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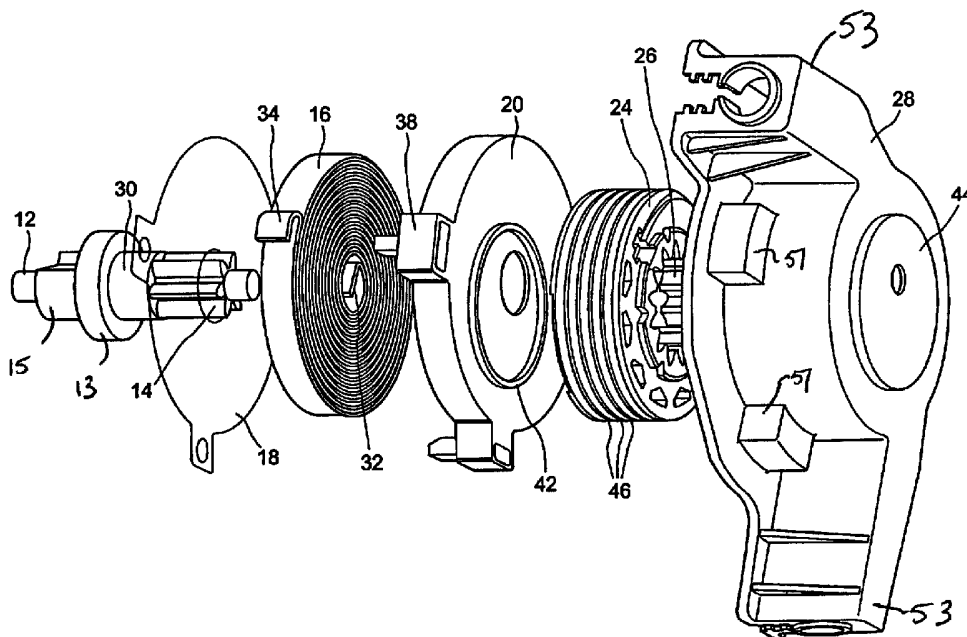
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(54) Title: WINDOW REGULATOR ASSEMBLY



(57) Abstract: A window regulator assembly including a shaft (12) having a pinion gear (14) and a counter balance spring (16) mounted on the shaft which winds or unwind as the shaft rotates. A spring housing (14) is mounted on the shaft. A cable-guiding drum (24) having an inner gear (26) is driven directly by the pinion gear, as the drum has a rotational axis that is offset from a rotational axis defined by the shaft, thus providing mechanical advantage. A casing (28) houses the spring (16), spring housing (20) and the drum (24) in abutting relationship. A guide such as a rail (42) is disposed on at least one of the spring housing and the drum for maintaining rotational alignment of the drum relative to the shaft.

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## Window Regulator Assembly

### Field of Invention

The invention relates generally to a window regulator for automotive  
5 applications.

### Background of Invention

An automotive door comprises inner and outer door panels that define a  
relatively shallow depth therebetween. A window regulator together with its requisite  
10 hardware must fit within this constrained space. For example, US Patent No.  
5,987,819 illustrates a representative window regulator. The regulator typically  
includes a window drive assembly that converts rotational motion from a motor or  
handheld crank to translate one or more cables that control the opening and closing  
movement of the window. In order to the limit the size of the regulator, it is helpful  
15 to minimize the depth or profile of the drive system, whether the motive source be  
electrical or mechanical.

PCT Publication No. WO 01/14673 describes a window drive system for  
automotive applications. This system includes a counter-balance spring that functions  
to reduce torque requirements when the window is moved upwards. The size of this  
20 drive system is minimized by placing the counter balance spring on the shaft of a  
crown gear that drives a cable-guiding drum.

### Summary of Invention

One aspect of the invention provides an improved window regulator assembly  
25 that utilizes fewer parts and minimizes the depth or profile of the regulator assembly  
as compared to the known prior art. Generally speaking, the drum of the window  
regulator assembly is directly driven in order to minimize the stack height or profile  
of the assembly.

