Feb. 15, 1927. 1,617,775

W. C. STARKEY

STARTER FOR AUTOMOBILES

Filed May 16, 1925

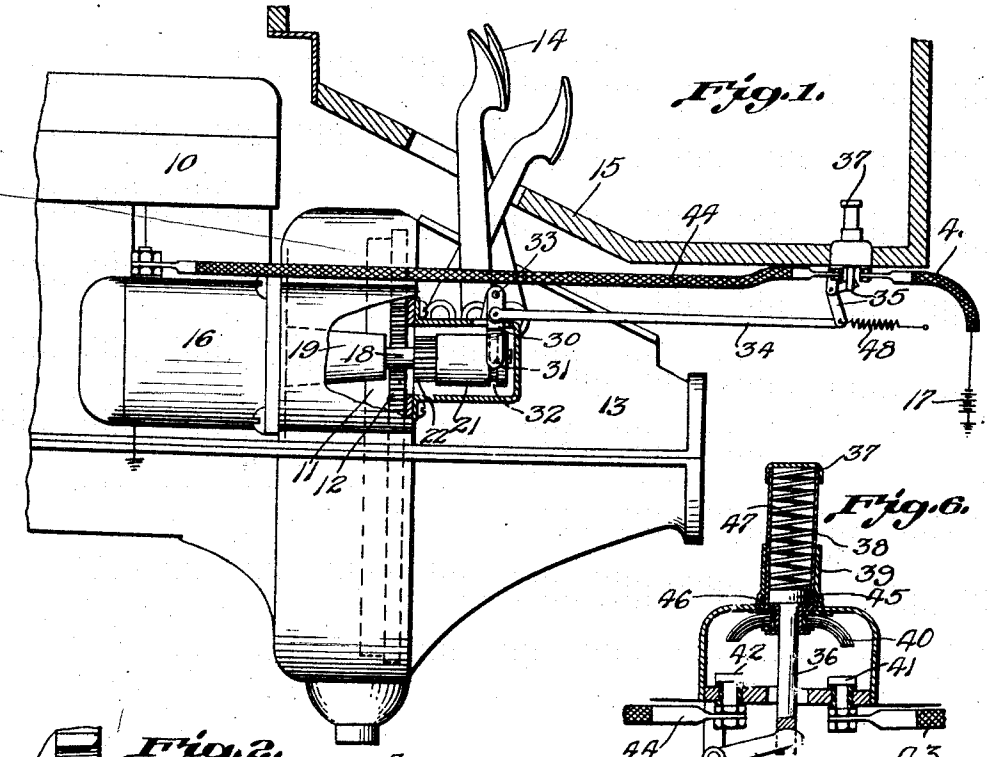


Fig. 1.

Fig. 6.

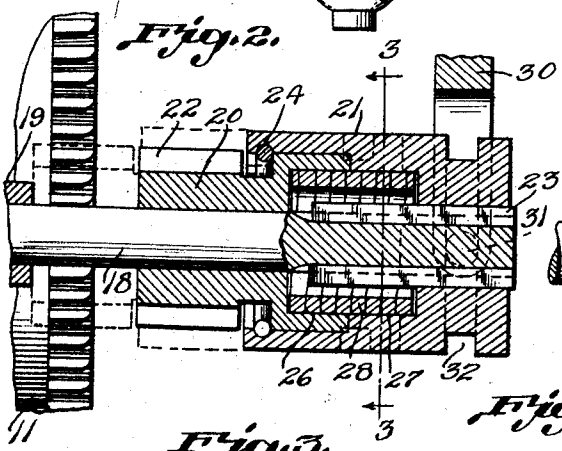


Fig. 2.

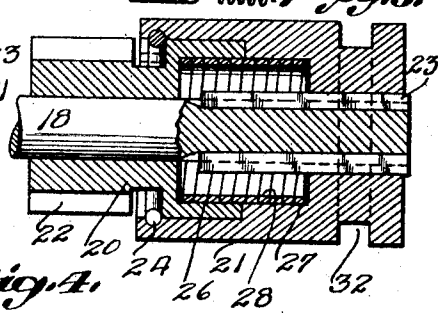
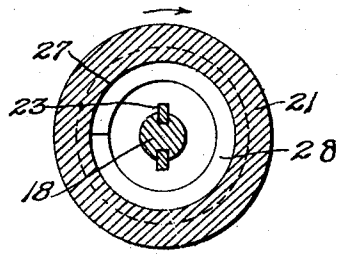


Fig. 5.

Fig. 4.

Fig. 3.





