Sept. 6, 1927. 1,641,434

J. H. HUNT ET AL

LIGHTING AND IGNITION APPARATUS

Filed Jan. 21, 1925 3 Sheets-Sheet 1

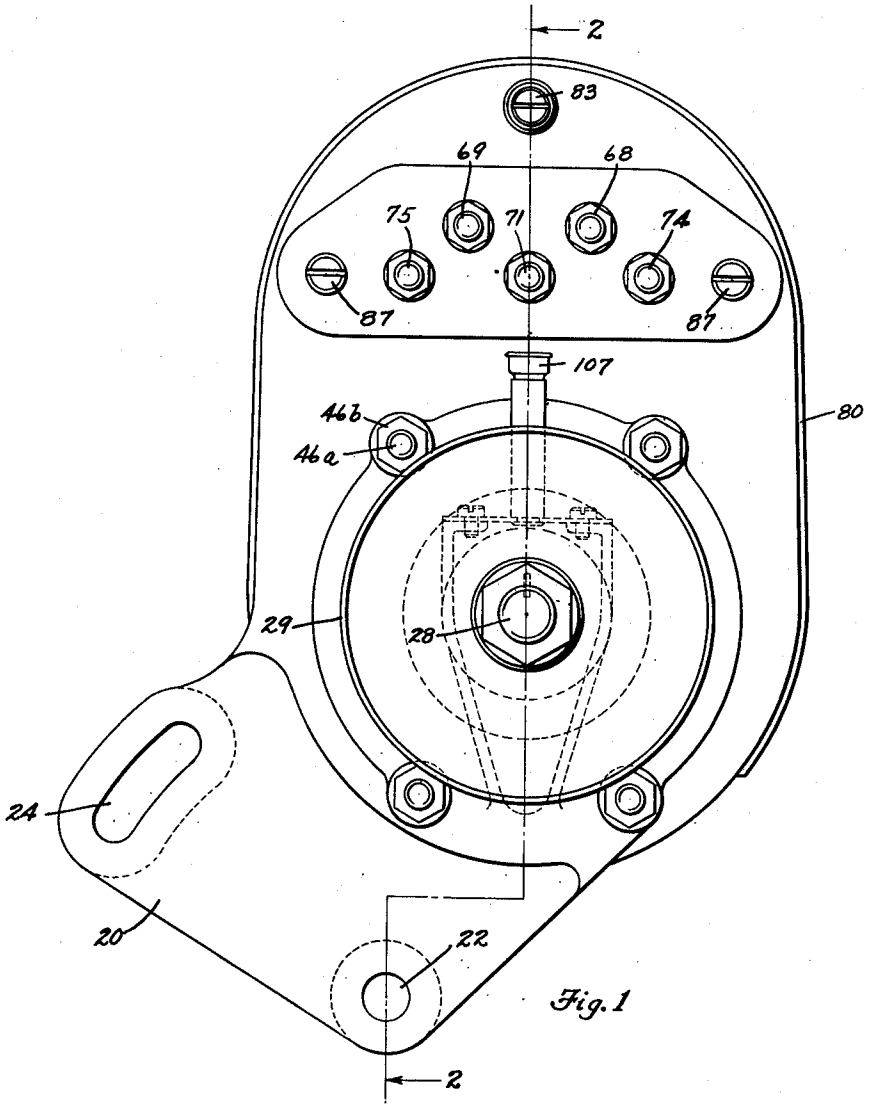


Fig. 1

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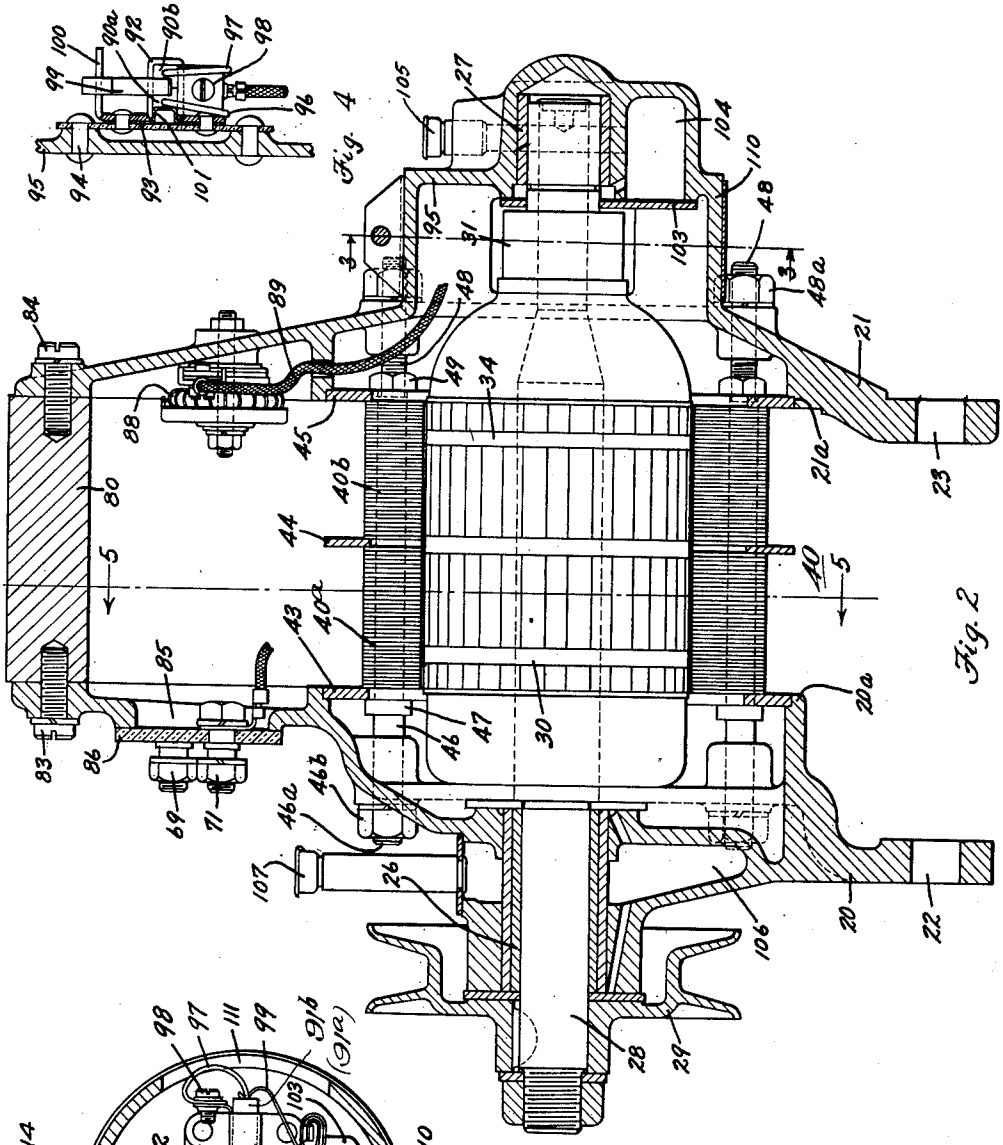


