

Nov. 14, 1961

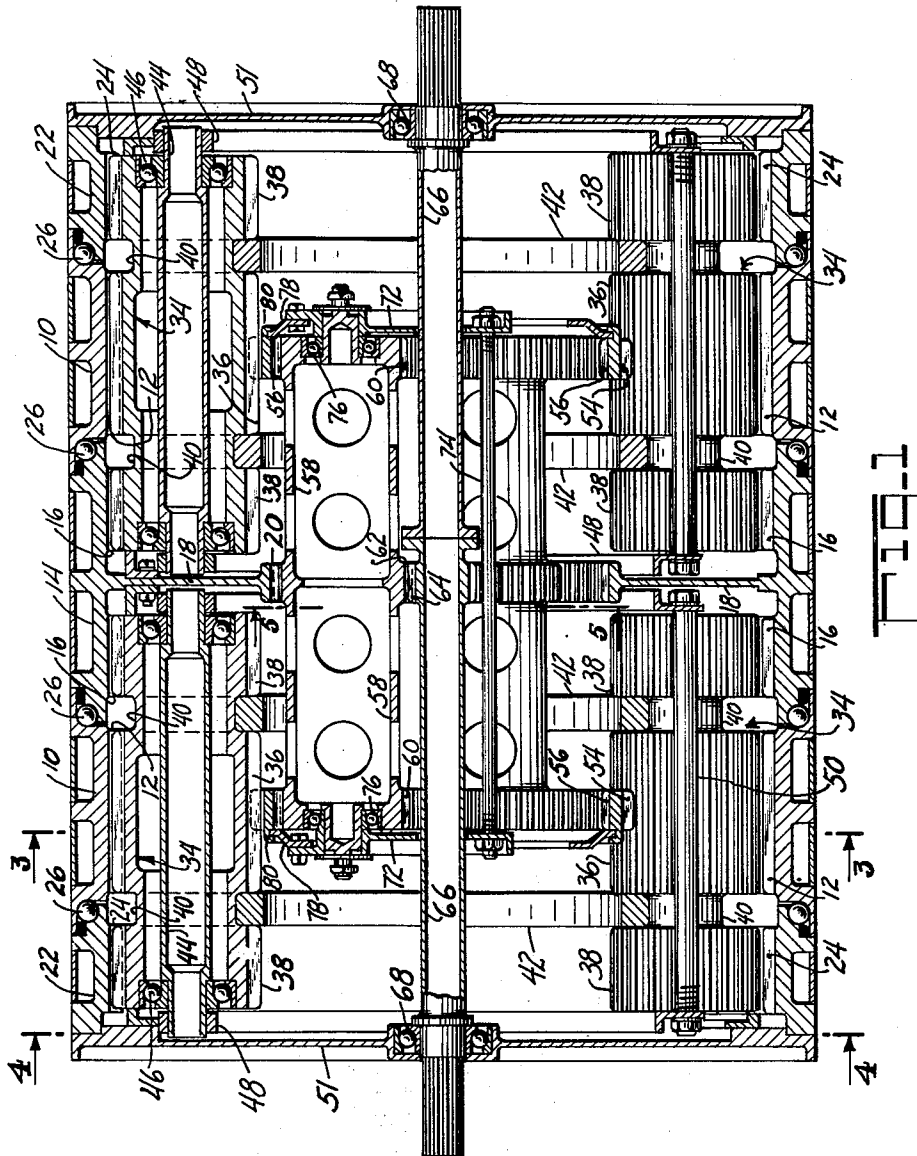
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3,008,355

