Oct. 8, 1940. E. B. NOWOSIELSKI 2,217,232

IGNITION APPARATUS

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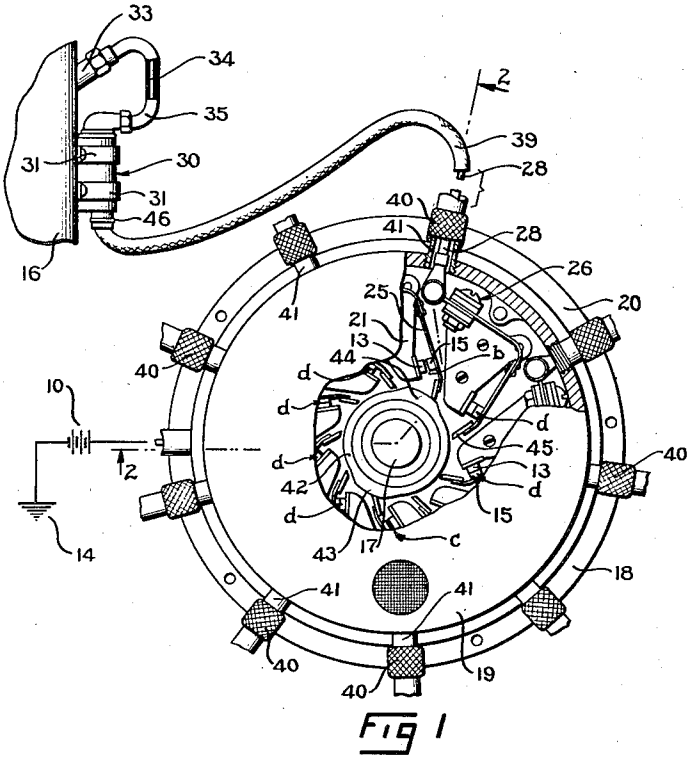


Fig 1

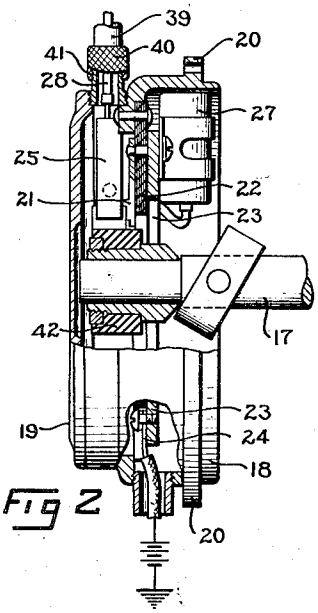


Fig 2

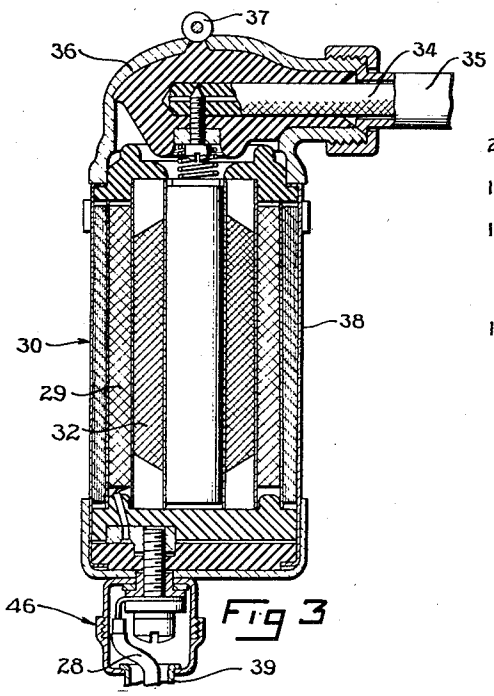


Fig 3

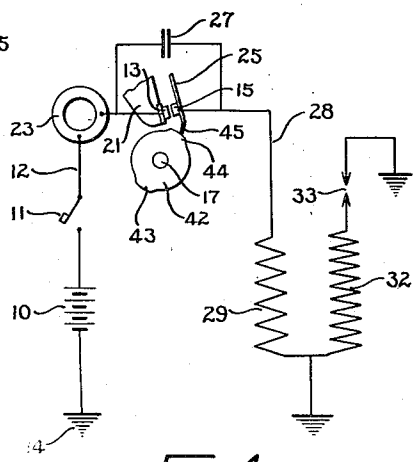


Fig 4

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IGNITION APPARATUS

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4 Claims. (Cl. 123—148)

This invention relates to internal combustion engines and more particularly to the ignition distribution system thereof.

