March 14, 1944. H. KLEIN 2,344,152

STARTING DEVICE FOR INTERNAL COMBUSTION ENGINES

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Fig. 1

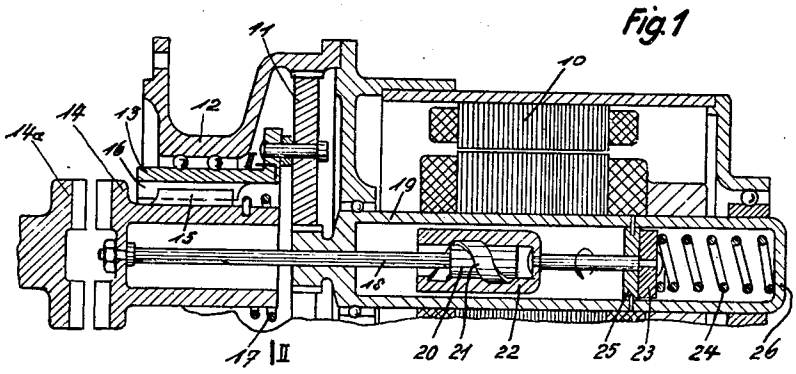
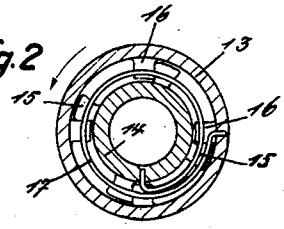


Fig. 2



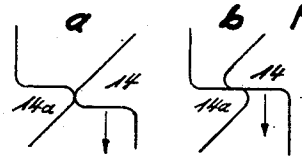
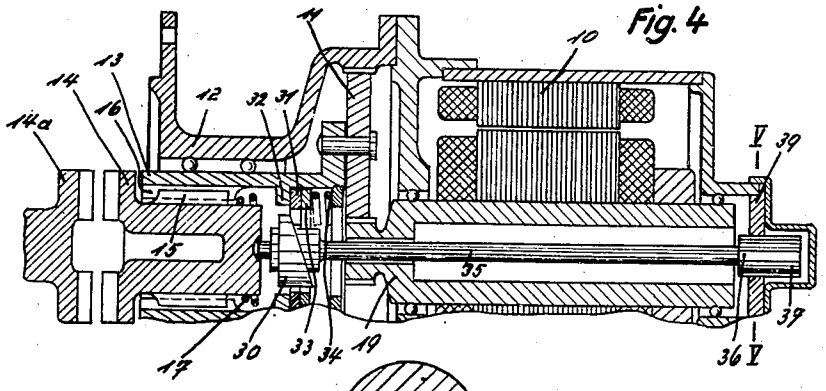


Fig. 3

Fig. 4



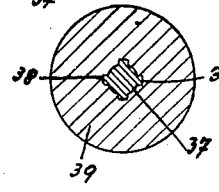


Fig. 5

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STARTING DEVICE FOR INTERNAL COMBUSTION ENGINES

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4 Claims. (Cl. 74—7)

The invention relates to a starting device for internal combustion engines, in which a driving element to be coupled with the engines is turned and automatically engaged by the turning force of the device. For the engaging by turning force the Bendix gears are to be mentioned as best known form of construction, in which the driving element is screwably arranged and screws, owing to its inertia, on the driving shaft when this is rotated. These devices possess the fundamental inconvenience that the driving element sticks on the rim of teeth of the engine, if at the adjusting, the end faces of the teeth or claws encounter one another, because the turning moment of the starter exerts upon the pinion, owing to the screw-thread, a great, axially directed tensile force.

In order to ensure an adjusting free from disturbance of the driving element in starting devices of the above type in all instances, the device is constructed according to the invention so that the driving element can rotate relative to the driving part by a certain amount and the moving forward force produced by the turning force is limited, the idle movement of the driving part relative to the driving element being tuned to the pushing movement of the driving element so that the latter movement is first completed.

Starting devices, in which the driving element can rotate by a certain amount relative to the driving part are known. In these devices the adjusting movement or the speed, with which this movement is completed, is not tuned relative to the idle movement of the driving element so that in all instances a satisfactory adjusting is effected.

