April 10, 1951 W. C. STARKEY 2,548,747

STARTER TYPE CLUTCH

Filed July 12, 1947

FIG. 1

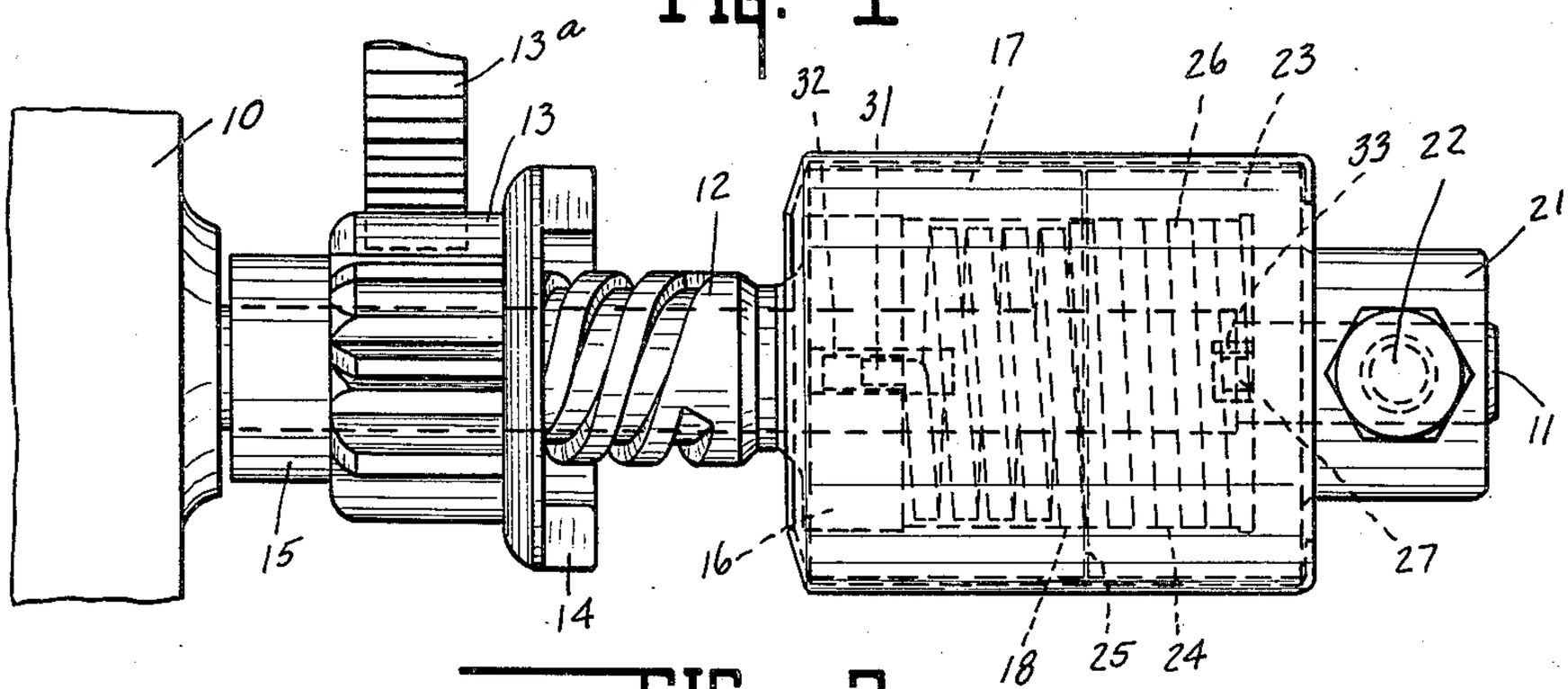


FIG. 2

