Oct. 10, 1961 J. DE RUGERIS 3,004,115

COMMUTATOR MAKE AND BREAK DEVICE

Filed Oct. 24, 1958

FIG_1

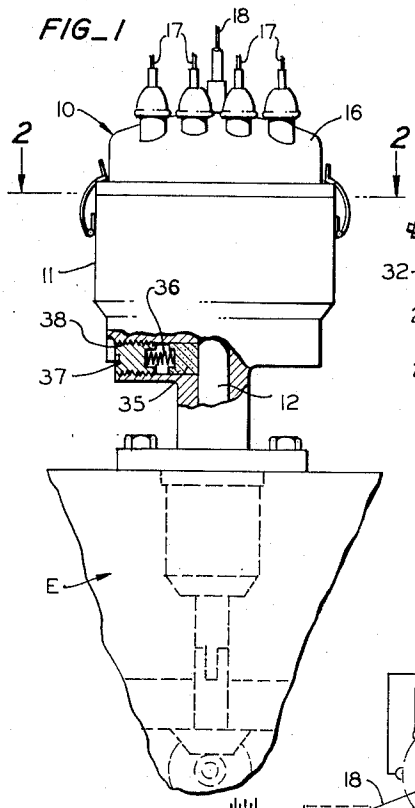



FIG_2

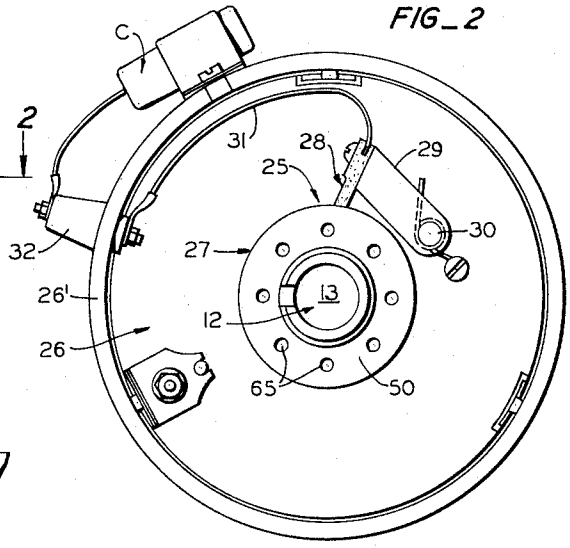
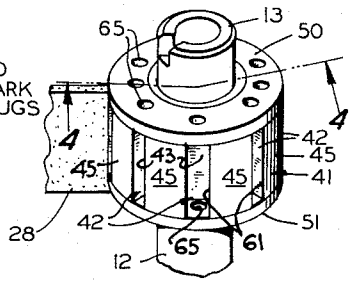



FIG_3



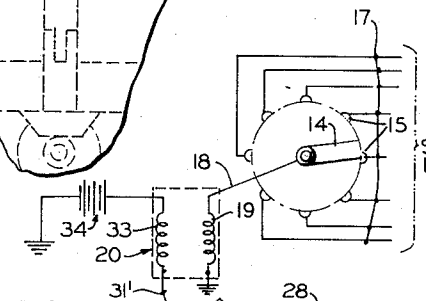




FIG_6

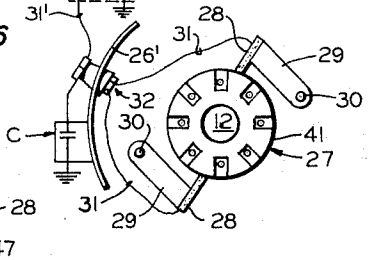



FIG_5

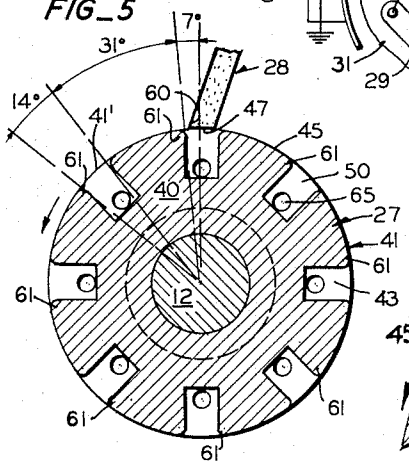
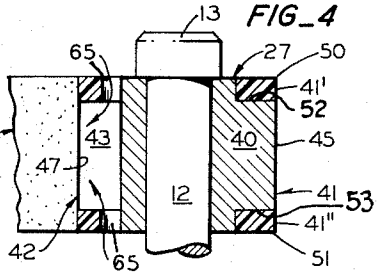



