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[54] YARDER HAVING AN INFINITE RATIO DRIVING INTERLOCK FOR SPOOLING DRUMS

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[52] **U.S. Cl.** .....**60/6,** 254/185 R

[51] **Int. Cl.** **F01b 21/00**

[58] **Field of Search** .....60/6; 254/185 R; 212/84

[56] **References Cited**

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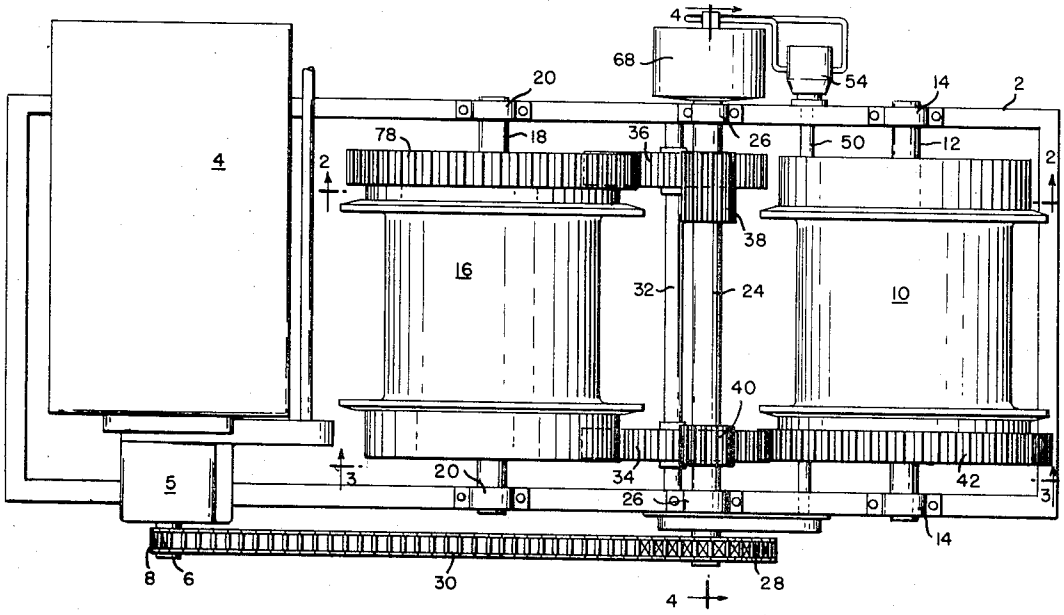
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Assistant Examiner—Allen M. Ostrager
Attorney—Seed, Berry & Dowrey

[57] **ABSTRACT**

A yarder having a plurality of cable drums and a driving connection between the drums having an infinite variable driving ratio including an improved application of a hydraulic motor driving the haulback drum of a logging yarder allowing a controlled relative rotation between the drums. The pump for driving the motor is directly associated with the drive of the main drum. Further included are means for driving a mobile yarder mechanism using the power source and control mechanism for the drums as the motivating and control means for driving the tracks of the vehicle.

