Sept. 10, 1935. S. A. FARRELL 2,014,316

POWER TRANSMISSION MECHANISM

Filed Jan. 29, 1934 2 Sheets-Sheet 1

Fig. 1.

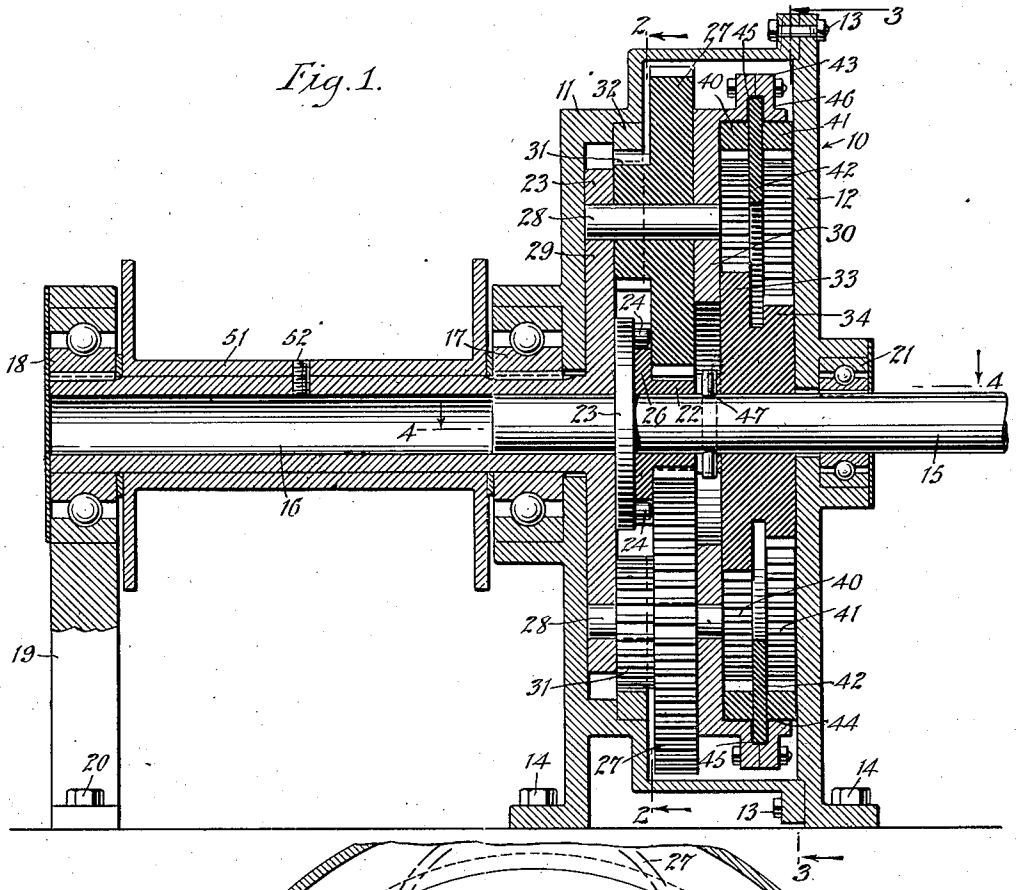
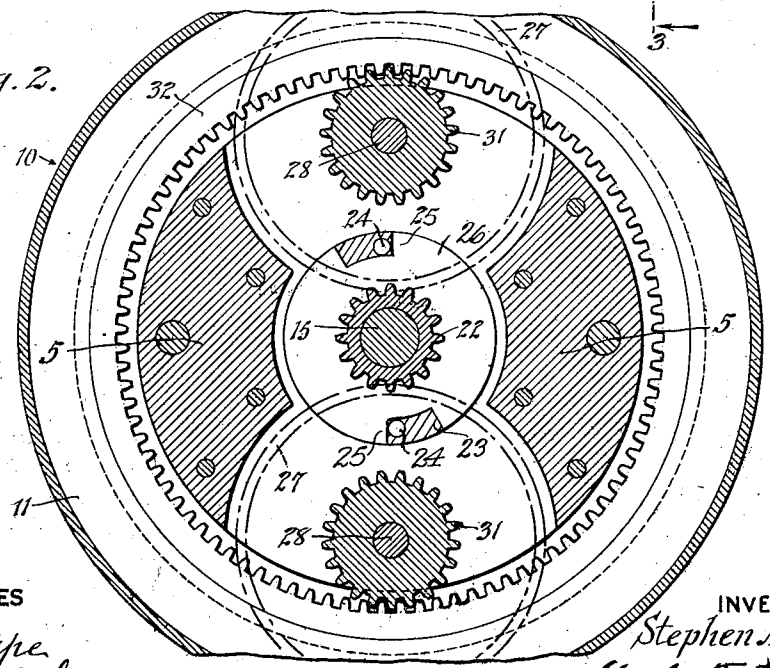


