E. VARLEY.

POWER SYSTEM FOR AUTOVEHICLES.

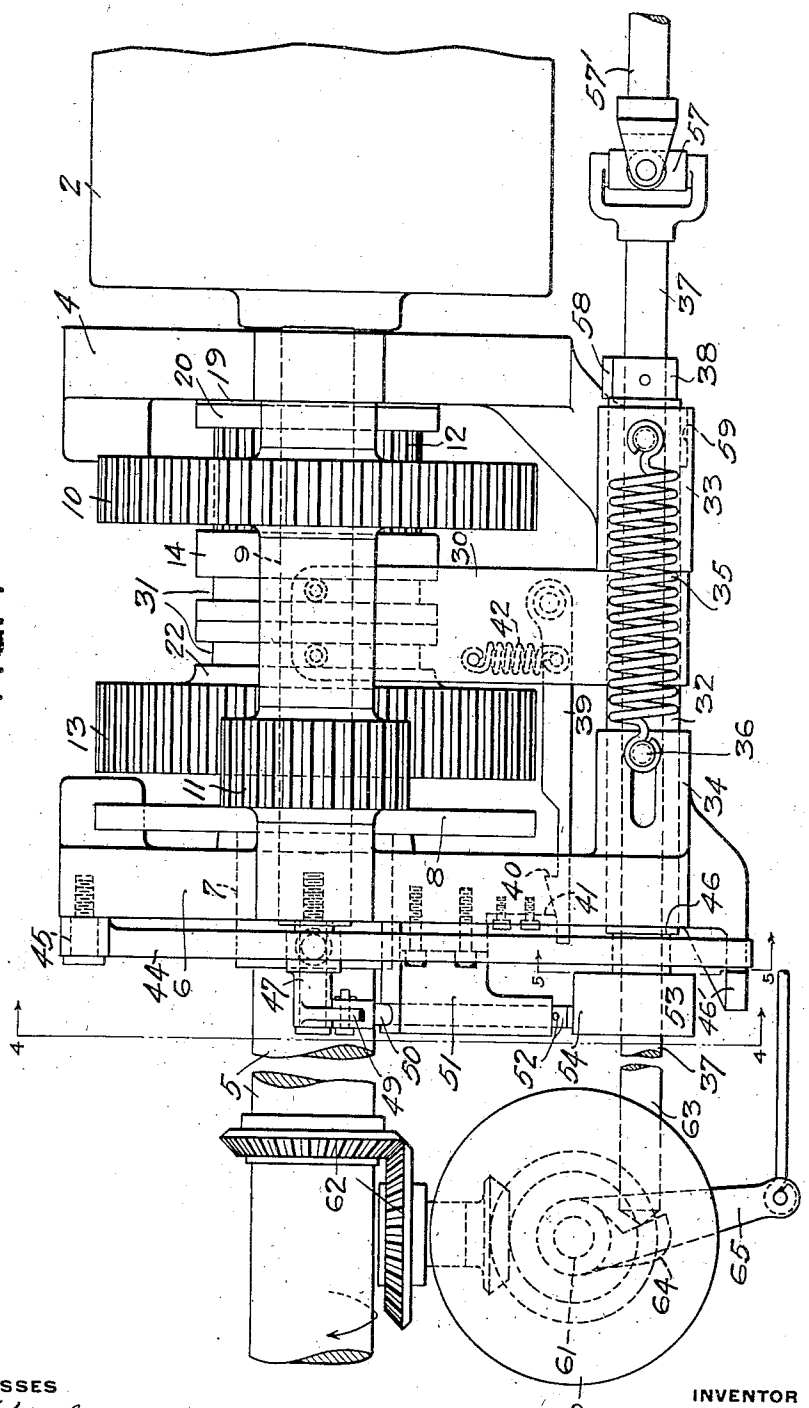
APPLICATION FILED NOV. 6, 1912.

1,129,147.

Patented Feb. 23, 1915.

8 SHEETS—SHEET 1.

FIG. 1



WITNESSES

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8 SHEETS—SHEET 2.

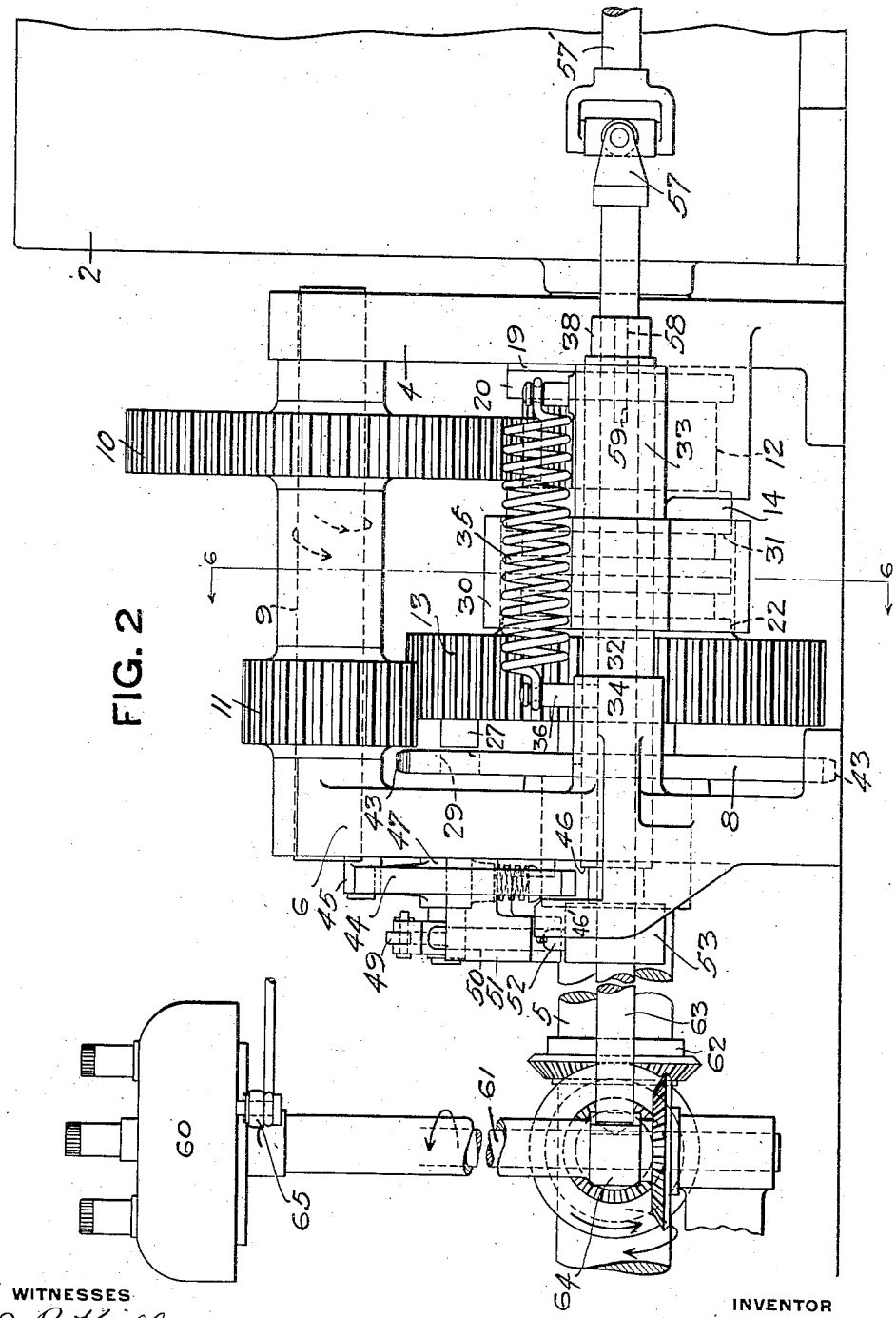

FIG. 2

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8 SHEETS—SHEET 3.