4 Claims, 10 Drawing Figures



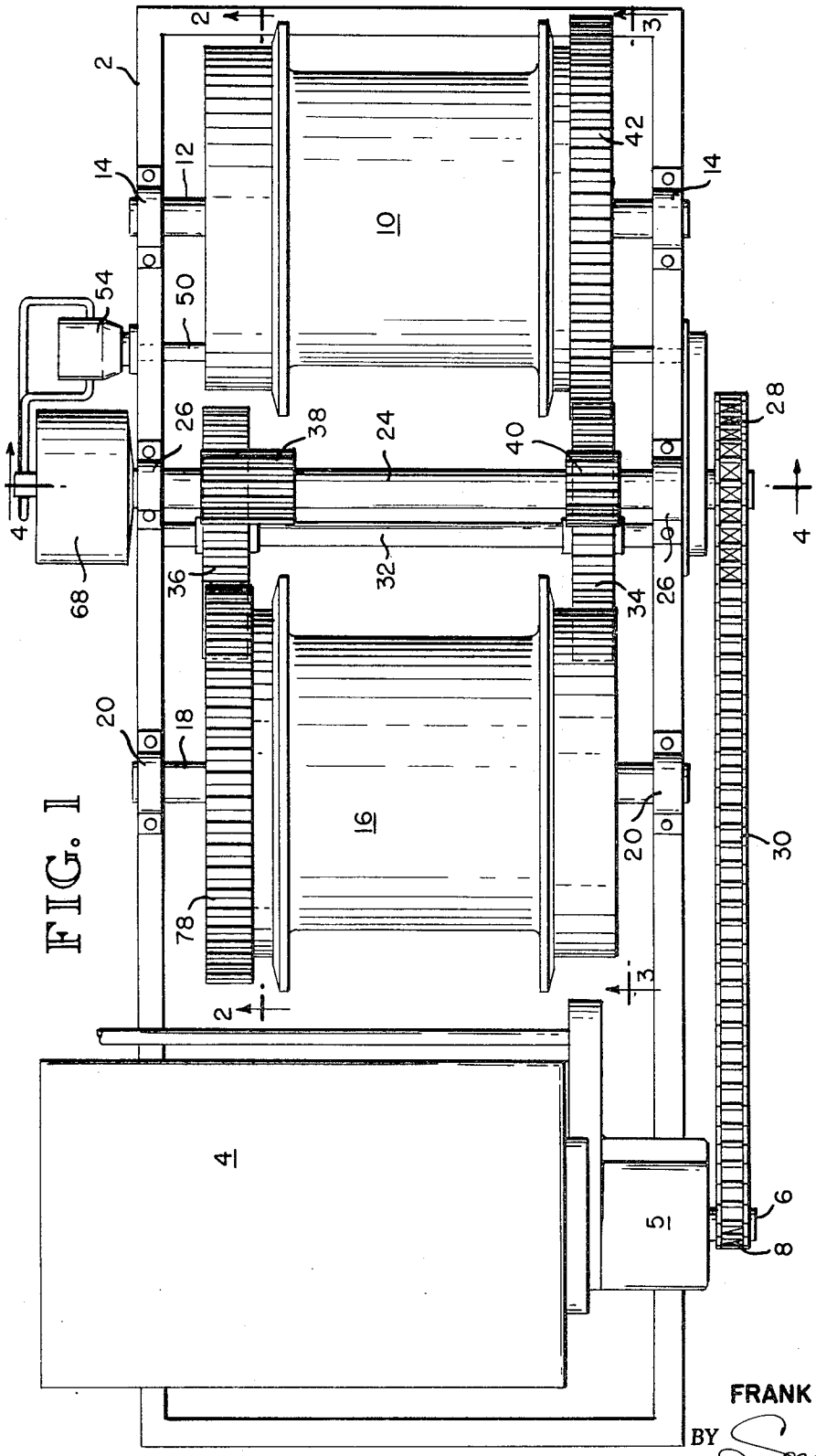


FIG. 1

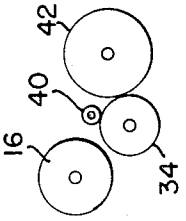


FIG. 3

