W. H. SCOTT.

ELECTRIC STARTER FOR INTERNAL COMBUSTION ENGINES.

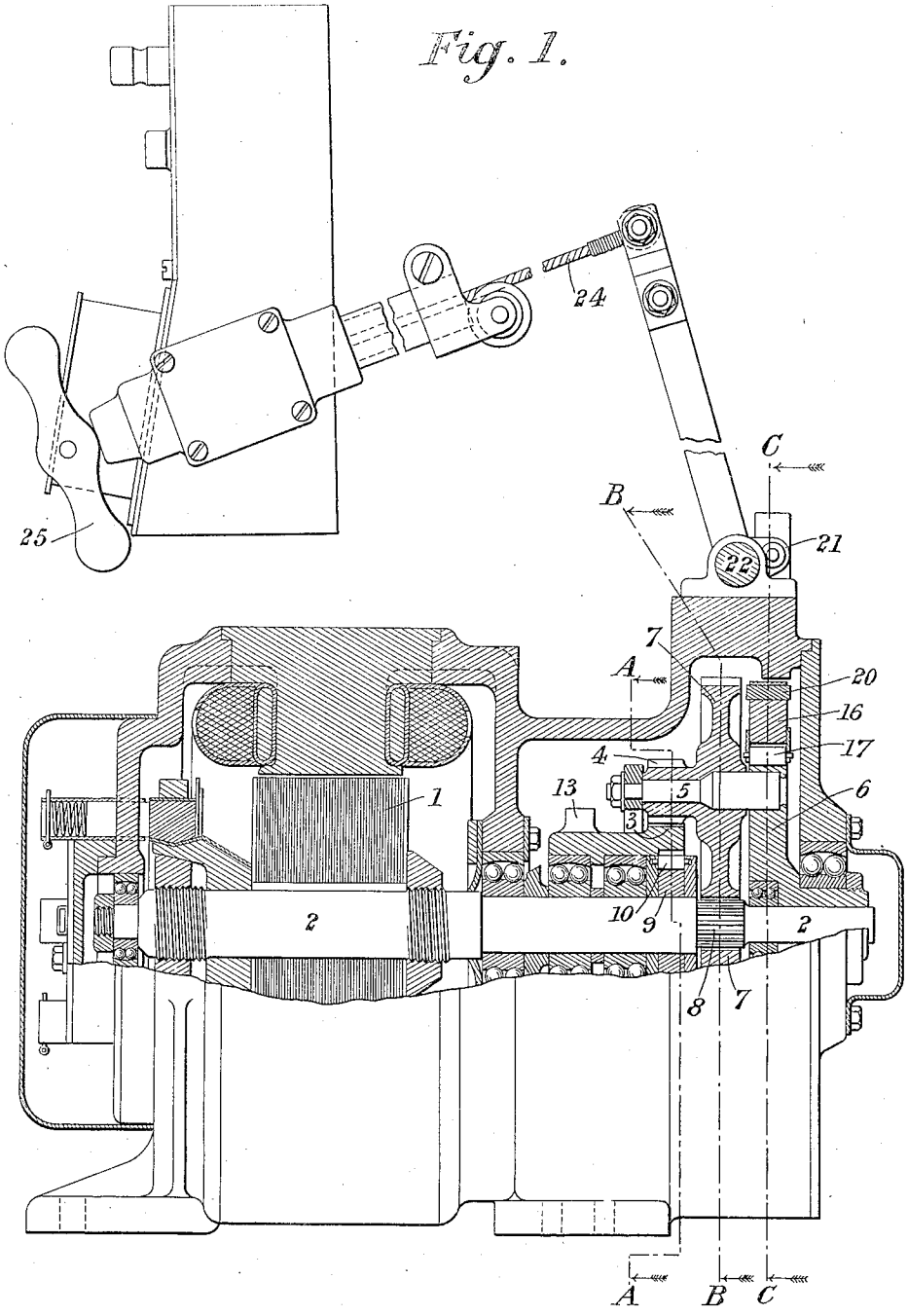
APPLICATION FILED MAY 9, 1913.

1,104,710.

Patented July 21, 1914.

5 SHEETS—SHEET 1.

Fig. 1.



