July 30, 1963 J. E. MARTENS 3,099,168

MOTION-TRANSMITTING DEVICE

Original Filed March 14, 1958 2 Sheets-Sheet 1

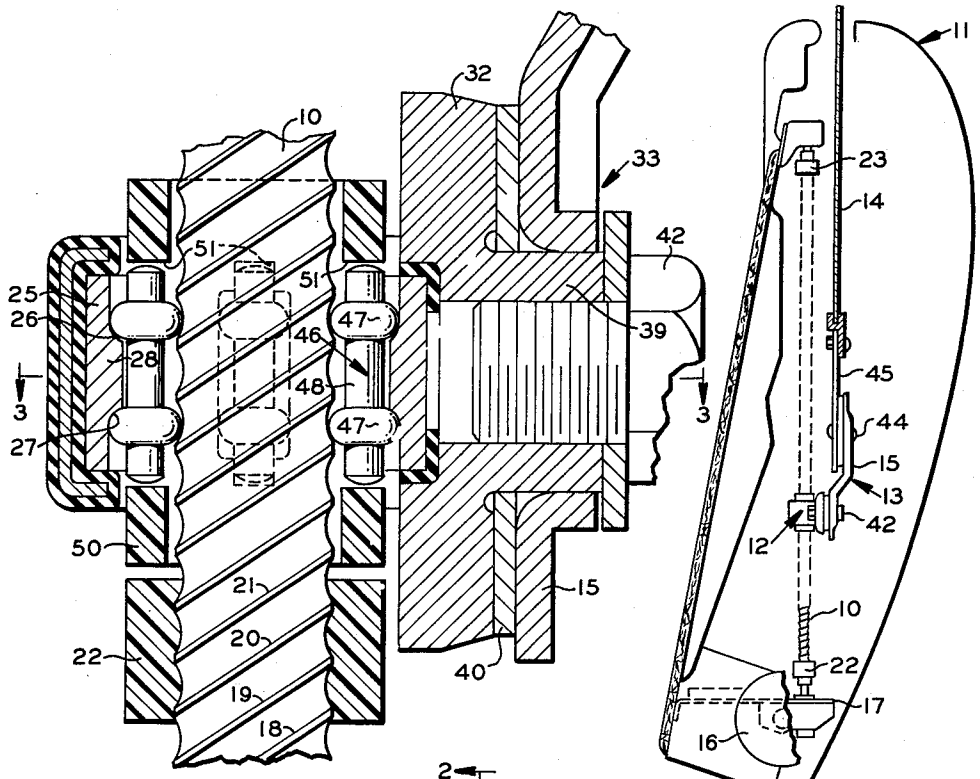


Fig. 2

Fig. 1

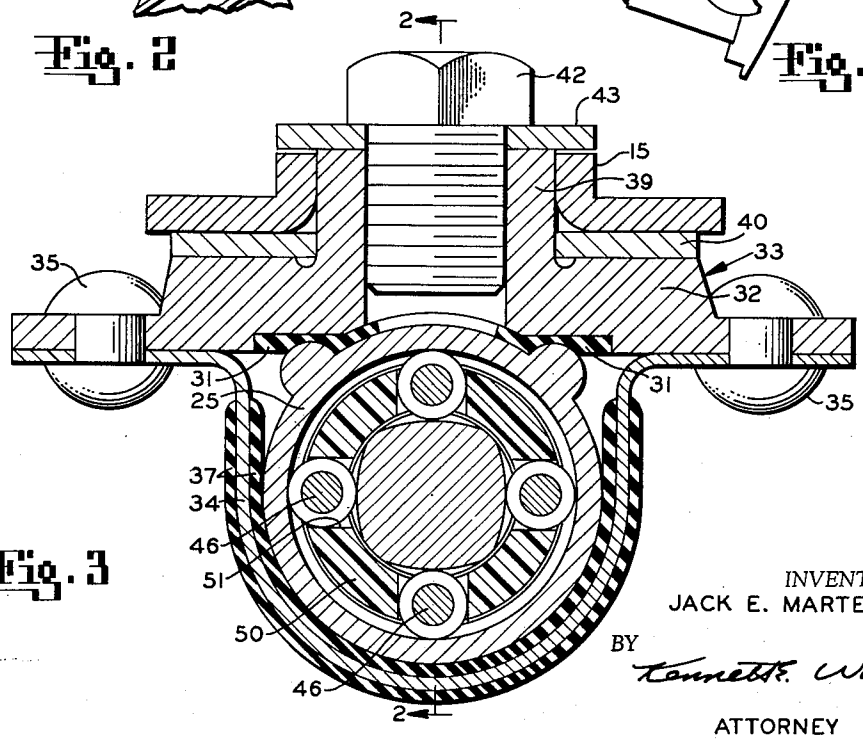


Fig. 3

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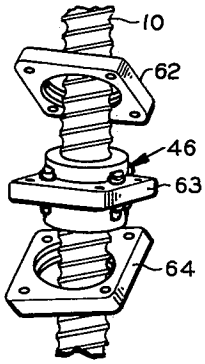