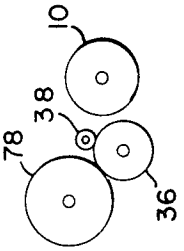


FIG. 2

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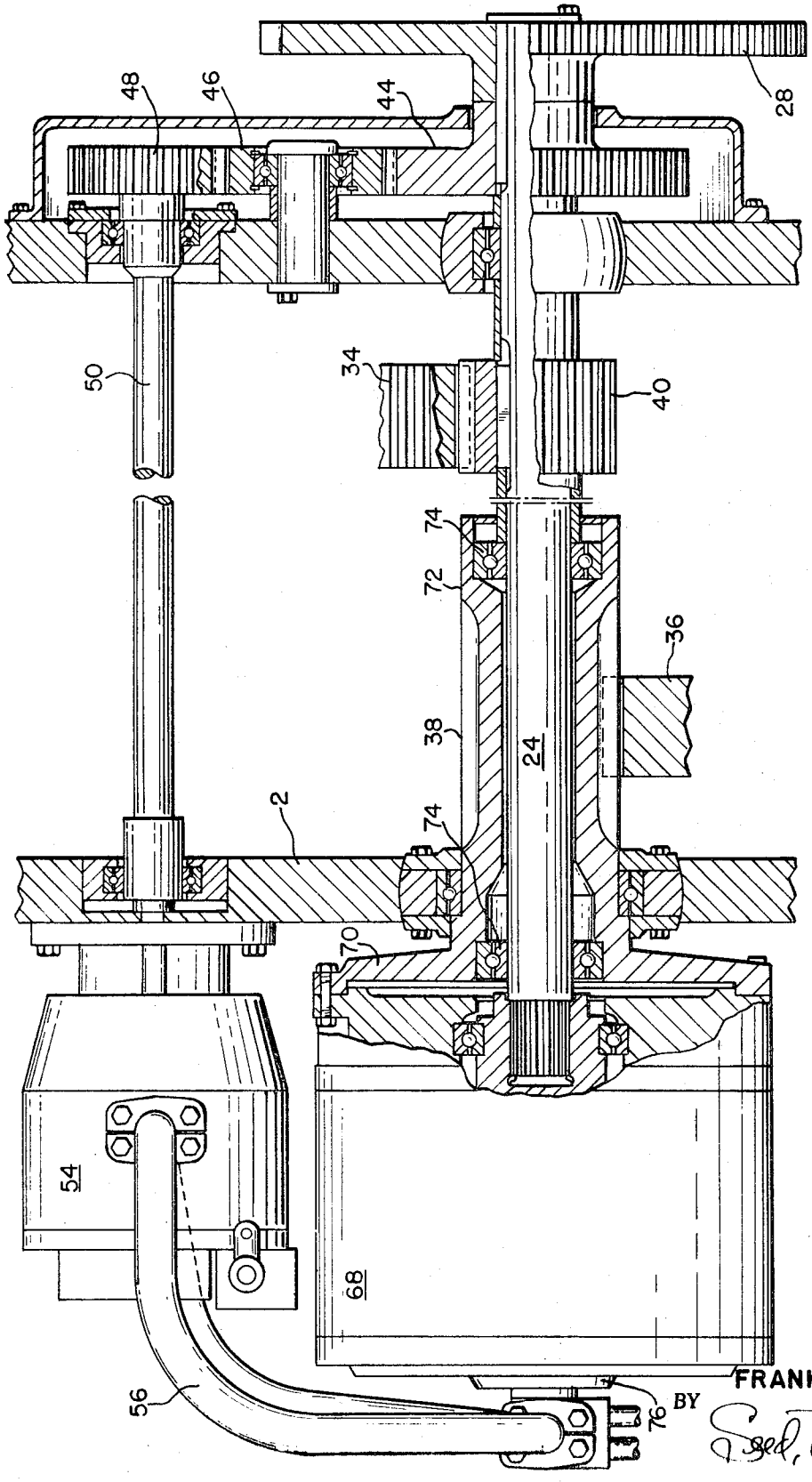