Fig. 2

Fig. 4

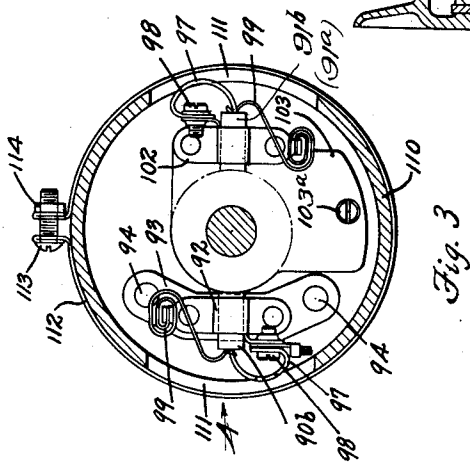


Fig. 3

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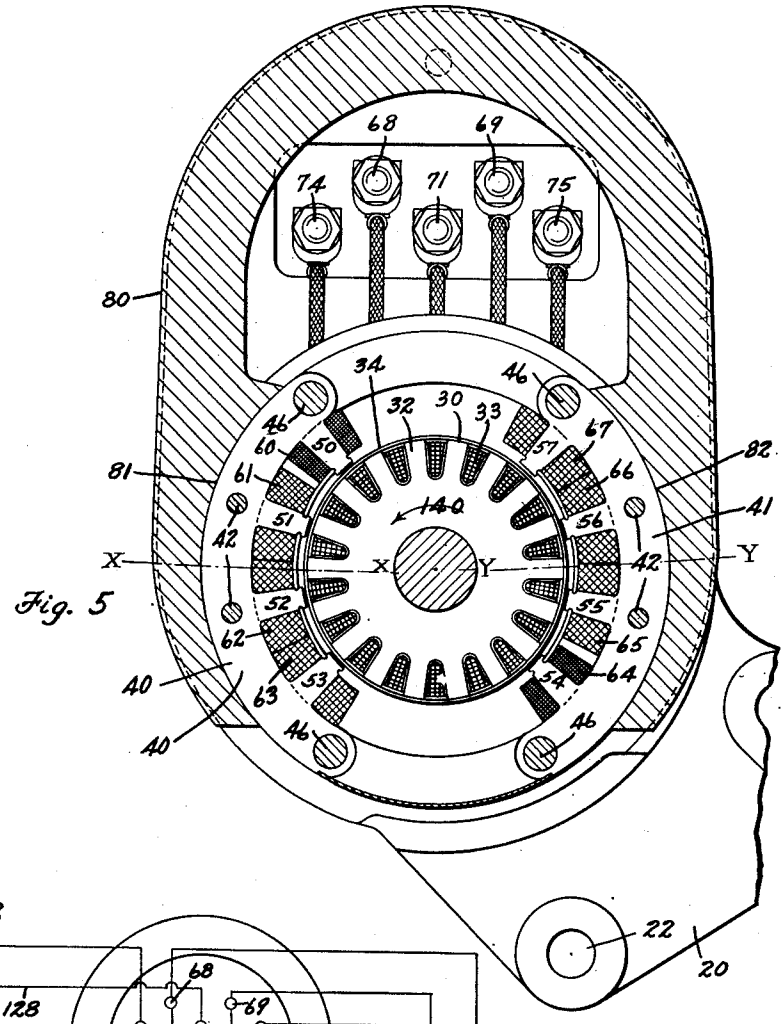


Fig. 5

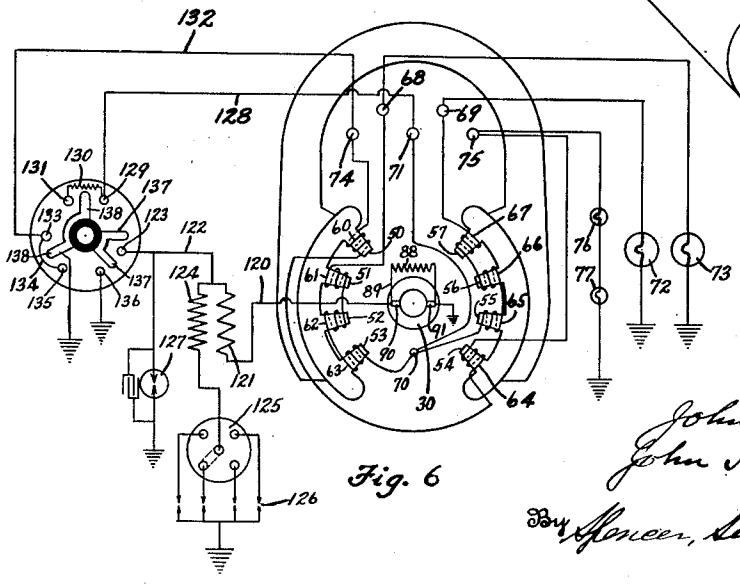


Fig. 6

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UNITED STATES PATENT OFFICE.

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LIGHTING AND IGNITION APPARATUS.

Application filed January 21, 1925. Serial No. 3,732.

This invention relates to electrical lighting and ignition apparatus for automotive vehicles, such as light delivery trucks which do not carry a storage battery and motor for starting the engine.

The copending application of John H. Hunt, Serial No. 576,493, filed July 21, 1922, discloses an electrical lighting and ignition system including a generator comprising a field magnet having pole face windings in which lighting current is generated, and a single rotor for generating an alternatng current for ignition purposes. It is necessary that this generator be driven by the engine in fixed relation therewith. This type of apparatus requires a gear or chain and sprocket drive between the engine and the generator and cannot be belt driven.