Fig. 2.



WITNESSES

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Fig. 3.

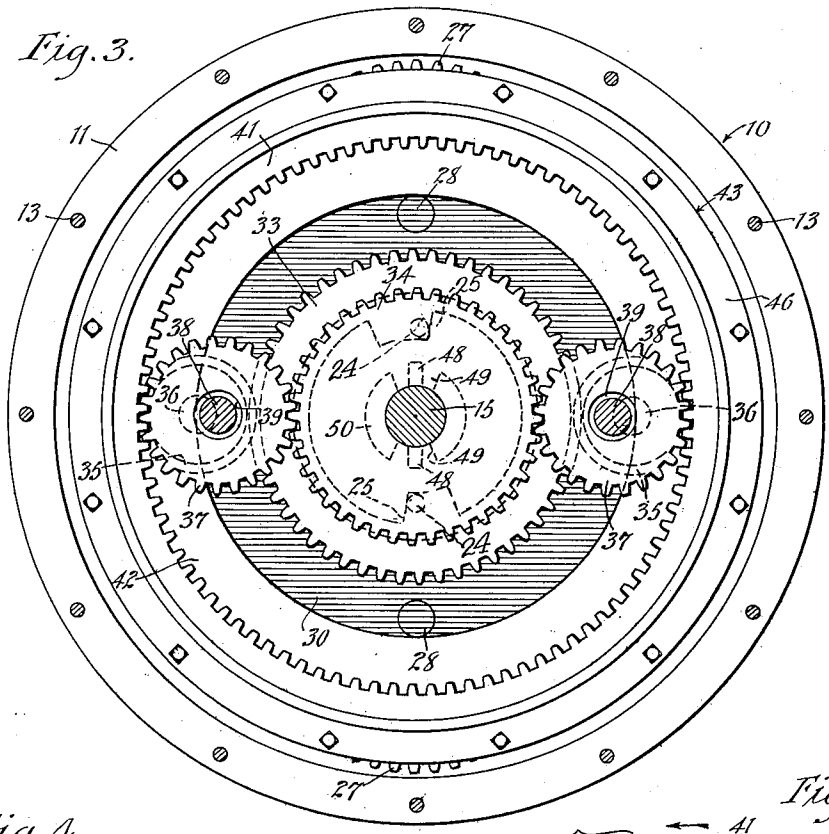


Fig. 4.

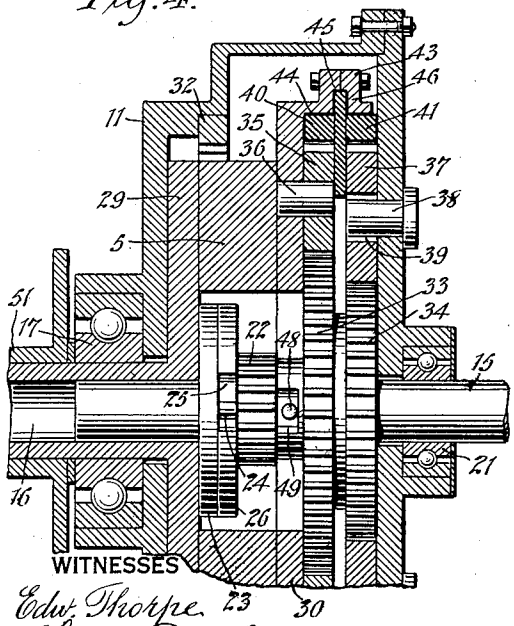


Fig. 5.

