PUBLISHED

MAY 4, 1943.

BY A. P. C.

H. KLEIN

STARTING DEVICE FOR INTERNAL COMBUSTION ENGINES

Filed March 20, 1942

Serial No. 435,446

Fig.1

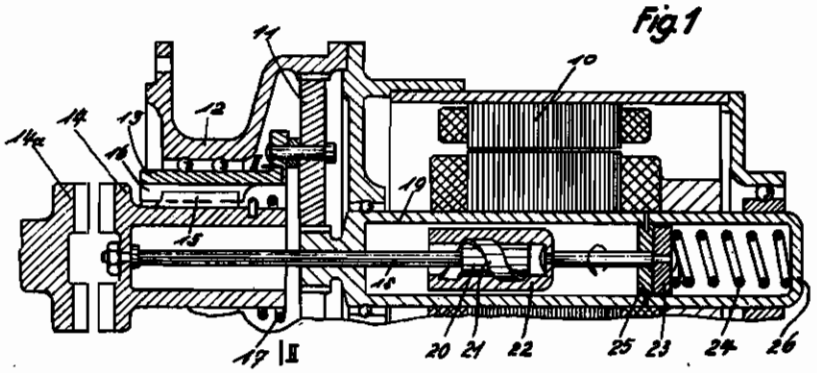
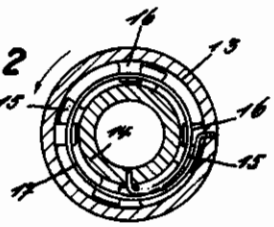


Fig.2



a

b

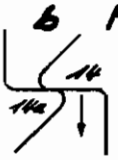
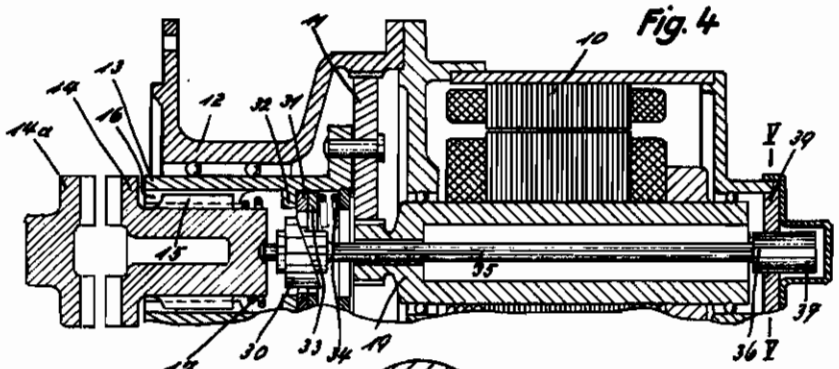


Fig.3

Fig.4



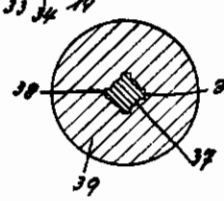


Fig.5

Inventor

Hermann Klein

By Roy F. Steward

His Attorney

Published May 4, 1943

Serial No. 435,446

ALIEN PROPERTY CUSTODIAN

STARTING DEVICE FOR INTERNAL COMBUSTION ENGINES

Hermann Klein, Vaihingen-Rohr, Germany; vested in the Alien Property Custodian

Application filed March 20, 1942

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 ledges 15 engaging between ledges 16 on the inner side of the drum. The ledges 15 are thinner than the intervals between the ledges 16 of the drum, so that the clutch element can be turned by a certain amount relative to the drum. Between the drum and the clutch element a helical spring 17 is arranged which turns the clutch element 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 this end a head 20 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 side of a disc 25 fixed in the armature shaft 19, this side being remote from the sleeve. The spring 24 presses against the inner side of the bottom 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 lathes 16 of the drum have reached the lathes 15.

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, 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 in axial direction. If the clutch element has been adjusted, the drum further rotates relative to the clutch element in overcoming the power of spring 17, until the ledges 16 of the drum have reached the lathes 15 of the clutch element, whereupon the internal combustion engine is started. 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 draw-

ing 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 ledges **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 clutch element **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 ledge-like projections **38** is mounted. The ledges engage in grooves **39** 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 ledges **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 ledges **16** and the ledges **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.

HERMANN KLEIN.