According to this aspect of the invention, a window regulator assembly is  
30 provided which includes a shaft having a pinion gear and a counter balance spring  
mounted on the shaft and disposed to wind or unwind when the shaft rotates. A

spring housing is mounted on the shaft for covering the spring. A drum having an inner gear is in meshing engagement with the pinion gear. The drum has cable guides on its exterior periphery for guiding at least one cable wound therearound. A casing houses the spring, the spring housing and the drum in abutting relationship. Means, such as a guide disposed on at least one of the spring housing and the drum, is provided for maintaining rotational alignment of the drum relative to the shaft. Preferably, the drum has a rotational axis that is offset from a rotational axis defined by the shaft, thus providing mechanical advantage.

## 10 Description of the Drawings

In drawings that illustrate embodiments of the invention,

Figure 1 is an exploded perspective view of the window regulator assembly according to the preferred embodiment;

Figure 2 is a perspective view of a counter balance spring cover disk of the assembly shown in Figure 1;

Figures 3a and 3b are perspective views of a cable drum of the assembly shown in Figure 1; and

Figure 4 is a plan view of the gear engagement of the assembly shown in Figure 1.

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## Description of the Invention

Figure 1 illustrates the window regulator assembly 10 of the present invention.

The major components of the assembly 10 include:

- a drive shaft 12 having an integrated pinion gear 14;
- a counter balance spring 16;
- a counter balance spring cover disc 18;
- a spring housing 20;
- a cable drum 24 having an inner circumferential gear face 26; and
- a drive housing or casing 28.

30 The drive shaft 12 has a central shaft including a flange 13. A lost motion connection 15 is on one side of the flange 13 and a bearing surface 30 and pinion gear

14 are located on the opposite side. Preferably, drive shaft 12 is made of machined steel.

The counter balance spring 16 is a conventional counter balance spring made of flat spring steel stock. The counter balance spring 16 extends between the drive shaft and the spring housing 20 to provide a counter balancing force on drive shaft to minimize winding efforts required to open and close a window. Counter balance spring 16 is wound about bearing surface 30 of the drive shaft 12. The inner end of spring 16 has a hook 32 that engages an axially aligned receiving slot on drive shaft 12. The spring 16 is wound up a few turns to provide a pre-tension. The pre-tension tightens the first few inner coils around the drive shaft 12, thereby holding the spring hook 32 in place.

The spring housing 20 is generally cup shaped having an axial thickness of about the thickness of the spring 16. The housing 20 has a pair of tabs 38 extending radially from an outer wall 41. Preferably, the tabs 38 are located approximately 90° relative to each other. As seen best in Fig. 2, each tab 38 has a hooked slot 39, 39', being left and right handed slots. Each tab 38 also has a tang 37 that is available for final assembly of the regulator.

The inner face of spring housing 20 has an outer coil guide ring 40. The guide 40 is arcuate and extends between the two tabs 38. The guide 40 is spaced from the wall 41 of the housing approximately equivalent to the radial thickness of the spring 16. The outermost coil of spring 16 is inserted between guide 40 and wall 41, while the hooked end is inserted into one of slots 39, 39'. This installation prevents bias of the spring 16 in the housing during wind-up. This reduces hysteresis and produces a much smoother torque curve.

The spring 16 functions to achieve similar operating torques when the window is moved in either direction, up or down. Ideally, the spring slope should be relatively shallow in order to avoid large differences between the torque assist and full down and full up positions.

Spring housing 20 has a central aperture 43 through which drive shaft 12 extends and defines a drive axis. As shown in Fig. 1, the outer surface of the spring housing 20 preferably includes a ring 42 that is offset from the drive axis.

The drum 24, which is also shown in isolation in Fig. 3A, includes a circular groove 144 that mates with the circular ring 42 to maintain the offset alignment and defines a drum axis offset from the drive axis. The drum 24 has a central bore having a series of internal teeth on an inner circumferential face 26. The outer drum surface  
5 has a helical groove 46 that communicate with terminal pockets 47, 49 on opposite axial end faces of the drum 24. The terminal pockets receive drive cable end fittings in a manner well known in the art.