WITNESSES

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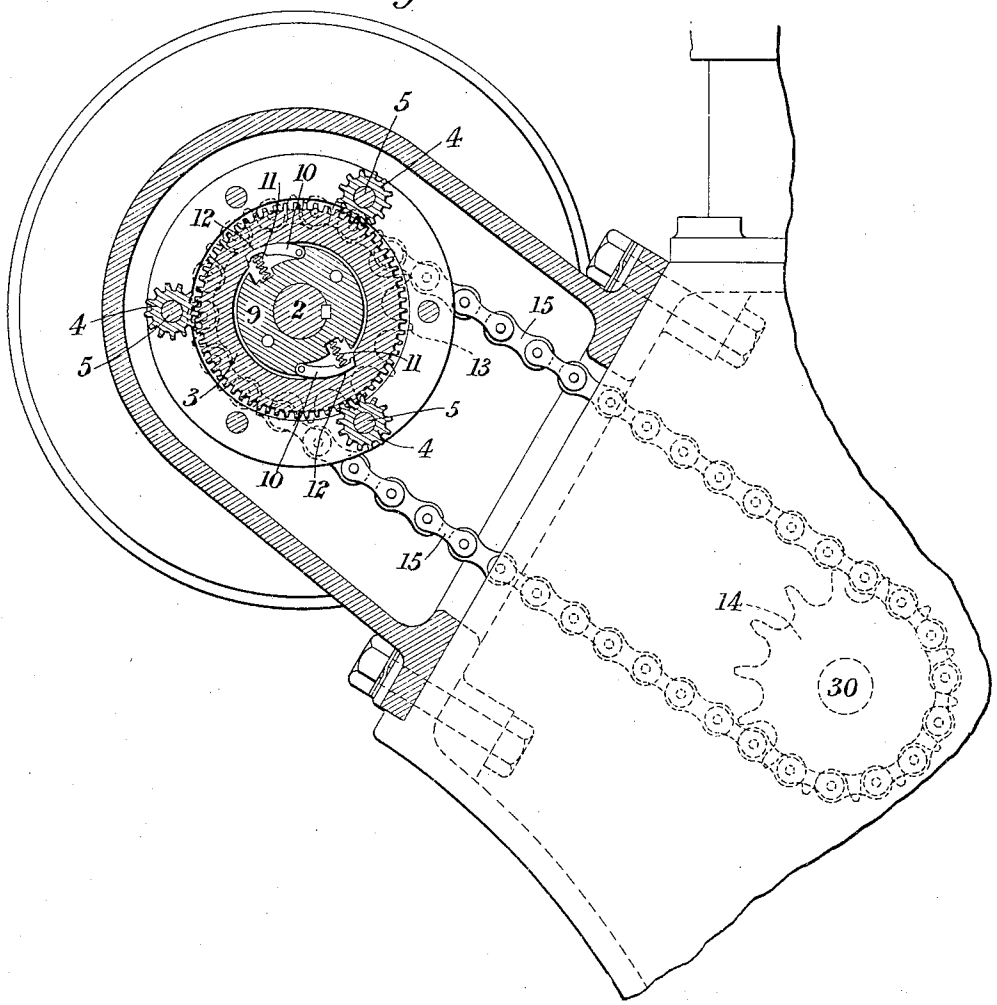
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5 SHEETS—SHEET 2.

Fig. 2.



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5 SHEETS—SHEET 3.

Fig. 4.

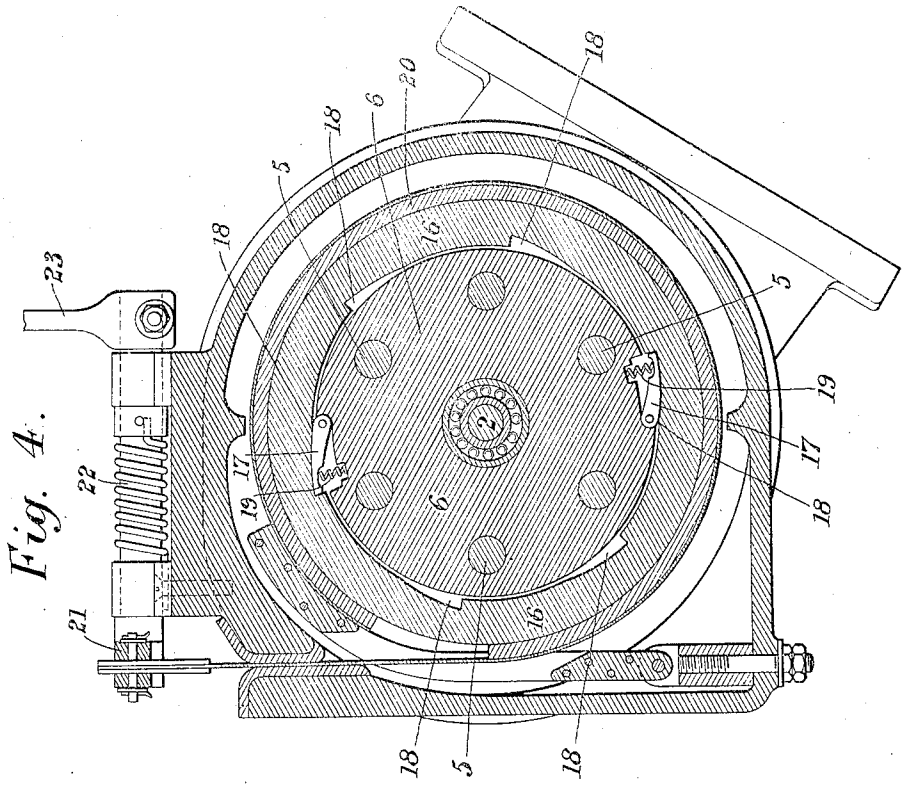
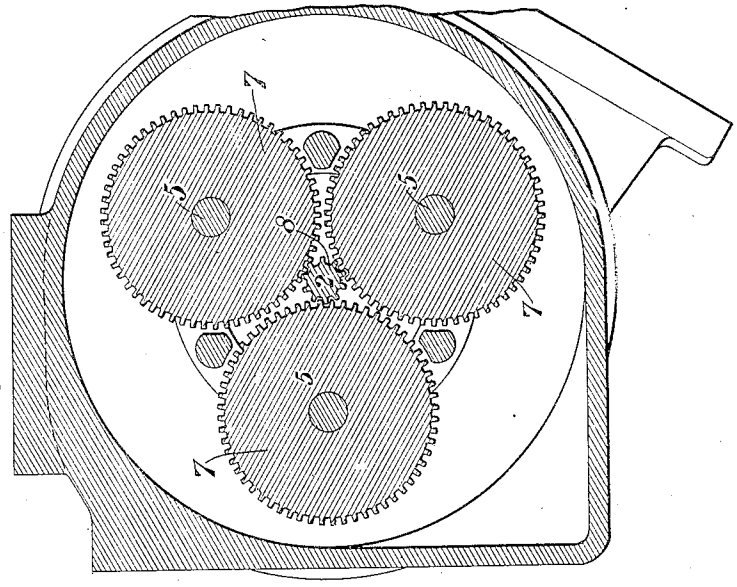