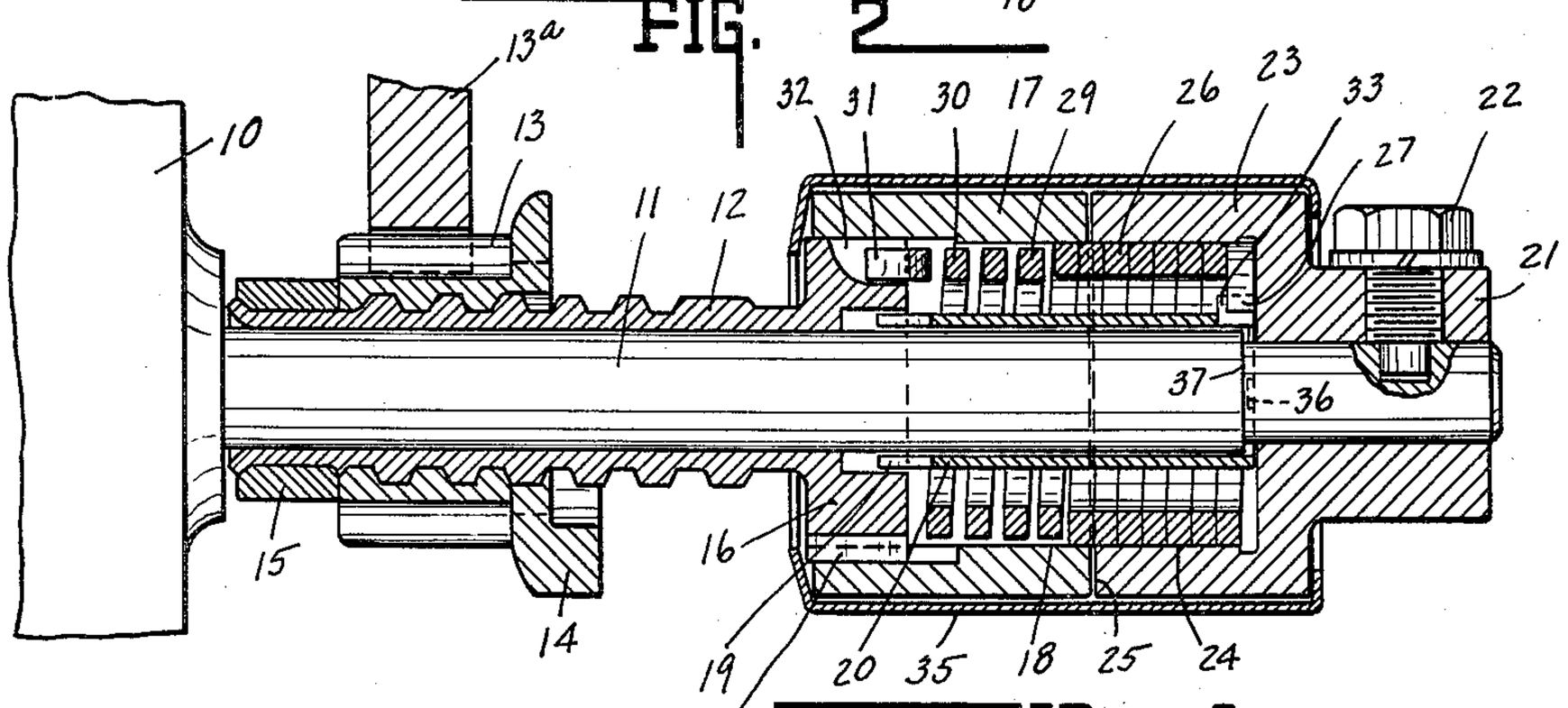


FIG. 3

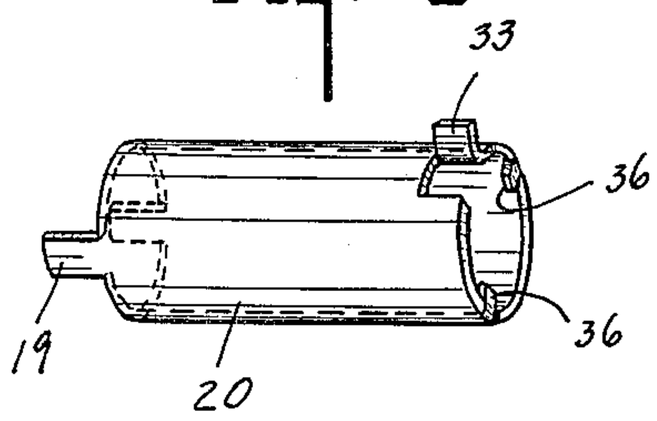
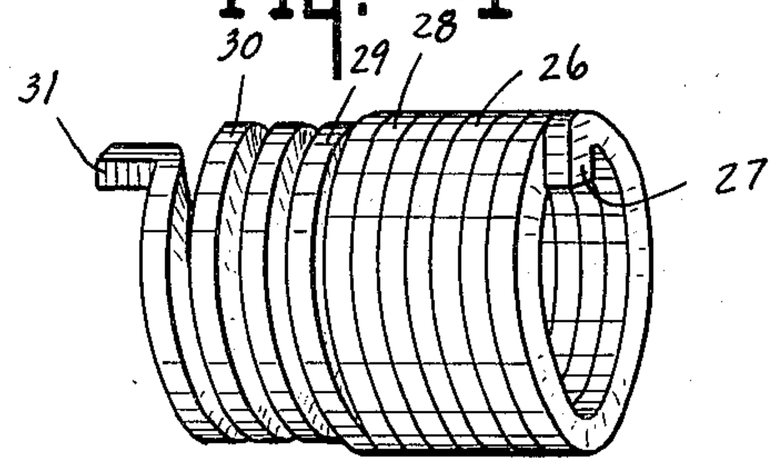


