

Sept. 17, 1929.

J. W. HEGELER ET AL
DIFFERENTIAL DRIVING MECHANISM

1,728,899

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2 Sheets-Sheet 1

Fig-2.

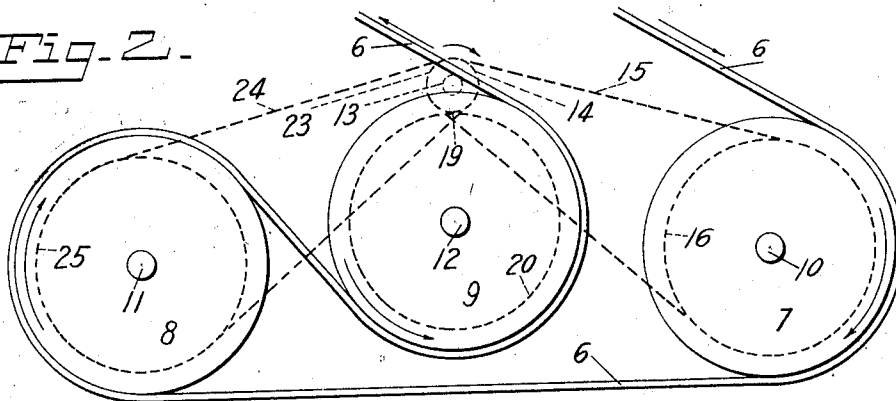
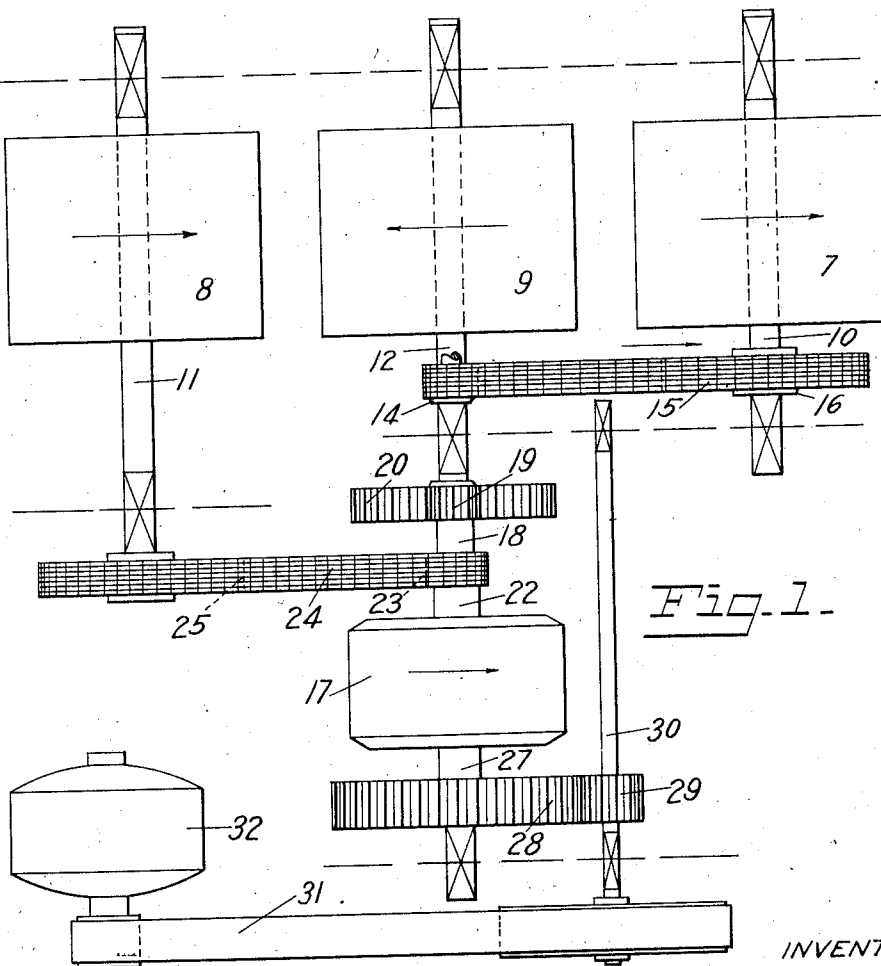


Fig. 1.