Fig. 3.



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5 SHEETS—SHEET 4.

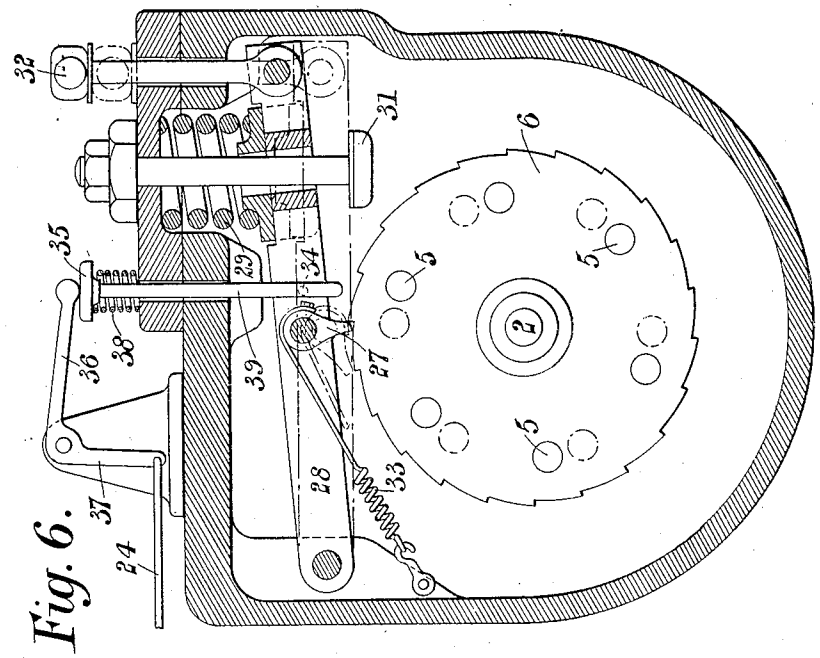


Fig. 6.

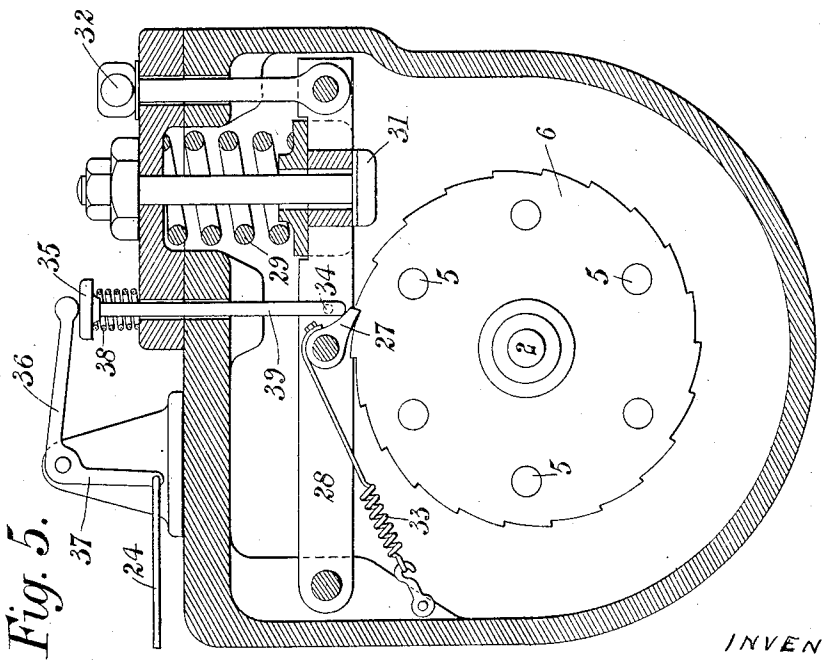


Fig. 5.