FIG. 4



INVENTOR.
WILLIAM CARLETON STARKEY.

BY
Lockwood, Goldsmith & Galt.
ATTORNEYS.

Patented Apr. 10, 1951

2,548,747

UNITED STATES PATENT OFFICE

2,548,747

STARTER TYPE CLUTCH

William Carleton Starkey, Indianapolis, Ind.; Fletcher Trust Company executor of said William Carleton Starkey, deceased

Application July 12, 1947, Serial No. 760,670

7 Claims. (Cl. 192—41)

1

This invention relates to a torque limiting device, and more particularly as applied to a starter drive unit of the "Bendix drive" type as disclosed in the Bendix Patent No. 1,256,102, granted February 12, 1916, entitled "Engine Starter."

The Bendix starter drive has many advantages and is widely used, but it has certain inherent defects and faults to which this invention is directed. For example, such a starter drive is designed to provide a high break-away torque which gives increased cranking power over that of the usual manual shift type of starter unit. While this is highly advantageous, it is a disadvantage under certain conditions, such as a stiff engine, hard or gummy grease or lack of lubricant. Wherein the driving pinion of the starter may fail to spiral itself into mesh with the engine fly wheel gear until the starting motor has acquired a speed of several thousand R. P. M., a terrific impact load upon the entire unit as well as upon the gear teeth results. This often has the effect of breaking the torque spring of such a drive, as well as wearing the pinion and gear teeth so that they have to be replaced. By means of this invention the driving connection between the starting motor and pinion will be released at a predetermined torque overload below that which may cause damage to the operating parts of the starter as above mentioned.

It is also well known that in the occasional back fire of the engine there is an excessive torque reaction against the relatively high R. P. M. of the starting motor armature, such as to be likely to either strip the teeth of the pinion and fly wheel gear or break the torque spring of the driving unit. However, by means of this invention the driving connection between the starting motor and pinion will immediately be released upon back fire, thus allowing the pinion to run free and avoid damage.

The invention as applied to a starter is of advantage wherein the starter pinion and fly wheel teeth do not readily slide into mesh. When that occurs, the impact blow due to the high R. P. M. will cause a peening or upsetting action of the ends of the teeth. After this has occurred a number of times, the starter unit becomes inefficient in functioning, which may require the rocking of the vehicle in which it is used, back and forth to disengage the starter pinion from the fly wheel and separate the imbedded teeth. This invention will prevent such an impact blow under excessive torque force. Furthermore, as the torque force becomes excessive there will be a clutch slippage such that the pinion teeth will

2

be permitted to change their angular position relative to the teeth on the fly wheel gear so as to go into mesh and instantly start the cranking of the engine.

One feature of the invention resides in a torque limiting device wherein the driving and driven members are positively connected through a load carrying coil of a clutch spring in association with a series of load transmitting coils terminating in a free or unloading end. Associated with the load carrying coil there is prvided a freely flexible coil such as to flex and permit slippage of the load carrying coil upon an overload torque being applied. The load carrying coil or its associated flexing coil is operatively connected through one or more torsion coils with either the driving or driven member, whereas the load transmitting coils are in clutching engagement with the other or opposed member. The member to which the torsion coils are connected is also provided with an unloading element which, upon relative angular displacement of said members through overload is brought into unloading engagement with the unloading end of the load transmitting coils to progressively unload them from their clutching engagement and relieve the driving connection.

By means of the torsion coils, a wide range of action is permitted in the unloading of the clutch allowing for a substantial tolerance in spacing the unloading element from the unloading end of the spring.