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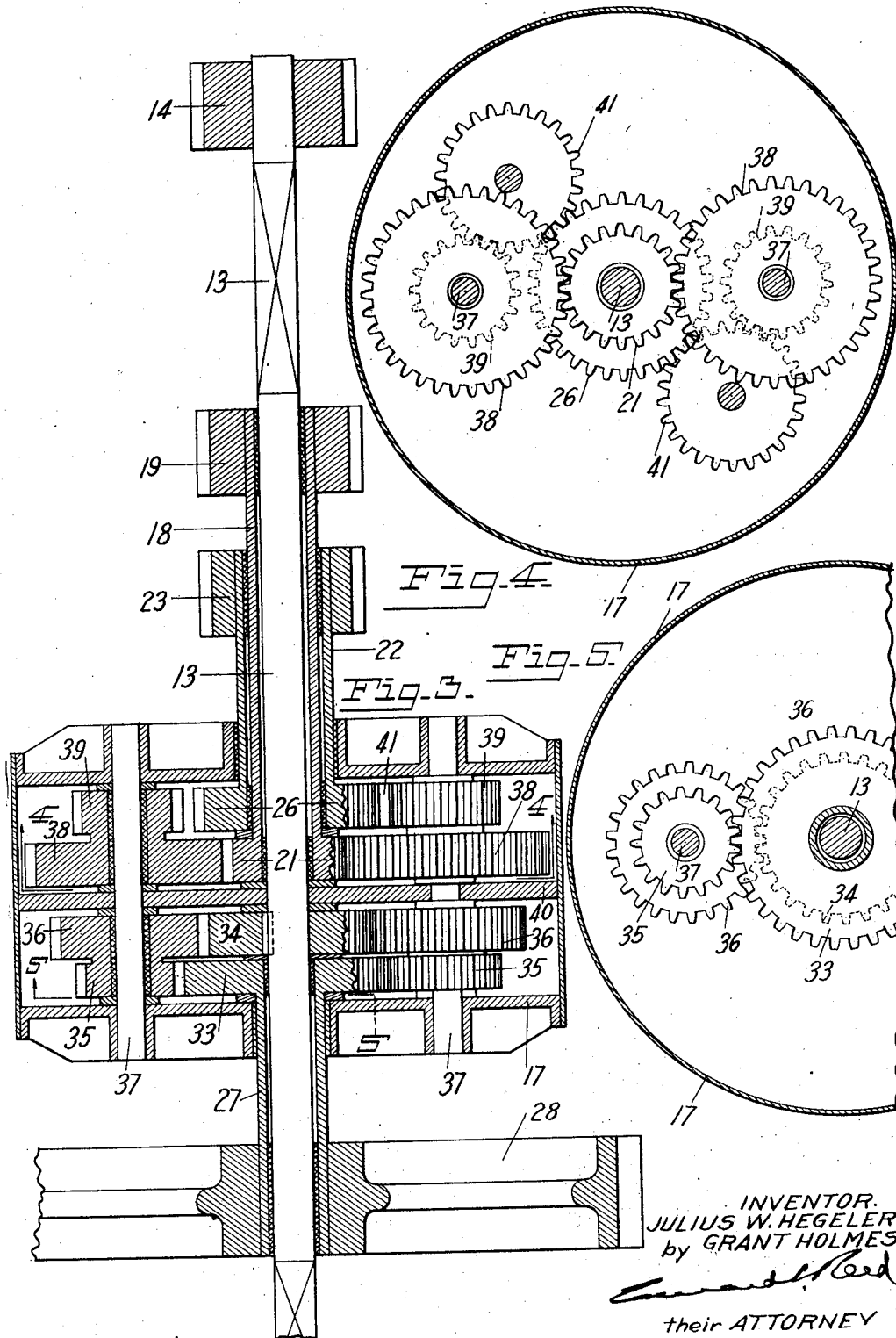
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UNITED STATES PATENT OFFICE

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DIFFERENTIAL DRIVING MECHANISM

Application filed January 28, 1929. Serial No. 335,485.

This invention relates to a differential driving mechanism which is designed primarily for the purpose of proportionally dividing the power between a plurality of driving elements for an endless driven member, such as a conveyor belt, and is in the nature of an improvement on the mechanism shown and described in Patent No. 1,176,290, granted March 21, 1916, to Hegeler and Holmes.

One object of the invention is to provide a mechanism which will operate positively and efficiently to apply the power to the several driving elements in the desired proportions.