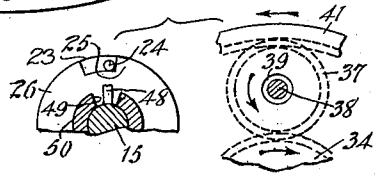


Fig. 6.

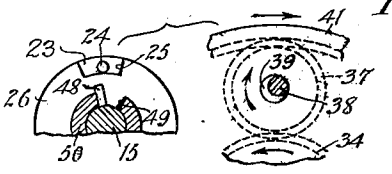
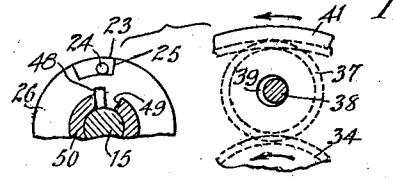


Fig. 7.



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2,014,316

UNITED STATES PATENT OFFICE

2,014,316

POWER TRANSMISSION MECHANISM

Stephen A. Farrell, Brooklyn, N. Y.

Application January 29, 1934, Serial No. 708,875

14 Claims. (Cl. 74—305)

This invention relates to improvements in power transmitting mechanism which is operatively disposed between power means and a load, and may be used advantageously in all fields of industry for the performance of work in raising and lowering loads, and in suspending loads at desired elevations.

An important object of the invention is to materially increase the efficiency of mechanisms of the indicated character, and to materially reduce costs of operating the same.

Another object is the provision of a mechanism of the indicated character including a self-locking gear set which remains in a nascent state during the raising of a load, and which is ever ready to instantly prevent unintentional lowering of the load when the power is withdrawn or removed for any reason.

The mechanism utilized in a hoist has the following advantages. It prevents the load from overhauling itself so as to make the hoist safe and accurate. It moves the load precisely to the desired level. It allows the use of various prime movers including manual power, electrically operated prime movers, and internal combustion engines. It requires a relatively small torque to lower a load regardless of its weight. Failure of the prime mover presents no danger of a falling load because the positive self-locking means will function instantly to relieve the prime mover of the load, making possible the use of the mentioned types of prime movers. The hoist will be light in weight, durable, highly efficient and will gain efficiency in use.

With the foregoing, other objects and advantages will appear from the embodiment of the invention, which, by way of example, is described in the following specification, defined as to scope in the appended claims, and illustrated in the accompaying drawings, in which—

Figure 1 is a central vertical longitudinal sectional view of gearing embodying the features of the invention;

Figure 2 is a transverse section taken on the line 2—2 of Figure 1, looking in the direction indicated by the arrows, portions being broken away.

Figure 3 is a transverse section taken on the line 3—3 of Figure 1, looking in the direction indicated by the arrows;

Figure 4 is a fragmentary horizontal section taken on the line 4—4 of Figure 1;

Figure 5 is a diagrammatic view showing the relationship and direction of rotation of certain parts when the drive shaft is rotating directly to transmit power or to hoist a load;

Figure 6 is a view similar to Figure 5, but showing the relationship and direction of rotation of the parts when the drive shaft is rotating reversely to cause reverse rotation of the driven element or to lower a load; and

Figure 7 is a view similar to Figure 5, but showing the relationship of certain parts when locking action takes place; the arrows indicating the direction of rotation of certain gears which causes the locking action.