PLANETARY SPEED REDUCER AND POWER ACTUATED HINGE DEVICE

Filed May 1, 1959

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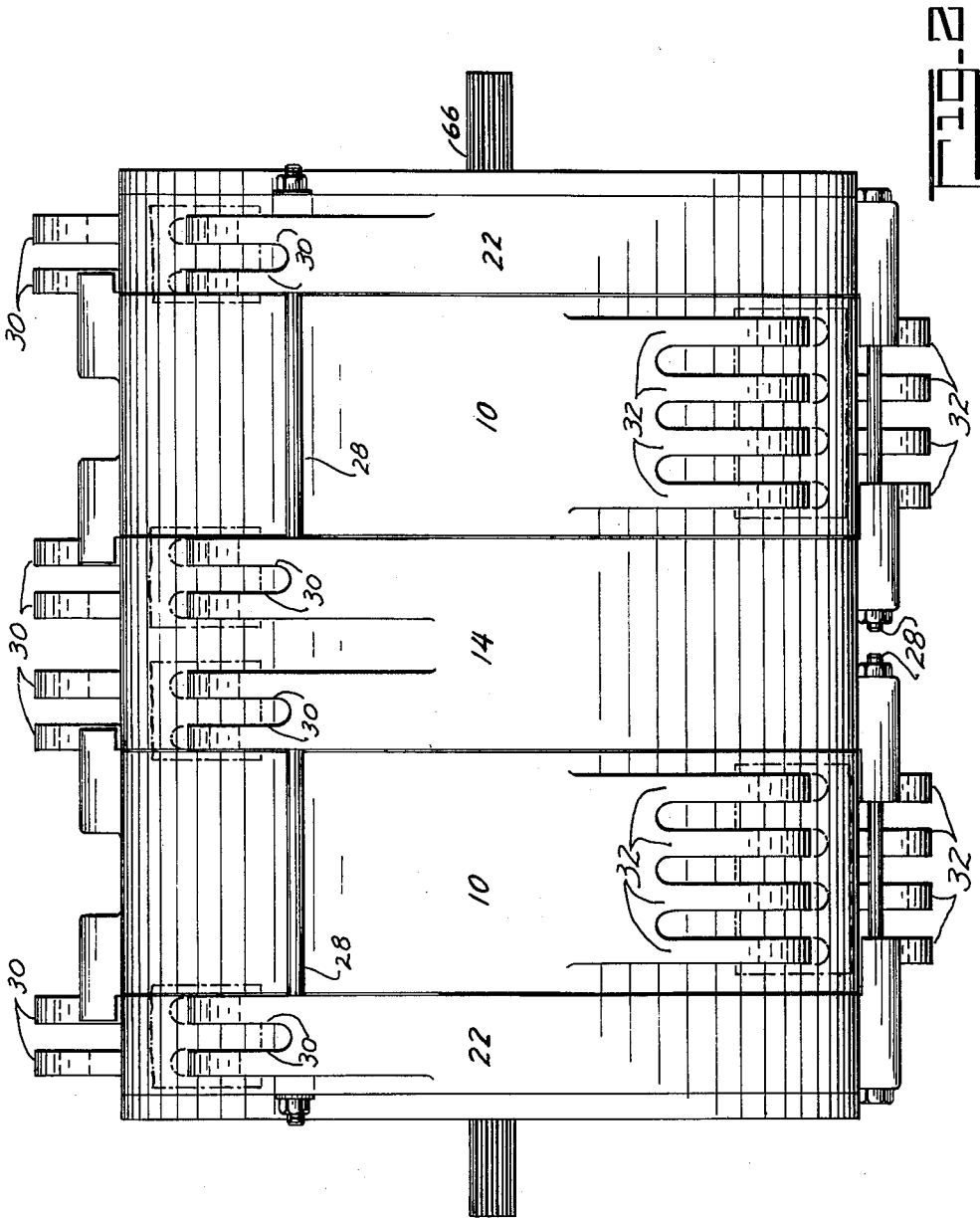
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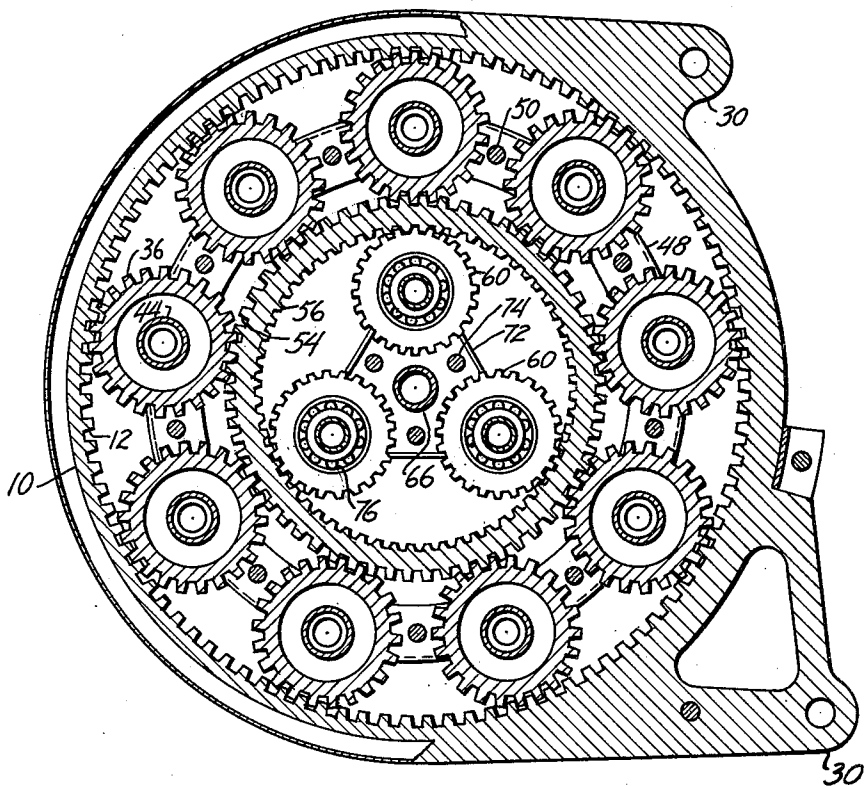