A further object of the invention is to provide a single compensating device having means for distributing the applied torque to three driving elements or pulleys in a predetermined ratio.

A further object of the invention is to provide such a mechanism which will be simple in its construction and compact in form.

Other objects of the invention will appear as the mechanism is described in detail.

In the accompanying drawings Fig. 1 is a diagrammatic view showing the invention applied to the driving pulleys for a conveyor; Fig. 2 is a side elevation of a portion of the conveyor belt and the driving pulleys therefor; Fig. 3 is a longitudinal sectional view taken centrally of the differential driving mechanism; Fig. 4 is a transverse section taken on the line 4—4 of Fig. 3; and Fig. 5 is a transverse section taken on the line 5—5 of Fig. 3, part of the mechanism being broken away.

In these drawings we have illustrated one embodiment of our invention and have shown the same as applied to a three pulley drive for a conveyor belt. It will be understood, however, that the mechanism may take various forms and may be applied to endless driven members of various kinds and having different numbers of driving elements.

In Fig. 2 of the drawings we have shown a portion of a conveyor belt 6 which is driven by three pulleys 7, 8 and 9, arranged in tandem and mounted respectively on shafts 10, 11 and 12. Because of the increasing tension to which the belt is subjected as it passes over

the successive pulleys, and due in part to the elasticity of the belt, the speed of the belt will vary slightly at different points and this necessitates a different peripheral speed for each pulley in order that each pulley may properly transmit power to the belt. The torque applied to each pulley is proportioned according to the location of the pulley, the first pulley 7 receiving the major portion of the power, the second pulley 8 receiving a smaller portion of the power and the third pulley 9 a still smaller portion of the power, the third pulley, 9, being preferably arranged between the pulleys 7 and 8. In order to apply the torque differentially to the several pulleys or driving elements we have interposed between the pulleys and the source of power a differential driving mechanism which will properly divide the torque and transmit the same proportionately to the several pulleys.

The differential driving mechanism, in the form here illustrated, comprises a main shaft 13 having means for connecting the same with one of the driving elements or pulleys. In the present construction a pinion 14 is secured to the shaft and is connected by a chain 15 with a gear 16 on the shaft 10 of the pulley 7. A supporting structure is mounted for rotation about the axis of the shaft 13 and, as here shown, this supporting structure comprises a housing 17 rotatably supported by the shaft 13. Mounted for rotation about the axis of the shaft 13 and extending through one end wall of the housing 17 is a tubular shaft or quill 18 having on its outer end means for connecting the same with one of the driving elements. As here shown, a pinion 19 is secured to the outer end of the tubular shaft 18 and meshes with a gear 20 on the shaft 12 of the third pulley 9. It will be noted that the pulley 9 engages that side of the belt opposite the side engaged by the pulley 7, and, due to the direct gear drive, the pulley 9 is rotated in a direction opposite to that in which the pulley 7 is rotated by the chain 15. A gear 21 is rigidly secured to the inner end of the tubular shaft 18 within the housing. A second tubular shaft 22 is mounted for rotation about the axis of the

shaft 13 and is here shown as mounted on the tubular shaft 18 and as extending through the end wall of the housing 17. This second tubular shaft 22 has at its outer end means for connecting it with one of the driving elements and this means is shown as comprising a pinion 23 which is connected by a chain 24 with a gear 25 secured to the shaft 11 of the second driving pulley 8. The second tubular shaft 22 has secured to its inner end within the housing a gear 26.