The ignition systems in substantially all, if not all, aircraft engines at the present time comprise a magneto which supplies low tension current to the primary winding of an induction coil, the secondary winding of which is connected to a movable distributor terminal. From the distributor the high tension current from said secondary winding is directed in a predetermined sequence through a plurality of conductors connected to the engine spark plugs. In systems of this character much difficulty has been experienced, particularly in engines having a large number of cylinders and at high altitudes, in preventing flash-overs in the distributor unless the latter is made relatively large, heavy and cumbersome. Furthermore, it becomes necessary, in order to avoid radio interference, to metallically shield the distributor and the long high tension conductors between the distributor and spark plugs, thereby increasing the weight and introducing capacity and corona losses which decrease the intensity of the sparks and efficiency of the engine. Another difficulty which is inherent in systems of the above character resides in the fact that a single circuit breaker is employed for effecting the necessary interruptions in the primary circuit of the induction coil. In modern high-speed multiple-cylinder engines the large number and rapidity of these interruptions often over taxes the breaker mechanism, as well as the induction coil.

It is accordingly one of the objects of the present invention to provide a novel ignition distribution system wherein the foregoing difficulties are overcome.

Ignition systems have been heretofore proposed wherein a separate circuit including a cam operated breaker and an induction coil is provided for each individual plug. These prior systems have not, however, been suitable for high speed engines. It is accordingly another object of the invention to provide a novel ignition distribution system of the above character which is adapted for use on a high speed engine having a large number of cylinders, such as 14 and 18 cylinder double-row radial engines, for example.

Still another object is to provide a novel battery ignition system for internal combustion engines for use in high speed engines wherein ample time is insured for adequate building up of the current in the primary winding of the induction coils.

A further object is to provide a novel radio shielded low tension distribution system for high speed engines.

The above and further objects and novel features of the invention will more fully appear from the following detailed description when the same is read in connection with the accompanying drawing. It is to be expressly understood, however, that the drawing is for the purpose of illustration only and are not intended as a definition of the limits of the invention, reference being primarily had for this latter purpose to the appended claims.

In the drawing wherein like reference characters refer to like parts throughout the several views:

Fig. 1 is a diagrammatic front elevation partly in section and with parts broken away illustrating one form of apparatus embodying the invention;

Fig. 2 is a side elevation, partly in section and with parts broken away, of the breaker mechanism shown in Fig. 1, the section being taken substantially along line 2—2 of Fig. 1;

Fig. 3 is a sectional view on an enlarged scale of one form of shielded induction coil which may be used in carrying out the invention; and,

Fig. 4 is a wiring diagram showing a portion of the distribution system of Fig. 1.

A single embodiment of the present invention is illustrated in the accompanying drawing, by way of example, in the form of a radio-shielded ignition distribution system adapted for use on a nine cylinder high speed radial aircraft engine. In the form shown the source of low tension electrical energy is constituted by a battery 10, one terminal of which is connected through an ignition switch 11 and conductor 12 to the stationary contacts 13 of each of a plurality of circuit breakers and the other terminal of which is connected to ground at 14. The current to each spark plug of the engine is controlled by one of said breakers, and an independent circuit, including an induction coil mounted on the engine cylinder near the spark plug, is provided between each plug and the corresponding breaker points.