FIG. 3

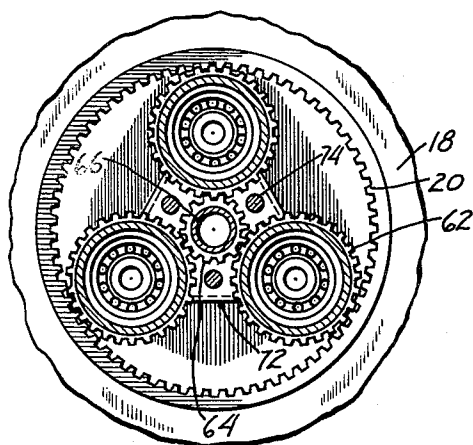


FIG. 5

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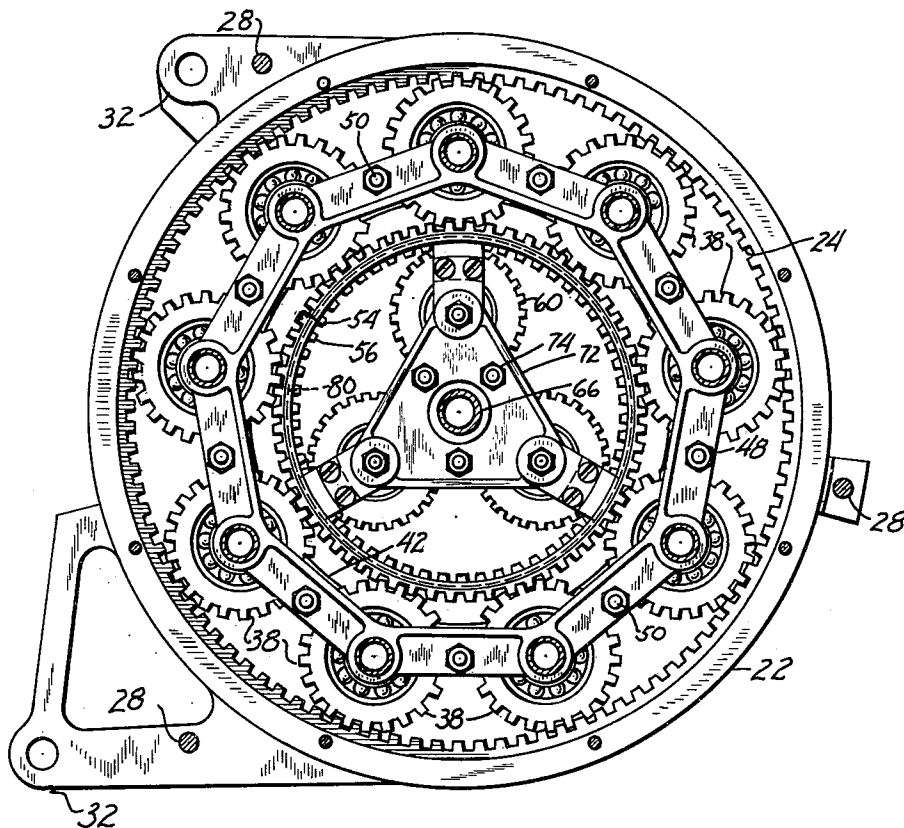


FIG. 4

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PLANETARY SPEED REDUCER AND POWER ACTUATED HINGE DEVICE

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Filed May 1, 1959, Ser. No. 810,339
12 Claims. (Cl. 74-801)

This invention relates to power driven hinge devices and to rotary or oscillatory actuators. The invention, in certain respects provides modifications in the invention covered by co-pending patent application Serial No. 782,537, filed December 23, 1958, now Patent No. 2,966,808.