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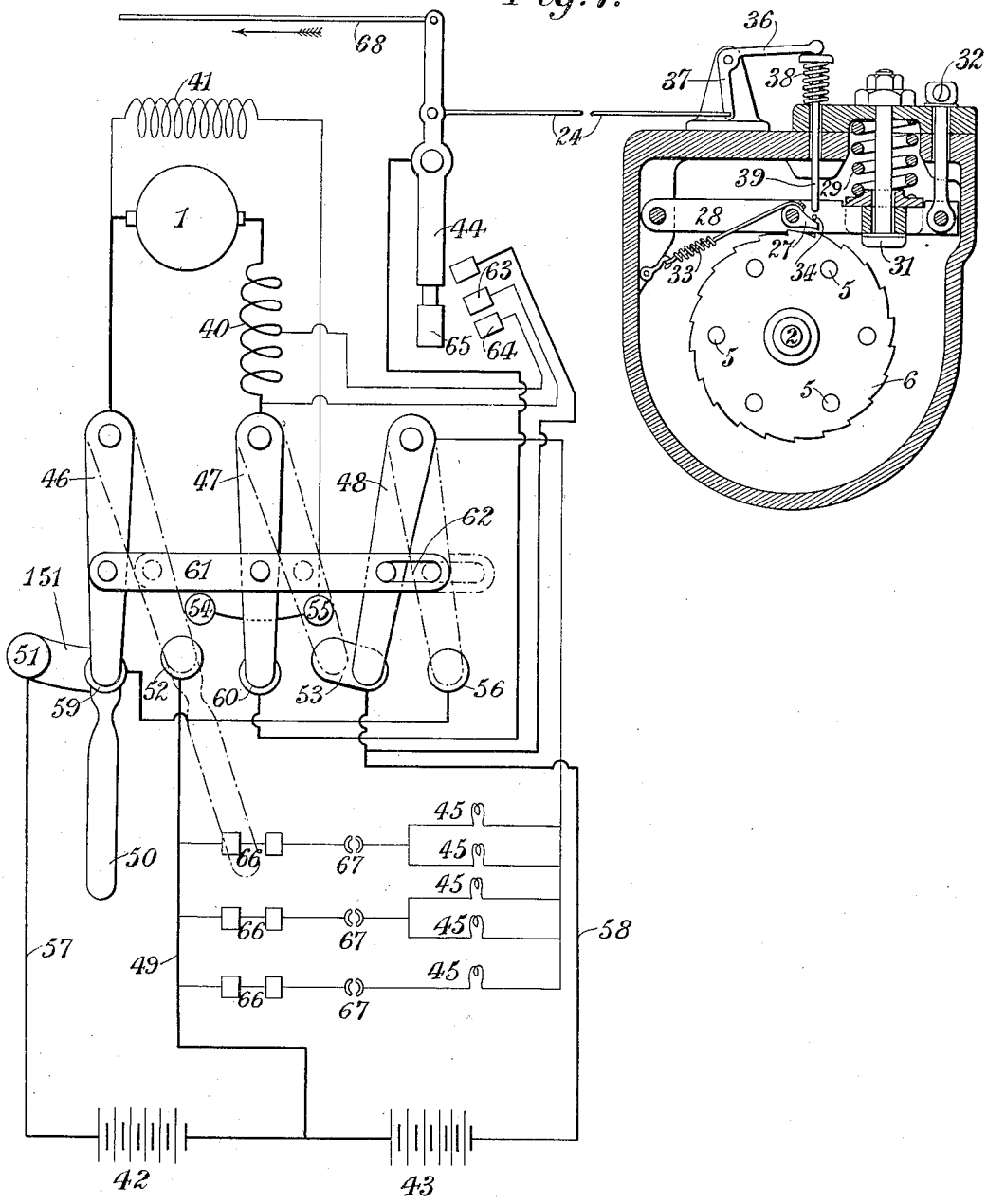
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5 SHEETS—SHEET 5.

Fig. 7.



WITNESSES

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UNITED STATES PATENT OFFICE.

WILLIAM HARDING SCOTT, OF NORWICH, ENGLAND.

ELECTRIC STARTER FOR INTERNAL-COMBUSTION ENGINES.

1,104,710. Specification of Letters Patent. Patented July 21, 1914.

Application filed May 9, 1913. Serial No. 766,602.

To all whom it may concern:

Be it known that I, WILLIAM HARDING SCOTT, a subject of the King of Great Britain, residing at Gothic Works, Norwich, in the county of Norfolk, England, have invented new and useful Improvements in Electric Starters for Internal-Combustion Engines, of which the following is a specification.

The object of this invention is to provide improved means for starting internal combustion engines (more especially those of motor cars, or the like) by means of a dynamo-electric machine which, when the engine is working normally, is driven by the engine for generating electricity to be stored and used, as required, for lighting, or other purposes, the said means being of the kind in which an epicyclic gear is employed to transmit rotary motion at the requisite speed from the dynamo-electric machine shaft to the engine shaft to start the engine and when the said engine is properly started to transmit rotary motion at the requisite speed from the engine shaft to the dynamo-electric machine shaft, the said epicyclic gear having two clutches, one for preventing the rotation of the gearing in a backward direction and one for preventing the rotation of the sun wheel of the said gear when the dynamo-electric machine is starting the engine.