The drum 24 has a raised embossment 45 on the face opposite the groove 144. Referring back to Figure 1, the drive casing 28 is configured to receive the drum 24  
10 and spring housing 20. The casing 28 has a circular recess 44 that receives embossment 45 of the drum in a sliding relation. Recesses 51 receive tabs 38. The casing 28 has two cable outlets 53 from which the cables extend.

Once assembled, the drive pinion 14 drivingly engages with the teeth of inner periphery 26. As shown schematically in Fig. 4, the pinion gear 14 is relatively small,  
15 preferably comprising a six-tooth involute gear, that mates with a thirteen-tooth internal gear forming the inner circumferential face 26 of the drum 24. This arrangement, made possible by the aforementioned offset alignment, provides a gear reduction system (2.17:1 in the preferred embodiment). It is understood that the present invention is not limited to this specific gear reduction and it will be  
20 appreciated by those skilled in the art that other gear ratios may be utilized within the scope of the present invention. It will also be appreciated that the axial offset between the drum 24 and shaft 12 can be provided by other types of guiding mechanisms. For example, the drum could have a circular rail and the spring housing could have a corresponding groove. Alternatively, the casing 28 could be modified to contain the  
25 drum circumferentially instead of axially (or in addition thereto) in order to maintain the offset alignment.

The present system uses fewer parts than the system disclosed in PCT Publication No. WO 01/14673, thus enabling a shallower depth profile. The present system also reduces motive torque requirements as compared to the prior art.

30 The above-described embodiment of the invention is intended to be an example of the present invention and alterations and modifications may be effected thereto, by those of skill in the art, without departing from the spirit of the invention.

What is claimed is:

1. A window regulator assembly, comprising:
  - a shaft having a pinion gear;
  - a counter balance spring mounted on said shaft and disposed to wind or unwind when said shaft rotates;
  - a spring housing mounted on said shaft for covering said spring;
  - a drum having an inner gear in driving and meshing engagement with said pinion gear, said drum having cable guides on its exterior periphery for guiding at least one cable wound therearound;
  - a casing for housing said spring, said spring housing and said drum in abutting relationship; and
  - means for maintaining rotational alignment of said drum relative to said shaft.
2. An assembly according to claim 1, wherein said drum has rotational axis that is offset from a rotational axis defined by said shaft.
3. An assembly according to claim 2, wherein said rotational alignment means comprise a guide disposed on at least one of said spring housing and said drum.
4. An assembly according to claim 3, wherein said guide comprises a rail disposed on one of said spring housing and said drum and a corresponding groove disposed on the other of said spring housing and said drum.
5. An assembly according to claim 2, wherein said rotational alignment means includes an embossment formed in said drum and a recess formed in said casing receiving said embossment.
6. An assembly according to claim 2, wherein said rotational alignment means includes a guide formed in said casing for circumferentially containing said drum.

7. An assembly according to claim 1, wherein said spring housing is constrained from rotating by said casing, said spring having an inner end thereof fixed to the shaft and outer end thereof fixed to said spring housing.
8. An assembly according to claim 7, wherein said spring housing includes at least one tab and said casing includes a recess in which said tab is seated.
9. A window regulator assembly, comprising:
  - a shaft having a pinion gear;
  - a counter balance spring mounted on said shaft and disposed to wind or unwind when said shaft rotates;
  - a spring housing mounted on said shaft for covering said spring;
  - a cable-guiding drum having an inner gear in driving and meshing engagement with said pinion gear, wherein said drum has a rotational axis that is offset from a rotational axis defined by said shaft;
  - a casing for housing said spring, said spring housing and said drum in abutting relationship; and
  - a guide disposed on at least one of said spring housing and said drum for maintaining rotational alignment of said drum relative to said shaft.