Generally, the invention includes a plurality of coaxial annular members which are piloted and secured relative to one another on bearings. Alternate annular members are secured together so that one set of members is movable in unison relative to the other set of members. The invention further provides power driving means wholly disposed within the annular members to enable driving of one set of members relative to the other.

The referred to co-pending application discloses the broad aspect of the invention above mentioned, and also, certain sorts of internal actuating mechanism. In this invention, an alternative form of actuating mechanism is provided which enables the construction of a power actuated hinge device having very great torque capacity, the gearing being so arranged that it operates at high efficiency, utilizes a minimum number of parts, and is so constructed as to provide a light weight overall structure.

Objects of the invention are to provide a self-contained power actuated hinge device assembly capable of moving heavy loads;

To provide a gear drive arrangement which is simple in construction and which is so arranged as to omit a considerable number of parts which might otherwise be deemed necessary;

To provide a primary gearing arrangement in which planet gearing is self centering and mutually self supporting;

To provide a compact two-stage compound planetary gear set having novel features of arrangement and construction.

One embodiment of the invention is disclosed in the annexed drawings. In these drawings:

FIG. 1 shows a longitudinal section through a power actuated hinge device embodying novel gearing,

FIG. 2 is a plan of the power actuated hinge device,

FIG. 3 is a section on the line 3-3 of FIG. 1,

FIG. 4 is a section on the line 4-4 of FIG. 1, and

FIG. 5 is a section on the line 5-5 of FIG. 1.

As will be seen most clearly in FIGS. 1 and 2, there are two similar annular members 10 which are spaced apart and comprise internal gears noted at 12. Between the two members 10 is a member 14 having two sets of identical internal gear teeth comprising internal gears 16. Between the two sets of teeth 16 is an inwardly extending annular partition 18 having an internal gear 20 formed at its bore. At the ends of the members 10, annular members 22 are disposed which are formed with internal gear teeth which comprise gears 24. The internal gears 12 are identical to one another, and the internal gears 16 and 24 are identical with one another but are provided with a number of teeth slightly different from the number of teeth in the gears 12. The members 22 and 14 are journaled upon one another in sequence, preferably by antifriction bearings 26 so that all members are constrained to concentricity and to mutual support one by the other. As noted in FIG. 2, the left end member 22 is secured to the left end of member 14 as by bolts

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28 which bridge member 10. In similar fashion, the right end member 22 is secured to the right end of member 14 by bolts 28 which bridge the right member 10.

The members 22 and 14 are furnished with ears 30 to be secured through multiple shear connections with appropriate structure, not shown. In like fashion, the members 10 are provided with ears 32 to be secured in multiple shear to a second support structure, the two support structures thus being attached to one another for hinging movement by the assembly shown, the movement between the support members taking place about the axes of the several coaxial members 10, 14 and 22 by virtue of the bearings 26. These bearings support the load on the supports.

The gearing arrangements within the annular members include two stages of compound planetary gearing, one being an input stage and the other being an output stage. The output stage comprises two similar gear sets, to the right and left respectively of the central partition 18. The elements of the two gear sets carry similar reference characters. The output gearing includes a plurality of planet members 34, each including a central pinion 36 meshed with the gear 12 and two similar end pinions 38, one meshed with the internal gear 24 and the other with the internal gear 16. These pinions 36 and 38 are formed with different numbers of teeth and are designed to mesh perfectly, of course, with the internal gears with which they are associated. A large number of these planet members 34 are disposed within the annular members, as shown in FIGS. 3 and 4, this large number of planet members, through their teeth which are engaged with the internal gears, providing a large number of load points to enable the sustention of heavy torque loads between the two sets of annular members 22, 14, 22 and 10, 10. The gears 38 on each planetary member 34 are symmetrically arranged at either end of the planet pinion 36 so that the loading of each planetary member is balanced—that is, a torsional load imposed on the member 10 will be divided and reacted against, in equal fashion, by the annular members 22 and 14.