One of the objects of the present invention is to provide an electrical system of the type referred to but including a generator having pole face windings and a single rotor for generating lighting and ignition currents and which may be belt driven by the engine. Consequently this generator may be used interchangeably with a conventional type of belt driven direct current generator used on automobiles for charging the storage battery. This object is accomplished by providing a generator with a drum wound armature from which direct current is commutated for ignition purposes.

A further object is to minimize the fluctuations in the armature voltage and this is accomplished by a particular arrangement of the pole face teeth with respect to the armature core teeth.

A further object of the invention is to provide for the regulation of the ignition current in an ignition system including an induction coil and a generator of the type referred to.

A further object is to provide for protection of the lighting circuit including the pole face winding in case of accidental short circuiting of the generator armature.

Further objects of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred form of embodiment of the present invention is clearly shown.

In the drawings:

Fig. 1 is an end view of a dynamo embodying the form of the present invention.

Fig. 2 is a longitudinal sectional view on the line 2—2 of Fig. 1.

Fig. 3 is a sectional view on the line 3—3 of Fig. 2.

Fig. 4 is a fragmentary view in the direction of the arrow 4 in Fig. 3.

Fig. 5 is a cross sectional view on the line 5—5 of Fig. 2.

Fig. 6 is a wiring diagram.

The dynamo comprises end frames 20 and 21 provided with aligned holes 22 and 23 for receiving a rod providing a pivot for the frame of the dynamo. This pivot is preferably arranged parallel to the crank shaft of the engine. In order to secure the dynamo in desired position for tightening the belt which drives it, one of the frames, such as frame 20, is provided with a slot 24 for receiving a screw (not shown) which clamps the frame 20 to a part of the engine frame. Frames 20 and 21 provide bearings 26 and 27 respectively for the armature shaft 28 which carries a pulley 29, an armature 30 and a commutator 31. Pulley 29 is adapted to receive a belt for connecting the dynamo shaft 28 with a pulley driven by the engine. This belt may be the same belt which drives the engine fan at the front end of the engine. The armature 30 is drum wound but differs from the ordinary direct current drum wound armature, in that the core teeth are relatively narrow and the ratio of copper and core iron is higher than shown in the conventional types. The dimensions of the armature which have been found satisfactory are as follows: diameter 2.8 inches; length 3 inches; 18 core slots; one coil per slot having 12 turns of #19 wire; each coil surrounds 8 teeth; the ends of the armature coil #1 are connected to commutator bars #5 and #6, there being a commutator bar opposite each slot; and the armature core teeth are $\frac{3}{16}$ of an inch wide at the tip. In Fig. 5, the armature core teeth are designated by numeral 32, the section through the windings is indicated at 33; and 34 in Figs. 5 and 2, indicates the bands for holding the armature windings in position.

The pole pieces 40 and 41 each comprises two bundles of laminations, the two bundles comprising the pole piece 40 being designated 40^a and 40^b in Fig. 2. The laminations

of each bundle are secured by rivets 42. The four bundles of laminations comprising the pole pieces 40 and 41 are attached to spacing rings 43, 44 and 45 by means of bolts 46 which pass through the rings and laminations. Each bolt 46 is provided with a shoulder 47 and with a threaded portion 48 for receiving a nut 49. The laminations and rings are clamped between the shoulders 47 and the nut 49. The pole face teeth 50, 51, 52 and 53 of the pole piece 40 are therefore located in a certain relation to the pole teeth 54, 55, 56 and 57 of the pole piece 41, and in a certain relation to the armature core teeth 32 as will be explained later. The pole pieces 50 to 57 inclusive are surrounded, respectively, by pole face windings 60 to 67 inclusive. As indicated in Fig. 6, windings 61, 62, 63, 65, 66 and 67 are connected so that their E. M. F.'s will be cumulative. The terminals of this series of windings are indicated at 68 and 69 in Fig. 6, and the center point 70 of this series is connected with a terminal 71. Each of the coils in this series has 25 turns of #17 S. C. E. wire and the current generated therein is used to supply lighting current for the head lamps 72 and 73. The windings 60 and 64 are connected in series so that the E. M. F.'s are cumulative. One end of this series of windings is connected with a terminal 74 and the other with a terminal 75. Each of these windings 60 and 64 has 140 turns of #29 S. C. E. wire and the current generated therein is used for operating lamps of smaller candle power indicated at 76 and 77. These lamps may be the cowl and tail lamps of the vehicle.