Referring more particularly to Figs. 1 and 2, the form of breaker mechanism illustrated comprises a pair of separable contacts 13, 15 for each cylinder 16 of an engine which is only partially shown. Nine pair of breaker contacts, one pair for each cylinder, are shown circularly arranged in a single plane around a cam shaft 17 which projects into a two-part housing 18, 19 and is rotatably mounted to be driven by the engine crank shaft in any suitable manner well-known in the art. Housing 18, 19 may be secured to the engine cas-

ing by means of radially projecting ears 20. Stationary contacts 13 are mounted on suitable brackets 21 which are preferably adjustably carried by an annular insulating plate 22 which is in turn fixedly secured in housing member 18. Mounted on the opposite side of plate 22 and electrically connected to brackets 21 is a conductor ring 23 which is connected at 24 to one terminal of battery 10 by means of lead 12. Movable contacts 15 are preferably carried by suitable spring arms 25 which are mounted on and electrically insulated from brackets 21 at 26. Arms 25 may serve as current conducting means, as well as means for normally holding movable contact points 15 in engagement with fixed contact points 13. Also mounted in casing 18 are a plurality of small condensers 27, one of the latter being connected across each pair of contacts 13, 15, as best seen in Fig. 4.

The fixed end of each contact arm 25 is connected by a suitable insulated conductor 28 to the primary winding 29 of a small induction coil 30 which may be secured, as by means of brackets 31, to engine cylinder 16 near a spark plug 33 extending into said cylinder. The secondary winding 32 of each of the coils 30 may be electrically connected to the central electrode of its associated spark plug 33 by a relatively short high tension conductor 34.

Preferably both the high and low tension portions of the above-described current distribution system are shielded to prevent interference with radio reception by electrical and magnetic radiations from the live conductors. For this purpose, shielded spark plugs of the general character shown in the copending application of Roy T. Hurley, Serial No. 102,298, filed September 24, 1936, may be employed and the high tension secondary conductors 34 may be enclosed in flexible metallic conduits 35 detachably connected to the spark plugs at one end in any well-known manner and at the other end to a shielding cap 36 of known construction that is removably secured by means of a bale 37 to a metallic casing 38 surrounding each induction coil 30. Although it is not essential that the primary or low tension conductors be radio shielded, the same may be provided with shielding conduits 39 which are detachably connected by means of nuts 40 to nipples 41 threaded into spaced openings around the periphery of casing 18. It will thus be seen that the necessary shielding in the distribution system of the present invention is materially less than in distribution systems now in common use.

Means are provided for controlling the opening and closing of the pairs of contact points 13, 15 in a novel manner to thereby insure a sufficient build up of current in the primary winding 29 of each induction coil 30 before the circuit containing the same is broken in order that a good spark at the spark plug will be assured. In the form shown said means includes a cam 42 on shaft 17, the two lobes 43 and 44 of which are adapted to engage followers 45 mounted on the free ends of spring arms 25. The annular extent of lobes 43 and 44 is proportioned, in accordance with the spacing of the pairs of contacts 13, 15 so that the flow of electrical current to the primary windings of coils 30, which are to be successively energized, will overlap, so to speak, i. e., so that while a spark is occurring in one cylinder, current will be flowing from battery 10 to one or more of the coils 30 associated with cylinders to be subsequently fired. Each pair of contacts is permitted to close for an appreciable interval prior to the opening thereof by cam 42, said interval being greater than the time between successive sparks in the various cylinders and sufficiently long to permit an adequate build-up of current in the induction coils to insure a good spark at plug 33 when the primary circuit is broken.

This, in the illustrated embodiment (Fig. 1) contacts 13, 15 at *a* are about to be opened, the contacts at *b* are being held in open position by the lobes of cam 42, the contacts at *c* are about to be permitted to close and the contacts at *d* are in closed position for conducting uni-directional currents from battery 10 to the respective induction coils associated therewith. Accordingly, when the spark plug in one cylinder is caused to fire by the opening of the contacts at *a*, for example, current is building up in the primary windings of the coils connected to the closed breakers at *d*. The importance of this novel mode of operation will be more readily understood when it is realized that some modern aircraft engines rotate at speeds as high as several thousand revolutions per minute and have as many as 14 or 18 cylinders. It will be apparent that in such engines the time interval between sparks even in a given cylinder is quite short and that the interval between sparks in the cylinders which are successively fired is extremely short. Accordingly, unless a system of the character above-described is employed in modern high speed engines having large numbers of cylinders the spark intensity may be insufficient to properly ignite the highly compressed combustible charges in the engine cylinders and thus cause inefficient operation and perhaps complete failure.