FIG. 4

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FIG. 5

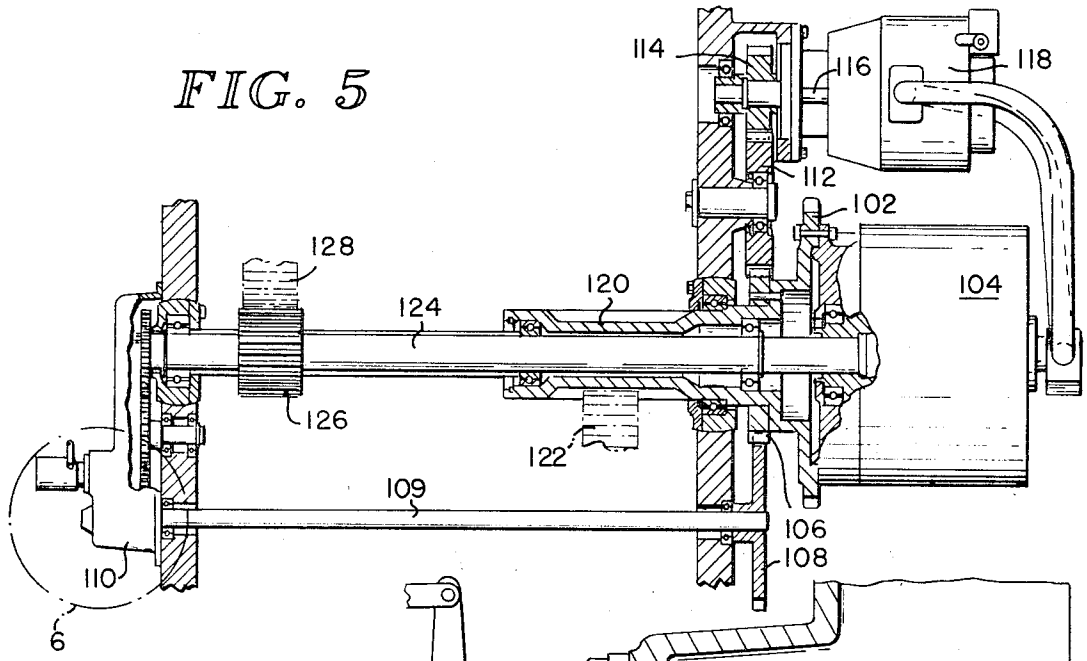


FIG. 6

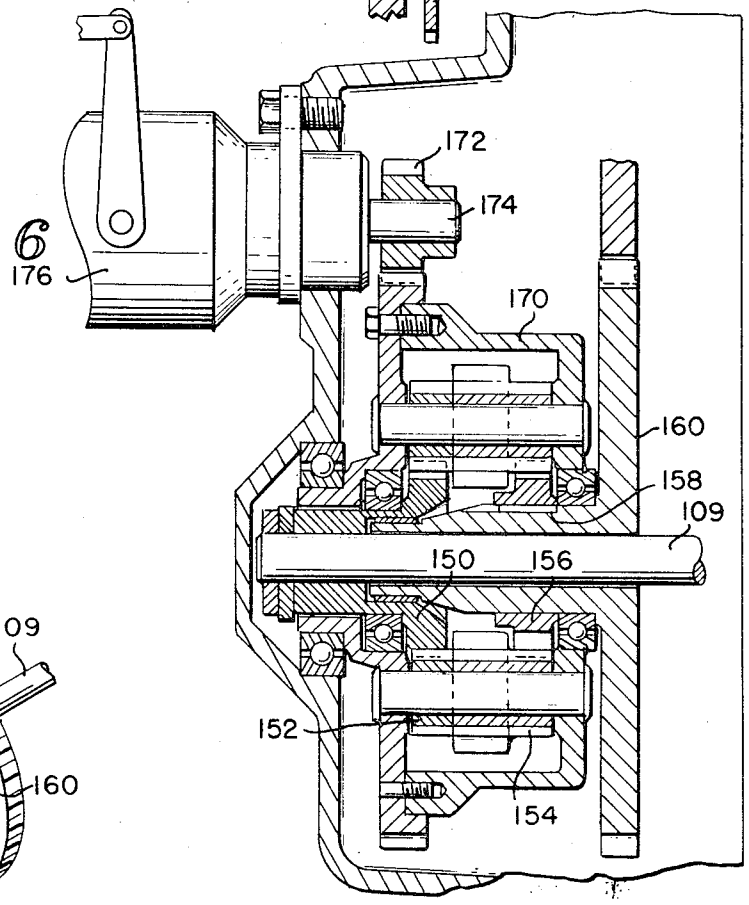
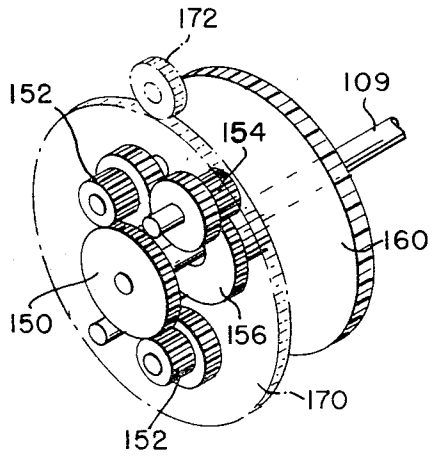