The mechanism is illustrated and hereinafter described by way of example as applied to a hoist or elevator for raising and lowering a load, and for suspending the load at desired elevations. Therefore, it will be understood that the mechanism will be operatively disposed between power means and the load. As illustrated, the mechanism will be housed within a casing 10 constructed of two sections, a section 11, and a section 12, which is bolted to the section 11 by bolts 13. Both sections 11 and 12 of the casing are held stationary on a suitable support in any suitable manner, as indicated at 14. The mechanism includes two distinct epicyclic or planetary gear trains or sets which cooperate with each other and which also interpose a power or drive shaft 15, and a rotary driven element or shaft 16. The element or shaft 16 is of hollow construction and is mounted for rotation in roller bearings 17 and 18 respectively on the casing section 11 and a pedestal 19, the latter being held stationary by any suitable means as at 20. The drive shaft 15 is rotatably mounted by journaling one end thereof in the hollow shaft 16 and is also supported by a roller bearing 21 on the casing section 12.

As before stated, the mechanism includes two distinct gear trains or sets, and for the sake of clearness, one set of gears will be referred to as the transmitting or hoisting set, while the other set will be referred to as the locking set. The terms "locking gear set" and "locking gearing" are used in the claims because the locking characteristics of this set or gearing are inherent therein. The transmitting or hoisting gear train or set includes a pinion 22 freely rotatable on the shaft 15. A lost motion connection is arranged between the drive shaft 15 and the pinion 22, and consists of a disk 23 integral with the shaft 15, pins 24 carried by the disk 23 and arranged diametrically opposite each other, which are disposed respectively in notches 25 in a flange 26 integral with the pinion 22. The pinion 22 meshes with the planetary gears 27, freely ro-

tatable on arbors or shafts 28 respectively supported by a disk 29 integral with the driven shaft 16, and an annulus 30. A planetary gear 31 is connected or formed integral with each gear 27 to freely rotate therewith on the arbor or shaft 28, the gear 31 being smaller than the gear 27. Each of the gears 31 is constantly in mesh with an internal gear 32 fixedly secured to or held stationary on the casing section 11. The arbors or shafts 28 are disposed so as to provide axes for the gears 27 and 31 parallel to the axis of the drive shaft 15. Spacers 5 are secured between the disk 29 and the annulus 30 to aid the arbors 28 in securing the annulus 30 in spaced relation to the disk 29. The driven shaft 16, disk 29, arbors 28 and the annulus 30 constitute an assembly of parts or a unit which rotate together on the axis provided by the shaft 16, and in construing the claims, this assembly in its entirety may be referred to as a driven element.

The locking gear set includes external gears 33 and 34 respectively which are connected or formed integral with each other to rotate in unison, the said gears being freely rotatable on the drive shaft 15 between the annulus 30 and the casing section 12. The gear 33 is larger than the gear 34. The gear 33 meshes with planetary gears 35 freely rotatable on arbors 36 respectively carried by or fixed to the annulus 30 diametrically opposite each other, and disposed respectively 90 degrees from the arbors 28. The gear 34 meshes with gears 37 loosely arranged on arbors 38 respectively carried by or fixedly secured to the casing section 12 diametrically opposite each other, and approximately adjacent the arbors 36, as shown in Figures 3 and 4. The gears 35 are smaller in diameter than the gears 37. Each gear 37 has an arbor hole 39 which is larger in diameter than its arbor 38 for a purpose to be explained. The gears 35 are constantly in mesh with an internal gear 40, and the gears 37 likewise are constantly in mesh with an internal gear 41. The gears 40 and 41 are disposed on opposite sides of an annulus 42 which serves as a spacing means, and said gears 40 and 41 are fixed to said annulus 42 so that the gears 40 and 41 and the annulus 42 rotate as a unit. The annulus 30 has a race 43 on the outer periphery thereof to provide a race-way 44 for the gears 40 and 41 so that the latter may freely rotate therein, and also to provide a race-way 45 for the outer periphery of the annulus 42. The race 43 includes a removable section 46 in order that the gears 40 and 41 and the annulus 42 may be assembled. The outer periphery of the annulus 42, being received in the race-way 45, prevents lateral displacement of the gears 40 and 41, while the planetary gears 35 and the gears 37 are disposed respectively on opposite sides of the annulus 42 and are held against axial movement by the annulus 30 and the casing section 12, as shown in Figure 4. A lost motion connection is disposed between the gear 33 and the drive shaft 15, and said connection consists of a pin 47 which extends diametrically through the shaft 15 with its opposite ends 48 disposed respectively in notches 49 in a hub 50 on the gear 33.