FIG_4



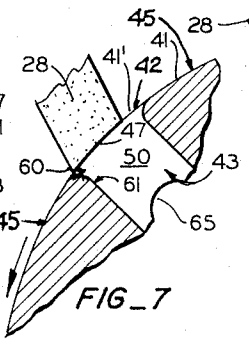




FIG_7

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United States Patent Office 3,004,115 Patented Oct. 10, 1961



3,004,115

# COMMUTATOR MAKE AND BREAK DEVICE

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Filed Oct. 24, 1958, Ser. No. 769,470
6 Claims. (Cl. 200—26)

This invention relates to improvements in ignition systems for internal combustion engines and more particularly to a uniquely different form of commutator in the make and break arrangement by which the current of the primary side of an induction coil in such systems is controlled.

The most common form of make and break arrangement in use is the point type device which consists of a pair of contact points, one on a stationary arm, the other on a movable arm normally urged toward the stationary arm and movable away from the latter by a cam on the distributor shaft which is driven in timed relation with the drive shaft of the engine. The greatest objections to the point type device are its arcing and frequent need for replacement and/or cleaning; its need for setting, i.e., proper spacing, to assure positive opening and closing; and the fact that the return spring on the movable arm must be strong enough to return it to closed condition, i.e., the point on the movable arm in contact-making position with the point on the other or stationary arm at each dwell of the cam. It is during this latter function of the point type device that the greatest deficiency is encountered. This is so even though the distributor shaft is geared down to only one-half the speed of the crank shaft of the engine. For example, assuming the crank shaft at maximum speed is turning 4000 r.p.m. with resultant 2000 r.p.m. of the distributor shaft. When it is considered that in a six cylinder engine the point type device must open and close six times during each revolution of the distributor shaft, the points must open and close 12,000 times each minute. Picture now the movable arm being hit by the cam six times each revolution or 12,000 times each minute. At that rate of operation, a fluttering usually occurs, or at least only during a minute fraction of time are the points closed to allow D.C. current to flow into the primary winding of the coil. This is a very critical aspect of the function of the ignition system in that it is only during this period, when the points are in contact with each other, that D.C. current flows into the primary side of the coil so as to build up a charge of sufficient magnitude (pressure) as to discharge an adequate impulse to the secondary winding of the coil when the points are separated. On test devices I have discovered that point type devices drop in efficiency of from 2 to 25% at maximum speeds. With this thought in mind a make and break arrangement of the commutator and brush design has been devised.

Commutator type make and break arrangements for the ignition system of internal combustion engines are shown in the patents to Callander No. 2,510,067, dated June 6, 1950; Jernigan No. 2,730,582, dated January 10, 1956; and Robertson No. 2,830,140, dated April 8, 1958. Each of these prior devices contemplates a make and break arrangement which will give a long period of current build-up to the primary winding of the coil. Robertson in particular contemplates the provision of such an arrangement in which the break is sudden so as to enable the discharge of the current from the primary winding at the peak of its charge.

Another advantage of the commutator type make and break arrangement is that no cam action is required. That is to say, the two conductive elements are relatively stationary and in constant contact with each other to avoid fluttering. In this connection it should be



understood that in the brush and commutator type structure, the make and break is effected by conductive and non-conductive areas on the periphery of the commutator. Although this structure is not basically new, the key to its success is found in a structure which entails the provision of a maximum circuit-making area or dwell and a short but positive circuit-breaking area or sudden and positive discharge phase on the commutator. This entails the use of non-conductive areas on the commutator so coordinated with the contact area on the brush as to effect a quick discharge within a minimum of time while facilitating the longest possible period of contact to effect a maximum build-up of current in the primary winding of the coil.