Load reaction between members 22, 14, 22 and 10, 10, is wholly assumed by the planetary members. Turning between the annular members is enforced by rotating the planetary members relative to the annular members, because of the differential numbers of teeth in the sets of gears.

It will be noted that the pinions 38 and 36 are slightly separated from one another by grooves 40. The bottoms of these grooves provide races for rings 42, these rings being disposed within the array of planetary members, each ring engaging a groove of all of the planetary members. Thus, the radial force which is required to hold the gear teeth of the planetary members in contact with the teeth of the internal gears is provided by the rings 42. Since the radial force for all planetary members is the same and acts more or less radially inwardly, the rings 42 enable the support of all planetary members against one another and obviate the need for caging the planetary members or for providing any other significant bearing support for them. In operation, as the planetary members roll within the annular members, the rings 42 roll with them whereby there is only rolling engagement with no sliding or bearing engagement between the rims of rings 42 and the surfaces of grooves 40.

Primarily for expeditious assembly of the planetary member arrays, each planetary member is provided with a light pilot shaft 44 upon which its planetary member is loosely journaled through bearings 46, the shafts 44 in turn being secured in light floating cages 48. Bolts 50 secure the cages 48 to one another and thus hold the planetary members in their approximately correct loca-

tions. The true correct locations of the planetary members 34 are established by tooth mesh and by the support afforded by rings 42. Cages 48 further serve to locate the planetary members 34 axially, through their contact with the partition 18 and with end plates 51 secured to the ends of annular members 22.

By minor redesign of the assembly the cages 48 and shafts 44 may be wholly eliminated; the invention includes the concept that the planetary members 34 along with the rings 42, are self-supporting in operation with no need for additional supporting or caging mechanism.

The two sets of planetary members 34 are driven simultaneously by two externally toothed gears 54 which are located concentrically within the assembly. One of these gears engages one set of planet pinions 36 and the other engages the other sets of planet pinions 36. Alternatively the gears 54 may drivably engage the innermost pinions 38, closest to the partition 18, with no change in function of the arrangement. The gears 54 are also formed with internal teeth to provide internal gears 56. The number of teeth in the gears 56 is made slightly different from the number of teeth in the fixed gear 20 of the web 18. These gears 56, 20, 56 are bridged by a plurality of compound planets 58 which lie within the assembly. Planets 58 include pinions 60 engaged with internal gears 56, and a pinion 62 engaged with internal gear 20. The planets 58 are driven by a concentric sun pinion 64 secured to or forming part of a high speed input drive shaft 66 which extends axially through the entire assembly. This shaft 66 is carried in bearings 68 secured in the end plates 51. The planets 58 may be minimum in number, preferably three, for balanced loading, since they constitute part of the high speed low torque stage of the two-stage gearing.

As the planets 58 are driven by the pinion 64, the internal gears 56 are driven at a moderate speed with respect to the fixed gear 20, the gears 54, 56 then driving the planetary members of the low speed high torque stage of the gearing. Rotation of the planetary members 34, as previously pointed out, causes low speed rotation between the members 10, 10 and 22, 14, 22 whereby high torque low speed relative motion of these members is afforded.

The planets 58 are caged, preferably by end plates 72 secured to one another by bolts 74. End plates 72 are connected to the planets 58 through bearings 76. Tabs 78 secured to the end plates 72 engage grooves 80 formed on portions of gears 54, 56 to provide definite axial location of these gears relative to the planets and cages. The planets 58 and their cages require no pilot bearings concentric with the assembly since the external loads imposed on them by gears 56, 20 and 56 are reacted by the engagement of pinion 62 with 64, in a balanced manner. Further, the subassembly of the first stage gearing is held in concentric relation to the overall assembly at all times by the established concentric relation of the second stage gearing.

The high speed input shaft 66 of the assembly may be driven in any suitable manner by an external power source or, if desired, an electric motor or the like might be embraced within the assembly whereby the entire assembly is a unitary high gain power actuated hinge device.