If desired all of the low tension conductors may emerge from housing 18, 19 through a common opening and extend through a manifold shielding conduit to a manifold shielding ring secured to the engine and partially encircling the propeller shaft in a manner well-known in the art. Coils 30 may be secured directly to the manifold ring in the same manner in which said coils are secured to the shielding caps 46 (Fig. 3) or shielding conduits corresponding to leads 39 may be interposed between the coils and the manifold ring. The latter may be in two parts with a cover secured to the body portion by means of through bolts or the like.

There is thus provided a novel ignition distribution system adapted for use in both high and low speed multiple cylinder engines wherein the necessity for a distributor and extensive radio shielding is obviated and wherein large losses due to capacity and corona effects are accordingly eliminated. The novel system provided by the present invention also eliminates the usual difficulties encountered in present ignition systems at high altitudes. The present invention also comprehends a novel mode of operation in a low tension ignition distribution system for internal combustion engines.

Although only one embodiment of the invention has been illustrated and described in detail, it is to be expressly understood that the same is not limited thereto. For example, it will be apparent that the pairs of breaker points 13, 15 may be arranged in line instead of circularly and operated by a plurality of cams axially disposed along a cam shaft. It will also be apparent that the lobes of the breaker operating cam or cams might be caused to function to operatively hold normally disengaged breaker contacts in engagement. Various other changes may also be made particularly in the design and arrangement of

parts illustrated as will now be apparent to those skilled in the art without departing from the spirit and scope of the invention. For a definition of the limits of the invention, reference is had primarily to the appended claims.

What is claimed is:

1. In an ignition system for high speed multiple cylinder internal combustion engines, the combination of a source of uni-directional electrical current, a spark plug in each cylinder of said engine, a plurality of normally closed circuit breakers, means connecting said source to each of said circuit breakers, circuit means connecting each of said circuit breakers to a different one of said spark plugs including an induction coil mounted adjacent the spark plug, a low tension conductor connecting the breaker to the primary winding of said coil and a high tension conductor connecting the secondary winding of said coil to the spark plug, and rotatable cam means for opening said circuit breakers in a predetermined sequence, one or more of said breakers being in closed position to permit flow of current when another of said breakers is opened by said cam means.

2. In an ignition system for a multiple cylinder internal combustion engine, the combination of a source of uni-directional electrical current, a spark plug in each cylinder of said engine, an induction coil for each of said cylinders, one of said coils being mounted near each of said spark plugs, means for electrically connecting the secondary winding of each of said coils to the center electrode of the adjacent spark plug, a plurality of circuit breakers, means connecting each of said circuit breakers in circuit with the primary winding of a different one of said coils, means electrically connecting said circuit breakers to a common terminal of said source, and cam means operated by the engine for actuating said circuit breakers to simultaneously connect a plurality of said coils in circuit with said source and to open said circuits one at a time in a predetermined sequence.

3. In an ignition system for a multiple cylinder internal combustion engine, the combination of a source of uni-directional electrical current, a spark plug in each cylinder of said engine, a plurality of circuit breakers each including a pair of points, means for normally holding the points of each of said circuit breakers in yielding engagement, separate circuit means connecting each of said spark plugs in circuit with a different one of said circuit breakers, each of said circuit means including an induction coil mounted near the spark plug connected therewith, and cam means operated by said engine for opening said circuit breakers in a predetermined sequence and permitting the same to close, the period during which each circuit breaker is in closed position being greater for a given engine speed than the interval between the opening of two successively operated circuit breakers.

4. In an ignition system for a multiple cylinder internal combustion engine, the combination of a source of electrical current, a radio shielded spark plug in each cylinder of said engine, a radio shielded induction coil mounted adjacent each of said spark plugs, a radio shielded conductor electrically connecting the secondary winding of each of said coils to the center electrode of the spark plug adjacent thereto, the shielding of said conductors being electrically connected to the shielding on the corresponding coils and spark plugs, a plurality of circuit breakers, means electrically connecting the primary winding of each of said coils to a different one of said circuit breakers, means connecting said circuit breakers to a common source of electrical energy, and means for opening and closing said circuit breakers in a predetermined sequence.

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