This arrangement, allowing of greater tolerance in the unloading operation is of material advantage in the production of torque limiting devices of this character.

A further feature of the invention is concerned with forming the torsion coils open wound to permit axial displacement of the pinion carrying threaded sleeve relative to the driven portion thereof. Thus, in event the starter pinion fails to mesh with the ring gear of the motor to be started, the open wound torsion coils of the clutch spring yield under the impact to momentarily free the pinion and permit slight angular movement sufficient to bring its teeth into meshing alignment.

The full nature of the invention will be understood from the accompanying drawings and the following description and claims:

Fig. 1 is a plan view of a starter unit embodying the invention.

Fig. 2 is a central vertical section therethrough with the driving shaft in elevation.

Fig. 3 is a perspective view of the unloading sleeve.

Fig. 4 is a perspective view of the clutch spring in its unstressed condition.

By way of illustrating one embodiment of the invention, there is shown in the drawings an engine starter unit adapted to be driven by an electric starter motor 10 embodying a driving shaft 11. Rotatably mounted on the driving shaft there is a spirally threaded sleeve 12 carrying a rotatably supported driving pinion 13. The driving pinion is provided with external gear teeth adapted to mesh with the gear teeth of an engine fly wheel 13*a*, and is internally threaded to mesh with the spiral threads of the threaded sleeve 12. The driving pinion is provided with a flange carrying weight 14, such as to give it the desired inertia for effecting its relative rotation about the sleeve 12 to spiral it into and out of driving position. As shown herein, the driving pinion is in driving position bearing against a spacer sleeve 15 carried by the threaded sleeve 12 adjacent the starter motor.

The threaded sleeve 12 is carried by and integral with a driven collar 16 to which is slidably keyed a pocket member 17 having an internal clutch surface 18. Said collar 16 is slotted to slidably receive a tongue 19 of an unloading sleeve 20, whereby said collar may be axially displaced relative to the pocket member 17 and unloading sleeve 20.

Adjacent the end of the driving shaft 11 and beyond the collar 16 there is mounted a driving collar 21 locked thereto by an anchor screw 22, said collar having formed thereon a driving pocket 23 in opposed relation to the pocket 17 and having an internal clutch surface 24. The clutch surfaces 18 and 24 of the two pockets are arranged coaxially relative to each other to provide the usual split pocket clutch, being separated by the split indicated at 25.

Mounted within said pockets there is a clutch spring 26 having a group of load transmitting coils normally in clutching engagement with the clutch surface 24 of the pocket 23, said group of coils terminating in a deenergizing or unloading end having an inwardly extending toe 27. Said toe extends inwardly toward the driving shaft 11 and the sleeve 20 extending longitudinally thereof and in rotative relation thereto. Opposite the unloading end of the spring the load transmitting group of coils continue into the load carrying coil or coils 28, one of which spans the split 25 between the pockets. Said load carrying coils are normally in clutching engagement with the adjacent clutch surfaces 18 and 24 through which the torque load is transmitted from the shaft 11 through the pocket 23, load carrying coils 28, and pocket 17 to the driven sleeve 12. Adjacent the load carrying coils 28 there is a load sensitive element in the form of a relieved or reduced coil 29 which extends into one or more open wound torsion coils 30, the end torsional coil being provided with a laterally extending toe 31 slidably keyed in the slot 32 of the driven collar 16 on the sleeve 12.

The unloading sleeve 20, which is slidably keyed to the collar 16, is provided with an upstanding projection 33 lying adjacent the toe 27 of the clutch spring for engagement therewith in a direction to unload said spring and permit slippage of its load transmitting coils upon overload.

In operation of the starter unit upon an overload occurring, the clutch spring is unloaded so as to permit slippage relative to its clutch surfaces and thereby relieve the driving connection between the driving member 11 and the driven member 12. The overload may comprise a predetermined maximum torque beyond which the unit will fail to drive, but below which a positive drive is provided. The predetermined maximum load may for the purpose of such a unit be of substantial tolerance or range inasmuch as it is unnecessary that the unloading occur at any specific foot pound torque. It is only necessary that the clutch spring be so designed as to positively drive up to a foot pound torque required for normal operation and somewhat beyond the normal requirements, but well within the safety factor. Upon the maximum torque load exceeding the normal requirements, but being below the safety factor, the spring is designed to unload so that the driving member will no longer drive the driven member as long as such overload persists. However, upon the overload being relieved, it will continue to drive to the extent of the normal load required.