At that end of the housing opposite the tubular shafts 18 and 22 is a tubular shaft 27 which extends through the adjacent end of the housing and is provided at its outer end with means for connecting the same with a suitable source of power. In the present construction, a gear 28 is rigidly secured to the outer end of the tubular shaft 27 and meshes with a pinion 29 on a shaft 30 which is connected by a belt 31 with a motor 32. Rigidly secured to the inner end of the tubular shaft 27 is a gear 33, the gear 33 and shaft 27 being rotatable with relation both to the shaft 13 and the housing 17. Rigidly secured to the shaft 13 within the housing and adjacent to the gear 33 is a gear 34. Mounted within the housing and carried thereby are two pairs of planetary gears 35 and 36, the gears of each pair being of different diameters and the two pairs of gears being rotatably mounted, respectively, on shafts 37 mounted in the end walls of the housing and on opposite sides of the shaft 13. The smaller gear 35 of each pair meshes with the gear 33 of the tubular shaft 27 and the larger gear 36 of each pair meshes with the gear 34 which is rigidly mounted on the shaft 13. Consequently the rotation of the gear 33, which is in effect a driving gear, will be transmitted through the gears 35 and 36, the gears of each pair being rigidly connected one with the other, to the gear 34 and shaft 13 which, as has been explained, is connected with the driving element or pulley 7. The action of the driving gear 33 on the planetary gearing will cause the housing to rotate about the axis of the shaft 13, with relation to that shaft, thus dividing the power which is transmitted by the gear 33 into two parts, one part being transmitted to the shaft 13 and the other part being transmitted to the housing. In the present instance, the ratio of the gears is such that the larger part of the torque, 53.7% will be transmitted to the shaft and the smaller part 46.3% will be transmitted to the housing.

Mounted within the housing and rotatable therewith are two other pairs of planetary gears 38 and 39. In the present instance, the gears of each pair are rigidly secured one to the other and the two pairs of gears are rotatably mounted on the respective shafts 37, which carry the planetary gears 35 and 36. As here shown, the housing is divided into two compartments by means of a partition 40

and the two sets of planetary gears are mounted in the respective compartments. The larger planetary gear 38, of the last mentioned set, meshes directly with the gear 21 of the inner tubular shaft 18 and the smaller planetary gears 39 of the last mentioned sets are connected through intermediate gears 41 with the gear 26 of the outer tubular shaft 22. Thus the rotary movement of the supporting structure or housing 17 is transmitted to the gears 21 and 26 and the power which is delivered from the gear 33 to the housing 17 is again divided and is delivered unequally to the two tubular shafts. In the present instance, the gear ratio is such that the outer tubular shaft 22 will receive 34.7% of the power and the inner tubular shaft 18 will receive 11.6% of the power that is transmitted by the housing. The main shaft 13 being connected with the first pulley 7, the outer tubular shaft 22 being connected with the second pulley 8 and the inner tubular shaft 18 being connected with the third pulley 9 it will be obvious that the power will be transmitted to these pulleys in fixed proportions so designed that each pulley will exert the desired force upon the belt. By thus distributing the applied torque to the several pulleys in a predetermined ratio each pulley is caused to receive that percentage of the total torque which its location in the tandem series, and the wrap of the belt thereon, will enable it to transmit as tractive effort to the belt.

While we have shown and described one embodiment of our invention we wish it to be understood that we do not desire to be limited to the details thereof as various modifications may occur to a person skilled in the art.

Having now fully described our invention, what we claim as new and desire to secure by Letters Patent, is:

1. In a driving mechanism for a conveyor or the like comprising an endless member and three driving elements therefor, a single compensating gear unit having means for distributing the applied torque unequally and in a predetermined ratio to the three driving elements.

2. In a driving mechanism for a conveyor or the like comprising an endless member and three driving elements therefor, a unitary compensating device having three power transmission elements to be connected with the respective driving elements and having means for applying torque unequally to said power transmission elements and for applying said torque to each of said power transmission elements in a predetermined ratio to the torque applied to the other power transmission elements.

3. In a driving mechanism for an endless belt conveyor or the like having three driving pulleys arranged in tandem, a unitary compensating device having three power trans-

mission elements connected with the respective driving elements and having means for causing each transmission element to transmit to the pulley with which it is connected such a percentage of the total applied torque as the location of that pulley and the wrap of the belt thereon will enable it to transmit as tractive effort to the belt.

4. In a driving mechanism for a conveyor or the like comprising an endless member and three driving elements therefor, a unitary compensating device comprising a driving member, three driven members having means for connecting the same with the respective driving elements for said endless member, and means actuated by said driving member for imparting movement to said driven members and distributing the applied torque between said driven members unequally and in a predetermined ratio.

5. In a driving mechanism for a conveyor or the like comprising an endless member and three driving elements therefor, a compensating device comprising a driving member, three driven members all rotatable about a common axis, said driven members having means for connecting the same with the respective driving elements for said endless member, and means actuated by said driving member for imparting movement to said driven members and distributing the applied torque between said driven members unequally and in a predetermined ratio.