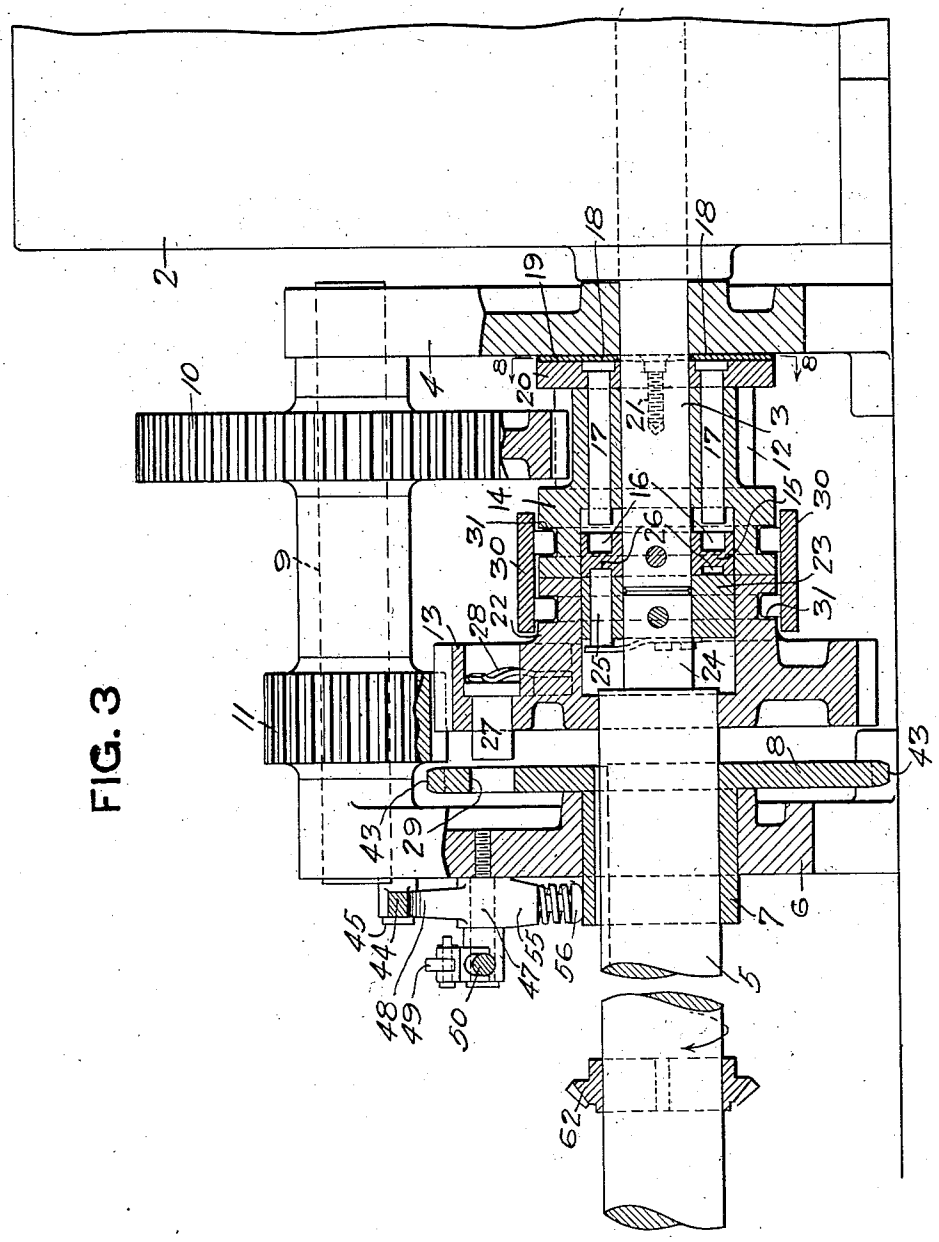

FIG. 3

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8 SHEETS—SHEET 4.

FIG. 4

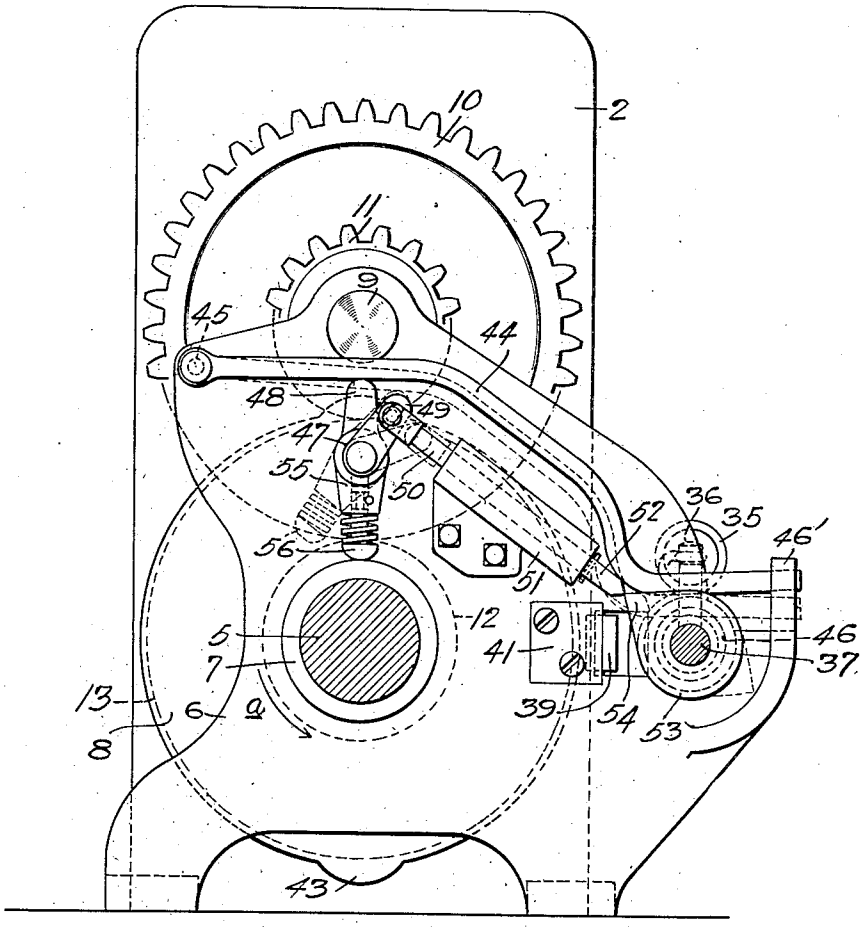
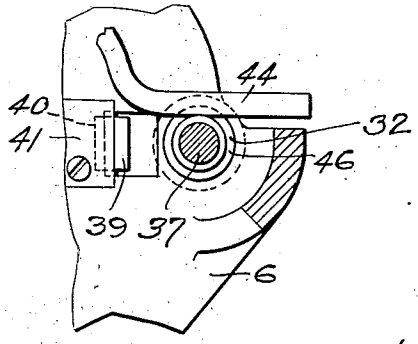


FIG. 5



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8 SHEETS—SHEET 5.

FIG. 7

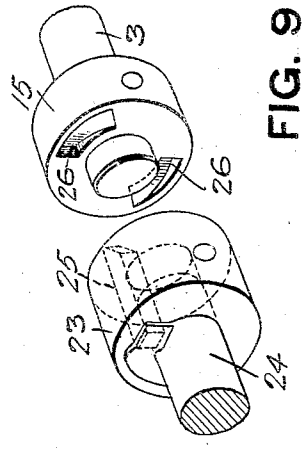


FIG. 9

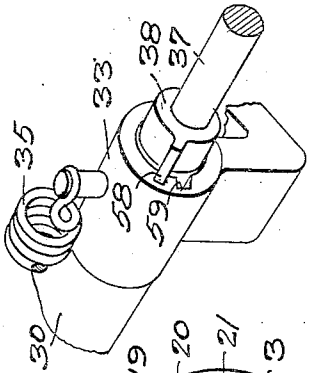


FIG. 8

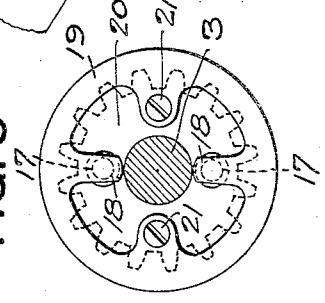
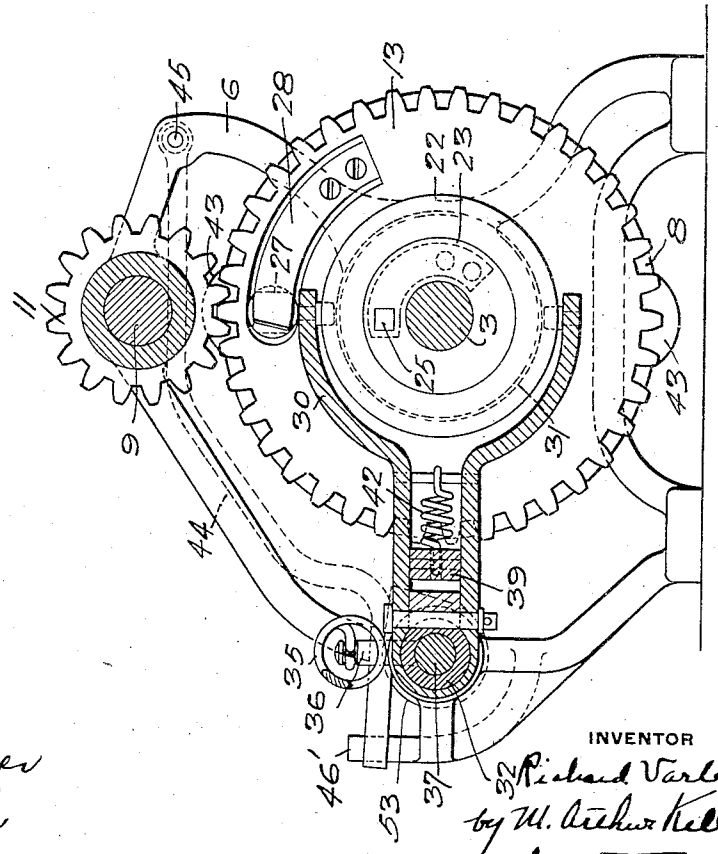


FIG. 6



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8 SHEETS—SHEET 6.