The drum 51 fixed as at 52 to the driven shaft 16, or equivalent means is employed to cooperate with suitable means connected with the load for raising and lowering the load, and also sustaining the load.

In hoisting or raising the load, the operation of the mechanism is, as follows: the mechanism has been adjusted so that the ends 48 of the pin 47 are in neutral positions in the notches 49, or out of contact with the hub 50, while the pins 24 are in contact with the flange 26, as shown in Figure 5. When power is applied to the drive shaft 15 to rotate it in a clockwise direction, looking at the mechanism from the right hand end of the shaft 15, the pins 24 bear on the flange 26 and couple pinion 22 to the shaft 15 causing the gears 27 and 31 to rotate on their own axes in a counter-clockwise direction by reason of the pinion 22 being in mesh with the gears 27. Gears 31 being in mesh with the stationary gear 32 take purchase on gear 32 and cause the assembly consisting of the shaft 16, the disc 29, arbors 28, spacers 5, annulus 30, arbors 36 and gears 35 to rotate clockwise around the axis provided by the shaft 16 to hoist the load. The load is thus hoisted by the hoisting or transmission gear set, in response to the direct rotation of the shaft 15, while the locking gear set remains nascent. However, during the hoisting or raising operation, the ends 48 of the pin 47 engage the hub 50 in the clockwise rotation of the shaft 15 just after the hoisting gear set has begun to hoist or raise the load. At that instant the ends 48 of the pin 47 bear on the hub 50 of the gear 33, thereby coupling gears 33 and 34 to the shaft 15 so that the former will rotate clockwise with the latter. The gears 33 and 34 being in mesh respectively with the gears 35 and 37, will cause the latter to rotate counter-clockwise on their own axes, and the gears 35 and 37, being in mesh respectively with the gears 40 and 41 will cause the latter to rotate in a counter-clockwise direction. The rotation of the gears 35 counter-clockwise by the gear 33 makes it possible for the gears 35 to have orbital movement with the aforesaid assembly in a clockwise direction. The gears 33, 34, 35, 37 and internal gears 40 and 41 are so proportioned that the gears 35 will rotate on their own axes 36, and also planetate around the axis provided by the shaft 15 at the same rate of speed that pinion 22 is causing the arbors 36 to travel with the aforesaid assembly. The clockwise rotation of said assembly as hereinbefore described will cause the drum 51 to rotate in a clockwise direction to hoist or raise the load. In this hoisting or raising of the load the power will be transmitted from the prime mover through shaft 15, disc 23, pins 24, flange 26, pinion 22 to the gears 27, arbors 28, the disc 29 and shaft 16 to the drum 51. The locking gear set will remain nascent, but ready instantly to prevent reverse rotation of the shaft 16.

The load may be lowered by rotating the drive shaft 15 counter-clockwise or in a reverse direction by applying enough force thereto to overcome the friction of the locking gear set. This counter-clockwise rotation of the shaft 15 causes the pins 24 of the disc 23 to be moved out of contact with the flange 26 into a neutral position in the notches 25, and the ends 48 of the pin 47 are moved into contact with the hub 50 of the gear 33, as shown in Figure 6. The continued counter-clockwise rotation of the shaft 15, by reason of the ends 48 bearing on the hub 50, causes similar rotation of the gears 33 and 34, which, in turn, cause clockwise rotation of the gears 35 and 37 on their own axes, and counter-clockwise orbital movement of the gears 35 about the axis provided by the shaft 16. This allows counter-clockwise rotation of the assembly consisting of the arbors 36, annulus 30, arbors 28, spacers 5, disc 29 and shaft 16. During the counter-clockwise rotation of the said assembly the

gears 31, being in mesh with the stationary gear 32, will cause clockwise rotation thereof and also similar rotation to the gears 27 connected therewith on their arbors 28, and the gears 27 and 31 also to planetate counter-clockwise around the axis provided by the shaft 15. The clockwise rotation of the gears 27 on the arbors 28 causes the counter-clockwise rotation of the pinion 22 on the shaft 15 at the same rate of speed that the shaft 15 is being rotated, thereby keeping the pins 24 in the out of contact relation to the flange 26 as shown in Figure 6. In this manner the load may be lowered through the intervention of the locking gear set in response to the reverse rotation of the shaft 15, while the hoisting or transmission gear set remains in a nascent state.