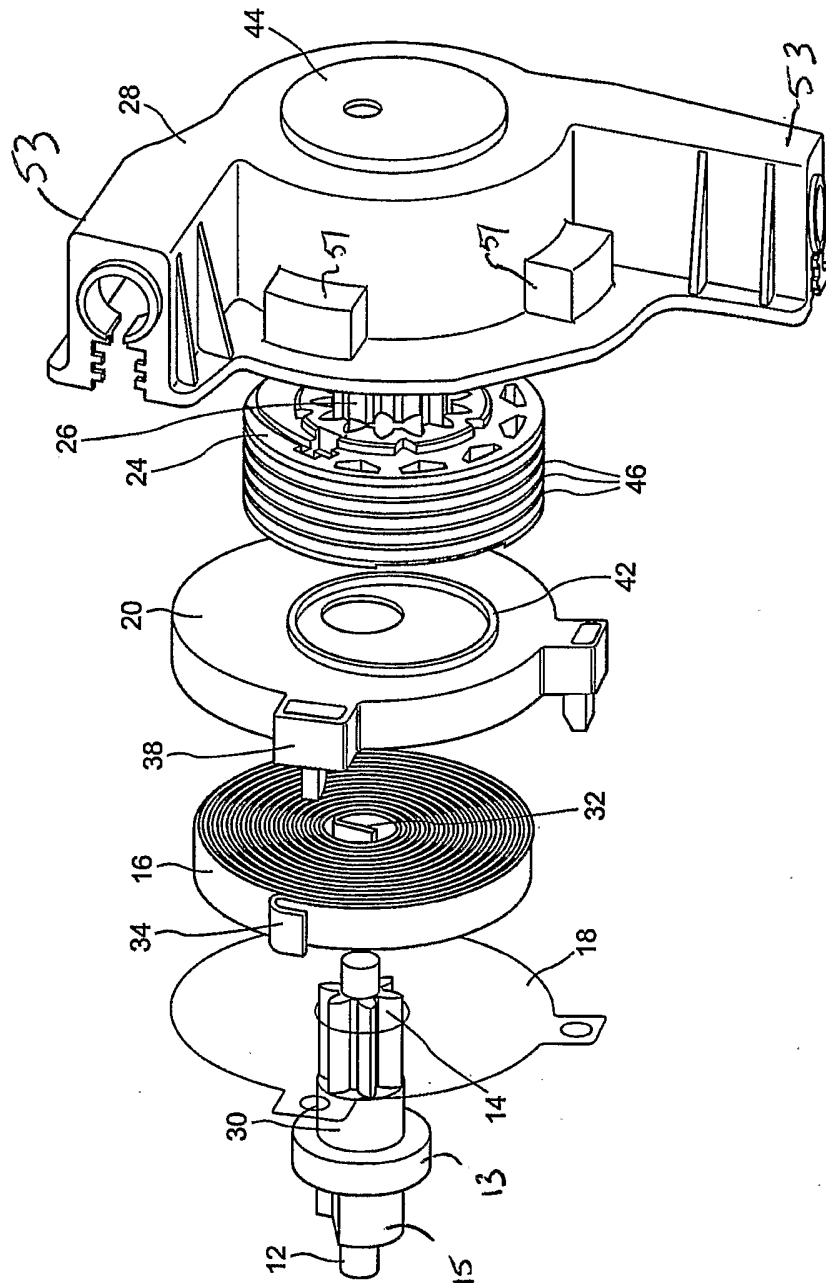


Figure 1

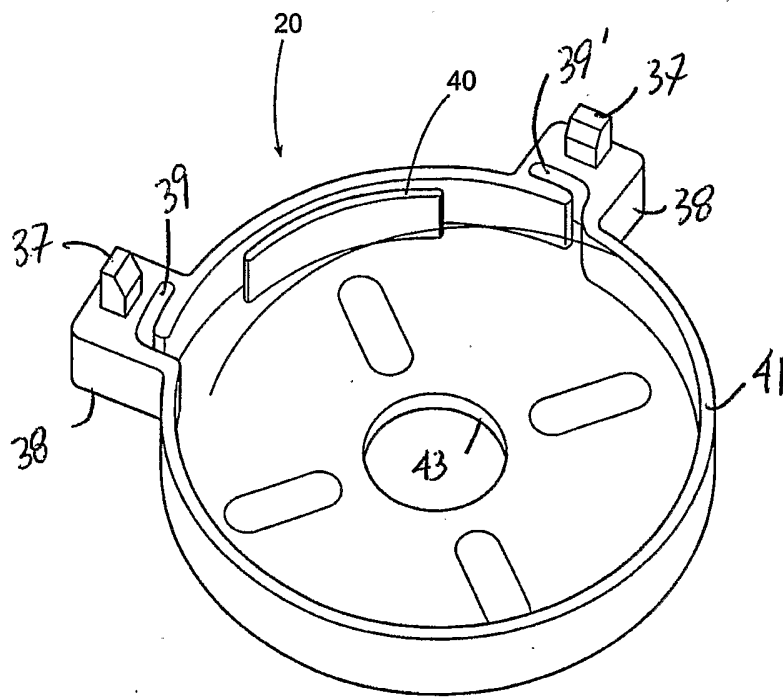


