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ENGINE STARTER

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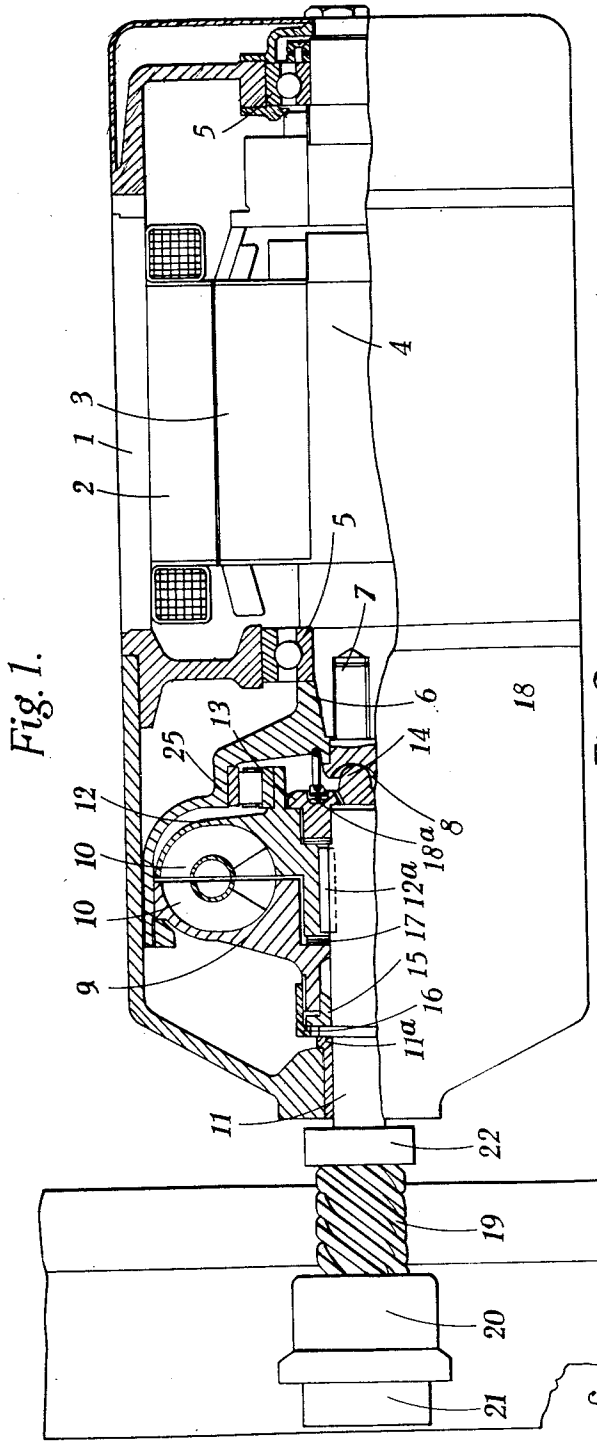

Fig. 1.

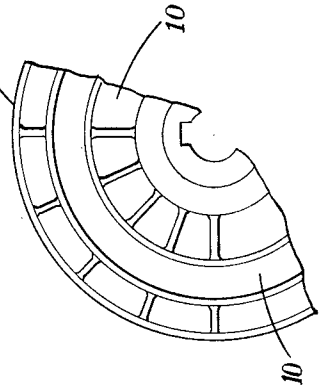

Fig. 2.

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ENGINE STARTER

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12 Claims. (Cl. 74—7)

In electrical engine starters, where a small electrical motor, having its supply from a battery or accumulator, is used to turn the engine over at a speed sufficient to ensure firing, two types of drive are common, viz., the inertia type, in which the starter pinion by reason of its inertia is caused to thread itself along a quick pitch screwed shaft into engagement with the engine flywheel, and the axial type, where the starter pinion is directly coupled to the motor shaft which is caused to move longitudinally to engage the pinion by the magnetic influence of the motor field winding.

A difficulty associated with such starters is that the sudden application of load on to the starter motor, caused by the engagement of the pinion into the engine flywheel, often results in mechanical breakdown occasioned by a jammed drive, a bent shaft, a stripped flywheel gear or a broken spring where a spring is incorporated. Moreover, since the drive locks solid when subject to a reversal of rotation, a severe "back-fire" (such as sometimes occurs, for example, in a compression ignition type engine) may also cause breakdown of the engine starter.