Fig. 4

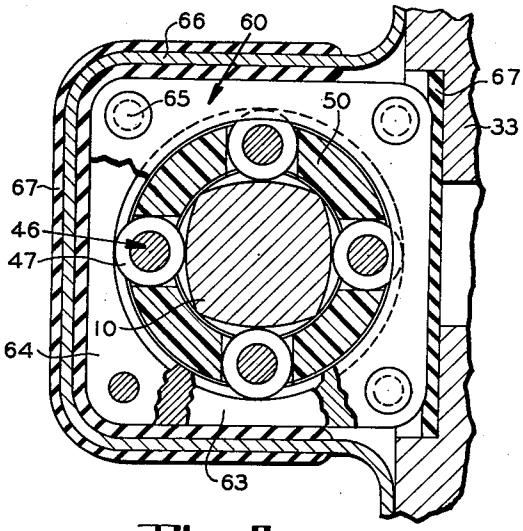


Fig. 5

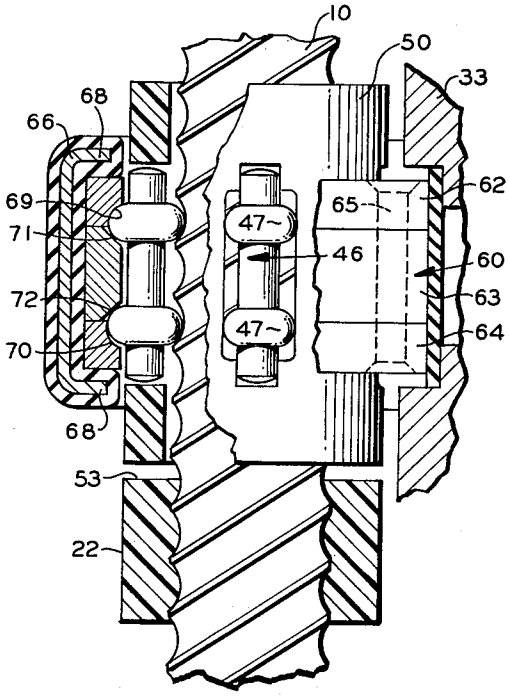


Fig. 6

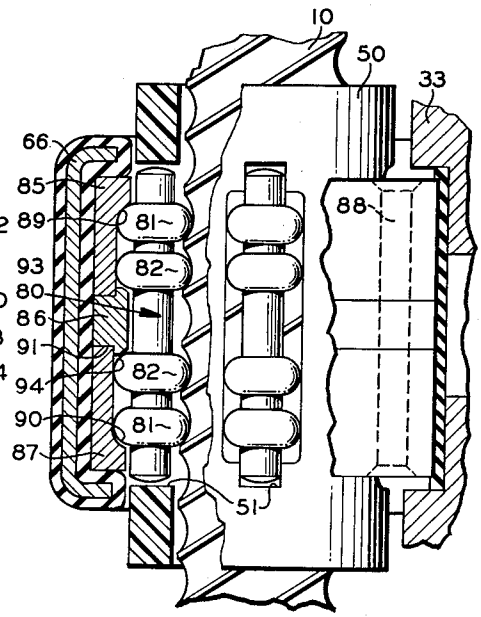


Fig. 7

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3,099,168

MOTION-TRANSMITTING DEVICE

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Continuation of application Ser. No. 721,493, Mar. 14, 1958. This application July 1, 1960, Ser. No. 40,250
4 Claims. (Cl. 74—459)

This invention relates to a motion-transmitting mechanism and more particularly to an improved nut-and-screw type motion-transmitting mechanism.

This application is a continuation of my copending application Serial No. 721,493 filed March 14, 1958, and now abandoned.

It is a principal object of this invention to provide an improved nut-and-screw type motion-transmitting device having improved force-transmitting and motion-transmitting characteristics.

It is a further object of this invention to provide an improved nut member which is capable of improved load-carrying capacities.

It is still a further object of this invention to provide an improved nut-and-screw device comprising a few simple, practical and dependable parts which are combined to product a dependable and smoothly operating device.

And a still further object of this invention is to provide a motion-transmitting mechanism which can be advantageously embodied in a form which is not only simple, requiring few operating parts, but also is compact, making it practical for use in situations where only a limited space is available.

Another object of this invention is to provide an improved nut-and-screw device having a simplified and efficient freewheeling feature.

Still another object of this invention is to provide a nut-and-screw device having an improved freewheeling operation that does not require the standard parts of the device to have any special shapes or forms.

And still another object of this invention is to provide an improved nut-and-screw assembly that is quiet in operation and relatively inexpensive to build and maintain.

Additional objects and features of the invention will become evident when the description hereinafter set forth is considered in conjunction with the drawing annexed hereto.