Figure 2

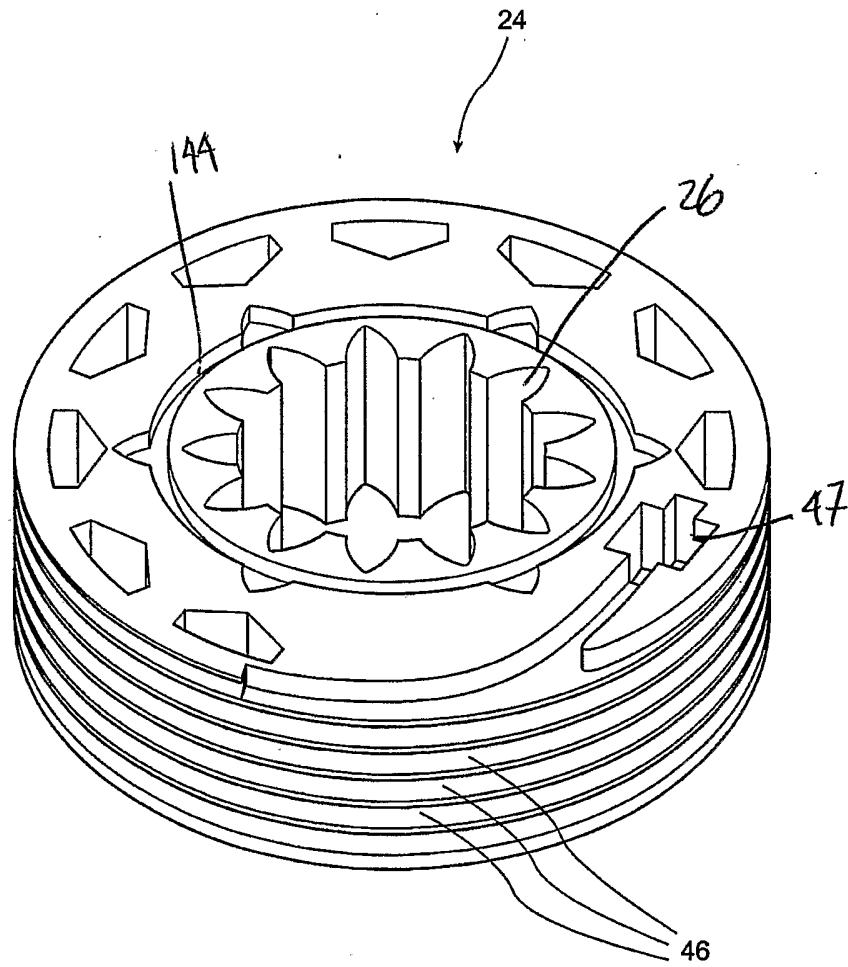


Figure 3A