The lost motion connections allow the locking gear set to run in unison with the hoisting gear set, although the former starts operating a little later than the latter for hoisting the load. The lost motion connections allow the hoisting gear set to run in unison with the locking gear set, although the former starts operating a little later than the latter in lowering the load. Therefore, it follows that the lost motion connections keep the two gear sets from functioning at the same time in raising a load or lowering a load, but serve to keep the locking gear set in a nascent state while a load is being hoisted or raised, and the hoisting gear set in a nascent state while a load is being lowered. The lost motion connections are introduced between the two gear sets and the shaft 15 to prevent them from interfering with each other, and also to allow the load to be hoisted only with the hoisting gear set and to be locked and/or lowered with the locking gear set. In this manner a load may be hoisted with a highly efficient gear train, and locked and/or lowered with a gear train which is fully efficient for these purposes.

It is to be understood that the hoisting gear set and the locking gear set must be so proportioned that they will operate in unison, that is to say, if the hoisting gear set causes the arbors 36 to travel around the shaft 15 at a ratio of 15 to 1, then the locking gear set must cause the gears 35 to planetate around the shaft 15 at a rate of speed of 15 to 1 with respect to the speed of the shaft 15.

The load is held elevated at the desired level by the mechanism which operates in this respect, as follows: the load reaction on the drum 51 tends to cause the shaft 16, disc 29, spacers 5, arbors 28 and 36, and annulus 30 to rotate in a counter-clockwise direction. This will tend to cause the gears 33 and 34, and the gears 40 and 41 to rotate counter-clockwise. The reactive force of the load will be divided equally by the gears 35 on the gears 33 and 34 and the gears 40 and 41. The gears 37 will not be able to rotate on their arbors 38 because the gear 34 and the gear 41, with which gears 37 mesh, are tending to rotate in the same direction by reason of the equal strain imposed on the gear 34 and the gear 41, as indicated in Figure 7. Due to the fact that the gears 37 cannot rotate, the locking gear set will be locked at the instant that the reaction of the load is imposed on the drum 51, thereby sustaining the load precisely at the desired level. In order to raise the load or lower the same from its suspended level, it is only necessary to cause the drive shaft 15 to rotate in the required manner, as set forth hereinabove.

The small amount of play between the gears 37 and their arbors 38 is for the purpose of a certain amount of flexibility between the two gear trains or sets inasmuch as they start operating one after the other in the manner hereinbefore described.

The mechanism may be adjusted so as to raise the load with the drive shaft rotating either clockwise or counter-clockwise and to lower the load with the drive shaft rotating in a corresponding reverse direction. It is to be understood that any preferred number of gears 27, 31, 35 and 37 may be employed. By changing the diameters of the gears 33, 34, 35 and 37 the gears 35 may be caused to planetate at greater or lesser speeds.

It is further to be understood that the invention is not restricted to the precise arrangement of parts shown and described, as details of construction may be modified and rearranged without departing from the spirit of the invention, the scope of which is limited only by the terms of the appended claims.

I claim:—

1. In mechanism of the class described, a driven element, first and second planetary gears rotatably mounted on said driven element, said first and second planetary gears being connected to rotate in unison, a stationary gear meshing with said first planetary gears, a drive shaft, means to couple said shaft with the second planetary gears, to cause the rotation of the first and second planetary gears in response to the rotation of said shaft, and means including freely rotatable gears mounted on said driven element, to prevent retrograde rotation of the driven element when the latter is subjected to the reaction of a load.