In the drawings:

FIGURE 1 is a partial vertical section showing the application of the invention to a window in a vehicle door;

FIGURE 2 is a sectional view taken on the line 2—2 of FIGURE 3 showing the details of one form of my improved device;

FIGURE 3 is a sectional view taken on the line 3—3 of FIGURE 2;

FIGURE 4 is an exploded perspective view of a modified form of my nut assembly;

FIGURE 5 is a top view partially in section of the modified ford of the nut assembly of FIGURE 4 together with a mounting bracket;

FIGURE 6 is a side view partially in section of the nut assembly of FIGURE 5 together with the freewheeling stop on the screw; and

FIGURE 7 is a side view partially in section of a further modified form of nut assembly.

The invention as mentioned above may be utilized wherever applicable but, as illustrated in the drawings, is operatively associated with the window of an automotive vehicle.

Referring particularly to FIGURE 1 of the drawing, there is shown, among other things, a screw or threaded shaft member **10** vertically supported to rotation in a vehicle door **11**, a nut assembly generally designated **12**

carried by the screw, and connection means **13** operatively connecting the nut assembly with a window assembly **14** through a link **15**. A power unit, such as an electric motor **16**, shown partially broken away, is operatively connected to the screw through a gear reduction box **17** whereupon the screw is rotated in either a clockwise or counterclockwise direction to cause the nut assembly to travel longitudinally on the shaft.

The screw member shown in FIGURES 1–3 of the drawing is of the multiple-thread type. More particularly, it includes quandruple right-hand threads **18, 19, 20** and **21** which, as shown in the drawings, are produced by any one of the well-known methods such as rolling or the like. Obviously, there may be any desired number of threads on the screw member which may be left or right-handed without departing from the spirit of the invention. A pair of spaced-apart stop members **22, 23** are secured to the opposite end portions of the shaft in a manner and for a purpose to be described hereinafter.