The field is excited by a permanent magnet 80 of the horse-shoe type. The poles of the magnet are formed with accurate cylindrical faces 81 and 82 for fitting closely around the outer cylindrical surface of the groups of laminations, comprising pole pieces 40 and 41. The end frames 20 and 21 are secured to the magnet 80 by screws 83 and 84. The bolts 46 are provided with threaded extensions 46^a extending through the frame 20, receiving nuts 46^b, which clamp the end frame 20 to the pole piece assembly. Frame 20 is provided with a recess 20^a for receiving the ring 43. The threaded extensions 48 of the bolts 46 extend through the frame 21 and receive nuts 48^a which clamp the frame 21 to the pole piece assembly. The end frame 21 is provided with an annular recess 21^a for receiving the ring 45.

Frame 20 is provided with an opening 85 for receiving wires leading from the pole face windings to the terminals 68, 69, 71, 74 and 75 and these terminals are insulatingly mounted upon a non-conducting support 86 attached to the frame 20 by screws 87 covering the opening 85. The frame 21 supports a resistance element 88 having one end grounded upon the frame 21, the other connected by a wire 89 with the insulated or non-grounded brush 90 indicated in Fig. 6. The other brush 91 is grounded upon the frame 21.

The mounting of the brushes is shown in Figs. 3 and 4. A box type brush holder 92 is attached to a non-conductor 93 which is secured by rivets 94 to a wall 95 of the frame 21. The brush indicated at 90 in Fig. 6 includes two brushes 90^a and 90^b for a purpose to be described later. One of the brushes, such as 90^a, is a carbon brush relatively high in resistance, and the brush 90^b is a metal relatively low resistance brush. The brushes are connected by pigtails 97 with a terminal 98, and are engaged by the same brush spring 99 having one end fixed to a portion 100 of the brush holder 92. The brush holder 92 cooperates with a spacing element 101 tending to maintain the brushes 90^a and 90^b spaced from the non-conducting plate 93.

The pressure exerted by the brush spring 99 is sufficient to maintain the carbon brush 90^a in good electrical contact with the commutator throughout the speed range of dynamo operation, but is sufficient only to maintain the heavier metal brush in good contact with the commutator at relatively low engine speeds. The other brush 91 indicated in Fig. 6 includes elements 91^a and 91^b corresponding, respectively, to the brush elements 90^a and 90^b. The brush holder 102 of the brush 91 is mounted directly upon a plate 103 which is attached to the end wall 95 of the frame 21 by screws 103^a. This plate forms one wall of a lubricant reservoir 104 for feeding oil to the shaft bearing 27. The reservoir 104 is filled through a covered oil cup 105. The frame 20 provides a similar reservoir 106 filled through a covered oil cup 107.

The commutator and brushes are enclosed by a cup shaped extension 110 provided with openings 111 to provide access to the brushes and commutator. These openings are covered by a cover band 112 secured by bolt 113 and nut 114.

Referring to Fig. 6 the dynamo brush 90 is connected by wire 120 with ignition coil primary winding 121 which is connected by wire 122 with a switch contact 123. The ignition coil secondary 124 is connected with wire 122 and with distributor 125 for distributing sparking impulses to the spark plugs 126. Wire 122 is connected with a timer 127 operated by the engine. The dynamo terminal 71 is connected by wire 128 with switch contact 129 which in turn is connected by dimmer resistance 130 with switch contact 131. Dynamo terminal 74 is connected by wire 132 with switch contact 133 connected by wire 134 with contact 135. It is obvious that the connection of the switch contact 123 with a grounded contact 136 by a movable

contact 137 will cause the timer 127 to be short circuited. Consequently the ignition will be rendered inoperable and the engine will stop. When the contact 137 is in the position shown in Fig. 6 the timer 127 is operative to control the energizing and discharging of the ignition coil which is supplied by current generated in the armature 30.