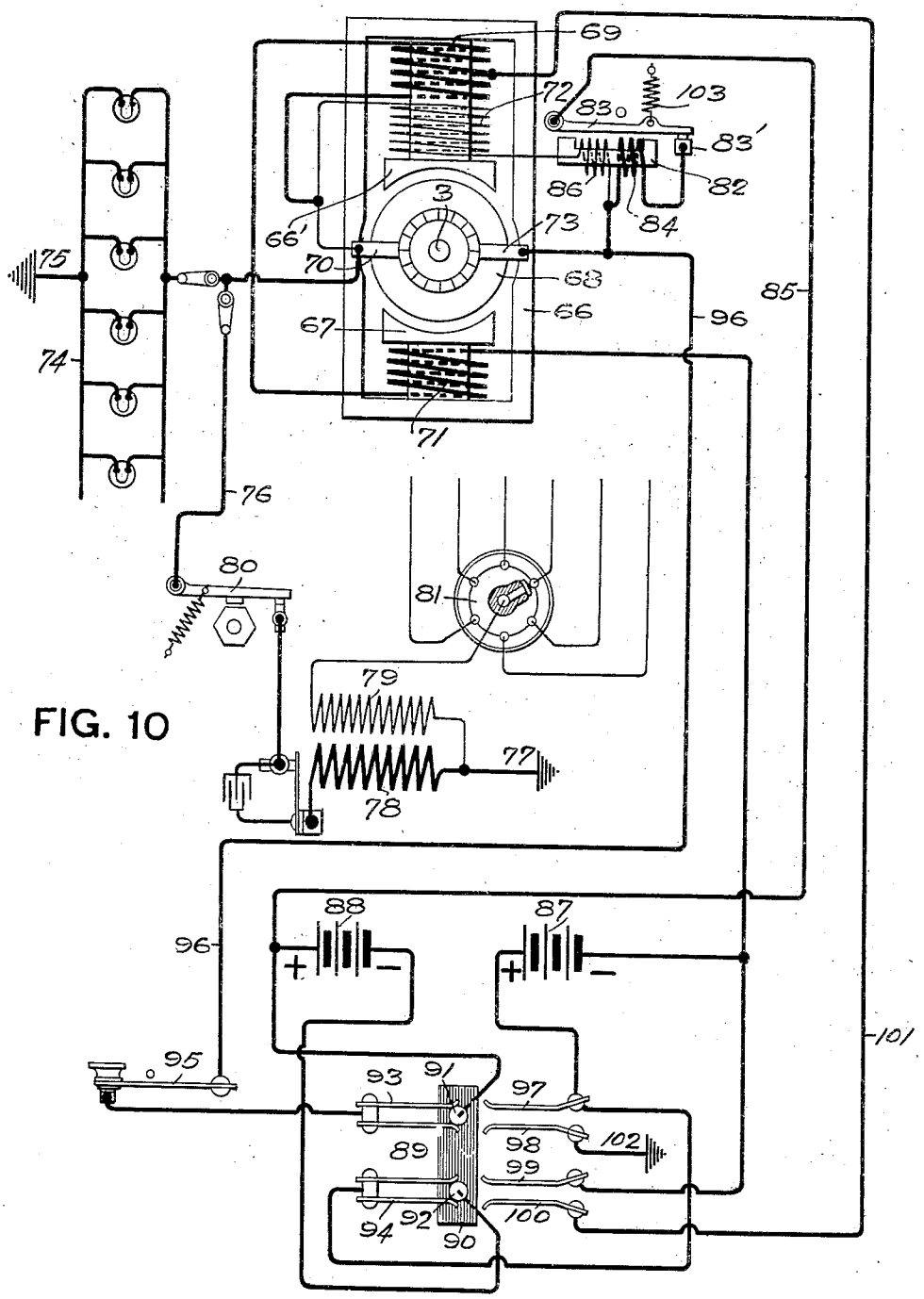

FIG. 10

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8 SHEETS—SHEET 7.

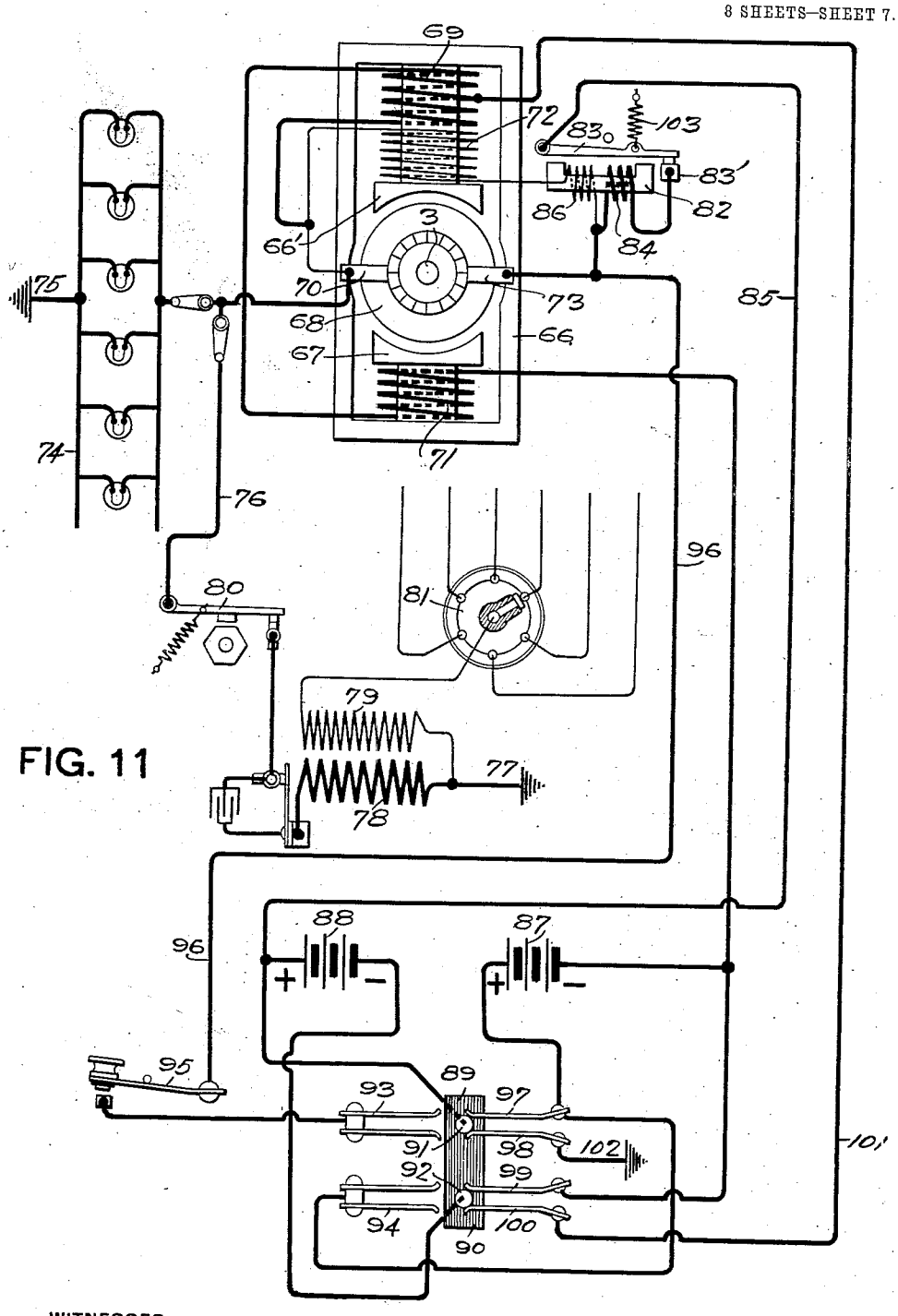

FIG. 11

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8 SHEETS—SHEET 8.

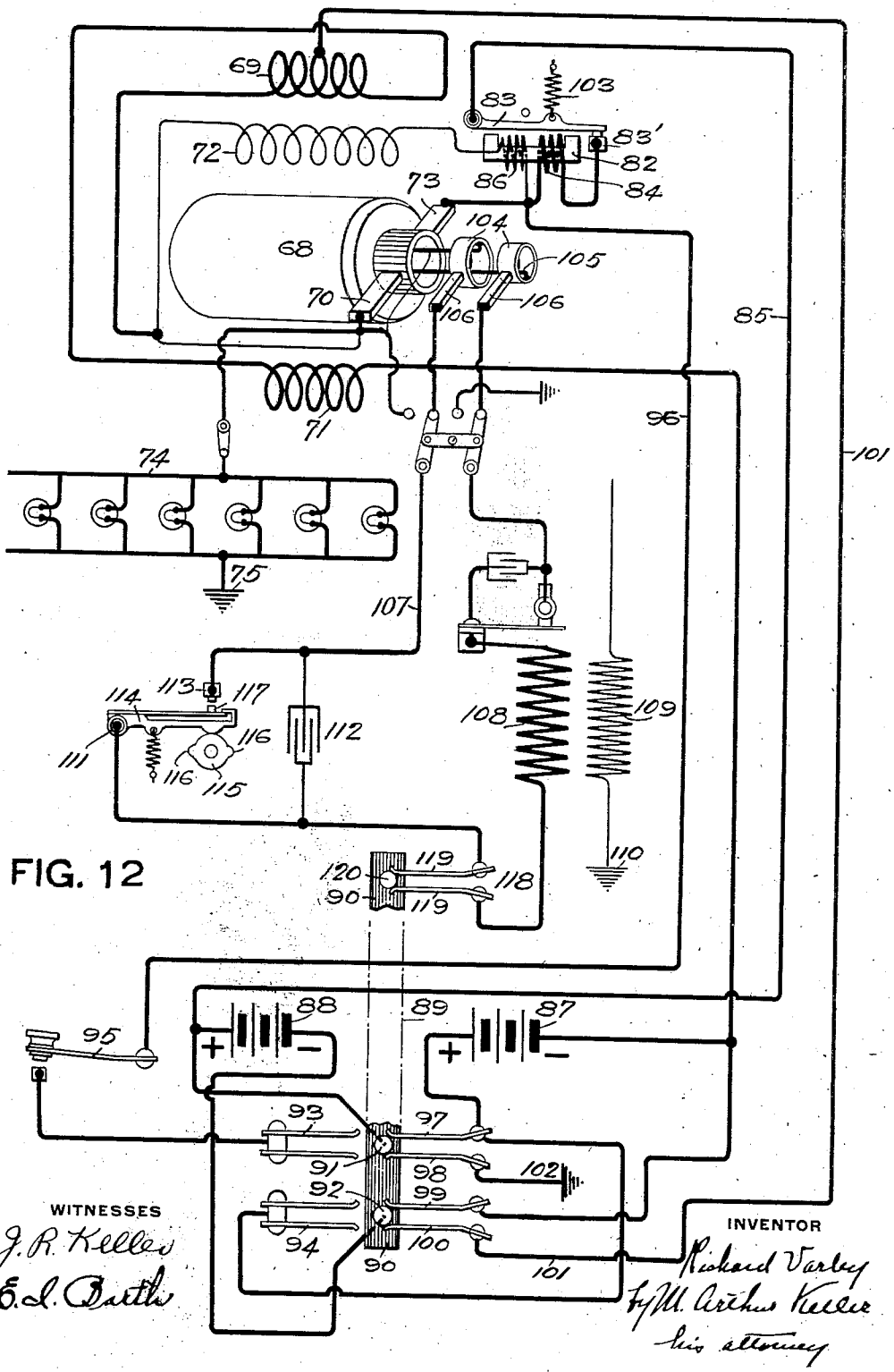

FIG. 12

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UNITED STATES PATENT OFFICE.