The nut member generally designated **12** may be constructed in various ways and as shown in FIGURES 2 and 3 preferably includes a ring-shaped housing **25** which has a pair of oppositely facing raceways or abutments **26, 27** formed therein from the opposite open-end portions. The abutments are formed in such a way as to present a shaped contacting surface in the direction of the respective open end of the ring with a portion **28** of reduced diameter extending in an axial direction between the abutments. The housing **25** has a pair of axially directed, radially disposed positioning or retainer lugs **30** formed on the outer surface thereof which are adapated to seat against a resilient pad **31** carried by a mounting base **32** of the bracket **33**. A strap member **34** is secured by rivets **35** to the base **32** and is shaped to surround the major portion of the circumference of the housing **25**. A resilient covering **37** surrounds the strap member **34** between the strap member and the housing **25** so as to cushion the housing from the bracket **33** whereby the operating vibrations and noises of the nut member are substantially reduced.

The bracket **33** has an internally threaded radially extending shank **39** about which is seated a nylon washer **40** and a shoulder portion of the link **15**. Threaded into the shank is a bolt member **42** which positions a washer **43** in overlapping relationship with the shoulder of the link **15** and in spaced relationship with said shoulder so as to provide an operating clearance therebetween. The other end portion of the link **15** is pivoted by a pin **44** to bracket **45** which is carried by the base of the window assembly **14**. The link **15** is adapted to pivot both about the shank **39** and about the pin **44** so as to permit misalignment between the nut assembly and the window assembly **14** without interfering with the operation of the driving mechanism.

A plurality of rotatable bearing elements **46** are interposed between the threads of the shaft member **10** and the raceways **26, 27** of the nut member **12** to adapt these members for relative rotational and longitudinal movement and to transfer or transmit the motion and load or force from the one member to the other. The bearing elements **46** are preferably of the type wherein at least two enlarged bearing surfaces **47** are axially spaced apart along a tubular-shaped member **48** a distance which will substantially coincide with the axial dimension of the portion **28** of the ring-shaped housing so that the bearing surfaces **47** are substantially positioned in contact with the raceways **26, 27**. In the form of invention shown in FIGURE 2 the portion **28** of the nut member is of an axial length such as to require the bearing surfaces **47** of each bearing element **46** to engage with every other one of the threads **18, 19, 20** and **21**. An increase or decrease in the number of threads on the shaft member

will increase or decrease the number of bearing elements in the particular nut herein described.

Loosely positioned about the threaded shaft **10** and within the ring-shaped housing **25** is a tubular cage member or carrier **50** which has openings **51** within which are nested the bearing elements **46**. The openings **51** are formed in the carrier **50** at equally spaced predetermined peripheral positions about the carrier with the long axes of each opening lying substantially parallel to the axis of the carrier. In the form of carrier shown in FIGURES 2 and 3, the short axes of the openings lie in a common plane passing perpendicular to the axis of the carrier. Although the carrier member **50** may be made of any suitable material, either metal or plastic, it has been found that material of the polyamide types, such as nylon, are most satisfactory. The axial extremities of the carrier **50** are substantially flat and lie in parallel planes that are substantially perpendicular to the axis of the screw member.