The lighting circuits are controlled by a movable grounded switch contact 138 which is adapted to connect either contacts 133 and 129, or contacts 135 and 131. If the contact 138 is in position to connect contacts 133 and 129 the lamp 72 will be connected with a group of pole face windings through the following circuit: Lamp 72, terminal 69, windings 67, 66 and 65, terminals 70 and 71, wire 128, contact 129, contact 138 and a ground return to the lamp 72. Likewise the lamp 73 will be connected with a group of pole face windings to the following circuit: Lamp 73, terminal 68, windings 61, 62 and 63, terminals 70 and 71, wire 128, contacts 129 and 138, and a ground return to the lamp 73. The tail and cowl lamps 76 and 77 will be connected with a group of pole face windings through the following circuit: Lamp 77, lamp 76, terminal 75, pole face windings 64 and 60, terminal 74, wire 132 and contacts 133 and 138 and a ground return to the lamp 77. To dim the head lamps 72 and 73, the switch contact 138 is moved to connect contacts 131 and 135. The head lamp circuit is changed from that described only by introducing the resistance 130 in series with lamps 72 and 73. The lamps 76 and 77 will burn as before since the circuit in these lamps has been changed only by the introduction of wire 134 and contact 135. In case one of the head lamps burn out the other lamp will continue to burn since each head lamp is connected with a set of pole face windings.

In case of short circuit of the armature during the operation of the engine, the voltage of the pole face windings will be automatically regulated so that the voltage will not be excessive to cause the lamps to burn out. Referring to Fig. 5 the arrow 140 indicates the direction of rotation of the armature 30. The pole windings 60 and 64 which supply the tail lamps 76 and 77 which are of relatively low candle power, are placed on the leading pole teeth 50 and 54. The short circuiting of the armature will produce armature reaction upon the dynamo field in such a manner as to crowd the flux toward the trailing pole teeth and away from the leading pole teeth, therefore, the voltage generated by the windings 60 and 64 will be automatically limited to a safe value for the lamps 76 and 77. This armature reaction will tend to pull the field flux threading the armature from the pole teeth 51 and toward the pole 53 and away from the pole 55 and toward the pole 57, but the total flux in the poles 51, 52, 53, 55, 56 and 57 will be substantially the same so that the total E. M. F. generated in the group of windings 61, 62, 63, or the group of windings 65, 66 and 67 will not be substantially higher than before the short circuit occurred. Hence voltage of the current delivered to the head lamps 72 and 73 will not become excessive due to the armature short circuit while the engine is running.

One of the important features of the present invention is that of arranging the pole teeth with respect to the armature core teeth so that the fluctuation in armature voltage will be minimized. As disclosed and claimed in the copending application of John H. Hunt referred to, it has been found advantageous in machines of this type to make the spacing of adjacent pole teeth one and one-half times the spacing of the armature pole teeth. There is not a complete circle of pole teeth as it is necessary to omit some of the teeth to provide a zone of commutation of the armature. If, a direct current armature is used and the teeth are arranged so that the windings of one pole are in phase with the windings of the other, there will be such a fluctuation in voltage of the direct current windings as to cause the possibility of low speed ignition failure if the contacts open when the armature current is too small to produce a spark. It has been found, however, that by shifting the pole pieces the same amount toward the symmetrical axes of the machine in order to bring the windings of the poles out of phase with each other, the fluctuation of armature voltage will be substantially reduced and a higher average attained. Satisfactory results have been obtained when the windings of one pole are out of phase with the windings of a pole of opposite sign by from 90 to 180 electrical degrees. For example, if the armature core has 18 teeth, the cycle of alternating current occurs every 20° of rotation of the core. The polar projections defined by the groups of teeth 50 to 53, and 54 to 57 should be displaced from 5° to 10° from the conventional arrangement. In Fig. 5 lines x—x and y—y are used to designate the axes of the polar projections, and it will be noted that these axes are displaced about 10°.

When a direct current machine of this type is operating at variable speed throughout the speed range there is a wide variation of armature voltage. The voltage must be high enough to provide ignition current when cranking the engine by hand. On the other hand it is necessary to limit the current of the ignition coil to a safe value when

the engine is operating at high speed. To accomplish this, the inductance of the ignition coil is relatively high. A coil having an inductance of 100 mh. has been found satisfactory. The resistance of the coil should be as low as possible consistent with good manufacturing products, since it is necessary that the resistance of the ignition circuit be low in order to obtain sufficient current for ignition at low engine speed. The core inductance determines the resistance to some extent. For example, a primary coil resistance of .75 ohm has been found satisfactory. The armature resistance should be as low as possible in order to obtain the maximum current at low engine speed. The resistance of the armature circuit for an armature having dimensions given in the example is about .65 ohm and this resistance includes the resistance of the brushes and the lead wires as well as the armature coils. To obtain the required coil inductance and low resistance the primary coil 121 may have 250 turns of #18 wire.