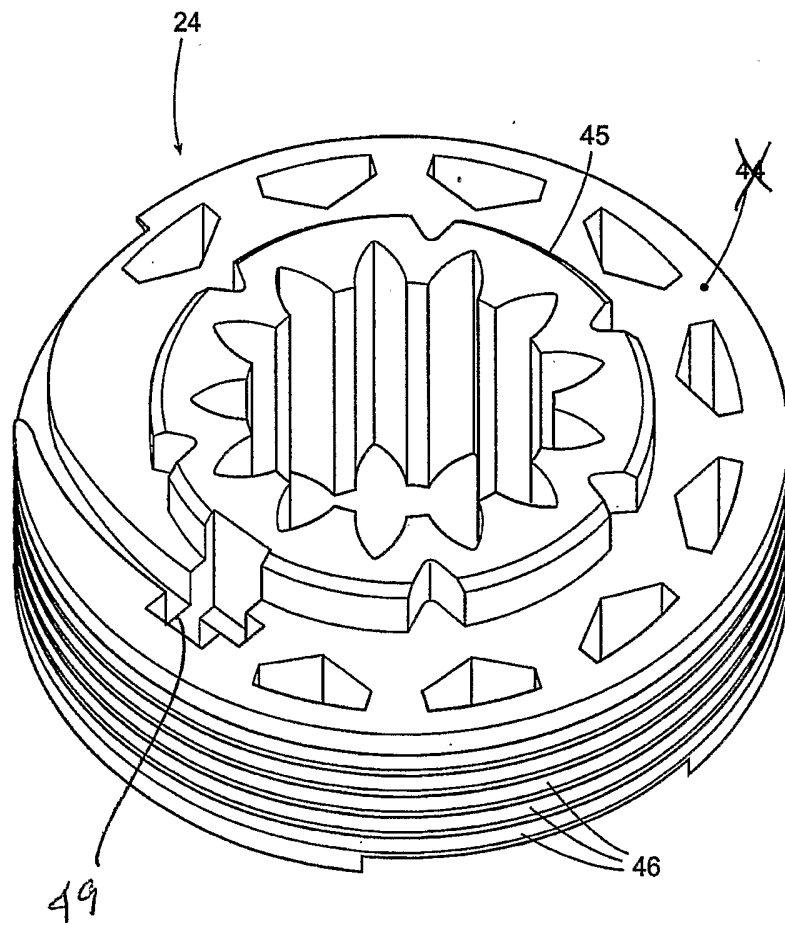
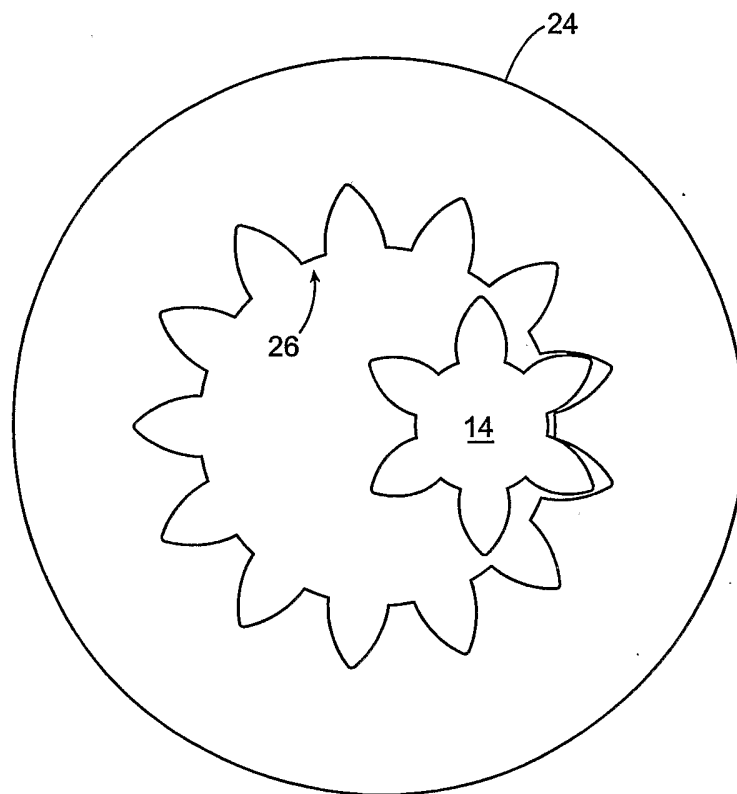


Figure 3B



**Figure 4**