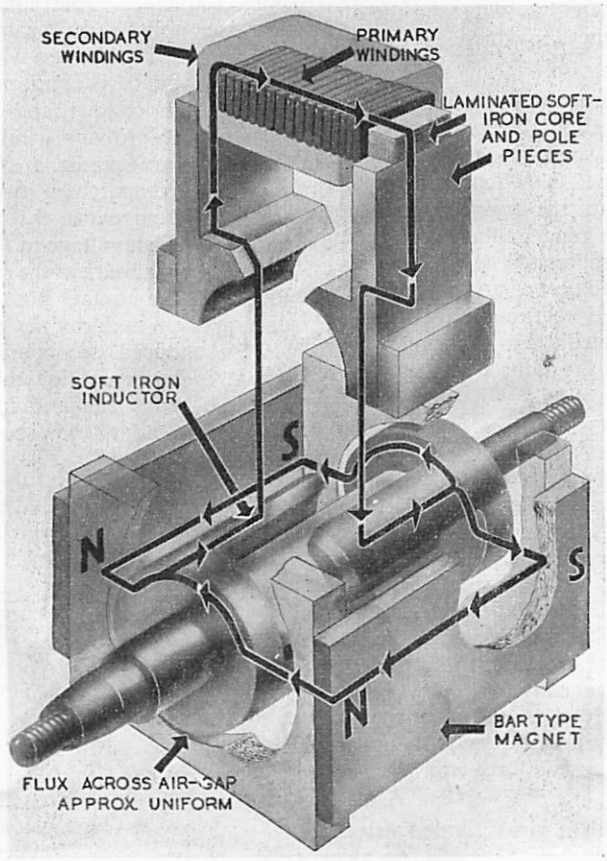

Fig. 2. Polar Inductor Magneto.

Impulse Starter

10. When the engine is being started, the magneto rotates too slowly to generate a high enough voltage to give a sufficiently intense spark at the plug points to ensure ignition of the charge. In some magnetos this is overcome by incorporating an impulse starter. Essentially this consists of a spring-loaded clutch device between the drive from the engine and the magneto spindle, which is thus flicked round in jerks, so momentarily increasing the rate of rotation and the voltage generated. As soon as the r.p.m. increase, the clutch goes "solid". On later types of magnetos a similar effect is produced by means of a booster coil.

H.T. Booster Coil

11. Booster coils are of two main types. The first, the high-tension type, consists of an entirely separate induction coil, with its primary winding energized from the aircraft (or ground starter) battery when the circuit is made by pressing the booster-coil push button, or in some cases the main engine starter push button. The trembler type interrupter on the coil then ensures a high-tension output from the secondary winding; this output, being fed into a separate brush on the magneto distributor rotor, causes a stream of sparks to occur at the points of each sparking plug in turn, as the brush rotates past the segments of the distributor.

L.T. Booster Coil

12. In the second type—the low-tension booster coil—current is fed from the aircraft electrical system, when the booster-coil (or starter) push button is pressed, to the primary winding of the magneto itself. The voltage generated by the magneto is thus augmented at low r.p.m.

13. Any electrical machine emitting sparks, or conductor carrying a fluctuating high-tension current, acts to some extent as a radio transmitter. The metal case of the magneto, however, being earthed, prevents any radio frequency impulses generated within it, reaching and interfering with the radio equipment on the aircraft. For the same reason, and also to protect the rubber insulation from mechanical damage, the high-tension wires from the magneto to the plugs are covered by earthed metallic sheathing.

14. The magneto casing is provided with ventilation holes to allow ionization products to disperse, these holes being protected by flame traps to prevent sparks in the distributor starting a fire by igniting fuel vapour outside the magneto.

15. To guard against engine failure due to a defect in the ignition system, two entirely independent magnetos, with two sets of sparking plugs and connecting leads, are fitted to each engine. The provision of two sparking plugs in each cylinder also ensures more efficient ignition of the charge, and it is for this reason that a small drop in r.p.m. occurs when one magneto is switched off to test the ignition.

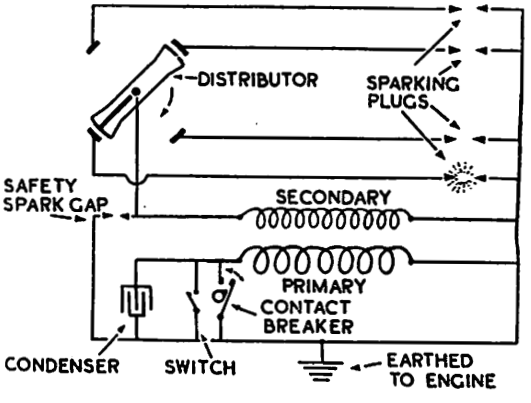

Fig. 3. Ignition System—Circuit Diagram.