The resistance 88 across brushes 90 and 91 is for the purpose of absorbing self-inductance of the armature windings when the breaker points of the timer 127 open. This self-inductance may also be absorbed by a condenser connected with the brushes 90 and 91.

At low engine speeds the heavier metallic and low resistance brush elements 90^b and 91^b remain in good electrical contact with the commutator 31 so that the resistance of the armature circuit at low speeds will be relatively low. However, for commutating during higher speeds of the engine the higher resistance carbon brushes have been found more satisfactory since they can be maintained in good electrical contact with the commutator without excessive pressure required by the metal brush, and metal brushes would permit undesirably high short circuit current in the armature coils short circuited by the brushes at the higher engine speeds. The springs 99 are adjusted so that the high resistance brush elements 90^a and 91^a will be maintained with good electrical contact with the commutator at all dynamo speeds, but this pressure will not be sufficient to maintain the heavier metal brush in contact with the commutator at the higher engine speeds.

The generator constructed in accordance with the example given will produce satisfactory ignition at 100 R. P. M. and satisfactory operation at 400 R. P. M. or greater of two 6.3 volt, 21 c. p. lamps, and two 6.3 volts, 2 c. p. lamps.

A dynamo constructed in accordance with the present invention can be used interchangeably with the conventional types of D. C. generator used in two-unit automotive electric systems, without requiring any change in the manner of mounting upon the chassis or engine frame. This makes the system particularly adaptable to present methods of interchangeable manufacture. The greater demand at present is for the two-unit system, but the demand for an electrical lighting and ignition system without storage battery can be supplied immediately because the generator of the present invention can be installed in place of the usual battery charging generator, and the timer and distributor of the present system can be the same as the apparatus used generally in battery ignition systems.

While the form of embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. A generator comprising, in combination, a toothed rotor carrying commutated windings, a stator member provided with a plurality of groups of spaced teeth, the angular pitch of which is greater than the pitch of the rotor teeth, each group of stator teeth providing a polar projection of the generator field, and cumulatively connected generating windings individually surrounding the stator teeth, the polar projections being displaced angularly by such amount that the current generated in one group of pole-tooth windings will be out of phase with the current generated in the group of pole-tooth windings of a pole of opposite sign.

2. A generator comprising, in combination, a toothed rotor carrying commutated windings, a stator member provided with a plurality of groups of spaced teeth, the angular pitch of which is greater than the pitch of the rotor teeth, each group of stator teeth providing a polar projection of the generator field, and cumulatively connected generating windings individually surrounding the stator teeth, the polar projections being displaced angularly by such amount that the current generated in one group of pole-tooth windings will be from 90 to 180 electrical degrees out of phase with the current generated in the group of pole-tooth windings of a pole of opposite sign.

3. A generator comprising, in combination, a toothed rotor carrying commutated windings, a stator member provided with a plurality of groups of spaced teeth, the angular pitch of which is one and one-half times greater than the pitch of the rotor teeth, each group of stator teeth providing a polor projection of the generator field and cumulatively connected generating windings individually surrounding the stator teeth, the polar projections being displaced angularly by such amount that the current generated in one group of pole-tooth windings will be from 90 to 180 electrical degrees out

of phase with the current generated in the group of pole-tooth windings of a pole of opposite sign.

4. A generator according to claim 3, in which the rotor has an even number of teeth for each pair of generator field poles.

5. A generator comprising in combination, a slotted rotor having eighteen equi-spaced teeth, a bi-polar stator member, each polar projection of which has four spaced pole teeth, the pitch of which is one and one-half times the pitch of the rotor teeth, cumulatively connected generating windings surrounding the stator teeth, and commutated generating coils carried by the rotor, the polar projections being displaced angularly by an amount such that the currents generated in the two groups of pole-tooth windings will be as much as 180 electrical degrees out of phase.

In testimony whereof we hereto affix our signatures.

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