According to my invention I employ an arrangement of gear as hereinafter described for transmitting rotary motion, at the requisite speed, from the dynamo electric machine shaft to the engine shaft to start the engine, and, when the said engine is properly started for transmitting rotary motion at the requisite speed from the engine itself to the dynamo electric machine shaft, the said gear comprising an improved epicyclic arrangement having combined therewith two clutches one of which is arranged between the dynamo electric machine shaft and the central, or sun wheel, of the epicyclic gear and adapted to free the said central, or sun wheel, from the dynamo electric machine shaft when the dynamo electric machine is starting the engine and to clutch the said central, or sun wheel, to the dynamo electric machine shaft when the dynamo electric machine is operated as a generator. The other of the said clutches is arranged between the housing, or disk, carrying the planet wheels of the epicyclic gear and a yielding braking device and adapted to clutch the said housing, or disk, to the braking device when the engine is being started and to free the said housing, or disk, from the braking device when the engine is properly running the yielding braking device being so adapted that the speed at which the engine shaft is caused to rotate to start the engine can be controlled thereby and should back-fire occur the said brake is caused to be released and the epicyclic gear to be inoperative.

I will now particularly describe my invention with reference to the accompanying drawings in which—

Figure 1 shows in elevation, with parts in section, a dynamo-electric machine provided with transmitting gear and means for controlling it in accordance with my invention. Figs. 2, 3 and 4 are transverse sections taken respectively on the lines A A, B B, and C C, Fig. 1. Figs. 5 and 6 show in transverse section, in different positions, a modification of the braking device shown in Figs. 1 and 4. Fig. 7 is a diagram showing the electrical connections between the accumulator cells and the dynamo-electric machine and the controlling switches therefor.

The dynamo-electric machine 1 has combined therewith epicyclic gear so arranged that for the purpose of starting the engine rotary motion is transmitted from the shaft 2 of the said dynamo-electric machine to the engine shaft 30 at a properly reduced speed but as soon as the engine fires, however, it drives the dynamo-electric machine direct as a generator at the engine speed, or at other desired speed.

The arrangement of epicyclic gear employed comprises a central, or sun, wheel 3, mounted on the dynamo-electric machine shaft 2, and planet wheels 4 which gear with the said central, or sun wheel 3, the said planet wheels 4 being rotatably mounted on spindles 5 fixed in a housing, or disk 6, rotatably mounted on the dynamo-electric machine shaft 2. Formed in one with, or fixed to, the planet wheels 4 are larger planet wheels 7 which gear with a pinion 8 secured to, or formed on, the said shaft 2. Between the central, or sun, wheel 3 and a disk 9, secured to the shaft 2, is a clutching device which in accordance with the direction of rotation of the said parts either clutches, the said central, or sun, wheel to, or frees it from, the said shaft 2. Any suit-

able clutching devices may be employed, such for instance as those commonly known as "free-wheel" clutches. The one illustrated consists of pawls 10 hinged to the disk 9 and at the proper time caused by springs 11, to engage with ratchet shaped recesses 12 formed in the central, or sun, wheel 3. Formed in one with, or fixed to, the central, or sun, wheel 3, is a sprocket wheel 13, and a sprocket wheel 14 is secured to the engine shaft 30, a chain 15 transmitting rotary motion from one sprocket wheel to the other.

I arrange the housing, or disk, 6, so that it is free to rotate in the direction in which the engine runs, that is, clockwise as viewed in Fig. 4, but is checked, or can be checked in the opposite direction, that is counter-clockwise in the arrangement illustrated. The housing, or disk 6, being prevented from rotating in the direction opposite to that of the dynamo-electric machine the said dynamo electric machine will, for starting the engine, drive through the epicyclic gear until the engine fires and starts.

When the dynamo-electric machine is starting the engine the central, or sun, wheel 3, is free but when the engine is started and running normally the said central, or sun, wheel is clutched to the disk 9 and the engine drives, at the requisite speed, the dynamo-electric machine as a generator, the whole of the epicyclic being then locked and the housing, or disk, 6, being free in this direction, also rotates in the same direction.