This application is a continuation in part of my United States application Serial No. 718,611 filed March 3, 1958. In my previous application as well as in the case of commutator and brush arrangements heretofore employed, the brush or roller, as the case might be, bore directly against the conductive areas and required solid non-conductive lands to support the brush peripherally of the commutator. Moreover, the meeting line between the trailing edge of a conductive area and a non-conductive land is a vulnerable spot for arcing due to the fact that resistance increases between the brush and trailing edge of the conductive area. This arcing causes pitting at the trailing edge of the conductive area and ultimately results in fluttering of the brush or roller over the irregular surface created by the pitting. It is therefore one object of this invention to provide a commutator in which the non-conductive zones are voids between the conductive areas. This object also contemplates the provision of non-conductive means for supporting the brush peripherally of the commutator as the voids of the latter pass the brush.

It is another object to provide a commutator body of conductive material embraced by non-conductive brush supporting tracks and having its periphery divided into a plurality of conductive lands separated by gaps. In this connection it is a further object to provide air vents in the non-conductive brush supporting tracks which vents communicate with each of the gaps to facilitate cooling of the brush and commutator arrangement.

With the foregoing structure in mind it is a still further object to provide a rotary type commutator in which the inevitable arcing which occurs as the brush, relatively speaking, leaves the trailing edge of a conductive land, will occur within the adjacent gap, that is to say, below the periphery of the commutator, and thereby minimize, if not completely eliminate the possibility of fluttering of the brush as it rides upon the periphery of the commutator when it travels at high speed.

These and other objects and advantages of the present invention will become apparent in the following description when read in the light of the drawings in which:

FIG. 1 is a side elevation of a distributor mounted on an engine block which is fragmentarily shown.

FIG. 2 is an enlarged plan view of FIG. 1 with the distributor cap thereof removed, this view being taken along line 2—2 of FIG. 1 to show a plan view of the make and break arrangement embodied in the present invention.

FIG. 3 is a perspective view of the commutator of the present invention mounted on the distributor shaft which is shown fragmentarily.

FIG. 4 is a section through FIG. 3 taken along line 4—4 thereof.

FIG. 5 is an enlarged horizontal section through the commutator embodying the principles of the present invention taken, for example, transversely of FIG. 4.

FIG. 6 is a schematic wiring diagram of an ignition system embodying the commutator of the present invention in a make and break arrangement.

FIG. 7 is an enlarged fragmentary portion of FIG. 5 to show the effect arcing has on the structure of the present invention.

The distributor 10 shown in FIG. 1 is of conventional design except insofar as it is conditioned for use with a make and break arrangement embodying the commutator of the present invention. Suffice it to say that the distributor 10 has a housing 11 through which a shaft 12 extends, which shaft 12 is drivingly connected in the customary manner to the drive or crank shaft of the internal combustion engine E so as to turn in timed relation therewith, usually at half speed with respect thereto.

The upper end 13 of shaft 12 is configurated for keyed connection to a rotor arm 14, the outer end of which makes contact with several conductive lands 15 embedded in a distributor cap 16 in conventional manner and having connection by wires 17 to the respective spark plugs (not shown) of the internal combustion engine E with which the distributor is operatively associated. The rotor arm 14 is also connected by a wire 18 to one side of the high voltage or secondary winding 19 of a coil 20, the opposite side of which is grounded to the block of the engine E.

The make and break arrangement in which the present invention is embodied is shown at 25 in FIG. 2 which depicts a chamber 26 confined within a wall 26' of the distributor housing 11 and accessible for repairs when the cap 16 is removed from the housing 11. The make and break arrangement 25 consists of a commutator 27 secured to the distributor shaft 12 for rotation therewith and a brush 28 normally urged toward the commutator for continuous surface contact therewith. The brush 28 is secured to one end of an arm 29 having its other end pivotally mounted on a stud pin 30 standing up from the floor of chamber 26 and having the usual coil spring arrangement for urging the arm 29 toward the center of the chamber 26.