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Patented Feb. 15, 1927. 1,617,775

UNITED STATES PATENT OFFICE.

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STARTER FOR AUTOMOBILES.

Application filed May 16, 1925. Serial No. 30,762.

It is the object of my invention to provide a simple and efficient starting drive for an internal combustion engine, as of an automobile.

More specifically, it is the object of my invention to provide between a starter motor and such an engine a releasable drive which will eliminate strains incident to drives now in common use, by producing a releasable meshing of the motor-driven pinion with a gear on the engine shaft before the motor has gained momentum; which will permit the free overrunning of the motor-driven pinion when the engine starts in operation under its own power, until the motor-driven pnion is demeshed from the engine gear; and which desirably will permit a release of the drive upon excess stress even in the driving direction, so that if a backfire of the engine occurs the starter motor may continue to rotate in its normal or forward direction and thus the strain which is ordinarily put upon the starter motor and other parts upon a backfire is eliminated.

In attaining these objects, I mount on a shaft driven by the starter motor an axially shiftable pinion which by its axial movement may be meshed with and de-meshed from a gear on the engine; and provide this pinion as part of a unit which is shiftable in its entirety along the starter-motor-driven shaft and which embodies a special form of coiled-spring clutch which transmits power from the starter-motor-driven shaft to the pinion in one direction while permitting free overrunning of the pinion when necessary; and desirably make this coiled-spring clutch of such character that the stress which it transmits even in one direction from the starter-motor-driven shaft to the pinion is limited in amount, so that when such stress tends to exceed that amount the clutch releases itself and permits free relative rotation of the pinion and the starter-motor-driven shaft even in the direction in which the driving stress is normally transmitted.

The coiled-spring clutch which I prefer to use consists of a coiled spring which is received in mating recesses which face each other axially, so that the coiled spring extends into both and its outer surfaces cooperate with the inner surfaces of the mating recesses. The mating recesses are provided in the pinion which is loose on the starter-motor-driven shaft and in a member which is splined on such shaft so as to be movable axially thereof. Such a coiled-spring clutch transmits power from one of the interconnected members to the other when the relative movement of such parts tends to be such that the friction of the recess walls on the spring tends to unwind the spring, but allows overruning when the tendency to relative motion between the two interconnected members is in such a direction that such friction tends to wind the spring tighter. By properly proportioning this spring, the stress which is transmitted even in the first-named direction is limited, so that when there is an effort to transmit a greater stress the parts slip upon one another. The unit consisting of the pinion and the member splined on the starter-motor-driven shaft is desirably interassociated with the starter-motor switch so that the movement of the switch shifts such unit. The starter-motor switch is so arranged that such shifting normally occurs to produce meshing of the starter-motor-driven pinion and engine gear before the starter-motor switch is closed; but allows the closing of the switch first if the teeth of such pnion and gear at any time happen to be so nearly in direct alinement that the pinion teeth cannot enter the spaces between the gear teeth, as sometimes occurs.

The accompanying drawing illustrates my invention: Fig. 1 is a side elevation of a starting drive embodying my invention, some of the parts being broken away or in section in order better to illustrate the construction; Fig. 2 is an enlarged longitudinal section through the drive itself, to show the coiled-spring clutch and the associated parts; Fig. 3 is a section on the line 3—3 of Fig. 2; Fig. 4 is an elevation of the coiled spring of the clutch; Fig. 5 is a longitudinal section similar to Fig. 4, with a coiled spring of material of smaller cross-section, by reason of which slipping may occur on excess load even in the direction in which power is normally transmitted; and Fig. 6 is a sectional detail of the shifter switch.

The engine 10 may have the usual fly-wheel 11, on which is the usual ring-gear 12. The engine 10 may be any type of internal combustion engine; it is shown as an automobile engine, associated with a well-known type of

transmission device 13, controlled by pedals 14 which project through the floor board 15 of the driver's compartment of the automobile.

The starter motor 16 may also be of any suitable or convenient construction, and is most conveniently an electric motor supplied with current from a battery 17, as is common practice. The shaft 18 of the starter motor is mounted in the usual bearings, including a bearing 19 from which such shaft projects, toward the rear as shown, to carry my improved drive unit. This drive unit is desirably mounted directly on the starter-motor shaft, without intervening gearing; but it is not essential that there be no intervening gearing between the starter motor and the starter-motor-driven shaft which carries my drive unit. The bearing 19 may also serve as a limit-stop to limit the movement in one direction of the drive unit along the shaft 18.

The engine and starter motor, per se, may be of any standard or desirable construction.