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POWER SYSTEM FOR AUTOVEHICLES.

1,129,147. Specification of Letters Patent. Patented Feb. 23, 1915.

Application filed November 6, 1912. Serial No. 729,785.

To all whom it may concern:

Be it known that I, RICHARD VARLEY, a citizen of the United States of America, residing at Englewood, in the county of Bergen and State of New Jersey, have invented new and useful Improvements in Power Systems for Autovehicles, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, which form part of this specification.

This invention is an improvement in power systems for autovehicles, such as automobiles, motor boats, etc., and it aims primarily to provide new and improved means whereby the engine of the vehicle may be started and a generator element driven to supply electrical energy for the vehicle equipment, including the work or light circuit and the ignition circuit. As such a device, a motor element, preferably a dynamo, is associated with apparatus of such character that the engine may be initially turned over or driven by the electric element operating in motor capacity, after which the said dynamo may be driven, preferably at engine speed, to supply current for the above mentioned equipment.

In the particular construction illustrated in the accompanying drawings and hereinafter described, I employ mechanism for multiplying the torque of the motor and one of the objects sought to be accomplished is the provision of means for bringing the torque multiplying mechanism into operative relationship with the motor and engine, and means for releasing, preferably automatically, said mechanism, after operating to start the engine, in such manner that it may remain stationary and non-operative during self-propulsion of the engine, thereby affording apparatus in which is absent all wear and tear incident to continuous or extended driving of the parts.

A further object of my invention is to enable the starter mechanism to so drive the engine as to effect complete dissipation or expulsion of the dead or waste gases from the engine cylinders preparatory to energizing of the ignition circuit and spark plugs and firing of the engine upon release of said starter mechanism in a manner preferably substantially uniactional with said firing and assumption of self-propulsion of the engine, whereby full potential gas charges may be taken into the cylinders for the initial explosion or explosions, and abortive firing overcome.

Another object of my invention is the provision of starter mechanism which cannot be brought into starting relationship with and during running of the engine and after being brought out of starter service, thereby removing liability of injury to the torque multiplying means. And a further object of my invention is to provide a power system in which a strong magnetic field may be created in the dynamo, for the attainment of a high torque for use in starting the engine, and in which said field may be so weakened or controlled as to afford conditions suitable for the requirements of the work and ignition circuits. As such a device, means for bringing about the above characteristics are preferably combined with and dependent for operation upon and in unison with the operations of other elements of the system.

I also provide other improved features, as will be hereinafter more fully described in the specification and pointed out in the claims.

Figure 1 is a top plan view, showing apparatus embodying my invention, the dynamo element being partly broken away; Fig. 2 is a side elevation of the same; Fig. 3 is a longitudinal vertical sectional view; Fig. 4 is a transverse section on the line 4—4 of Fig. 1; Fig. 5 is a fragmentary transverse section on the line 5—5 of Fig. 1, but showing the gear shifting mechanism locked in an inoperative position; Fig. 6 is a section on the line 6—6 of Fig. 2; Fig. 7 is a perspective view showing the clutch elements for driving of the dynamo by the engine; Fig. 8 is a section on the line 8—8 of Fig. 3; Fig. 9 is a fragmentary perspective view of the gear shifting mechanism, and showing means for preventing shifting of the gears to engine starting position, during self-propulsion of the engine; Fig. 10 is a diagrammatic view of a dynamo and electric circuits which may be used in connection with my system, and showing condition thereof for driving of the engine by the dynamo; Fig. 11 is a similar view showing circuit conditions during driving of the generator by the engine; and

Fig. 12 is a similar view showing dynamo and circuits for supplying an alternating current to the ignition element.

The dynamo element indicated by the numeral 2, may be of any suitable design, but for the attainment of certain objects through coöperation with other elements of the system, I may employ the dynamo and circuit arrangements hereinafter more fully described in connection with Figs. 10, 11 and 12.

The shaft 3 of the dynamo passes through a housing or bearing frame 4 of starter mechanism, and in alinement with the shaft is a shaft 5 which may be the engine shaft or constitute an auxiliary shaft which may have geared connection with the engine shaft. This shaft 5 is also supported by an end frame or housing 6, being more directly journaled therein by means of the hub or sleeve portion 7 of a face plate or disk 8 which is keyed or otherwise fixedly secured to the shaft. Paralleling the shafts 3 and 5 and journaled at the top of the housings 4 and 6 is a shaft 9 fixedly carrying a gear 10 and pinion 11, and meshing with the gear 10 is a pinion 12 loosely mounted on the shaft 3, while the pinion 11 meshes with a gear 13 loosely carried by the shaft 5. As shown in Fig. 3, the pinion 12 has an enlarged head portion or hub 14 bored to harbor a ring or collar 15 fixed to the shaft 3 and having on its inner face recesses 16 arranged to receive spring clutch pins 17 mounted in the pinion 12, when said pinion is longitudinally shifted on the shaft, for driving of the said pinion, as will be hereinafter more fully set forth. As shown in Figs. 3 and 8, the clutch pins 17 are preferably headed, so as to limit their outward travel, and are backed up by the spring fingers 18 of the flat spring ring 19 attached to a mounting disk 20 as by screws 21 which may also serve to secure the disk to the end face of the pinion 12. Contiguous to the head 14 of the pinion 12 is a similarly formed hub-like head or extension 22 of the gear 13, mounted within the bore of which is another collar 23 fixedly secured to the reduced end 24 of the shaft 5 and carrying the longitudinally movable spring pressed pawl 25 adapted to engage ratchet teeth or recesses 26 formed in the abutting face of the first collar piece 15 (see Fig. 7), for driving of the dynamo shaft 3 by the engine, as hereinafter brought out. Carried by the gear 13 is a clutch finger 27 held normally projecting from the face of the gear, by a spring 28, and adapted for engagement with a pocket 29 formed in the member 8.

The gears 12 and 13 are so mounted on their respective shafts as to be capable of being slidingly shifted thereon for the purpose of bringing the clutch pins 17 and finger 27 into (and out of) engagement with their respective clutch pockets 16 and 29, when it is desired to drive the shaft 5 by the motor shaft 3, the pinion 12 being driven by the rotating collar 15 and the disk 8 by the clutch fingers 27; the torque of the shaft 3 being multiplied through the gear reduction existing between the pinion 12 and the gear 13, sufficiently to drive said shaft 5 with its engine load. To bring about such shifting, a common shifting yoke 30 is provided and arranged for operative association with the peripheral annular grooves or recesses 31 in the hub-like extensions 14 and 22 of the gears. This shifting yoke is operatively carried by a hollow shaft or sleeve 32 (see Figs. 1 and 2) slidably mounted in bearings 33 and 34, preferably extensions of the housings or frames 4 and 6. Normally, the sleeve 32 and yoke 30 are held in the retracted or inoperative position shown (*i. e.*, a position in which the clutch pins 17 and finger 27 are free from engagement with the pockets 16 and 29) by means of a contractile spring 35 anchored at one end to the bearing 33 or other fixed point, and secured at the other end to the sleeve 32 by a stud 36 which passes through a slot in the bearing 34. Means for shifting the sleeve 32 and consequently the yoke 30 forward to move the gears 12 and 13 to engine starting position, comprises a shifting rod or shaft 37 which is received by and passes through the bore of the hollow shaft 32 and is provided with a fixed collar 38 lying in terminal abutment therewith, this shaft 37 may connect with the running board of the vehicle or be mounted for manual operation in any desired manner.

Pivoted to the yoke 30 is an arm 39 having a latch face 40. As clearly shown in Fig. 1, when the yoke is advanced by the shaft 37 to engine starting position, the latch 40 will engage a lock shoulder or plate 41 on the housing 6, and thereby hold the yoke in advanced position; a spring 42 being employed to normally urge the arm against the plate 41. The face plate or disk 8 has a plurality of radial lugs 43 (see Figs. 2 and 4) which, when the said plate is rotated by driving of the shaft 5 in either normal or a reverse direction, strike the arm 39 and release the latch 40 so that the spring 35 will return the shifting yoke 30 to normal position, and, as hereinafter described, said lugs 43 are preferably so disposed as to cause a restoration of the gears to inoperative or non-starting position at a time substantially coincident with initial firing or assumption of self-propulsion of the engine.