Many attempts have been made to overcome the above difficulties, notably by the inclusion of plate clutches arranged to slip when subjected to excessive torque, and spring drives which take up the initial shock of engagement and uncoil when the engine back-fires to release the drive.

An object of this invention is to achieve the desired result in a simplified, inexpensive and practical manner.

In accordance with the invention, "fluid" coupling means (hereinafter termed hydraulic coupling) is interposed between the starter motor and the starter pinion to protect the mechanical parts of the starter against excessive shocks and consequent breakdown under all eventualities likely to occur during the operation of the starter.

Preferably the driven member of the hydraulic coupling is splined or slidably mounted on the starter pinion shaft and spring-urged into frictional engagement with the co-acting driving member which is positively rotatable with the motor armature shaft.

With such an arrangement the application of the load (on engagement of the starter pinion with the engine fly-wheel consequent on the setting into operation of the starter) may stop rotation of the pinion and driven coupling member, causing such movement of the fluid in the coupling (under continued rotation of motor and driving coupling member) as to decelerate the motor and increase its torque until this is sufficient to begin turning the engine, whereafter the speed of the starter increases until the engine runs under its own power. Should a back-fire occur, the pinion and driven coupling member will be rotated in the reverse direction and the starter motor will be slowed up without shock as a result of the reaction that occurs between the coupling members.

By way of example a form of starter embodying the foregoing and other features of the invention is illustrated on the accompanying drawing.

Fig. 1 shows the starter partly in longitudinal section.

Fig. 2 is a fragmentary end view of the driven member of the hydraulic coupling.

The starter motor may be of the series torque characteristic type or a high speed shunt wound machine may be employed having a slightly compounded characteristic, the speed of the motor being arranged to suit the characteristics of the hydraulic coupling.

Reference 1 denotes the starter motor frame or housing, 2 the field system, 3 the armature, and 4 the armature shaft which is supported by anti-friction bearings 5, 5.

The armature shaft 4 is finished in the form of a taper upon which is fitted a flywheel 6 which also forms the outer casing of a hydraulic coupling or clutch. The flywheel is secured to the armature shaft by means of a stud 7 having its outer end recessed to form a thrust cup 8.

The combined outer casing and flywheel 6 is also fixed at its extermity to a driving member 9, which has around its periphery concave fluid galleries 10 suitably partitioned. The driving member loosely surrounds a starter pinion shaft 11 mounted in a bearing 11a in axial alignment with the motor armature shaft 4. The driven member 12 of the hydraulic coupling is splined or keyed at 12a to the pinion shaft, being free to move longitudinally between certain limits, and has fluid galleries 10 (see also Fig. 2) to match those in the driving member 9. 25 denotes an anti-friction bearing between the driven member and the combined outer casing and flywheel 6. A locking collar 13 on the pinion shaft suitably positions and retains the driven member 12. The end of the locking collar is shaped in the form of a button 14 to co-act with the aforesaid thrust cup 8 and take the thrust during operation.

The hydraulic arrangement is rendered fluid-

tight by the inclusion of a stuffing gland 15 for the driving coupling member 9 which gland is held in position by a gland nut 16.

Interposed between the driving and driven members 9, 12 of the coupling is a friction disc 17 of suitable material, while a coiled tension spring 18 is included between the locking collar 13 and the outer casing 6 of the coupling for the purpose of holding the driving and driven members of the coupling in contact with the friction disc. This spring bears against a thrust race 18a carried by the locking collar 13.

The outer end of the pinion shaft 11 has fixed to it a sleeve threaded externally with a quick pitch screw, and the starter pinion 20 is screwed internally to suit. Front and back stop collars 21 and 22 pinned to the pinion shaft and sleeve limit the axial movements of the pinion on the sleeve.

23 denotes the engine flywheel and 24 the toothed starter ring thereon to be engaged by the starter pinion 20.