In case of back-fire in the engine there is a tendency to drive the housing, or disk 6, in the same direction as that for starting the engine that is, counter-clockwise as viewed in Fig. 4 and, to prevent damage being done I provide a braking device which, by yielding pressure, (such as by a spring, or by the foot, or hand), prevents, or retards, the rotation of the housing, or disk 6, when the engine is started but is arranged so that while the force exerted for starting is easily resisted, yet on back-fire occurring the resistance is overcome and breakage prevented. This can be effected, as shown in Figs. 1 and 4 by a ring 16 mounted on the periphery of, and capable of clutching with, the housing, or disk 6, and I provide this ring with a band 20 or other suitable brake of a type in which the resistance to braking tends to throw the brake off. For starting the engine, the brake is held on by a spring, or by foot, or hand, pressure, or any suitable means which will hold against the starting effect but not against back-fire. By this band, or equivalent, brake arrangement, the speed of the housing, or disk 6, can be gradually checked and the power of the dynamo-electric machine be gradually applied for starting the engine while the said housing, or disk, is free to rotate in the direction of the engine, that is clockwise in the arrangement illustrated. Any suitable means may be employed which will clutch the housing, or disk 6, to the ring 16 when rotating in one direction and be free when rotating in the opposite direction, such for example as what are known as "free-wheel" arrangements. In the drawings, pawls 17 are shown hinged to, or otherwise carried by, the said housing, or disk, which are caused, by springs 19, to enter ratchet shaped recesses 18 formed in the said ring 16. The band 20 is shown in the said Fig. 4 encircling the greater part of the said ring 16 and it has one end connected to the gear casing and the other end connected to a lever 21 secured to a rocking shaft 22 mounted in bearings on the said gear casing, the said rocking shaft having secured thereto a lever 23 which is connected by a flexible connection, such for instance as a cord 24, to a handle 25, situated on the dashboard of the car, or in other position easily accessible for manipulation by the driver, so that by pulling the said handle, the band 20 can be applied to the ring 16 with any desired degree of braking pressure. Any forcible tendency for the housing, or disk 6, to rotate in the wrong direction, that is, counter-clockwise, which would occur upon the engine back-firing, causes the ring 16 to ease off the said brake owing to the pull in this direction acting against and overcoming, or partially overcoming, the yielding pressure of the hand or foot, or spring, which held the band 20 onto the said ring 16.

As regards the generation, storing and utilization, of electricity I may employ, for example, twelve accumulator cells which are all put in series for driving the dynamo-electric machine for starting the engine and which are put in three groups in parallel when the said motor is running as a generator, and I may employ a switch which is normally held in such position that the said cells are put in groups in parallel as aforesaid but which can be removed, for example by the handle 25, in opposition to the action of a spring, into a position whereby they are all put in series, and I also prefer to arrange the switch so that the said handle 25 can be pulled to apply the band-brake 20 only when the said switch is in the series position. It is preferred, however, to arrange the accumulator cells in two batteries, each battery being charged at a time and to arrange switch-gear so that, although for starting the engine by the dynamo-electric machine all the cells are used, for generating one battery of cells is first charged and then the other battery, the lighting, or the like, being obtained from the battery which is not being charged.

The operation of the parts for starting the engine from the dynamo-electric machine

1, and after the engine has been started, to drive the said dynamo-electric machine so that it operates as a generator, is as follows:— The handle 25 is turned in the proper direction to put the accumulator cells in series and to complete the electric circuits whereby the motor 1 and its shaft 2, are caused to rotate in a clockwise direction. The rotation of the motor shaft 2 tends, by its pinion 8, to rotate the planet wheels 7 and 4 but their housing or disk 6, being, at this time, free to rotate and the central, or sun, wheel 3, offering resistance to rotation the said planet wheels 4 and 7 are caused to revolve around the central, or sun, wheel 3, and the pinion 8, respectively, and the housing, or disk, to rotate on the shaft 2, all in a counter-clockwise direction. The electric motor and the epicyclic train now running freely, that is, with no load, the handle 25 is pulled in the direction to apply the band-brake 20 gradually to the ring 16 whereupon the rotation of the housing or disk 6, is retarded, or prevented, according to the degree of pressure applied, so that the central, or sun, wheel 3, now offers less resistance to rotation than the housing, or disk 6, and is rotated by the planet wheels 4 in the same direction as the dynamo-electric machine shaft, that is, in a clockwise direction which rotation is transmitted, by the sprocket wheels 13 and 14 and chain 15, to the driving shaft 30, of the engine which is thereby started. The diameters of the wheels of the epicyclic train, the pinion, and the sprocket wheels are such that when the rotation of the housing, or disk 6, is entirely prevented by the band-brake 20 the engine shaft 30 is rotated by the dynamo-electric machine at a speed considerably less than that of the dynamo-electric machine shaft 2, and in accordance with the amount of rotation of the housing, or disk 6, which may be permitted by the band-brake 20, the speed of rotation of the said engine shaft will be proportionately further reduced. The engine after being started by the dynamo-electric machine fires, and then runs at a higher speed than the dynamo-electric machine and, by the sprocket wheels 14 and 13 and chain 15 transmits motion to the central, or sun, wheel 3 which then clutches with the disk 9 secured to the dynamo-electric machine shaft 2 and thereby drives the said dynamo-electric machine direct at engine speed, presuming the sprocket wheels 13 and 14 to be of the same diameter. The central or sun, wheel 3 and the pinion 8 now rotating at a higher speed than when the dynamo-electric machine was acting to start the engine, but being of different diameters tend to rotate their respective engaging planet wheels at proportionately different speeds which causes the said wheels to be locked so that the whole epicyclic train and the housing, or disk 6, rotate with the dynamo-electric machine shaft, the clutch device on the said housing, or disk, permitting, as before mentioned, the rotation of the housing, or disk, in the same direction as the dynamo-electric machine shaft. The speed at which the dynamo-electric machine now runs is the proper speed for generating electricity.