2. In mechanism of the class described, power transmission gearing including a stationary internal gear and planetary gears meshing with said internal gear; a drive shaft, a pinion rotatably mounted on said shaft meshing with said planetary gears, coupling means to couple said pinion with said shaft in response to the rotation of the shaft to drive said gearing directly, and means which cooperate with said planetary gears to prevent reverse operation of said gearing by the reaction of a load thereon.

3. In mechanism of the class described, a drive shaft, a pinion freely rotatable on said shaft, a rotary driven element, arbors carried by said driven element and providing axes parallel to the axis of said shaft, a stationary internal gear, a gear freely rotatable on each of said arbors which meshes with said internal gear, a second gear freely rotatable on each of said arbors which is connected with the first gear thereon to rotate therewith and which meshes with said pinion, a planetary locking gear set having a rotatable internal gear, a rotatable external gear, additional arbors carried by said driven element, and a gear rotatable on each of said additional arbors meshing with said internal and rotatable external gears, and means to cause the pinion to rotate in response to the rotation of the drive shaft.

4. The combination of transmission gearing, locking gearing which cooperates with said transmission gearing to prevent reverse operation of the latter, when subjected to the reaction of a load, driving means, a lost motion connection between the driving means and the transmission gearing, and a lost motion connection between the driving means and the locking gearing, the provision and arrangement being such, that the first lost motion connection functions in response to the direct operation of said driving means to drive the transmission gearing; and that the

second lost motion connection functions initially to unlock the locking gearing, followed by both lost motion connections functioning simultaneously to allow the reverse operation of the transmission gearing in response to the reverse operation of the driving means.

5. In mechanism of the class described, a drive shaft, a pinion loosely mounted for rotation on said shaft, a lost motion connection between the shaft and the pinion to drive the latter in response to the rotation of the shaft, a gear meshing with the pinion, a small gear integral with the first gear, an arbor on which both of said gears are loosely mounted for rotation, a rotary element mounted on said shaft, said arbor being secured to said element so that it provides an axis for said gears parallel to the axis of the shaft, a stationary internal gear meshing with the smaller gear, and gearing operating in conjunction with said shaft and rotary element, to prevent the reverse rotation of the rotatory element, when the latter is subjected to the reaction of a load, and allowing reverse rotation of the rotary element when the shaft is reversely rotated.

6. In mechanism of the class described, a drive shaft, transmission gearing including a pinion freely rotatable on said drive shaft, and a lost motion connection between the drive shaft and said pinion; locking gearing geared with said transmission gearing, said locking gearing including a gear freely rotatable on said shaft, and a lost motion connection between said shaft and said gear, the provision and arrangement being such, that the first mentioned lost motion connection rotates said pinion in response to the direct rotation of said shaft, to cause the direct operation of the transmission gearing; said second mentioned lost motion connection rotating said gear in the reverse rotation of the shaft, to allow the reverse operation of said transmission gearing, said locking gearing serving to automatically prevent the reverse operation of the transmission gearing when the latter is subjected to the reaction of a load thereon.

7. In mechanism of the class described, a driven element, first and second planetary gears rotatably mounted on said driven element, said first and second planetary gears being connected to rotate in unison, a stationary gear meshing with said first planetary gears, a drive shaft, means to couple said shaft with the second planetary gears, to cause the rotation of the first and second planetary gears in response to the rotation of said shaft, and means including a stationary part, arbors carried by said stationary part, and gears mounted for rotation on said arbors respectively, to automatically prevent reverse rotation of the driven element when subjected to the reaction of a load.

8. In mechanism of the class described, a driven element, first and second planetary gears rotatably mounted on said driven element, said first and second planetary gears being connected to rotate in unison, a stationary gear meshing with said first planetary gears, a drive shaft, means to couple said shaft with the second planetary gears, to cause the rotation of the first and second planetary gears in response to the rotation of said shaft, and means to prevent retrograde rotation of the driven element when the latter is subjected to the reaction of a load, said last means comprising rotatably mounted internal gears, external gears mounted for rotation in unison on said shaft, arbors carried by said driven element, planetary gears mounted for rotation on said arbors respectively and meshing with one of said internal gears and one of said external gears, additional arbors, and gears mounted for rotation on said additional arbors respectively and meshing with the remaining internal and external gears.