The brush 28 is connected by a flexible wire 31 to the internal end of a binding post 32 extending through the wall 26' of the distributor housing 11. The opposite end of the binding post 32 is connected to a condenser C and by wires 31' to one side of the primary winding 33 of the coil 20, the opposite side of which winding 33 is connected to one terminal of the source of electrical energy 34 for the ignition system. In the present disclosure I have shown the source of electrical energy as a storage battery but it could well be a magneto if desired.

The battery 34 has its other terminal grounded to the engine block E. In accordance with the present invention the commutator 27 is also grounded to the block E so as to complete the foregoing low voltage circuit between the battery 34 and the brush and commutator. To effect grounding of the commutator 27, the ground brush 35 is embodied in the distributor housing 11 which is secured to block E as best seen at the cut away section of FIG. 1. This ground brush 35 is urged radially toward the shaft 12 by a spring 36 which is backed up a screw plug 37 threaded into a bore 38 provided in the housing 11.

It is appreciated that a commutator and brush arrangement is not broadly new and I am aware of the fact that others have attempted to use this type of arrangement in ignition systems before. In every case of such use of which I am aware, little or no success has been achieved mainly because of failure to understand the function and operation of the current build-up in the primary winding 33 of the induction coil 20. Experiments with prior known commutators and brushes have established the fact that they have been unsatisfactory because the actual contact between the brush and the conductive areas on the commutator have been of so short a duration that insufficient build-up of current is afforded the primary winding 33. Moreover, the brush, although touching the conductive areas of the commutator, has been allowed to bridge or maintain some contact with the non-conductive area of the commutator with the result that leakage or gradual current drop occurred before, and during the gap or discharge period. In other words, it is now well established that it is only when a complete and sudden break of contact occurs that the current built up in the primary winding of the coil can be discharged with its fullest impact. Consequently, in the embodiment of the present invention there must be a direct relationship between the surface area of the brush 28 with respect to the area of the non-conductive zones when the break occurs after each current build-up received from a conductive land.

In FIG. 2 I have shown the commutator 27 as consisting of a solid body 40 of conductive material. This body 40 is press fit upon the distributor shaft 12 to assure electrical conductivity as well as rotary movement of the body 40 with the shaft 12. The body 40 is round and concentric to shaft 12 so as to present the periphery 41 of body 40 to the brush 28 for surface contact therewith.

In accordance with the present invention, nonconductive zones 42 are provided in the body 40 by forming recesses 43 therein opening up onto the periphery of the body 40. In FIG. 5 the receses 43 are formed in the body 40 in radial array on a common radius and at angular disposition relative to each other, there being one such recess 43 for each cylinder of the engine E with which the commutator 27 is to be associated.

In the construction of this form of commutator the body 40 is milled out to form kerf-like recesses 43 at proper locations radially from the periphery toward the center of the body. The balance of the conductive area of the periphery 41 is thus equally divided into segmental conductive areas 45 which are of greater circumferential length than the gaps presented by the recesses 43 formed therebetween. This is important insofar as the conductive areas 45 providing a greatest period of contact possible with the brush 28 prior to register of the latter with the next successive gap or non-conductive zone 42.

In FIG. 5 I have shown each recess 43 of rectangular cross section, the width of each recess 43 being slightly greater than the thickness of the brush 28 so that the circuit making period or dwell is greater than the circuit breaking or discharge period. This is exemplified in FIG. 5 geometrically to show the conductive zones 45 of more than twice the lineal area than the non-conductive zones 42. Moreover, FIG. 5 also shows the thickness or commutator contacting surface 47 of the brush 28 as being slightly less than the width of any one recess 43. This is essential to obtaining a complete break of current between the commutator and brush.