6. In a driving mechanism for a conveyor or the like comprising an endless member and three driving elements therefor, a compensating device comprising a driving gear and three driven gears all rotatable about a common axis, means for connecting said driven gears with the respective driving elements for said endless member, and planetary gearing connecting said driving gear with said driven gears and arranged to distribute the applied torque unequally between said driven gears.

7. In a driving mechanism for a conveyor or the like comprising an endless member and three driving elements therefor, a compensating device comprising a driving gear and three driven gears all rotatable about a common axis, means for connecting said driven gears with the respective driving elements for said endless member, a supporting structure rotatable about said common axis, and planetary gearing carried by said rotatable supporting structure and arranged to connect said driving gear with said driven gears and to distribute the applied torque unequally between said driven gears.

8. In a driving mechanism for a conveyor or the like comprising an endless member and three driving elements therefor, a compensating device comprising a driving gear and a plurality of driven gears all rotatable about a common axis, means for connecting said

driven gears with the respective driving elements for said endless member, a supporting structure rotatable about said axis with relation to said driving gear and said driven gears, and other planetary gearing carried by said rotatable supporting structure and connected with another of said driving gears.

9. In a driving mechanism for a conveyor or the like comprising an endless member and three driving elements therefor, a compensating device comprising a driving gear and a plurality of driven gears all rotatable about a common axis, means for connecting said driven gears with the respective driving elements for said endless member, a supporting structure rotatable about said axis with relation to said driving gear and said driven gears, a pair of planetary gears carried by said rotatable supporting structure, connected one to the other for rotation in unison and connected respectively with said driving gear and one of said driven gears, and a second pair of planetary gears carried by said rotatable supporting structure, connected one to the other for rotation in unison and connected respectively with the other driven gears.

10. In a differential driving mechanism for applying torque unequally to a plurality of driving elements for an endless driven member, a rotatable shaft having means for connecting the same with one of said driving elements, a supporting structure rotatable about the axis of said shaft, a gear rotatably mounted on said shaft, means separate from said supporting structure for connecting said gear with a source of power, a second gear rigidly secured to said shaft, planetary gears carried by said supporting structure, connected one to the other and meshing respectively with the gears on said shaft, whereby the power applied to the first mentioned gear will be divided between said shaft and said supporting structure, and means for dividing the power which is applied to said supporting structure between the other driving elements.

11. In a differential driving mechanism for applying torque unequally to a plurality of driving elements for an endless driven member, a rotatable shaft having means for connecting the same with one of said driving elements, a supporting structure rotatable about the axis of said shaft, a gear rotatably mounted on said shaft, means separate from said supporting structure for connecting said gear with a source of power, a second gear rigidly secured to said shaft, planetary gears carried by said supporting structure, connected one to the other and meshing respectively with the gears on said shaft, whereby the power applied to the first mentioned gear will be divided between said shaft and said supporting structure, and means carried by

said supporting structure and said shaft for dividing the power which is applied to said supporting structure between the other driving elements.

5 12. In a differential driving mechanism for applying torque unequally to a plurality of driving elements for an endless driven member, a main shaft, a plurality of tubular shafts rotatable about the axis of said main shaft, means for operatively connecting the
10 several shafts with the respective driving elements, a supporting structure rotatable about the axis of said main shaft, means for rotating said main shaft and said supporting structure with relation one to the other, and
15 means carried by said supporting structure for separately rotating said tubular shafts.

13. In a differential driving mechanism for applying torque unequally to a plurality of driving elements for an endless driven member, a main shaft, a plurality of tubular shafts rotatable about the axis of said main shaft, means for operatively connecting the
20 several shafts with the respective driving elements, a supporting structure rotatable about the axis of said main shaft, a gear mounted about the axis of said main shaft for rotation with relation thereto and with relation to
25 said supporting structure, means actuated by said gear to rotate said main shaft and said supporting structure, and means carried by said supporting structure for separately rotating said tubular shafts.

14. In a differential driving mechanism for applying torque unequally to a plurality of driving elements for an endless driven member, a main shaft, a plurality of tubular shafts rotatable about the axis of said main shaft, means for operatively connecting the
35 several shafts with the respective driving elements, a supporting structure rotatable about the axis of said main shaft, a gear rotatable about the axis of said main shaft with relation both to said main shaft and said supporting
40 structure, a gear secured to said main shaft, planetary gears carried by said supporting structure, connected one with the other and meshing respectively with the gears mounted about said main shaft, gears
45 secured to the respective tubular shafts, and planetary gears carried by said supporting structure and connected with gears on the respective tubular shafts.