I do not limit myself to the precise details of construction and arrangements hereinbefore described with reference to the accompanying drawings as they may be modified without departing from the nature of my invention, for instance, instead of employing the arrangement hereinbefore described and illustrated for preventing the rotation of the housing, or disk 6, in a counter-clockwise direction under normal conditions for starting the engine, but which will permit of the rotation of the said housing, or disk, in the said counter-clockwise direction upon the engine back-firing, the arrangement shown in Figs. 5 and 6 of the accompanying drawings may be employed. In this arrangement the housing, or disk, 6, is, under normal engine-starting conditions, prevented from rotating in a counter-clockwise direction by a pawl 27 engaging ratchet teeth formed on the periphery of the said housing, or disk. The pawl 27 is suitably mounted between a pair of arms (only one, 28, of which is shown in the said Figs. 5 and 6) pivoted, at one end, to the gear casing the other end of the said arms being forced down by a spring 29 onto a stop 31. This spring 29 is of such strength that the ordinary thrust on the pawl 27 that occurs when starting the engine does not affect the parts, but when a severe thrust caused by back-fire occurs the ratchet tooth with which the pawl 27 engages acts to turn the pawl out of engagement therewith so that the said housing, or disk, is freed. To permit of this turning movement of the pawl 27 the free end of the arms 28 is raised in opposition, to the spring 29, which is effected by the ratchet tooth through the pawl. When the pawl has turned past its dead center the arms 28 return by the action of the spring 29, and again bear upon the stop 31.

Fig. 6 shows, in full lines, the pawl 27 partly turned and the arm 28, raised, and, in dot and dash lines, the said pawl completely turned and the said arm returned and again bearing upon its stop 31. In order that the pawl 27 may again be brought into engagement with the ratchet teeth the arms 28 are raised by the driver, a handle 32, connected to the free end of the arms being provided for this purpose, whereupon the pawl, under the action of a comparatively weak spring 33, returns to its normal position. Under ordinary running conditions the spring 33 normally holds the pawl 27

against stops 34 (one on the inner side of each of the arms 28) and out of engagement with the ratchet teeth. The pawl is pushed into engagement with one of the ratchet teeth when starting the engine by a rod, or bar, 39, the lower end passing between the stops 34 and the upper end projecting through the gear casing and provided with a head 35 upon which one arm 36 of a bell-crank lever bears, the other arm 37 of which is connected, by a flexible connection, 24, to an operating handle, such for example as that, 25, shown in Fig. 1, so that upon the handle being pulled by the driver, the said rod, or bar, 39, descends, in opposition to the action of a spring 38, and its lower end pushes the pawl into engagement with one of the ratchet teeth as aforesaid. Upon the release of the operating handle the rod, or bar, 39, under the action of its spring, 38, ascends and permits the pawl 27, under the action of its spring 33, to disengage from the said ratchet teeth and bear upon the stops 34 on the arms 28.

Fig. 7 of the accompanying drawings illustrates diagrammatically the preferred arrangement of accumulator cells in two batteries hereinbefeore referred to, and their connections and controlling switch-gear. The dynamo-electric machine 1 is differentially wound for generating with both series and shunt windings, the series winding 40 being arranged and proportioned so that it opposes the shunt winding 41 when generating. The batteries 42 and 43 of accumulator cells are connected in series when the electric motor 1 is starting the engine, and when desired a part of the series winding 40 can be "cut out" or "short-circuited" by a starting switch 44 as hereinafter described. I place the lamps 45 on either one or other of the two batteries 42 or 43 and connect the dynamo-electric machine, for generating, onto the other battery, so that the lamps 45 are always lighted by the battery that is not being charged and so are not liable to be overrun during the charging of the other battery. This is effected by means of a switch comprising three arms 46, 47, and 48, connected by a link 61, the arms 46 and 47 being in electrical connection at their pivoted ends with the dynamo-electric machine 1, as shown, and the arm 48 being similarly connected, through the lamps 45, to a common main 49 of the batteries 42 and 43. When the operating handle 50 on the arm 46 is moved to the left electrical connection is made between the dynamo-electric machine 1 and the battery 42 by the arms 46 and 47 engaging with contact pieces 51 and 52 respectively, the contact piece 52 being connected to the common main 49 of the batteries, and when the said handle 50 is moved to the right electrical connection is made between the said dynamo-electric machine and the battery 43, by the arms 46 and 47, engaging with the aforesaid contact piece 52 and a contact piece 53 respectively, as shown in dot and dash lines. In either of these positions the shunt winding 41 is in electrical connection with one, or the other, of the batteries by the arm 47 engaging with one, or the other, of two contact pieces 54, or 55, and both of these extreme right and left positions are generating positions.