In operation the commutator body rotates counterclockwise, FIGS. 2, 3, 5 and 6. The brush 28 remains stationary and has its commutator contacting surface 47 disposed for constant engagement with the periphery 41 of the commutator body 40. As best seen in FIGS. 3 and 4 the brush 28 is of a width greater than that of the contact making width of the periphery 41 of the commutator body 40. As best illustrated in FIG. 4 the periphery 41 of the commutator body is embraced between insulated tracks or rails 50 and 51. These tracks or rails 50 and 51 which are of insulation material are molded or shrunk into position in annular recesses 52 and 53, respectively, which are cut into the ends of the commutator body 40. Thus it will be seen that the gaps presented by the recesses 43 are confined at both ends by portions of the insulated tracks 50 and 51 and that the brush 28 bridges the space between the tracks 50 and 51 and is actually supported on the peripheries 41' and 41'' of these two non-conductive members when passing over (relatively speaking) the recesses. This is one of the most im-

portant features of the present invention as will now be explained.

Now then, as the periphery of the commutator sweeps past the fixed brush 28, the surface 47 of the brush alternately makes and breaks connection relative to the conductive zones 45 of the commutator. As best seen in FIG. 6, irrespective of the speed (r.p.m.) of the commutator 27, there is always a positive circuit making period or dwell which is better than twice as long as the period of discharge effected by contact of the brush with the non-conductive zones 42. This is extremely important because it assures sufficient time for the building up of current in the low voltage side or primary winding 33 of the coil 20. In addition thereto the current so built up in the primary winding 33 is discharged suddenly and quickly into the secondary (high voltage) winding 19 of the coil as soon as the contact surface 47 of the brush is in full register with the gap provided by the recess 43, i.e., a non-conductive zone 42. According to my discovery there is no need to prolong this phase of the operation. As a matter of fact, it is essential that this phase of the operation occur abruptly after the low voltage builds up to its peak in the primary winding of the coil. Thereafter it matters not that the circuit is broken between the battery and the primary side of the coil.

To understand the foregoing phenomenon, consider it analogous to closing of a fluid supply line as the load of the fluid therein builds up to its peak pressure followed by a complete opening of the discharge end of such supply line so that the fluid bursts forth therefrom in a sudden spurt. This, in effect, is comparable to the operation of the make and break arrangement constructed in accordance with the present invention. As a matter of fact, during testing of first experimental models it was discovered that there must be a complete break of contact if ever so slight. In models in which the contact face 47 of the brush bridges the gap between conductive zones 45 a bleeding effect occurred which caused leakage of the low voltage build-up in the primary winding of the coil. This caused a gradual, rather than a sudden or abrupt drop in the voltage built up in the primary winding, resulting in a loss in efficiency in the discharge of the pent-up current into the secondary winding of the coil.

From the foregoing experiments, it was found that even the use of a material having high resistance such as carbon for the brush 28, although satisfactory during normal operating or even idling speed of the engine, is not too satisfactory when the engine is being turned over by a starter.

In such a case of slow turning of the commutator 27, it was discovered that during partial contact of a carbon brush 28 with the conductive zone 45 while entering register with a non-conductive zone 42 caused leakage of current from the primary winding into the secondary winding of the coil. Thus it will be seen that a gradual voltage drop would occur prior to firing time, i.e., complete contact of the brush with the zone 42 or, to use the analogy of the fluid line explained above, it is as though the discharge end of the pressurized line had been slightly opened prior to complete opening thereof, causing a gradual loss in pressure, thus diminishing the final spurt expected at complete opening of the line.

The foregoing pre drop in voltage built up at slow speed in the primary winding was found to occur only when the brush 28 is made of material such as carbon having a high resistance. It was found that during the slow relative movement of the carbon brush over the non-conductive zone 42 and while only a fraction of the contact surface 47 of the brush is in contact with the conductive surface 45 of the commutator, the resistance of the brush material being only a part of the full surface area 47 was so high that it was like a partial opening of the circuit causing a leakage of the built-up current from the primary winding into the secondary winding prior to firing time. However, when the brush 28 is made of material such as platinum, silver or even steel having a lower resistance than carbon, this leakage does not occur to such a great extent as to cause any appreciable voltage drop in the primary winding. With a brush of such low resistance then, the engine would start upon being turned slowly by the starter.