9. In mechanism of the class described, in combination, a drive shaft, transmission gearing, a self-locking gear set geared with said transmission gearing, lost motion means to cause the operation of the transmission gearing in response to the direct rotation of the shaft to transmit the power effort thereof, said gear set acting to prevent the reverse operation of the transmission gearing when subjected to the reaction of the load thereon, and lost motion means to cause the operation of the gear set in response to the reverse rotation of the shaft to allow the reverse operation of the transmission gearing.

10. In mechanism of the class described, a driven element, first and second planetary gears rotatably mounted on said driven element, said first and second planetary gears being connected to rotate in unison, a stationary gear meshing with said first planetary gears, a drive shaft, lost motion means to cause the operation of the second planetary gears in response to the direct rotation of the shaft to transmit the power effort thereof to the driven element, a self-locking gear set which cooperates with said planetary gears to prevent the reverse operation of the driven element when subjected to the reaction of the load thereon, and lost motion means to cause the operation of the gear set in response to the reverse rotation of the shaft to allow the reverse operation of the driven element.

11. In mechanism of the class described, a drive shaft, a pinion freely rotatable on said shaft, a rotary driven element, arbors carried by said driven element and providing axes parallel to the axis of said shaft, a stationary internal gear, a gear freely rotatable on each of said arbors which meshes with said internal gear, a second gear freely rotatable on each of said arbors which is connected with the first gear thereon to rotate therewith and which meshes with said pinion, a stationary part, a planetary locking gear set having a rotatable internal gear, a rotatable external gear, additional arbors carried by said stationary part, and a gear rotatable on each of said additional arbors meshing with said rotatable internal and external gears, and means to cause the pinion to rotate in response to the rotation of the drive shaft.

12. In mechanism of the class described, a driven element, first and second planetary gears rotatably mounted on said driven element, said first and second planetary gears being connected to rotate in unison, a stationary gear meshing with said first planetary gears, a drive shaft, means to couple said shaft with the second planetary gears, to cause the direct rotation of the first and second planetary gears and the driven element in response to the direct rotation of said shaft, and self-locking means cooperating with said gears to automatically prevent retrograde rotation of the driven element when the latter is subjected to the reaction of a load, said self-locking means being operable to allow the retrograde rotation of the gears and driven element in response to the reverse rotation of said shaft.

13. In mechanism of the class described, in combination, a stationary casing, a rotary driven disk within said casing, arbors carried by said disk and providing axes parallel to the axis of the

disk, first and second planetary gears freely rotatable on each of said arbors, a stationary internal gear within said casing meshing with each of said first planetary gears, a drive shaft extending through said casing axially with respect to said disk, a pinion loose on said shaft meshing with each of said second planetary gears, lost motion means between the shaft and pinion to rotate the latter in response to the rotation of the shaft, an annulus carried by said arbors so as to rotate with said disk, internal gears carried by and rotatable with respect to said annulus, planetary gears carried by said annulus meshing with one of said rotatable internal gears, locking gears rotatably mounted on said casing within the latter meshing with the other one of said rotatable internal gears, external gears loose on said shaft and rotatable in unison meshing respectively with the planetary gears carried by the annulus and the locking gears, and lost motion means between the shaft and one of said external gears to rotate the latter in response to the rotation of said shaft.

14. In mechanism of the class described, in combination, a stationary part, a rotary driven element, arbors carried by said element and providing axes parallel to the axis of said element, planetary gears freely rotatable on said arbors respectively, internal gears rotatable with said driven element, one of said internal gears meshing with said planetary gears, locking gears rotatably mounted on said stationary part meshing with the other one of said internal gears, a drive shaft, external gears loose on said shaft and rotatable in unison meshing respectively with the planetary gears and the locking gears, lost motion means between the shaft and one of said external gears to rotate the latter in response to the rotation of said shaft, and means which cooperates with the driven element and the shaft to cause rotation of the former in response to the rotation of the shaft.

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