When the electrical circuit to the starter motor is completed (by pressure of the conventional switch button or by any other means) the armature shaft 4 rotates, taking with it the combined outer casing and flywheel 6 and therefore the driving member 9 of the hydraulic coupling. Since the driven member 12 of the coupling is in contact with the driving member through the friction disc 17, this also is rotated, together with the pinion shaft 11. The pinion 20, by reason of its inertia, is therefore threaded along the sleeve 19 until engagement with the engine flywheel starter ring 24 is accomplished and the pinion comes up against the stop collar 22. Immediately this occurs, the application of the load caused by the engagement stops the pinion shaft 4 and, consequently, the driven member 12 of the hydraulic coupling. With the electric motor still supplied with power, and therefore rotating, maximum slip occurs between the driving and driven members 9, 12 of the hydraulic coupling, and therefore maximum agitation of the fluid in the hydraulic coupling, giving maximum turning effort. The speed of the starter motor is reduced and its torque is therefore increased, while the driven member 12 of the coupling is forced away from the driving member along the spline or key 12a and against the tension spring 18 by the pressure of the fluid in the galleries 10. This brings the thrust button 14 on to its seating 8 and relieves the friction disc 17, allowing the latter to run free. The motor continues to decelerate until the shaft torque is sufficient to commence turning the engine, after which the speed of the starter increases until the engine fires under its own power. All this is accomplished without shock to the mechanical drive, the hydraulic coupling making all adjustments smoothly and safely.

When the engine fires, the pinion is momentarily rotated faster than the starter motor shaft and is therefore threaded out of engagement with the engine flywheel starter ring 24.

Should a back-fire occur, both torque and rotation are reversed, so that the pinion remains solid with the pinion shaft. The pinion, pinion shaft and driven member of the hydraulic coupling are therefore reversed in rotation, which has the effect of causing a greater reaction between the two members of the coupling, thereby slowing up the starter motor. There is, however, no excessive shock to the mechanical part of the drive, the coupling again acting as the necessary cushion.

From the foregoing it will be apparent that the invention provides a simple and practical engine starter incorporating fluid coupling means for protecting its mechanical parts against breakdown under any eventuality likely to occur. The invention is not limited to the constructional form described and modifications may be made without departing from its scope.

I claim:—

1. An engine starter including an electric motor and a pinion arranged to be driven from the motor armature shaft, characterized by fluid coupling means interposed between the motor and the pinion for protecting the starter against excessive load and back-fire shocks and consequent breakdown during operation, said coupling means comprising a driving member positively rotatable with the motor armature shaft, a co-acting driven member, and spring means urging the driven member into frictional engagement with said driving member.

2. In an engine starter including an electric motor and a pinion supporting shaft arranged to be driven from the motor armature shaft, a fluid coupling interposed between the motor and the pinion shaft, said coupling comprising a combined outer casing and flywheel secured to the motor armature shaft, a driving member with interior fluid galleries secured at its periphery to the combined outer casing and flywheel, a co-acting driven member with similar interior fluid galleries rotatable with and axially movable on the pinion shaft, and resilient means urging the driving and driven members into frictional engagement.

3. In an engine starter including an electric motor and a pinion supporting shaft arranged to be driven from the motor armature shaft, a fluid coupling interposed between the motor and the pinion shaft, said coupling comprising a combined outer casing and flywheel secured to the motor armature shaft, a driving member with interior fluid galleries secured at its periphery to the combined outer casing and flywheel, a co-acting driven member with similar interior fluid galleries rotatable with and axially movable on the pinion shaft, a collar retaining the driven member on the pinion shaft, and resilient means between the combined outer casing and flywheel and the collar for urging the driving and driven members into frictional engagement.

4. In an engine starter including an electric motor and a pinion supporting shaft arranged to be driven from the motor armature shaft, a fluid coupling interposed between the motor and the pinion shaft, said coupling comprising a combined outer casing and flywheel secured to the motor armature shaft, a driving member with interior fluid galleries secured at its periphery to the combined outer casing and flywheel, a co-acting driven member with similar interior fluid galleries rotatable with and axially movable on the pinion shaft, a collar retaining the driven member on the pinion shaft, a thrust race carried by the collar, and resilient means between the combined outer casing and flywheel and the collar and bearing on the thrust race for urging the driving and driven members into frictional engagement.

5. In an engine starter including an electric motor and a pinion supporting shaft arranged to be driven from the motor armature shaft, a fluid coupling interposed between the motor and the pinion shaft, said coupling comprising a combined outer casing and flywheel secured to the motor armature shaft, a driving member with in-

terior fluid galleries secured at its periphery to the combined outer casing and flywheel, a co-acting driven member with similar interior fluid galleries rotatable with and axially movable on the pinion shaft, a stud securing the combined outer casing and flywheel to the motor armature shaft and presenting a thrust cup, a collar retaining the driven member on the pinion shaft and forming a button to co-act with the thrust cup, and resilient means between the combined outer casing and flywheel and the collar for urging the driving and driven members into frictional engagement.