15. In a differential driving mechanism for applying torque unequally to a plurality of driving elements for an endless driven member, a main shaft, a plurality of tubular shafts rotatable about the axis of said main shaft, means for operatively connecting the
55 several shafts with the respective driving elements, a supporting structure rotatable about the axis of said main shaft, a gear rotatable about the axis of said main shaft with relation both to said main shaft and said
60 supporting structure, a gear secured to said

main shaft, planetary gears carried by said supporting structure, connected one with the other and meshing respectively with the gears mounted about said main shaft, gears
70 secured to the respective tubular shafts, and planetary gears carried by said supporting structure and connected with gears on the respective tubular shafts, the last mentioned planetary gears being connected with the
75 first mentioned planetary gears for rotation about a common axis.

16. In a differential driving mechanism for applying torque unequally to a plurality of driving elements for an endless driven member, a main shaft, a plurality of tubular
80 shafts rotatable about the axis of said main shaft, means for operatively connecting the several shafts with the respective driving elements, a supporting structure rotatable about the axis of said main shaft, a gear
85 rotatable about the axis of said main shaft with relation both to said main shaft and said supporting structure, a gear secured to said main shaft, planetary gears carried by said supporting structure, connected one
90 with the other and meshing respectively with the gears mounted about said main shaft, gears secured to the respective tubular shafts, a planetary gear carried by said supporting structure, and meshing with the gear
95 of one of said tubular shafts, another planetary gear carried by said supporting structure, and an intermediate gear connecting the last mentioned planetary gear with the gear of the other of said tubular shafts, the
100 last mentioned planetary gears being rigidly connected one to the other.

17. In a differential driving mechanism for applying torque unequally to a plurality of driving elements for an endless driven member, a main shaft, a housing supported by and rotatable with relation to said main shaft, a gear mounted within said housing
105 about the axis of said main shaft and rotatable with relation to said main shaft and said housing, means for connecting said gear with a source of power, means actuated by said gear for rotating said housing and said shaft with relation one to the other, a plurality of tubular shafts rotatable about the
110 axis of said main shaft and extending through the wall of said housing, and means controlled by the rotation of said housing for transmitting power in unequal amounts to said tubular shafts, and means for connecting the several shafts with the respective
115 driving elements.

18. In a differential driving mechanism for applying torque unequally to a plurality of driving elements for an endless driven member, a main shaft, a housing supported by and rotatable with relation to said main shaft, a gear mounted within said housing about the
125 axis of said main shaft and rotatable with relation to said main shaft and said hous-
130

ing, means for connecting said gear with a source of power, a gear rigidly secured to said main shaft within said housing, planetary gears rotatably mounted in said housing and meshing with the respective gears on said shaft, whereby the rotation of the first mentioned gear will cause said shaft and said housing to rotate with relation one to the other, tubular shafts mounted for rotation about the axis of said main shaft and extending into said housing, gears secured to said tubular shafts within said housing, planetary gears mounted within said housing, connected with the gears on the respective tubular shafts and connected with the first mentioned planetary gears for rotation therewith, and means for connecting the several shafts with the respective driving elements.

19. In a differential drive for applying torque unequally to a plurality of driving elements for an endless driven member, a main shaft, a housing mounted for rotation about the axis of said main shaft and comprising two compartments each extending about said shaft, a gear mounted within one compartment of said housing for rotation about the axis of said shaft with relation both to said housing and to said shaft, a gear rigidly secured to said shaft within said compartment, a planetary gear shaft journaled in said housing and extending through both the compartments thereof, gears carried by said shaft, rigidly connected one with the other and meshing with the respective first mentioned gears, a plurality of tubular shafts mounted for rotation about the axis of said main shaft and extending into the other compartment of said housing, gears rigidly secured to said tubular shafts within the last mentioned compartment, gears mounted on said planetary gear shaft within said last mentioned compartment and rigidly connected one to the other, one of the last mentioned gears meshing directly with the gear on one of said tubular shafts, an intermediate gear connecting the other of the last mentioned gears with a gear on the other of said tubular shafts, and means for connecting said main shaft and said tubular shafts with the respective driving elements.

In testimony whereof, we affix our signatures hereto.

JULIUS H. HEGELER.
GRANT HOLMES.