To prevent gear stripping and injurious impulsive back-driving by shifting the gears to engine starting position during self running of the engine after starting, I provide means to lock the shaft or sleeve 32 against forward shifting while the engine is run-

ning. Essentially such mechanism comprises, a lock bar 44 (as shown in Fig. 4) pivoted at one end at 45 to the frame 6. During running of the engine and when the sleeve 32 is in a retracted position, normally, the bar 44 lies across and in front of a lock shoulder 46 on the forward end of the sleeve 32, and back of a stop or shoulder 46′ on the frame 6; the shoulder 46 being formed preferably by reducing the shifting sleeve at that point. Means for raising the bar 44 to sleeve unlocking position, comprises a pivotal jack 47 the upper finger 48 of which is adapted to be swung against the under side of and lift the bar 44, by means of a crank arm 49 actuated by a slide rod 50. The rod 50 is mounted in a bearing piece 51 attached to or forming part of the end frame and has the terminal portion 52 extending into the path of a beveled nose shifting cam 53 carried by the operating shaft 37. By rotating the shaft 37 the nose 54 of the cam will wipe against the beveled end of and shift the rod 50, forcing the finger 48 of the jack to an upright bar unlocking position, as shown in Fig. 4. Such righting of the finger 48 will also swing an oppositely disposed or depending finger 55 of the jack into position directly above the hub portion 7 of the disk 8. This finger 55 has a spring pressed nose 56 which frictionally engages or wedges against the curved face of the hub 7 when shifted thereover and thereby serves to maintain the finger 48 in its upright position. Upon rotation of the hub 7 with the shaft 5 in the normal direction of rotation or that of the arrow *a*, the finger 55 will be kicked outwardly thereby away from the hub, as indicated by the dotted position shown in Fig. 4, in which position it will be held by the weight of the resultantly lowered lock bar 44. The operating shaft 37 may be rotated by any suitable means, and in Figs. 1 and 2 I have shown it as being provided with a knuckle or universal joint 57 by means of which it may be flexibly connected with a suitable manipulating rod 57′.

To guard against holding of the lifting jack in bar unlocking position by the cam nose 54, against the force of the rotating hub 7 on the spring nosed finger 55, an auxiliary lock is provided which prevents forward shifting of the sleeve 32 until the nose 54 of the cam has wiped past the rod 50, and it consists of a lug or stop shoulder 58 on the collar 38, rotatively shiftable with said collar into a position of receptive registry with an internal slot or way 59 of the bearing 34, before the collar can be advanced to shift the sleeve 32. The relative positions of the slot 59 and the nose 54 are such that swinging of the lug 58 into registry with the slot shifts the nose 54 out of the path of the rod 50. It therefore will be seen that should the engine be running, and the jack 47 be shifted to bar unlocking position by travel of the nose 54 against and past the end of the rod 50, said jack would be immediately shifted to a reclining inoperative position by the rotating hub 7, and should the cam nose 54 be forcibly held in bar unlocking position during rotation of the hub, such position would be one of non-registration of the lug 58 and slot 59, so that the lug 58 would lock the sleeve 32 against shifting even though the lock bar 44 occupied non-locking position. It will be equally apparent that, with non-rotation of the hub 7, the jack 47 may be shifted to unlocking position by the travel of the cam nose 54 past the end of the rod 50, and will be held in such upright position by means of frictional engagement of the finger 55 with the non-rotating hub 7, so that the operating shaft 37 may be rotated to a position permissive of reception of the lug 58 by the recess 59 without attending dropping of the bar 44.

Referring to Figs. 1 and 2, 60 indicates an ignition timer or controller the shaft 61 of which may be operatively geared in any suitable manner so as to be driven in synchronism with the engine, as is well understood. I have indicated such gear connections 62 between the timer shaft 61 and the shaft 5. The operating shaft 37 has the forward extension 63 in the path of which and adapted to be engaged by said shaft is an arm 64 carried by the timer or controller and by means of which, when the shaft 37 is shifted forward to bring the starter into driving relationship with the engine, the controller may be adjusted or shifted to spark delay or retarding position, in a manner well understood by those skilled in the art. The controller is also shown as having a usual shifting arm 65 which may connect with the running board of the vehicle and by means of which spark advance may be obtained.

Summarizing briefly the operations of the above described mechanisms, it will be seen that when it is desired to start the engine, the operating shaft 37 is rotated, as by the member 57′ to shift the lock bar 44 to an elevated or sleeve unlocking position, and the lug 58 is brought into registry with the recess 59, thereby permitting the sleeve 32 and yoke 30 to be shifted by the collar 38, forward against the tension of the spring 35. Shifting of the yoke 30 will in turn shift the pinion 12 and gear 13 in such manner as to bring the clutch pins 17 against the collar 15 and the clutch finger 27 against the face plate 8. Should the spring pressed pins 17 not directly engage their pockets or recesses 16 they will yield under the shifting travel of the pinion 12, riding on the face of the collar 15 until said collar has rotatively traveled to a position permissive of the pins snapping into the recesses. Re-

sultant rotation or driving of the pinion 12 by the dynamo shaft 3, will drive the gear 13 through the medium of gears 10 and 11, so that the finger 27 if not in direct registry with the pocket 29, will also ride upon the face of the disk member 8 until brought into receptive registry with its pocket. The disk 8 being keyed to the shaft 5, will in turn drive the latter for starting of the engine. Upon advance of the gears to engine starting position the latch 40 of the arm 39 will engage the latch plate 41, thereby holding the gears in their operative or clutch engaging position pending automatic release thereof by the cam action of a lug 43 wiping past and freeing the arm 39 from its latch engaging position. I prefer to so dispose the lugs 43 on the periphery of the face plate or disk 8 as to cause release of the starter mechanism or return of the gears to non-operative position at a time substantially coincident with energizing of the ignition circuit of the vehicle, in synchronism with and assumption of self-propulsion of the engine. The advantages of such an arrangement are that the starter may be momentarily manually held against release until the dynamo has rotated the shaft 5 sufficiently to pump or scavenge all dead gas from the cylinders of the engine, after which and upon closing of the usual ignition circuit, an approaching lug 43 will release the said starter or torque multiplying means to non-starting position, coincidently as firing on the first live stroke of the engine takes place; the starter mechanism is not released at a period between compression strokes of the engine and before ignition of the combustible charge takes place, therefore the starter is always effective: and by insuring disconnection of such starter mechanism and engine at a time when the engine is fired, liability to impulsive-back driving at injurious speed through the compounding gears is obviated. It will be noted also that the controller 60 is positively shifted to spark retarding position as the starting mechanism is brought into driving relationship with the engine, but should there, for some other reason, (such as the existence of incandescent particles in the cylinders) occur an advanced or back-firing, resultant reverse travel of a lug 43 would free such starter mechanism from the engine so that it would be impossible to transmit an extended and injurious drive or back-fire through the gears, for, with the starter so released, the ratchet and pawl arrangement 25 and 26 would provide a direct slip between the shafts 5 and 3. During driving of the engine shaft 5 by the dynamo, the collar 15, which travels faster than the rotary movement imparted thereby to the shaft 5, carries the ratchet teeth or recesses 26 past the beveled face of the spring pressed pawl 25. After the engine becomes self-propulsive, the dynamo will be driven thereby through the said ratchet and pawl arrangement so as to supply generator current to the vehicle equipment.

In order that there may be a high torque provided for starting of the engine, a dynamo is provided, having peculiar advantageous features in that a high magnetic field may be created and maintained during starting of the engine and may be subsequently so controlled or weakened as to bring said element as a generator, into harmony with the requirements of the lamp or work circuit and the ignition circuit. I have shown in Figs. 10, 11 and 12 diagrammatically such a dynamo and associated circuits. It preferably takes the general form of the construction disclosed in my above mentioned applications Serial Nos. 704,258 and 704,259 in that it is so designed as to prevent injurious rise in voltage when being driven as a generator to supply energy for the vehicle equipment and battery or accumulator cells. As shown in Figs. 10 and 11, the frame 66 has the depending pole piece 66′ above the shallow upwardly extending pole piece 67 carried by the base of the frame. These poles form between them the magnetic field chamber for the armature 68 mounted on the shaft 3. Upon the pole piece 66′ is a field winding 69 connected at one end to the commutator brush 70, while to the other end of said winding is serially connected a field winding 71 mounted on the lower pole piece 67. The field pole 66′ also carries a winding 72 shunted across the brushes 70 and 73. The numeral 74 indicates a lamp circuit connected to brush 70 and having ground connection 75, while 76 indicates an ignition circuit also connected to brush 70 and grounded at 77. This ignition circuit is shown as equipped with a usual primary coil 78, secondary winding 79, interrupter mechanism 80 and a distributer 81 connected to the secondary coil and leading to spark plugs, (not shown). A relay 82 has an armature 83 adapted, when attracted, to close a circuit through relay winding 84, contact 83′ and lead 85, as hereinafter described. The relay winding 84 is wound in opposition to a larger or major relay winding 86 connected to brush 73 and shunt winding 72. I have shown a plurality of battery or accumulator cells 87 and 88 which, in the manner hereinafter described, are preferably brought into serial relationship with one another and the dynamo for the purpose of giving a high voltage discharge for and during driving of the dynamo to start the engine, and are subsequently connected in multiple whereby reduction in potential is obtained for the light and ignition system when the dynamo is being driven by the engine to supply current to the cells

and the light and ignition circuits; the batteries being charged in multiple and therefore at a reduced voltage when the generator attains a certain potential output. In order to bring about the above mentioned serial and multiple connections of the battery cells and to effect variation of the magneto characteristics of the dynamo field, I provide a switch arrangement 89 comprising a plurality of fixed and movable contacts, the movable contacts being carried by an insulated bar 90 which is preferably connected to the starter shifting mechanism above described or so associated therewith as to cause a reciprocation of said bar in unison with the shifting of the starter mechanism and the connection and disconnection of certain circuits.