The speed reduction ratios of the overall assembly may be established readily by the application of conventional compound planetary gearing design techniques. Ordinarily, when low speed high torque effort is required between the stacked output annular members, there would be a one-tooth differential between gears of members 22, 14, 22 and 10, 10; also between pinions 36 and 38; also between gears 56, 56 and 20; also between pinions 60 and 62. The number of planetary members 34 may be modified as desired according to torque load requirements. While nine such planetary members are shown in the present embodiment, it is perfectly feasible, by ad-

justment of gear size, to insert as many as twenty planetary members whereby the torsional capacity of the assembly may be greatly increased.

It is also feasible in practising this invention, should a low gain system be desired, to omit the first stage planetary gearing and to drive the second stage pinions, such as 36, 38 through gears directly connected to the input shaft 66.

The disposition and number of floating rings 42, which hold planetary members 34 in their proper engaged relation with the internally geared annular members 10, 14 and 22, may be varied according to design requirements. In any event, the use of floating rings 42 greatly increases the design flexibility of a power actuated hinge device of this type and enables the production of a very efficient mechanism.

It will be clear to those skilled in the art that various changes and modifications may be made in the structure shown and described without departing from the spirit and scope of the invention as set out in the appended claims.

I claim:

1. A gear mechanism comprising coaxial ring gears, which are relatively rotatable and have different numbers of teeth, a plurality of planet members spaced circumferentially therewithin, each having a pinion meshed with the teeth of each ring gear, said members each having a cylindrical smooth portion between their pinions no greater in diameter than the pinion root diameter, a rotationally free annular member within said gears having its rim engaged with the smooth portions of said members, and means within the space defined by said gears and members to drive said members rotationally.

2. A gear mechanism comprising three coaxial ring gears, the outer gears being secured to one another against relative rotation and having the same number of teeth, and the inner gear being rotatable relative to the other two and having a different number of teeth, planet members within said gears and spaced therearound, said members comprising outer pinions meshed with the other gears, an inner pinion meshed with inner gear, and smooth cylindrical portions between said pinions no greater in diameter than the pinion root diameter, said portions and pinions of each member being coaxial with one another, rotationally free annular members within said planet members having their rims engaged with said cylindrical portions to hold said members outwardly and their pinions in engagement with their gears, and means engaging a pinion of each planet member to drive said planet members rotationally and thus enforce rotation of said inner gear relative to said outer gear.

3. A mechanism according to claim 2, wherein said means to drive said planet members comprises an external gear engaging the inner runs of certain of said pinions, and planetary gear means driving said external gear.

4. Mechanism according to claim 1 including annular antifriction bearing means between the ring gears.

5. Mechanism according to claim 2 including annular antifriction bearing between said inner ring gear and each of the outer internal gears.

6. Mechanism according to claim 1 including a cage interconnecting and locating said planet members and rings for assembly purposes.

7. Mechanism according to claim 2 including a cage interconnecting and locating said planet members and rings for assembly purposes.

8. A driving mechanism comprising an annular member, a plurality of planetary members spaced circumferentially therewithin having their outer runs in driving engagement with the inner surface of the annular member, a rotationally free ring within said planetary members, concentric with said annular member, having its outer rim in engagement with inner portions of said planetary members and to roll with respect thereto, to hold said planetary members in driving engagement with said annular members and

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means for driving the said planetary members rotationally.

9. A mechanism according to claim 8 wherein said annular member is provided with internal teeth, wherein portions of said planetary members are provided with teeth engaging the annular member teeth.

10. A mechanism comprising at least two coaxial annular members of slightly different effective internal diameter, means securing said members in coaxial relation for relative rotation, a plurality of planetary members spaced circumferentially within said annular members, each planetary member having portions of different effective diameter, one such portion drivably engaging the inner surface of one annular member, a second such portion drivably engaging the inner surface of the other annular member, and a smooth third such portion of less diameter than the other portions, a freely rotatable circular element within said planetary members and engaging inner runs of all of them at said third portions to hold said planetary members outwardly in driving engagement with said annular members, and means to drive said planetary members in unison.

11. A mechanism according to claim 10, wherein each annular member is provided with internal teeth, the tooth numbers of the members being slightly different, and

wherein said first two planetary member portions are toothed in correspondence with the teeth of the annular members with which they are engaged.

12. A mechanism according to claim 10 wherein said annular members exceed two in number and are in alternately stacked relation, and including a plurality of circular elements, each annular member being engaged by a portion of a planetary member and each planetary member being engaged by a circular element.

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