Having thus explained the workings of the make and break arrangement of the present invention, it will be appreciated that the relationship of the surface area 47 of the brush 28 to the gap 42 be such as to afford a full clean break in the circuit in order to obtain a sudden drop in the voltage built up in the primary winding 33 of the coil 20. Equally important, however, is the prolonged period of contact between the brush and the conductive land or surface 45 of the commutator to assure a sufficient surge of low voltage current from the battery 34 into the primary winding of the coil. Now the critical condition prevailing in prior known brush and commutator arrangements is the arcing which occurs just as the trailing edge of the conductive land 45 leaves its contact with the pointed end 60 of the brush. This phenomenon is illustrated in the enlarged fragmentary detail of FIG. 7. Keeping in mind that as the degree of contact between the conductive lands 45 and the surface 47 of the brush diminishes in area, the greater is the conductive resistance between the current built up in the brush 28. Therefore all commutators of the type herein tend to become pitted at the trailing edge of the conductive land. This being the case, the pitting of this edge will create an irregularity in the surface upon which the brush is bearing and thus irregularity of surface occurs at the trailing edge of each conductive land. Therefore when the commutator rotates at high speeds the brush 28 is caused to flutter, thereby missing full prolonged contact with the conductive zones 45, the very thing relied upon to make the commutator and brush arrangement more efficient than the old make and break point systems.

In accordance with the present invention such arcing and ultimate tendency of pitting, although not eliminated, is compensated for. Since the non-conductive zone 42 in the present invention is a gap or recess 43 and since the brush is constantly bearing against the peripheries 41'—41" of the insulated tracks 50 and 51 there can be no fluttering of the brush 28 relative to the rapidly rotating commutator 27. Moreover, it will be noted in FIG. 7 that the trailing edge 61 of each conductive land 45 is rounded so that when arcing occurs, in the manner and for the reasons just above explained, any pitting of the trailing edge 61 occurs within or below the periphery 41 of the commutator body 40. Thus it will be appreciated that any irregularities caused by pitting at the trailing edge of the conductive lands 45 of the instant disclosure will in no way deter, affect or disturb the constant bearing of the brush 28 against the periphery 41 of the commutator body 40. In other words, no fluttering of the brush can occur because the contact surface 47 of the brush 28 will remain at the orbital plane in which the conductive surfaces 45 move and therefore as each conductive zone 45 passes the brush 28 the full dwell or period of contact will occur thus assuring maximum build up of current within the brush prior to its register with a non-conductive zone 42.

Another advantage of the gap type non-conductive zone 42 is found in the cooling effect it attains, first by reason of the intermittent contact as distinguished from the constant contact between the brush and commutator. This cooling effect is further enhanced by the provision of ports 65 at each end of the recesses. These ports are formed through the respective end walls of the recesses 43 by holes drilled through the insulated tracks 50 and 51 at positions to register with the several recesses 43 in the body 40 of the commutator 27. The effect of these ports 65 is one of utilizing the centrifugal force created by the rapidly rotating commutator body to

throw off air taken in through the ports 65 thus cooling the contact surface 47 of the brush 27.

While I have described my improved make and break arrangement in specific detail, it will be appreciated that it is susceptible to modification, alteration and variation in structure without departing from the spirit of my invention. I, therefore, desire to avail myself of all modifications, alterations and/or variations as fairly come within the purview of the appended claims.