To accomplish the above, the torsional coils 30 of the clutch spring are permitted to yield under overload to allow for a greater tolerance in arriving at the unloading point of the clutch, as well as act as a shock absorbing element within the drive. However, inasmuch as the load carrying coils 28 are normally in positive clutching engagement with both clutch surfaces 18, 24, no torsional strain will be placed upon the torsional coils 30 until there is sufficient overload developed to cause slippage of the driven pocket 17 relative to the load carrying coils 28. Such slippage is permitted by the flexing of the load sensitive coil 29. Upon such slippage occurring due to overload, the load sensitive coil 29, through which the clutch spring is connected to the driven member 33, will flex, as will the torsion coils 30. The combined slippage of the load carrying coils and the flexing of the load sensitive coil will, therefore, permit slight angular displacement between the two pockets.

Such angular displacement will be transmitted through the unloading sleeve 20 so that the projection 33 thereof will be moved into engagement with the toe 27 at the unloading end of the spring. As the angular displacement increases the projection 33 will move the unloading end of the spring in a direction to wrap it down, tending to progressively unload its load transmitting coils from their positive clutching engagement with the pocket 23. Thus, when the overload becomes excessive, the load transmitting coils in the driving pocket 23 will be unloaded sufficiently to permit slippage and thereby allow the driving member to rotate freely relative to the driven member so long as the overload persists. Upon the torque load being reduced below the permitted maximum or overload, the inherent spring tension of the coils, particularly the load sensitive coil, will cause the clutch spring to return to its normal clutching and driving engagement.

The clutch pocket 17 is splined to the collar 16 by the keyway 34 so as to be rotatable therewith but slidable relative thereto for permitting of axial displacement between the clutch pocket and the sleeve 12. The clutch pocket 17 is held in abutting relation to the clutch pocket 23, so that there will be no axial displacement between said pockets, by the surrounding casing 35, said casing having its ends flanged inwardly to embrace the opposed pockets. To retain the unloading sleeve 20 with its projection 33 in line with the unloading end 27 of the clutch spring,

it is formed with a pair of ears 36 peened over to engage a shoulder 37 on the shaft 11.

This arrangement is such that axial displacement is permitted between the driven sleeve 12 and the driven pocket 17 resisted by the compression of the open wound torsion coils 30 of the clutch spring. Thus, wherein the ends of the gear teeth and the starter pinion 13 may butt head-on into the adjacent teeth of the ring gear 13*a*, thus preventing the pinion from sliding into mesh therewith, coils 30 will yield permitting axial displacement of the sleeve carrying the pinion. Thus, there will be a yielding action of the sleeve 12 so that the pinion will not be wedged tight or jammed against the ring gear. With the teeth of the pinion yieldably movable into engagement with the ring gear, it will be free to receive a slight additional angular displacement such as to permit its teeth to be slid into mesh by the energy stored in the compressed open wound torsion coils 30.

In view of the above, it will be observed that a single clutch spring acts as a direct drive connection between the shaft 11 and the sleeve 12, at the same time functioning as a torque limiting device for releasing the driving connection upon overload; provide a load sensitive element in connection with its torque limiting character; provide torsion coils for allowing of substantial tolerance in unloading the load transmitting coils; and in addition thereto act as a yielding cushion to prevent undue impact and wedging of the pinion teeth whereby they will be permitted to more readily move into meshing engagement with the ring gear teeth.

While the illustration shows the type of starter assembly in which the pinion is rotatably secured to a steep pitch screw threaded driven sleeve element of the assembly, the mechanism hereof is equally well adapted to serve in the type of automatic starter unit wherein the pinion is rigid with the screw threaded sleeve, and an axially fixed but rotatable follower nut causes movement of the pinion into and out of engine starting position.

The invention claimed is:

1. A torque limiting device including a driving member having a cylindrical clutch surface, a driven member having an aligned coaxial and adjacent clutch surface, a clutch spring having a series of expansible and contractible coils normally in clutching engagement with one of said clutch surfaces and including an unloading end, said spring having a load carrying coil spanning the adjacent ends of said clutch surfaces in clutching engagement therewith through which driving torque is transmitted therebetween, a load sensitive coil in said spring adjacent said load carrying coil adapted to flex under an overload torque to permit angular displacement of said members, a flexible torsion spring coil connecting said load sensitive coil to the other of said members, and an unloading element operable by said angular displacement to engage the unloading end of said spring for progressively unloading the coils thereof to the extent that said load sensitive portion is flexed, and thereby limit the clutching capacity of said spring to substantially a maximum load.