Referring more particularly to Fig. 10, when the starter is shifted to engine starting position, contacts 91 and 92 carried by the insulated bar 90 and connected to the terminals of the battery cells 88, are shifted thereby into engagement with the double nibbed contacts 93 and 94. To cause a discharge or flow of current from the battery cells to the generator windings for rotation of the shaft 3, a press key or other suitable switch 95 is closed so that battery cells 87 serially connect with cells 88, in the circuit 96 leading through contacts 94, 92, 91 and 93 to shunt winding 72, field winding 69 and 71, back to batteries. The current flow through the field windings is unidirectional so that the magneto motive force of the shunt winding 72 is added to that of the series field winding 69. The result is that this high voltage discharge to the several windings creates an intense magnetic field to which the resultant torque response of the armature 68 is desirably high for the purpose of starting the engine. During driving of the engine by the dynamo with the conditions prevailing as just described, no part of the live circuits is grounded, and the lamp and ignition circuits are momentarily cut out, as such high voltage might prove injurious thereto; the idea being to obtain a great starting torque through a high voltage ordinarily incompatible with the voltage requirements of the usual lamp and ignition circuits. On account of the energizing of the relay winding 86 through flow of starting current, the armature 83 of the relay will be closed, but this does not affect flow of current through the generator, as the armature 83 is connected to the same side of the battery as the lead 96. Immediately upon automatic release of the starter mechanism by a traveling boss or lug 43 on the rotating disk 8, as above described, the lamp and ignition circuits will be established, as will be hereinafter described; the interrupter mechanism 80 and distributer 81 being geared in synchronism, in any well known manner. Upon return of the starter mechanism to non-starting position, the shaft 5 will pick up and rotate the dynamo motor shaft 3, through the intermediary of the pawl and ratchet arrangement above described, and the switch bar 90 will be shifted to the position illustrated in Fig. 11 wherein the contacts 91 and 92 are shown as in engagement with contacts 97, 98, 99 and 100. In this position the battery cells are connected in multiple so that a voltage of a reduced or one-half the value of that utilized in starting is available for the light and ignition circuits which are completed through lead 101, a portion of the series field winding 69 (the lower portion) ground connections 75, 77 and 102 and battery cells. As the speed of the generator increases, and the magnetic field resultantly builds up, the voltage in the shunt winding increases so that when the potential reaches battery charging value, the relay winding 86 will energize the relay, causing a closing of the relay armature 83 and resultant closing of a circuit through it and the contact piece 83′; said circuit being completed through minor relay winding 84, armature 83, lead 85, batteries 88 and 87, and part of the series field winding 69 back to brush 70. Portion of the current also passes through contact 98, ground 102 to ground connections 77 and 75 of the ignition and lamp circuits respectively back to brush 70. In this condition part of the series field winding 69 and all of the series field winding 71 on the lower pole piece are cut out, and the current in the active part of the series field winding 69 flows in opposition to that in the shunt winding, so that there is created a bucking or substantially neutralizing action resistive to the tendency to excessive rise in potential as the speed of the armature increases. Furthermore, with the lower pole winding inactive, there results a high flux leakage from the armature 68, which, combined with the restraining influence of the bucking action above described, also tends to maintenance of a substantially constant voltage for the circuits. With a reduction of voltage below battery charging value, as when the speed of the armature decreases, or when the armature stops, an instant back charge of current through the opposing relay winding 84 and drop of voltage in winding 86 will neutralize the magnetic force of the relay so that the armature 83 will be instantly released (as by a spring 103), breaking the battery circuit through contact 83′ and thereby preventing a dissipating discharge or back flow of current from the battery cells to the dynamo.

In both of the above mentioned applications Serial Nos. 704,258 and 704,259, I disclose a dynamo construction and system in which provision is made for supplying an

alternating current to an ignition circuit, and in which the armature is accordingly driven in synchronism with the engine. If desired, the dynamo described in connection with the present invention may take the form of the general type disclosed in said applications, in which case, to insure proper synchronous association of the dynamo and engine so that the periodic pulsation of the current wave is produced for utilization at the spark plugs coincidentally with the compression strokes of the engine, the ratchet teeth or faces 26 (see Fig. 7) of the collar 15 carried by the dynamo motor shaft are preferably diametrically disposed so that the pawl 25 will always engage said collar at a synchronous and non-shifting point. With the provision of these non-varying points of engagement of the engine and dynamo shafts, after the dynamo and engine are once synchronously adjusted, such relationship will be always maintained in subsequent driving of the dynamo by the engine irrespective of previous relative association of the two shafts, incident to starting.

I have indicated in Fig. 12 a dynamo and circuits including an ignition circuit adapted to be alternately and commensurately energized from the armature 68 through the medium of collector rings connected to the armature winding, in accordance with the disclosures of my application Serial No. 704,259. The general dynamo construction and arrangement of the circuits and feature of connecting the batteries in series and multiple correspond with those shown in Figs. 10 and 11 of the present application with the exception of the substitution of an alternating current ignition element for that previously described. Referring more particularly to Fig. 12, a plurality of collector rings 104 are shown as connected to the winding of the armature 68 by taps 105 which lead from said winding preferably at oppositely disposed points or 180 degrees apart so as to cause symmetrical impulses of current to be impressed upon the collector rings in each complete revolution of the armature, for ignition service. From the collector brushes 106 leads a primary circuit 107 included in which is a primary coil 108 which may form part of a suitable ignition or spark producing apparatus, being in inductive relationship to a secondary coil 109 which is grounded at 110 and leads to a suitable distributer, not shown. At 111 is indicated an interrupter mechanism intercalated in the primary circuit 107, while connected across the said primary circuit is the usual condenser 112. The interrupter mechanism comprises the usual fixed contact 113 and a movable contact lever 114 adapted to be oscillated by an interrupter cam 115. This cam carries the symmetrically disposed projections 116, and the cam is so geared and the projections so disposed thereon as to effect, upon rotation of the cam, a closing of the contacts 113 and 117 at periods coincident with the compression strokes of the engine and at or near the maximum points of the alternating current wave generated in the armature 68. Thus, as is well understood in the art, with the charging of the primary coil through closing of the primary circuit and resultant charging and discharging of the condenser a very high potential current is generated in the secondary winding 109 as the distributer arm of the regular distributer closes a circuit to a spark plug of a cylinder of the engine. To prevent the ignition circuit from being charged at the high potential used in starting the engine, a switch arrangement 118 is interpolated in the primary circuit and is of such character and is preferably so associated with the switch bar 90 as to cause an opening or breaking of the primary circuit when the starter mechanism is advanced to engine starting position, and to cause a closing of the circuit upon return of the starter to non-starting position and connection of the batteries in multiple. More particularly it comprises the switch members 119 and the movable contact 120 carried by the switch bar 90.

Many changes may be made in the construction shown and the arrangement of the parts and circuit connections may be varied without departing from my invention.

The advantages of the invention will be found to reside in the provision of a system which is compact in size and therefore readily adaptable to modern autovehicle construction; which provides for a high starting torque without the necessity of providing an unduly large motor element or encumbering winding, and for proper correlation and control of the light or work circuit and ignition circuit and dynamo element. Furthermore a system of starting is provided wherein the dead or waste gases may be completely scavenged or cleaned from the cylinders of the engine preparatory to starting on return of the torque multiplying means to non-operative position; wherein back firing is guarded against; in which means are provided for locking the torque multiplying means or starter in a non-operative position during self-running of the engine, and in which the reducing gears are relieved from travel after operating to start the engine; and a starter mechanism provided having few parts and in which wear and tear is reduced to the minimum degree.

The above mentioned method or system of producing an alternating current for use at the spark plugs is not claimed in this

application as the same forms subject matter of my above mentioned applications Serial Nos. 704,258 and 704,259.

The starter mechanism described in connection with my system forms subject matter of my separate application Serial No. 731,336.

Having described my invention what I claim and desire to secure by Letters Patent is:

1. In a power system for autovehicles, the combination with a combustion engine, of a shaft for transmitting power to and from the engine, a dynamo, and means connecting the shaft and dynamo whereby each may actuate the other and including reducing gears normally stationary and non-operative during self-propulsion of the engine, and mechanism for so connecting and disconnecting the shaft and gears as to cause the dynamo to drive the shaft and to subsequently render the gears non-operative and to cause the shaft to drive the dynamo without rotating the gears.

2. In a power system for autovehicles, the combination with a combustion engine, of a shaft for transmitting power to and from the engine, a dynamo, and means connecting the shaft and dynamo whereby each may actuate the other and including reducing gears and a clutch element associated with the shaft and gears, for so connecting and disconnecting the shaft and gears as to cause the dynamo to drive the shaft for starting of the engine and the shaft to subsequently drive the dynamo without rotating the gears.

3. In a power system for autovehicles, the combination with a combustion engine, of a shaft for transmitting power to and from the engine, a dynamo, and means connecting the shaft and dynamo whereby each may actuate the other and including reducing gears and dual clutch mechanism for so connecting and disconnecting the shaft and gears as to cause the dynamo to drive the first shaft and to subsequently render the gears non-operative and the shaft to drive the dynamo without rotating the gears.

4. In a power system for autovehicles, the combination with a combustion engine, of a shaft for transmitting power to and from the engine, a dynamo, means connecting the shaft and dynamo whereby each may actuate the other, for starting of the engine and driving of the dynamo, and means for bringing the dynamo out of engine starting relationship with the shaft at a point of time substantially coincident with an explosion stroke of the engine.

5. In a power system for autovehicles, the combination with a combustion engine, of a shaft for transmitting power to and from the engine, a dynamo, means connecting the shaft and dynamo whereby each may actuate the other and comprising reducing gears and clutch mechanism associated with the shaft, and means for automatically disconnecting the reducing gears and shaft at a point of time substantially coincident with an explosion stroke of the engine.