On the projecting end of the starter-motor-driven shaft 18 I mount my improved drive unit. This consists fundamentally of two parts 20 and 21, which may move together axially as a unit, but under some circumstances are fixed relatively to each other to rotate together as a unit while under other circumstances they may rotate relatively to each other.

The member 20 is loose on the starter-motor-driven shaft 18, so that it is free both to slide thereon and to rotate thereon. This member 20 is provided with pinion teeth 22 which may co-operate with the teeth of the ring-gear 12. Under normal conditions the pinion 22 is in the position shown in full lines in Fig. 2, so that it is out of the plane of the ring-gear 12 and so is demeshed therefrom. When the drive-unit 20—21 is shifted forward on the shaft 18, however, the pinion teeth 22 are brought into mesh with the teeth of the ring-gear 12, as is indicated in dotted lines in Fig. 2; the bearing 19 may serve as a limit-stop to limit this forward movement of the drive unit. The forward ends of the pinion teeth 22 are desirably beveled, to facilitate meshing with the teeth of the ring-gear 12, and the entrance ends of the ring-gear teeth may be similarly beveled if desired; as is standard construction in starter-motor drives.

The member 21 of the drive unit is associated with the starter-motor-driven shaft 18, as by splines 23, so that it cannot turn relatively to said shaft but may be shifted along the shaft. This longitudinal shifting is always of the two members 20 and 21 as a unit, for they are interlocked in any suitable way against relative axial movement other than is sufficient for clearance. This interlocking against relative axial movement may be obtained in any convenient way, as by having the rear end of the member 20 telescoped within the forward end of the member 21, and interlocked against separation by a split retainer ring 24 suitably located in a circumferential groove on the inside of the hollow open forward end of the member 21.

The two members 20 and 21 have mating circular recesses 26 and 27 in their abutting ends. A coiled clutch-spring 28 is located in these recesses, and extends across the transverse plane of separation between the two members 20 and 21 and into both recesses 26 and 27. The outer surface of this clutch-spring 28 is in frictional co-operation with the internal surfaces of the recesses 26 and 27. In consequence, when there is a tendency to rotate the two members 20 and 21 in one direction with relation to each other, the friction of the recess walls on the outer surface of the clutch-spring tends to unwind such clutch-spring and force the clutch-spring surface more tightly into engagement with the walls of the recesses 26 and 27, thus locking the two members 20 and 21 together against relative rotation in that direction; whereas when there is a tendency to rotate such two members 20 and 21 in the other direction with relation to each other, the friction of the recess walls on the outer surface of the clutch-spring tends to wind up said clutch spring more tightly, and thus releases the two members 20 and 21 from the clutch-spring and so from each other and permits relative rotation between said two members in that direction. The locking together of the two members 20 and 21 by the clutch-spring 28 is when the starter motor 16 is turning in the proper direction to start the engine 10, or clockwise in Fig. 3, and the engine is resisting such turning, as by its friction and compression; while the releasing of the two members for relative rotation between them occurs when the speed of the shaft 18 is less than the speed at which the pinion 22 is turned by the ring-gear 12 after the engine has started in operation under its own power; the coiled-spring clutch in the latter case permitting overrunning of the member 20 with respect to the member 21.

For shifting the drive unit 20—21 axially, I provide a shifter fork 30, which has inwardly projecting pins 31 which project into a circumferential groove 32 in one of the members 20 or 21; the groove 32 is probably most conveniently provided in the member 21, as illustrated. The shifter fork 30 may be hung on a suitable pivot 33, and is connected by a link 34 to the downwardly extending arm of a bell-crank 35. The rearwardly extending arm of such bell-crank 35 lies beneath and normally substantially in

contact with a pin 36 carried by a shifter switch 37.

This shifter switch, in the form shown, consists of a tube 38 slidingly mounted in a casing 39 and carrying at its lower end a cross-connector 40 for connecting two switch contacts 41 and 42 which are connected by conductors 43 and 44 to the battery 17 and the starter motor 16 in the usual way, the other terminals of such battery and starter motor being grounded. The head 45 at the upper end of the pin 36 lies within the tube 38, and is held from downward movement out of said tube by an inturned flange 46 at the lower end of said tube; and a spring 47 lies within the tube 38 between the pin-head 45 and the upper end of such tube 38, so that by the compression of the spring 47 the tube 38 may descend even though the pin 36 is held from descending. Normally the tube 38 and pin 36 move together; and the parts are so arranged and proportioned that when the tube 38 is depressed the cross-connector 40 does not engage the switch contacts 41 and 42 until after there has been sufficient movement of the tube 38 normally to produce meshing of the pinion 22 with the ring-gear 12. The downward movement of the tube 38 and pin 36, and the meshing-producing movement of the drive unit 20—21, are opposed by a spring 48, which when the operator's heel is released from the shifter switch 37 acts to raise such shifter switch and to withdraw the drive unit from mesh with the ring-gear 12. This spring 48 is shown, for example, as a tension spring acting on the depending arm of the bell-crank 35; but this is merely a convenient arrangement for the spring, and not a necessary one.