2. A torque limiting device including a driving member, a driven member, said members being provided with clutch pockets in adjacent coaxial relation, said pockets having internal clutch surfaces, a clutch spring having a series of expansible and contractible coils normally in clutching engagement with said clutch surfaces and including an unloading end, one of said clutching coils transmitting the greater portion of the torque load between said members, a load sensitive coil adjacent said load transmitting coil to permit slippage thereof upon overload through flexing of said load sensitive coil and effect angular displacment between said members, a torsion coil connecting one of said last mentioned coils to the other of said members, and an unloading element operable by said angular displacement to engage the unloading end of said spring and progressively unload the coils thereof to the extent that said load sensitive coil is flexed, and thereby limit the clutching capacity of said spring to substantially a maximum load.

3. A torque limiting device including a driving pocket, a driven pocket, said pockets being provided with separate but adjacent coextending internal cylindrical clutch surfaces, a clutch spring having a series of expansible and contractible coils normally in clutching engagement with one of said pockets and including an unloading end, said spring having a load carrying coil spanning the adjacent portion of said pockets in clutching engagement therewith through which driving torque is transmitted therebetween, a load sensitive coil embodied in said spring adjacent said load carrying coil adapted to flex under an overload torque to permit angular displacement of said pockets, a series of torsion coils connecting said load sensitive coil to the other of said pockets, and an unloading element connected with said last mentioned pocket operable by said angular displacement to engage the unloading end of said spring for progressively unloading the coils thereof to the extent that said load sensitive portion is flexed and thereby limit the clutching capacity of said spring to substantially a maximum load.

4. A spring clutch device including a driving member having a clutch pocket, a driven member having a clutch pocket connected therewith, said driven member being axially displaceable relative to its clutch pocket, said pockets having coaxial aligned clutch surfaces, and a clutch spring comprising a series of clutching coils adapted for clutching engagement with the respective clutch surfaces of said pockets to transmit driving torque between said members and a series of open wound torsion coils free of said pockets terminating in a sliding connection with said driven member for permitting axial displacement of said driven member relative to said driving member.

5. A spring clutch device including a driving member having a clutch pocket, a driven member having a clutch pocket connected therewith, said driven member being axially displaceable relative to its clutch pocket, said pockets having coaxial aligned clutch surfaces, a clutch spring comprising a series of clutching coils adapted for clutching engagement with the respective clutch surfaces of said pockets to transmit driving torque between said members, and a series of open wound torsion coils free of said pockets terminating in a sliding connection with said driven member for permitting axial displacement of said driven member relative to said driving member, and a housing embracing said pockets constraining them against axial displacement relative to each other.

6. A torque limiting spring clutch device comprising coaxial rotary members including respective circular clutch drum surfaces arranged

end to end, a helical clutch spring having a major clutching portion comprising a series of clutching coils normally gripping one said clutch surface and an axially contiguous minor clutch portion normally gripping the other said clutch surface but over a relatively small area thereof so as to slip in event of overload, and a torque sensitive and torque transmitting element connecting the minor clutching portion and the member having said other clutch surface so as to be subjected to torque only upon such slippage occurring between said last-mentioned member and minor portion, said last-mentioned member having means extending into coil unloading or deenergizing relationship to a terminal coil of the major spring portion remote from said minor spring portion.

7. A torque limiting spring clutch device according to claim 6, wherein the torque sensitive element comprises a non-clutching portion of the clutch spring.

WILLIAM CARLETON STARKEY.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,375,870	Van Ness	Apr. 26, 1921
1,403,022	Fornaca	Jan. 10, 1922
1,910,043	Palm et al.	May 23, 1933
1,935,683	Wemp	Nov. 21, 1933
1,984,297	Abell	Dec. 11, 1934
2,004,650	Collyear et al.	June 11, 1935
2,052,152	Webb	Aug. 25, 1936
2,360,187	Almen	Oct. 10, 1944
2,480,507	Pepper	Aug. 30, 1949