6. In a power system for autovehicles, the combination with a combustion engine, of a shaft for transmitting power to and from the engine, a dynamo, means connecting the shaft and dynamo whereby the dynamo may start the engine and be driven thereby, an ignition controller, means for automatically bringing the dynamo out of starting relationship with the engine and means associated with the connecting means, for shifting the controller to spark delay position.

7. In a power system for autovehicles, the combination with a combustion engine, of a shaft for transmitting power to and from the engine, a dynamo, means connecting the shaft and dynamo whereby the latter may start the engine and be driven thereby, an ignition controller, means associated with the connecting mechanism, for adjusting the ignition controller, and means for automatically bringing the dynamo out of starting relationship with the engine, at a point of time substantially coincident with an explosion stroke of the engine.

8. In a power system for autovehicles, the combination with a combustion engine, of a dynamo, mechanism for so connecting the dynamo and engine that each may actuate the other, and means for producing in the dynamo an engine starting magnetic field strength greater than the maximum potential value of the field when the dynamo is driven by the engine.

9. In a power system for autovehicles, the combination with a combustion engine, of a dynamo, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, and means for so bringing the accumulator into circuit with the dynamo as to produce in the latter an engine starting magnetic field strength greater than the maximum potential value of the field when the dynamo is driven by the engine.

10. In a power system for autovehicles, the combination with a combustion engine, of a dynamo, mechanism for so connecting the dynamo and engine that each may actuate the other, apparatus for controlling the connection between the dynamo and engine, an accumulator, and means associated with the controlling apparatus. for so bringing the accumulator into circuit with the dynamo as to produce in the latter an engine starting magnetic field strength greater than the maximum potential value of the field when the dynamo is driven by the engine.

11. In a power system for autovehicles, the combination with a combustion engine,

of a dynamo having a field winding, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, current using equipment including spark producing apparatus, means for so bringing the accumulator into circuit with the dynamo as to create a substantially supernormal magnetic field for the production of a high torque for starting of the engine, and for electrically excluding the spark producing apparatus during driving of the engine by the dynamo, and means, including a portion of the field winding, for reducing the field strength and maintaining it relatively normal when the dynamo is driven by the engine.

12. In a power system for autovehicles, the combination with a combustion engine, of a dynamo having field winding, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, current using equipment, means for so bringing the accumulator into circuit with the dynamo as to create a strong magnetic field for the production of a high torque for starting of the engine, means associated with said last named means for electrically excluding the current using equipment during driving of the engine by the dynamo, means including a portion of the field winding, for varying of the magnetic field strength when the dynamo is driven by the engine, and means for bringing the current using equipment into circuit with the accumulator.

13. In a power system for autovehicles, the combination with a combustion engine, of a dynamo having field winding, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, current using equipment including spark producing apparatus, means for so bringing the accumulator into circuit with the dynamo as to create a strong magnetic field for the production of a high torque for starting the engine, means associated with said last named means for electrically excluding the spark producing apparatus during driving of the engine by the dynamo, means including a portion of the field winding, for varying the magnetic field strength when the dynamo is driven by the engine, and means for bringing the current using equipment into circuit with the accumulator.

14. In a power system for autovehicles, the combination with a combustion engine, of a dynamo having field winding, mechanism for so connecting the dynamo and engine that each may actuate the other, means controlling the connecting mechanism, whereby the dynamo may be brought out of starting capacity with the engine, an accumulator, current using equipment, means for so bringing the accumulator into circuit with the dynamo as to create a strong magnetic field for the production of a high torque for starting of the engine, means for electrically excluding the current using equipment during driving of the engine by the dynamo, means including a portion of the field winding, for varying the magnetic field strength when the dynamo is driven by the engine, and means associated with the aforesaid controlling means, for bringing the current using equipment into circuit with the accumulator.

15. In a power system for autovehicles, the combination with a combustion engine, of a dynamo, having field winding, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, current using equipment, means for so bringing the accumulator into circuit with the dynamo as to create a strong magnetic field for the production of a high torque for starting of the engine, means for electrically excluding the current using equipment during driving of the engine by the dynamo, means including a portion of the field winding, for varying the magnetic field strength when the dynamo is driven by the engine, and means for bringing the current using equipment into circuit with the accumulator and a portion of the field winding.

16. In a power system for autovehicles, the combination with a combustion engine, of a dynamo having field winding, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, spark producing apparatus, means for so bringing the accumulator into circuit with the dynamo as to create a strong magnetic field for the production of a high torque for starting of the engine, means for electrically excluding the spark producing apparatus during driving of the engine by the dynamo, means including a portion of the field winding, for lowering the field strength and maintaining it relatively normal when the dynamo is driven by the engine, and means for bringing the spark producing apparatus into circuit with the accumulator.

17. In a power system for autovehicles, the combination with a combustion engine, of a dynamo having field winding, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, spark producing apparatus, means for so bringing the accumulator into circuit with the dynamo as to create a strong magnetic field for the production of a high torque for starting of the engine, and for electrically excluding the spark producing apparatus during driving of the engine by the dynamo, means, including a portion of the field winding, for lowering the field strength and maintaining it relatively nor-

mal when the dynamo is driven by the engine, and means for bringing the spark producing apparatus into circuit with the accumulator and a portion of the field winding.

18. In a power system for autovehicles, the combination with a combustion engine, of a dynamo, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, means for so bringing the accumulator into circuit with the dynamo as to create a substantially supernormal magnetic field for the production of a high torque for starting of the engine, means for reducing the field strength and maintaining it relatively normal when the dynamo is driven by the engine, and means for bringing the accumulator into receptive charging circuit with the dynamo.

19. In a power system for autovehicles, the combination with a combustion engine, of a dynamo, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, means for so bringing the accumulator into circuit with the dynamo as to produce a substantially supernormal magnetic field for the production of a high torque for starting of the engine, means for reducing the field strength and maintaining it relatively normal when the dynamo is driven by the engine, and means for bringing the accumulator into receptive charging circuit with the dynamo.

20. In a power system for autovehicles, the combination with a combustion engine, of a dynamo having generative winding, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, means for so bringing the accumulator into circuit with the dynamo as to produce a substantially supernormal magnetic field for the production of a high torque for starting of the engine, means for reducing the field strength and maintaining it relatively normal when the dynamo is driven by the engine, and means for bringing the accumulator into receptive charging circuit with the dynamo and dependent for operation upon rise of voltage in the generative winding of the dynamo.

21. In a power system for autovehicles, the combination with a combustion engine, of a dynamo having field winding, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, current using equipment, means for so bringing the accumulator into circuit with the dynamo as to create a strong magnetic field for the production of a high torque for starting of the engine, and for electrically excluding the current using equipment during driving of the engine by the dynamo, means including a portion of the field winding, for varying the magnetic field strength when the dynamo is driven by the engine, and means for bringing the accumulator into receptive charging circuit with the dynamo.

22. In a power system for autovehicles, the combination with a combustion engine, of a dynamo, having field winding, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, current using equipment, means for so bringing the accumulator into circuit with the dynamo as to create a strong magnetic field for the production of a high torque for starting of the engine, and for electrically excluding the current using equipment during driving of the engine by the dynamo, means including a portion of the field winding, for varying the magnetic field strength when the dynamo is driven by the engine, means for bringing the accumulator into receptive charging circuit with the dynamo and dependent for operation upon the voltage in the field winding.

23. In a power system for autovehicles, the combination with a combustion engine, of a dynamo having field winding, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, current using equipment, means for so bringing the accumulator into circuit with the dynamo as to create a strong magnetic field for the production of a high torque for starting of the engine, and for excluding the current using equipment during driving of the engine by the dynamo, means including a portion of the field winding, for varying the magnetic field strength when the dynamo is driven by the engine, and means for bringing the accumulator into and out of receptive charging circuit with the dynamo.

24. In a power system for autovehicles, the combination with a combustion engine, of a dynamo having field winding, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, current using equipment, switch means for so bringing the accumulator into circuit with the dynamo as to create a strong magnetic field for the production of a high torque for starting of the engine, and for electrically excluding the aforesaid equipment during driving of the engine by the dynamo, means including a portion of the field winding, for varying the magnetic field strength when the dynamo is driven by the engine, means coöperating with said switch means for bringing the current using equipment into circuit with the accumulator, and apparatus for bringing the accumulator into and out of receptive charging circuit with the dynamo.

25. In a power system for autovehicles, the combination with a combustion engine,

of a dynamo having field winding, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, current using equipment, switch means for so bringing the accumulator into circuit with the dynamo as to create a strong magnetic field for the production of a high torque for starting of the engine, and for electrically excluding the current using equipment during driving of the engine by the dynamo, means including a portion of the field winding, for varying the magnetic field strength when the dynamo is driven by the engine, means for bringing the current using equipment into circuit with the accumulator, and apparatus for bringing the accumulator into and out of receptive charging circuit with the dynamo, and dependent for operation upon the voltage in the field winding.

26. In a power system for autovehicles, the combination with a combustion engine, of a dynamo having field winding and inductive winding, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, means for bringing the accumulator into circuit with the field winding for creating a strong magnetic field for the production of a high torque for starting of the engine, and means for lowering the field strength and maintaining it relatively normal and including a portion of the field winding brought into circuit with the inductive winding, when the dynamo is driven by the engine.

27. In a power system for autovehicles, the combination with a combustion engine, of a dynamo having field winding and inductive winding, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, means for bringing the accumulator into circuit with the field winding, for creating a strong magnetic field for the production of a high torque for starting of the engine, and means for lowering the field strength and maintaining it relatively normal and including a portion of the field winding brought into circuit with the inductive winding and adapted to be brought into circuit with the accumulator, when the dynamo is driven by the engine.