In normal operation, the parts are in the position shown in Fig. 1 and in full lines in Fig. 2. The pinion 22 is out of mesh with the ring-gear 12. This is the condition when all the parts are at rest, and also when the engine 10 is in normal operation.

When, with the engine 10 at rest, it is desired to start such engine, the operator steps on the shifter switch 37. The resultant depression of the tube 38 and pin 36 acts to turn the bell-crank 35 against the spring 48, and to shift the drive unit 20—21 forward, or to the left in Figs. 1 and 2, to the dotted-line position shown in Fig. 2. This produces meshing of the pinion 22 with the ring-gear 12; unless the pinion teeth and the ring-gear teeth happen to register substantially exactly so that the entry of the pinion teeth into the spaces between the ring-gear teeth is prevented. In the latter case, the ends of the pinion teeth and the ring-gear teeth bear against each other, and the spring 47 is compressed to let the tube 38 descend even though the pin 36 is held from descending. The bevels on the ends of the teeth tend to promote meshing of the teeth; and such bevels are desirably in the proper direction that their camming action on each other tends to rotate the member 20 in the direction in which the spring 28 permits it to turn freely. At the last part of the downward movement of the shifter switch, the cross-connector 40 engages the switch contacts 41 and 42 to complete the starter-motor circuit; whereupon the starter motor starts at once to rotate. Ordinarily this starter-motor rotation does not start until after the pinion teeth and gear teeth are fully in mesh; but if the teeth of the pinion and ring-gear happen to have registered so that such meshing has been prevented, the meshing occurs as soon as the starter motor has turned the pinion 28 half a tooth-pitch, as by that time the spring 47, which is stronger than the spring 48, will have expanded to force down the pin 36 and move the drive unit forward as soon as the pinion teeth and the ring-gear teeth have been moved slightly out of line with each other. Thus the teeth of the pinion and ring gear, as well as all the other parts, are prevented from receiving the shock which occurs in certain present-day drives, because the meshing of the teeth occurs before the pinion has gained any material amount of speed.

Upon the starting of the starter motor 16, with the teeth of the pinion and ring-gear already in mesh, or in mesh within half a tooth-space, power is transmitted from the starter-motor-driven shaft 18 and member 21 through the clutch-spring 28 to the member 20 in such a direction that the friction of the parts tend to unwind the clutch-spring 28. This locks the two parts 20 and 21 together; and the power thus received by the member 20 is transmitted by its pinion teeth 22 to the ring-gear 12, to turn over the engine 10.

As soon as the engine 10 starts to operate under its own power, the ring-gear 12 starts to rotate more rapidly than while it was being driven by the starter motor, and drives the pinion 22 and part 20 with correspondingly increased speed. In consequence, the member 20 runs ahead of the member 21; which is permitted because this tendency to relative rotation between the parts 20 and 21 tends to wind up the clutch-spring 28 and thus to release it from such members to permit such relative rotation in that direction Ordinarily as soon as this occurs, the operator releases the shifter switch 37, whereupon the spring 48 raises such shifter switch and moves the drive unit to the rear (or to the right in Figs. 1 and 2) to the full-line position shown, to de-mesh the pinion teeth 22 from the ring-gear 12. However, if the operator fails to do this immediately, no harm ensues, because the in-

teraction of the clutch-spring 28 with the recesses 26 and 27 permits the free overrunning of the member 20 ahead of the member 21.

In case of a backfire of the engine 10 as it is being started, power is transmitted from the member 20 to the member 21 tending to drive the starter motor 16 backward; for with this back drive of the member 20 upon a backfire there is the same clutch-spring-unwinding tendency to relative rotation between the members 20 and 21 as there is when power is transmitted for said driving from the member 21 to the member 20. This may put a great strain on the parts, particularly on the starter motor. I may avoid this, however, by making the cross-section of the clutch-spring 28 smaller, as is indicated in Fig. 5, so that it has less ability to transmit power. That is, I have found by experiment that by making the clutch-spring 28 of smaller cross-section, its capacity to transmit power even in the spring-unwinding direction is thereby reduced; and, as a result, the capacity of the clutch-spring to transmit power even in the spring-unwinding direction may be reduced to a point below that which is reached upon a backfire of the engine, with the result that though the member 20 may turn backward the starter motor itself and its shaft 18 and the member 21 may continue to rotate forward. This reduction in cross-sectional area of the clutch-spring 28 will depend upon its diameter, upon the size of the engine, and upon the power of the starter motor, and will vary with different installations. Whether with or without the reduced cross-sectional area, it is not essential that the individual turns of the clutch-spring 28 should be square, although it is illustrated as square in Fig. 2, as such cross-section may take other shapes as desired.