Rotation of the screw member in either direction rotates the bearing elements **46** about their own axes and also planetates them about the axis of the screw. The planetation causes the bearing elements to roll up or down the spiral surfaces of the screw member. Since the nut member, principally the housing, is not permitted to rotate, and since the bearing elements are in rolling contact between the threads and the raceways, the axial movement of the bearing elements along the spiral of the screw will be transmitted to the nut member through the raceways **26** and/or **27**. The axial component of force from the screw member and the bearing elements is transmitted to the nut assembly housing through the innner axial portions of the bearing surfaces **47** of the bearing elements to the raceways **26** or **27**. Depending upon which direction the nut member is being moved determines which raceway and bearing surface is carrying the load. For instance, assuming the screw member of FIGURE 1 to be rotating in a counterclockwise direction, the nut travels in a downward direction along the axis of the screw. The loading is from the screw through the lower bearing surface **47** of the bearing element to the lower raceway **27** through the nut to the link **15**. The upper bearing surface **47** is acting as a radial thrust-type bearing with respect to the upper raceway **26** and is transmitting certain tensile and counteracting couple forces from the screw through the cylindrical body **48** of the bearing elements to the lower bearing element **47**.

The result of the internal loading of the nut and bearing elements is to place the body portion or shank **48** of each bearing element in tension instead of compression during a majority of the driving operations of the device so as to decrease distortion of the body portion **48** of the bearing elements. The internal loading principle also creates substantial savings in manufacturing and assembling costs.

Any suitable means may be provided for stopping axial movement of the nut member at a predetermined axial position relative to the screw. That, is with the screw member still rotating, it is desirable to have the nut assembly remain in a fixed predetermined axial position. The pair of stop members **22, 23** are secured to the screw at any predetermined axial positions, which, in the illustrated form. are near the extremities of the screw member **10**. The stops, as shown, are formed of solid plastic material, such as nylon, and are threaded onto the screw members into proper position among the axis of the screw. Threading the stop onto the screw member with an extremely tight fit will create a gripping between the stop and the screw which will hold the stop in the selected position without further fastening means and has the further advantage that the stoppping face **53** of each stop lies in a plane substantiallly perpendicular to the axis of the screw and can be very accurately positioned along the screw by simply turning the stop to the proper position. It is to be understood that any stop means that can be locked on the thread such as by set screws, lock nuts, clamps or the like are within the scope of this invention as long as a substantially flat planar stoppping face **53** is formed on the side of the stop facing the nut member.

When one end of the carrier **50** of the nut member of FIGURES 2–3, having the bearing surfaces **47** of the bearing elements **46** internally loaded with respect to the raceways **26, 27** of the housing, engages with the stopping face **53** of the stop member **22**, the carrier **50** is stopped from relative rotation about the axis of the screw, that is, the carrier **50** and the screw rotate together about the axis of the screw. Due to the locked condition of the carrier **50** relative to the screw, the bearing elements **46** are not planetating about the screw and are not advancing along the spiral of the thread on the screw. The bearing elements **46** may or may not rotate about their own axes depending upon the relative frictional forces acting on the bearing elements between the non-rotating raceways of the nut member and the rotating locked-up screw member and carrier. In the freewheeling condition, if the bearing elements do not rotate about their own axes, they will slide on the contacting raceways **26** or **27**. If the bearing elements do rotate about their own axes, they will rotate relative to the contacting raceways, but they will slide over the aligned contacting spot on the screw member. Since the carrier and screw member are held against relative rotation by the stop member, no axial movement is transmitted to the housing whereupon the movement of the window assembly is stopped. Immediately upon reversing the rotation of the screw member, the nut assembly will be advanced axially of the screw in the opposite direction until the stop **23** is contacted whereupon substantially the same freewheeling condition prevails.

FIGURES 4, 5 and 6 show a modified form of my invention wherein the threaded screw member **10**, the carrier **50** of the nut member **12** and the plurality of bearing elements **46** having bearing surfaces **47** engaging the threads of the screw member are identical in construction as in the form of invention shown in FIGURES 1–3. The nut assembly **12** comprises a block-shaped housing **60** having three stacked apertured plates **62, 63, 64** secured together by means of pins **65**. The housing **60** is peripherally encased by a strap member **66** which is secured to the base **32** of the bracket **33** by rivets or the like, not shown. Resilient material **67** such as rubber or the like encases most of the strap **66** and is seated between the housing **60** and the base **32** of the bracket to cushion the housing from the bracket. As best shown in FIGURE 6, the end portions **68** of the strap **66** are bent over so as to nest against the ends of the block-shaped housing **60** to retain the housing in position relative to the bracket.