28. In a power system for autovehicles, the combination with a combustion engine, of a dynamo having field exciting means including field winding and having inductive generative winding, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, current using equipment, means for bringing the accumulator into circuit with the field winding, to create a substantially supernormal magnetic field for the production of a high torque for starting of the engine, and for varying the field strength, means for electrically excluding the aforesaid equipment during driving of the engine by the dynamo, and means for bringing the equipment into circuit with the generative winding of the dynamo when the latter is driven by the engine.

29. In a power system for autovehicles, the combination with a combustion engine, of a dynamo having field exciting means, including field winding, and having inductive generative winding, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, current using equipment, means for bringing the accumulator into circuit with the field winding, to create a substantially supernormal magnetic field for the production of a high torque for starting of the engine, and for electrically excluding the aforesaid equipment during driving of the engine by the dynamo, and means for bringing the equipment into circuit with the generative winding of the dynamo and the accumulator when the dynamo is driven by the engine.

30. In a power system for autovehicles, the combination with a combustion engine, of a dynamo having field winding, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, means for bringing the accumulator into circuit with field winding to create a strong magnetic field for the production of a high torque for starting of the engine, current using equipment, means whereby the accumulator and the equipment may be brought into circuit with a portion of said field winding during driving of the dynamo by the engine, and means for bringing the accumulator into and out of receptive charging circuit with the dynamo.

31. In a power system for autovehicles, the combination with a combustion engine, of a dynamo having field winding, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, means whereby the accumulator may be brought into series with the field winding, to create a strong magnetic field for the production of a high torque for starting of the engine, and means whereby the accumulator may be brought into circuit with only a portion of the said field winding during driving of the dynamo by the engine.

32. In a power system for autovehicles, the combination with a combustion engine, of a dynamo having field winding, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, current using equipment, means whereby the accumulator may be brought into series with the field winding, to create a strong magnetic field for the production of a high torque for starting of the engine,

and means whereby the accumulator may be brought into multiple with a portion of the field winding and with the aforesaid equipment, during driving of the dynamo by the engine.

33. In a power system for autovehicles, the combination with a combustion engine, of a dynamo having series field winding, an inductive winding and a field winding shunted across said inductive generative winding, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, means for so bringing the accumulator into circuit with series field winding as to cause a current flow therethrough unidirectional with that in the shunt winding, for creating a substantially supernormal magnetic field for the production of a high torque for starting of the engine, and means for varying the field strength when the dynamo is driven by the engine, and including circuit connections for causing current to flow from the generative winding through only a part of the series field winding.

34. In a power system for autovehicles, the combination with a combustion engine, of a dynamo having series field winding, an inductive winding and a field winding shunted across said inductive generative winding, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, means for so bringing the accumulator into circuit with series field winding as to cause a current flow therethrough unidirectional with that in the shunt winding, for creating a substantially supernormal magnetic field for the production of a high torque for starting of the engine, and means for varying the field strength when the dynamo is driven by the engine, and including circuit connections for causing current to flow from the generative winding through a portion of the series field winding in a direction opposite to that of the current flow in the shunt winding.

35. In a power system for autovehicles, the combination with a combustion engine, of a dynamo having series field winding, an inductive winding and a field winding shunted across said inductive generative winding, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, current using equipment, means for so bringing the accumulator into circuit with series field winding as to cause a current flow therethrough unidirectional with that in the shunt winding, for creating a substantially supernormal magnetic field for the production of a high torque for starting of the engine, means for lowering the field strength when the dynamo is driven by the engine, and including circuit connections for causing current to flow from the generative winding through only a part of the series field winding, and means for bringing the aforesaid equipment into circuit with the accumulator.

36. In a power system for autovehicles, the combination with a combustion engine, of a dynamo having series field winding, an inductive winding and a field winding shunted across said inductive generative winding, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, current using equipment, means for so bringing the accumulator into circuit with series field winding as to cause a current flow therethrough unidirectional with the current flow in the shunt winding, for creating a strong magnetic field for the production of a high torque for starting of the engine, means for varying the field strength when the dynamo is driven by the engine, and including circuit connections for causing current to flow from the generative winding through a portion of the series field winding in a direction opposite to that of current flow in the shunt winding, and means for bringing the aforesaid equipment into circuit with the accumulator.

37. In a power system for autovehicles, the combination with a combustion engine, of a dynamo having series field winding, an inductive winding and a field winding shunted across the inductive generative winding, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, current using equipment, means for so bringing the accumulator into circuit with series field winding as to cause a current flow therethrough unidirectional with the current flow in the shunt winding, for creating a strong magnetic field for the production of a high torque for starting of the engine, means for varying the field strength when the dynamo is driven by the engine, and including circuit connections for causing current to flow from the generative winding through a portion of the series field winding in a direction opposite to that of current flow in the shunt winding, and means for bringing the accumulator into and out of receptive charging circuit with the generative winding of the dynamo during driving of the dynamo motor by the engine.

38. In a power system for autovehicles, the combination with a combustion engine, of a dynamo having series field winding, an inductive generative winding, and a field winding shunted across said inductive winding, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, current using equipment, means for so bringing the accumulator into circuit with series field winding as to

cause a current flow therethrough unidirectional with the current flow in the shunt winding, for creating a strong magnetic field for the production of a high torque for starting of the engine, means for varying the field strength when the dynamo is driven by the engine, and including circuit connections for causing current to flow from the generative winding through a portion of the series field winding in a direction opposite to that of current flow in the shunt winding, means for bringing the aforesaid equipment into circuit with the accumulator and apparatus whereby said accumulator may be brought into and out of receptive charging circuit with the generative winding of the dynamo during driving thereof by the engine.

39. In a power system for autovehicles, the combination with a combustion engine, of a dynamo having a plurality of series field windings, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, means for so bringing the accumulator into circuit with the series field windings, as to create a substantially supernormal magnetic field for the production of a high torque for starting of the engine, and means for varying the field strength when the dynamo is driven by the engine, and including circuit connections for excluding from field exciting service one of said series field windings and a portion of another of said series field windings, during driving of the dynamo by the engine.

40. In a power system for autovehicles, the combination with a combustion engine, of a dynamo having a plurality of series field windings, an inductive generative winding, and a field winding shunted across said inductive winding, mechanism for so connecting the dynamo and engine that each may actuate the other, an accumulator, means for so bringing the accumulator into circuit with the series field windings as to cause a current flow therethrough unidirectional with that in the shunt winding, for creating a strong magnetic field for the production of a high torque for starting of the engine, and means for varying the field strength when the dynamo is driven by the engine, and including circuit connections for causing current to flow from the generative winding through a minor portion of the series field windings.

41. In a power system for autovehicles, the combination with a combustion engine, of a dynamo, mechanism for so connecting the dynamo and engine that each may actuate the other, controlling means for bringing the dynamo out of engine actuating relationship at a predetermined time, means associated with the connecting mechanism for creating in the dynamo a substantially supernormal field strength for the production of a high engine starting torque, and means associated with the controlling means, for varying the field strength when the dynamo is driven by the engine.

42. In a power system for autovehicles, the combination with a combustion engine, of a dynamo, mechanism for so connecting the dynamo and engine that each may actuate the other and including engine starting mechanism, controlling means for effecting disconnection of the dynamo and starting mechanism at a time substantially coincident with assumption of self-propulsion of the engine, means for creating in the dynamo a substantially supernormal field strength for the production of a high engine starting torque, and associated with said connecting mechanism, and means for varying the magnetic field strength and associated with said controlling means.

43. In a power system for autovehicles, the combination with a combustion engine, of a dynamo, mechanism including a manually actuable clutch device for so connecting the dynamo and engine that the dynamo may operate to start the engine, means whereby the engine may actuate said dynamo, means for automatically releasing said manual means, and means under control of the engine for preventing connection of the dynamo with the engine in engine starting capacity during actuation of said dynamo by the engine.

44. In a power system for autovehicles, the combination with a combustion engine, of a dynamo, mechanism including a manually actuable clutch device for connecting the dynamo and engine so that the former may start the engine, means whereby the engine may drive the dynamo, controlling means for automatically bringing the dynamo out of starting relationship and into receptive driving relationship, and means under control of the engine for preventing starting connection of the dynamo and engine during driving of the former by the latter.

45. In a power system for autovehicles, the combination with a combustion engine having a crank shaft, of a dynamo, mechanism for connecting the dynamo and engine whereby the former may start the latter and the engine may drive the dynamo, controlling means for bringing the dynamo out of starting relationship with the engine, at a predetermined time with respect to angular position of the engine crank shaft, and means for preventing engine starting connection of the dynamo and engine during driving of the said dynamo by the engine.

46. In a power system for autovehicles, the combination with the crank shaft of a combustion engine, of a dynamo, mechanism including a manually actuable gear shifting

device connecting said dynamo and one end of the crank shaft, for causing the dynamo to start the engine and the latter to drive the dynamo subsequently to starting of the engine, and means under control of the engine for preventing starting connection of the dynamo and engine crank shaft after the dynamo has been brought out of engine starting relationship and is being driven by the engine.

In testimony whereof I have hereunto set my hand.

RICHARD VARLEY.

Witnesses:
MARY A. BARTH,
M. A. KELLER.

Corrections in Letters Patent No. 1,129,147.

It is hereby certified that in Letters Patent No. 1,129,147, granted February 23, 1915, upon the application of Richard Varley, of Englewood, New Jersey, for an improvement in "Power Systems for Autovehicles," errors appear on the drawings requiring correction as follows: Sheet 8, Fig. 12, one of the reference-numerals *105* is missing, and the lead line to this numeral is erroneously shown leading to and connecting with one of the circuits; and that the drawings should be read with these corrections therein, that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 30th day of March, A. D., 1915.

[SEAL.]

J. T. NEWTON,

Acting Commissioner of Patents.