In moving the switch arms 46 and 47 from right to left, or from left to right, as aforesaid, the lamp switch arm 48 is also moved and electrical connection is made with either the battery 42, or the battery 43, by the said arm engaging either with the aforesaid contact piece 53 or with a contact piece 56 to which the outer mains 57 and 58 of the batteries 42 and 43 are respectively connected. The ends of the switch arms 46 and 47 when in their central position, as shown in the diagram, engage with contact pieces 59 and 60, respectively, the contact piece 59 being connected, by a metallic piece 151, the outer main 57 of the battery 42 and the contact piece 60 being through the starting switch 44, connected to the outer main 58 of the battery 43 so that the whole of the accumulator cells of the two batteries are electrically connected with the dynamo-electric machine in readiness for starting the engine which is effected when the starting switch 44 is closed. When the arm 47 is in the aforesaid central position the shunt winding 41 is electrically disconnected from both of the batteries. In moving the operating handle 50 from either of the generating positions to the central position the lamp switch arm 48, owing to a slot 62 provided in the link 61, will remain stationary, but on moving the said handle 50 right over from one generating position to the other generating position, the said arm 48 will be moved over onto one, or other, of the contact pieces 53 or 56, and the lamps 45 will be electrically connected to either of the batteries which at the time is not being charged. As in some cases the series winding for generating has to have more coils than are required when the electric motor is starting the engine means may be provided whereby some of these coils can be "short-circuited" by the starting switch 44, such, for instance, as contact pieces 63 and 64 which can be electrically connected by a suitable piece 65 on the end of the said switch 44. In the diagram the lamp fuses are indicated at 66 and the lamp switches are indicated at 67.

The starting switch 44 is operated from the dash-board preferably by a cord 68, or the like, and the said switch has also connected thereto one end of the cord, or the like, 24, the other end of which is connected to the arm 37 of the bell-crank lever oper-

ating the pawl 27 hereinbefore described with reference to Figs. 5 and 6 of the accompanying drawings, but it will be readily understood that the said switch could be similarly connected to the operating lever 23 of the braking device hereinbefore described with reference to Figs. 1 and 4 of the accompanying drawings.

What I claim is—

1. The combination with an internal combustion engine a dynamo-electric machine driven by the said engine for generating electricity, and epicyclic gearing adapted to transmit motion from the dynamo-electric machine to the internal combustion engine to start the said engine and also adapted when the engine is running, to allow the engine to drive the electric motor at the proper speed for generating; of clutches one of which is arranged between the dynamo-electric machine shaft and the central, or sun, wheel of the epicyclic gearing adapted to free the said central, or sun, wheel from the dynamo-electric machine shaft when the said machine operates to rotate the engine shaft and to clutch the said central, or sun, wheel to the dynamo-electric machine shaft when the said machine is operating as a generator, a support carrying the planet wheels of the epicyclic gearing, a yielding braking device acting conjointly with the other of the said clutches to clutch said support thereto when the engine is being started and adapted to free the said planet wheel support from the braking device when the engine is properly running, substantially as hereinbefore explained.

2. The combination with an internal combustion engine a dynamo-electric machine driven by the said engine for generating electricity, and epicyclic gearing adapted to transmit motion from the dynamo-electric machine to the internal combustion engine to start the said engine and also adapted when the engine is running, to allow the engine to drive the electric motor at the proper speed for generating; of clutches one of which is arranged between the dynamo-electric machine shaft and the central, or sun, wheel of the epicyclic gearing adapted to free the said central, or sun, wheel from the dynamo-electric machine shaft when the said machine operates to rotate the engine shaft and to clutch the said central, or sun, wheel to the dynamo-electric machine shaft when the said machine is operating as a generator, a support carrying the planet wheels of the epicyclic gearing, a yielding braking lever acting conjointly with the other of said clutches to clutch said support thereto when the engine is being started and adapted to free the said planet wheel support, from the braking device when the engine is properly running, together with means in connection with the said braking device to control the speed at which rotary motion is transmitted from the dynamo-electric machine shaft to the engine shaft and on back fire to release said brake whereby the support for the planet wheels of the epicyclic gearing is freed and the said epicyclic gearing rendered inoperative; substantially as hereinbefore described.

3. The combination with an internal combustion engine a dynamo-electric machine driven by the said engine for generating electricity, and epicyclic gearing adapted to transmit motion from the dynamo-electric machine to the internal combustion engine to start the said engine and also adapted when the engine is running, to allow the engine to drive the electric motor at the proper speed for generating; of clutches one of which is arranged between the dynamo-electric machine shaft and the central, or sun, wheel of the epicyclic gearing adapted to free the said central, or sun, wheel from the dynamo-electric machine shaft when the said machine operates to rotate the engine shaft and to clutch the said central, or sun, wheel to the dynamo-electric machine shaft when the said machine is operating as a generator, a support having ratchet teeth and carrying the planet wheels of the epicyclic gearing, a yielding braking device acting conjointly with the other of the said clutches to clutch said support thereto when the engine is being started and adapted to free the said planet wheel support, from the braking device when the engine is properly running, together with a pawl adapted to engage the ratchet teeth on the said planet wheel support to prevent rotation thereof when starting, a pivoted lever carrying said pawl and held by yielding pressure which resists the force exerted for starting but which resistance, should back-fire occur, is overcome and the said lever is turned on its pivot and allows the said pawl to be disengaged from the ratchet teeth of the said planet wheel support, substantially as hereinbefore described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

WILLIAM HARDING SCOTT.

Witnesses:
GILBERT FLETCHER TYRON,
EDWARD GEORGE DAVIES.