Two embodiments of the invention are illustrated, by way of example, in the accompanying drawing, in which

Fig. 1 shows a starting device in section,

Fig. 2 is a section on line II—II of Fig. 1,

Fig. 3 different positions of the clutch element of the starting device,

Fig. 4 in section a second embodiment of the invention, and

Fig. 5 a section on line V—V of Fig. 3.

The starting device shown in Fig. 1 is driven by an electromotor 10, which by means of a planet gear 11 drives a drum 13 rotatably mounted in the casing 12 of the apparatus. A clutch element 14 is arranged in the drum and equipped on the outer side with lugs 15 extending between circumferentially spaced lugs 16 on the inner side of the drum. The lugs 15 are thinner than the spaces between the lugs of 16 of the drum, so that the clutch element can be turned through a predetermined arc relative to the drum, such independent movement being herein termed its idle movement. Between the drum and the clutch element a helical spring 17 is arranged to normally urge the clutch element to turn in one direction relative to the drum. A rod 18 is fixed on the clutch element and projects into the hollow armature shaft 19 of the electromotor and has at its inner end a head 20 provided with screw-thread 21. The internal screw-thread of a sleeve 22 engages with said screw-thread 21. The sleeve is rigidly connected with a disc 23 which, by a spiral spring 24, is lightly pressed against the rear face of a disc 25 fixed in the armature shaft 19. The spring 24 presses against the inner side of the rear wall 26 of the hollow shaft. The pitch of the screw-thread 21 is such, that the full forward shifting of the clutch element is terminated before the lugs 16 of the drum have reached the lugs 15, i. e. completed its idle movement.

The device operates as follows:

If for the starting of the internal combustion engine the electromotor 10 is engaged, the drum 13 on the one hand turns at slower speed corresponding to the gearing down of the planet gear than the armature of the electromotor while, on the other hand the disc 23, or the screw-threaded sleeve 22 connected with the same, is driven from disc 25 at the speed of the armature. As the screw-threaded sleeve 22 turns more rapidly than the screw-threaded head 20 connected with the clutch element, this head and with the same the clutch element are shifted forwardly in axial direction, against the tension of spring 17, until the lugs 16 of the drum have reached the lugs 15 of the clutch element, whereupon the internal combustion engine is started, as the forward movement has meanwhile brought the clutch element 14 into engagement with claw 14a of the crank shaft of the engine. As soon as the longitudinal movement of the clutch element is stopped, the sleeve 22 tends to screw back, in opposition to the pressure of spring 24, on the securely held head 20.

By the reduction of the pressure, at which the disc 23 is pressed against disc 25, the friction moment is reduced with which the disc 25 tends to draw along the disc 23 or the sleeve 22. The result is, that the discs 23 and 25 slip the one in the other, the slipping moment between the discs and the force of the screw-threaded sleeve

acting in opposition to the spring being in equilibrium.

At the adjusting of the clutch element two critical positions exist, which are diagrammatically shown in Fig. 3 at 3*a* and 3*b*. In the drawing a claw of the clutch element of the starting device is designated by 14, and a claw of the crank shaft of the engine to be started is designated by 14*a*. The arrow indicates the direction of rotation of the starting device. In the position *a* of the claws, the clutch elements are damaged when the feeding movement is produced by a screw thread connection which is driven by the not limited turning force of the device, as for instance in the gear system Bendix. The position *b* causes difficulties, if the full turning moment of the starting device begins to act immediately without retardation, when the claws come into engagement, but the flanges of the claws contact only on a portion of their length. The pressure onto the supporting faces of the claws is then so great that firstly a further adjusting of the claw 14 is impossible, and secondly that the material cannot withstand the pressure. None of the devices of known type has proved to act securely in both positions. In the device according to the invention, the shifting force for the clutch element is, on the one hand, limited by the slipping moment between the discs 23 and 25, on the other hand the idle movement between the drum 13 and the clutch element is so great, that it has been completed only when the clutch element has already terminated its forward movement. The pitch of the screw-thread 21 must be selected accordingly. If in the starting device described the points of the claws encounter the one the other, the clutch element 14 is prevented as well from carrying out its further feeding movement as from turning. The drum 13 will therefore first travel along the idle path between the lugs 15 and 16 in opposition to the action of spring 17, and then take along the clutch element. As the axial pressure upon the clutch element is little corresponding to the slipping moment on the disc 23, it is possible to push the clutch element along the claw 14*a* of the crank shaft without damaging the same. As soon as the point of claw 14, as shown in Fig. 3*a*, has slid along the point of claw 14*a*, the tensioned spring 17 can adjust again the clutch element at the forward feed which at the same time is started by the screw-thread 21.