6. In an engine starter including an electric motor and a pinion supporting shaft arranged to be driven from the motor armature shaft, a fluid coupling interposed between the motor and the pinion shaft, said coupling comprising a combined outer casing and flywheel secured to the motor armature shaft, a driving member with interior fluid galleries secured at its periphery to the combined outer casing and flywheel, a co-acting driven member with similar interior fluid galleries rotatable with and axially movable on the pinion shaft, a stud securing the combined outer casing and flywheel to the motor armature shaft and presenting a thrust cup, a collar retaining the driven member on the pinion shaft and forming a button to co-act with the thrust cup, a thrust race carried by the collar, and resilient means between the combined outer casing and flywheel and the thrust race for urging the driving and driven members into frictional engagement.

7. In an engine starter including an electric motor and a pinion supporting shaft arranged to be driven from the motor armature shaft, a fluid coupling interposed between the motor and the pinion shaft, said coupling comprising a combined outer casing and flywheel secured to the motor armature shaft, a driving member with interior fluid galleries secured at its periphery to the combined outer casing and flywheel, a co-acting driven member with similar interior fluid galleries rotatable with and axially movable on the pinion shaft, an anti-friction bearing interposed between the driven member and the combined outer casing and flywheel, and resilient means urging the driving and driven members into frictional engagement.

8. In an engine starter including an electric motor and a pinion supporting shaft arranged to be driven from the motor armature shaft, a fluid coupling interposed between the motor and the pinion shaft, said coupling comprising a combined outer casing and flywheel secured to the motor armature shaft, a driving member with interior fluid galleries secured at its periphery to the combined outer casing and flywheel, a co-acting driven member with similar interior fluid galleries rotatable with and axially movable on the pinion shaft, a stuffing gland and gland nut sealing the driving member with respect to the starter pinion shaft, and resilient means urging the driving and driven members into frictional engagement.

9. In an engine starter including an electric motor and a pinion supporting shaft arranged to be driven from the motor armature shaft, a fluid coupling interposed between the motor and the pinion shaft, said coupling comprising a combined outer casing and flywheel secured to the motor armature shaft, a driving member with interior fluid galleries secured at its periphery to the combined outer casing and flywheel, a co-acting driven member with similar interior fluid galleries rotatable with and axially movable on the pinion shaft, a stuffing gland and gland nut sealing the driving member with respect to the starter pinion shaft, an anti-friction bearing interposed between the driven member and the combined outer casing and flywheel, and resilient means urging the driving and driven members into frictional engagement.

10. In an engine starter including an electric motor and a pinion supporting shaft arranged to be driven from the motor armature shaft, a fluid coupling interposed between the motor and the pinion shaft, said coupling comprising a combined outer casing and flywheel secured to the motor armature shaft, a driving member with interior fluid galleries secured at its periphery to the combined outer casing and flywheel, a co-acting driven member with similar interior fluid galleries rotatable with and axially movable on the pinion shaft, a stuffing gland and gland nut sealing the driving member with respect to the starter pinion shaft, a collar retaining the driven member on the pinion shaft, and resilient means between the combined outer casing and flywheel and the collar for urging the driving and driven members into frictional engagement.

11. In an engine starter including an electric motor and a pinion supporting shaft arranged to be driven from the motor armature shaft, a fluid coupling interposed between the motor and the pinion shaft, said coupling comprising a combined outer casing and flywheel secured to the motor armature shaft, a driving member with interior fluid galleries secured at its periphery to the combined outer casing and flywheel, a co-acting driven member with similar interior fluid galleries rotatable with and axially movable on the pinion shaft, a stuffing gland and gland nut sealing the driving member with respect to the starter pinion shaft, an anti-friction bearing interposed between the driven member and the combined outer casing and flywheel, a collar retaining the driven member on the pinion shaft, a thrust race carried by the collar, and resilient means between the combined outer casing and flywheel and the thrust race for urging the driving and driven members into frictional engagement.

12. In an engine starter including an electric motor and a pinion supporting shaft arranged to be driven from the motor armature shaft, a fluid coupling interposed between the motor and the pinion shaft, said coupling comprising a combined outer casing and flywheel secured to the motor armature shaft, a driving member with interior fluid galleries secured at its periphery to the combined outer casing and flywheel, a co-acting driven member with similar interior fluid galleries rotatable with and axially movable on the pinion shaft, resilient means urging the driving and driven members into frictional engagement, an anti-friction bearing between the driven member and the combined outer casing and flywheel, and a stuffing gland and gland nut sealing the driving member with respect to the pinion shaft.

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