I claim as my invention:—

1. A starter drive, comprising a starter-motor-driven shaft, a member rotatably fixed on but movable axially of said shaft, a pinion axially fixed to said member but rotatable relatively to both said shaft and said member, a gear connected with an internal combustion engine and into and out of mesh with which said pinion is movable by axial movement on said shaft, adjacent end faces of said member and pinion being provided with mating recesses, and a helically wound clutch-spring located in said recesses to have frictional bearing with the walls thereof.

2. A starter drive, comprising a starter-motor-driven shaft, a member rotatably fixed on but movable axially of said shaft, a second member axially fixed to said first member and movable axially of said shaft therewith, said second member being rotatable relatively to both said shaft and said first member, a power-receiving member associated with an internal combustion engine and into and out of driving connection with which said second member is movable by the axial movement of said two members on said shaft, and a helical clutch-spring in frictional engagement with both of said two members to interconnect them to transmit power in one direction of relative rotation while permitting free rotation between them in the other direction.

3. A starter drive as set forth in claim 2, with the addition that said helical clutch-spring is so proportioned that it has a sufficiently small friction against a member in which it works that it will release its grip when the force between the two members it connects exceeds a certain maximum less than that produced on the backfire of the engine.

4. In combination, a driven member associated with an internal combustion engine, a starter motor, and a driving connection separably connecting said starter motor with said driven member for operating it to start the engine, said driving connection between said starter motor and the driven member including two coaxial parts rotatable relatively to each other and force transmission means acting between said two coaxial parts and co-acting directly with both of them and arranged and proportioned to transmit power from one to the other when the force between them in one direction does not exceed a certain maximum less than that produced on the backfire of the engine but to move relatively to each other without transmitting power both when the force between them exceeds such maximum in such one direction and when the force between them is in the opposite direction, said two coaxial parts having mating coaxial recesses, and said force-transmitting means being a coiled clutch-spring received in said mating coaxial recesses.

5. A starter drive, comprising a starter-motor-driven shaft, a power-receiving member associated with an internal combustion engine for turning the latter in starting, and means interconnecting said shaft and said power-receiving member and including two co-axial parts having mating recesses and a coiled clutch-spring received in said mating recesses and in frictional engagement with the walls thereof, said interconnecting means also including a completely separable connection besides said mating recesses and clutch-spring.

6. A starting driving train for starting internal combustion engines, comprising two power-transmitting devices in series, one of said power-transmitting devices including two members having mating axial recesses and a helical spring interconnect-

ing said two members and received in and bearing against the walls of said recesses, and the other power-transmitting device including two members which can be moved into and out of engagement with each other, said second power-transmitting device being located in the driving train closer to the outgoing-power end thereof than is the first power-transmitting device.

7. A starting driving train for starting internal combustion engines, comprising two power-transmitting devices in series, one of said power-transmitting devices including two members and a helical spring interconnecting said two members, and frictionally gripping both of them on curved surfaces and the other power-transmitting device including two members which can be moved into and out of engagement with each other, said second power-transmitting device being located in the driving train closer to the outgoing-power end thereof than is the first power-transmitting device.

8. In combination, an internal combustion engine, a starter motor therefor, and a driving train for interconnecting said starter motor to said internal combustion engine, said driving train comprising two power-transmitting devices in series, one of said power-transmitting devices including two members having mating axial recesses and a helical spring interconnecting said two members and received in and bearing against the walls of said recesses, and the other power-transmitting device including two members which can be moved into and out of engagement with each other.

9. In combination, an internal combustion engine, a starter motor therefor, and a driving train for interconnecting said starter motor to said internal combustion engine, said driving train comprising two power-transmtting devices in series, one of said power-transmitting devices including two members and a helical spring interconnecting said two members and frictionally gripping both of them on curved surfaces and the other power-transmitting device including two members which can be moved into and out of engagement with each other.

In witness whereof, I have hereunto set my hand at Indianapolis, Indiana, this 14th day of May, A. D. one thousand nine hundred and twenty five.

WILLIAM CARLETON STARKEY.