What I claim as new and desire to protect by Letters Patent is:

1. In a commutator and brush make and break arrangement for the low voltage phase of the ignition system of an internal combustion engine in which a source of direct current is intermittently connectable to the primary winding of a coil via a brush riding upon the periphery of said commutator; a commutator body of conductive material driven in synchronism with said engine, said body having a plurality of narrow recesses formed therein from the periphery thereof toward the center of said body to present a plurality of conductive lands of greater lineal area on the periphery of said body than the width of the gaps provided by any one of said narrow recesses, a brush of slightly lesser thickness than the width of any one of said gaps normally urged against the periphery of said body, and non-conductive tracks on each end of said body having uninterrupted continuous peripheries aligned with the periphery of said body for supporting the ends of said brush as it passes over any one of said gaps in said body.

2. In a commutator and brush make and break arrangement for the low voltage phase of the ignition system of an internal combustion engine; a commutator comprising a body of conductive material driven in synchronism with said engine, non-conductive tracks on each end of said body having uninterrupted continuous peripheries aligned with the periphery of said body, a brush constantly bearing against the periphery of said body including the peripheries of said non-conductive tracks, said body having a plurality of recesses formed therein from the periphery thereof toward the center of said body to present a plurality of conductive lands on the periphery of said body separated by a plurality of gaps, and vent openings formed in said non-conductive tracks below the peripheries thereof and in register with said recesses formed in said body for cooling said commutator and brush arrangement.

3. In a commutator and brush arrangement for the low voltage phase of the ignition system of an internal combustion engine in which a source of direct current connected to said commutator is intermittently connectable to the primary winding of a coil via said brush as it rides upon the periphery of said commutator; a rotor type commutator comprising a body of conductive material driven in synchronism with said engine, said body having a plurality of recesses formed therein from the periphery thereof toward the center of said body to present a plurality of conductive lands on the periphery of said body separated by a plurality of gaps, non-conductive tracks on each end of said body closing the ends of said gaps and presenting uninterrupted continuous peripheries at each end of said body in alignment with the periphery of said body for supporting said brush relative thereto as the gaps pass said brush, said conductive lands each having the trailing edge thereof which last engages said brush rounded so that arcing between said brush and any one land will occur within the periphery of said commutator.

4. In a commutator and brush make and break arrangement for the low voltage phase of the ignition system of an internal combustion engine in which a source of direct current is intermittently connectable to the primary winding of a coil via a brush riding upon the periphery of said commutator; a commutator body of conductive material driven in synchronism with said engine, said body having a plurality of narrow recesses formed therein from the periphery thereof toward the center of said body to present a plurality of conductive lands of greater lineal area on the periphery of said body than the width of the gap provided by any one of said narrow recesses, a brush of slightly lesser thickness than the width of any one of said recesses normally urged against the periphery of said body, non-conductive tracks on each end of said body having uninterrupted continuous peripheries aligned with the periphery of said body for supporting the ends of said brush as it passes over any one of said recesses in said body, said conductive lands having their trailing edges which last leave contact with said brush rounded whereby arcing between said brush and any one land occurs within the periphery of said commutator.

5. In a commutator and brush make and break arrangement for the low voltage phase of the ignition system of an internal combustion engine; a commutator comprising a body of conductive material driven in synchronism with said engine, non-conductive tracks on each end of said body having uninterrupted continuous peripheries aligned with the periphery of said body, a brush of predetermined thickness constantly bearing against the periphery of said body including the peripheries of said non-conductive tracks, said body having a plurality of recesses formed therein of slightly greater width than the thickness of said brush to present a plurality of conductive lands on the peripheries of said body, each said conductive land having a rounded trailing edge which is last to leave contact with said brush to thereby confine arcing between said brush and any one land to a zone beneath the periphery of said commutator, and vent openings formed in said non-conductive tracks below the peripheries thereof and in register with each of said recesses in said body for cooling said commutator and brush arrangement during operation thereof.

6. In the low voltage phase of the ignition system for an internal combustion engine, the combination with a commutator having a body of conductive material provided with a plurality of gaps equally spaced around its periphery and a periphery engaging brush having a thickness slightly less than the width of any one of said gaps, of non-conductive means operatively engaging said brush and said communicator for supporting said brush with its commutator periphery engaging surface in peripheral alignment relative to said commutator body as any one gap therein passes said brush.

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