The apertured plates **62, 64**, on the opposite ends of the housing **60**, have raceways **69, 70**, respectively, formed around an inner surface of the apertured portions thereof. The plate **63** is formed with the inner peripheral edges of the apertured portion tapered to form a pair of oppositely facing raceways **71, 72**. When the plate **63** is sandwiched between the plates **62, 64**, the raceways **69, 70** of the plates **62, 64** are made to coincide with the raceways **71, 72**, respectively, of the plate **63**. The bearing surfaces **47** on the bearing elements **46** are adapted to nest between threads on the screw member and the raceways in the housing **60**. The bearing surface **47** on one end of each bearing element **46** engages in the raceways **69** and **71** and the surface **47** on the other end of the bearing **46** engages in the raceways **70** and **72**. As shown in FIGURE 6, movement of the nut member upwardly on the screw member engages the bearing surfaces **47** with the raceway **72** on the lower end portion and with raceway **69** on the upper end portion. With the nut member pulling a work load down, the screw member reverses the engagement and causes contact of the bearing surfaces with raceway **71** on the upper end and with raceway **69**

on the lower end. The freewheeling stop 22 is shown in FIGURE 6 in position on the screw member with its stopping face 53 in substantially parallel relationship with the one end face of the carrier 50 such that contact between the two faces will stop the planetation of the carrier 50 about the axis of the screw whereupon the nut member and the screw member are free to rotate relative to each other without wedging or jamming relative to each other or without stalling the driving motor of the system.

FIGURE 7 shows a further modified form of my invention. The screw member 10, the carrier 50 and the strap 66 and bracket 33 are substantially the same as FIGURE 6. The bearing elements 80 are of the type wherein a plurality (two in the illustrated form) of bearing surfaces 81, 82 are formed on each end portion thereof. The bearing elements 80 are nested in the openings 51 in the carrier 50 in substantially the same manner as hereinbefore described.

The housing 84 has three stacked plates 85, 86, 87 which are assembled by pins 88 and which are seated in the bracket 33 to form the housing of the nut member. The plates 85 and 87 have raceways 89, 90, respectively, formed into the inner surfaces thereof which are adapted, when assembled with the plate 86, to provide contacting surfaces for the opposite extreme bearing surfaces 81 of the bearing elements 80. The plate 86 has an undercut portion 91 on each side into which the end portions of the plates 85, 87 nest. A pair of oppositely facing raceways 93, 94 are formed on the plate 86 in such a way as to form contacting surfaces for the inner bearing surfaces 82 of the bearing elements 80. Appropriate rotation of the screw will drive the nut member in an upward direction such that the bearing surface 81 on the upper end portion of the bearing 46 engages with the raceway 89 and the bearing surface 82 on the lower end portion of the bearing 46 engages with the raceway 94 as illustrated in FIGURE 7. Rotation of the screw in the opposite direction under certain conditions contacts the bearing surface 81 on the lower end portion of the bearing with the raceway 90 and the bearing surface 82 on the upper end portion of the bearing with the raceway 93.

The bearing elements 80 with the plurality of bearing surfaces 81, 82, in combination with the nut member of FIGURE 7 has the added advantage over the form of nut shown in FIGURES 2–3 of being capable of increased stability while transmitting increased loads. Each bearing surface 81 and 82 on each end of the element 80 is adapted for carrying axial loads in one direction only, that is, surface 81 on the one end portion is used for driving loads in one direction only, while surface 82 on the same end portion is used for driving loads in the opposite direction only, such that special treatment can be applied in designing the specific contacting surface to produce an optimum condition of wear and efficiency.