In the first embodiment of the invention which has just been described, the adjusting of the clutch element is effected absolutely automatically and begins instantaneously when the turning device begins to turn.

Fig. 4 shows a second embodiment of the engaging device according to the invention. For the elements which remain the same as in the first form of construction similar reference numerals have been employed as in Figs. 1 and 2. A cam gear serves for engaging the clutch element 14 and consists of a cam disc 30 and of a slidable disc 31 which is arranged on the inner side of drum 13 between a collar 32 and a friction disc 33 so that it can slide. The disc 33 is pressed by a spring 34 against the slidable disc 31. The cam disc is fixed on a rod 35 extending through the electromotor, on the end of which rod a head 37 having spline projections 36 is mounted. The splines 36 engage in grooves 38 of the plate 39 of the bearing.

In order to actuate the starting device, the driver first switches in the electromotor 10. The clutch element 14 driven by the electromotor and the slidable disc 31 rotate also, whereas the cam disc 30 is locked against rotation by the lugs 36. The cam disc 30, which is held in its position, is then pushed forward towards the clutch element 14 by the slidable disc 31 and brings this clutch element into engagement with the counterelement on the crank shaft of the internal combustion engine, whereupon the engine is started. When the claws of the coupling elements assume, at the engaging, the position shown at *a* in Fig. 3, the forward feeding of the cam disc 30 is stopped. Herefrom results, that the slidable disc 31 is securely held and the friction disc 32 slides along it. The drum moves, as shown in Fig. 2, along the idle path between its lugs 16 and the lugs 15 of the clutch element 14 in opposition to the force of spring 17 and, after the idle movement has terminated, draws along the clutch element, this being possible without damaging of the clutch elements for the reason that the axial force with which the claws are pressed the one against the other corresponds only to the small frictional moment between the slidable disc 31 and the friction disc 33. If the points of the claws have passed the one along the other, the adjusting proceeding takes place accurately as in the first form of construction. The condition for the frictionless adjusting is in both instances, that the claw is pushed forward with limited axial force and moved so rapidly, that its travel is terminated before the idle path on the clutch element has been covered.

I claim:

1. A starting device for internal combustion engines, in which a clutch element adapted to be coupled with the engine is automatically moved into engagement with a portion of the engine by the turning force of the starting device, comprising in combination a clutch element mounted for axial movement into engagement with the engine and provided with a cylindrical hub portion having on its periphery circumferentially spaced radial lugs, a motor, means for axially moving said clutch element upon energization of the motor, including cooperating cam and friction clutch means between the clutch element and the motor, means for rotating the clutch element at relatively low speed including a driving sleeve surrounding the hub portion of the clutch element and provided on its inner periphery with circumferentially spaced radial lugs arranged to engage said lugs on the clutch element after a predetermined idle movement, the spacing of said lugs being such that the axial movement of the clutch element into engagement with the engine is completed before the lugs on the driving sleeve engage the lugs on the clutch element.

2. A starting device as recited in claim 1 wherein said cam means comprises a head member provided with a screw-thread and a cooperating threaded sleeve member, one of said members being carried by the clutch element.

3. A starting device as recited in claim 1 wherein said friction clutch means includes a member rotated from the motor at a higher rate of speed than said driving sleeve is rotated.

4. A starting device as recited in claim 1 wherein said cam means includes a member carried by the clutch element, and said friction clutch means is arranged between such member and the motor.

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