The nut-and-screw assembly of the present invention has been shown in a vertical position wherein gravity acting on the work load is an important factor in describing the operation of the bearing elements in relation to the threads on the screw and the raceways on the nut. The device is equally efficient with the axis of the screw member lying in a horizontal plane. For instance, with a dead-weight load on the nut, each time the direction of rotation of the screw member is reversed, the contacting surface of the bearing elements will shift from one raceway (i.e. 26 in FIGURE 2) to the other (i.e. 27 in FIGURE 2).

The internally loaded nut, whether of the form shown in FIGURES 2, 6, or 7, has the further advantage of transmitting the major portion of the force from the bearing element through the solid intermediate portion of the nut housing (i.e. portion 28 in FIGURE 2) to the work piece. The result of this internal loading is to produce a nut assembly capable of carrying much higher loads through the greater cross-sectional load-carrying intermediate portion of the nut housing. When the internal loading feature is combined with the external loading, such as in FIGURES 4–7, a highly superior nut is produced which can be used for a range of work loads for exceeding currently designed types of nut-and-screw assemblies.

Having thus described my invention, it is obvious that various other modifications may be made in the same without departing from the spirit of my invention; hence, I do not wish to be understood as limiting myself to the exact forms, constructions, arrangements and combinations of parts herein shown and described or uses mentioned.

I claim:

1. A load-bearing assembly comprising a housing having three superimposed apertured members, the two end ones of said members having opposed portions oppositely offset to define a pair of facing abutments therebetween, a pair of oppositely facing abutments formed in the intermediate one of said members, said abutments in the intermediate member being adapted to coact with the abutments in the end members to form axially spaced raceways therein, a threaded shaft extending through the apertures in the superimposed members, and a plurality of roller elements having axially spaced radially enlarged bearing surfaces extending between the threads on the shaft and the spaced raceways whereby relative rotation of the housing and shaft moves one axially relative to the other.

2. A load-bearing assembly comprising a plurality of superimposed members, means for securing said members together, said members having two-sided internal raceways formed therein, rollers positioned about the inner periphery of the members and having axially spaced-apart radially enlarged bearing surfaces seated in the formed raceways, and a threaded shaft having a peripheral portion adapted to engage the rollers.

3. A screw-and-nut mechanical movement device comprising in combination; a screw member having external helical threads, a nut member, said nut member having an opening therethrough surrounding the screw member for cooperation therewith, said opening being defined by a pair of outer spaced-apart cylindrical portions adjacent opposite ends thereof and another inner cylindrical portion intermediate the spaced-apart cylindrical portions having a diameter less than the diameter of the spaced-apart cylindrical portions, the juncture of said inner and outer cylindrical portions providing axially facing annular shoulder means defining annular raceways, and a plurality of roller elements having axially spaced-apart radially enlarged bearing surfaces connected by a shank portion, said roller elements being disposed around the periphery of the screw member with the radially enlarged bearing surfaces in rolling contact between the helical threads and the annular raceways whereby relative rotation between the screw and nut members moves one axially relative to the other.

4. In a device of the class described, driving and driven members disposed for relative rotational and longitudinal movement, one of said members having a periphery forming helical threading having appreciable axial lead, the other of said members comprising a housing having an opening therethrough for operatively surrounding the one member, said opening comprising first, second and third axially disposed cylindrical portions, said first and second cylindrical portions lying in adjacent communication with opposite outer extremities of the other member, said third cylindrical portion being of a smaller diameter than the other two cylindrical portions and located therebetween, the juncture between the adjacent cylindrical portions providing shoulder means defining oppositely axially facing annular raceways, a plurality of roller elements having axially spaced-apart radially enlarged bearing surfaces connected by a shank portion, said bearing surfaces straddling the third cylindrical portion and engaging said raceways and the threading of said one member and being

freely rotatable relatively thereto about axes substantially parallel to the axis of said one member whereby relative rotational movement between the members produces relative translatory movement therebetween.

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