FIG. 7



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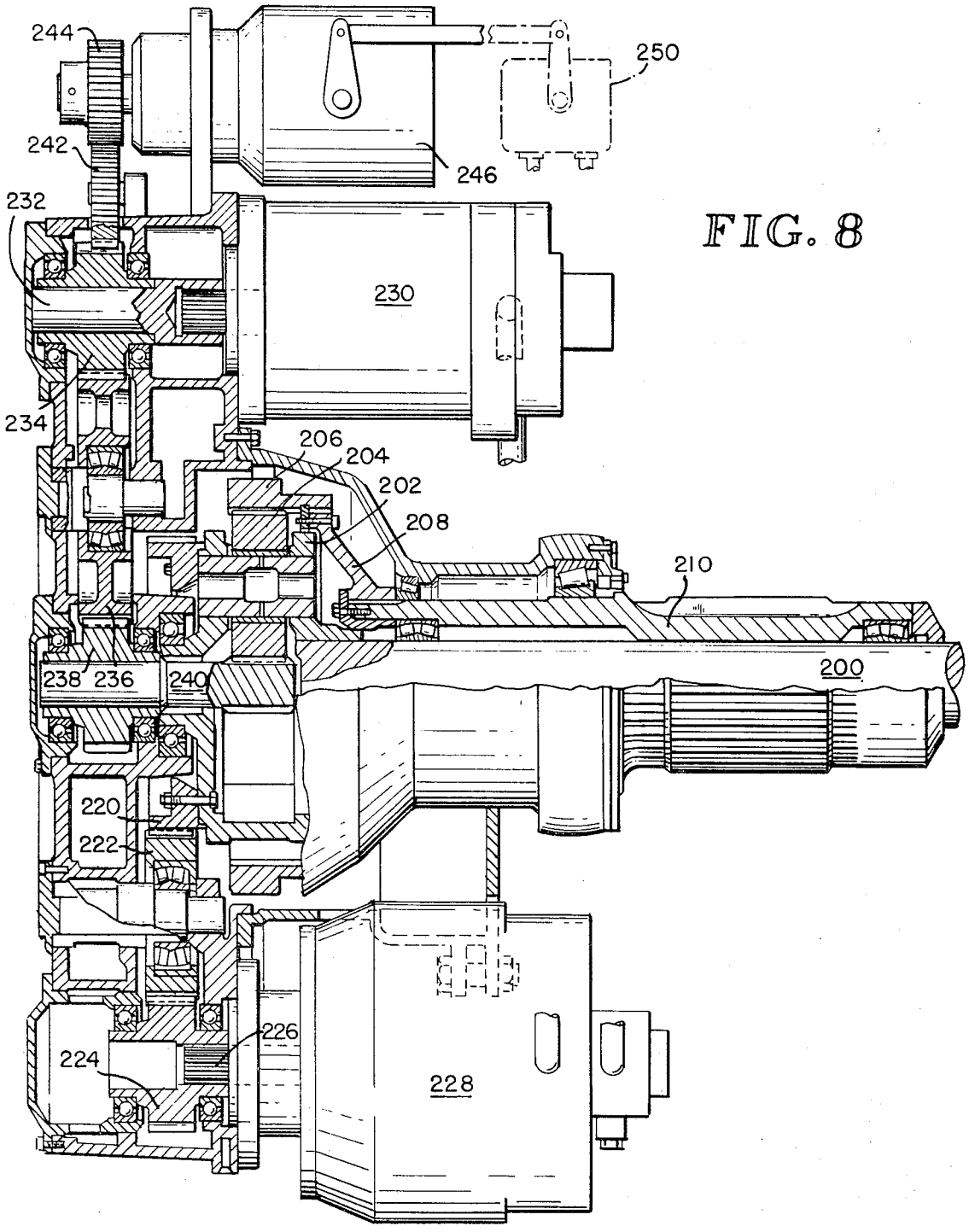


FIG. 8

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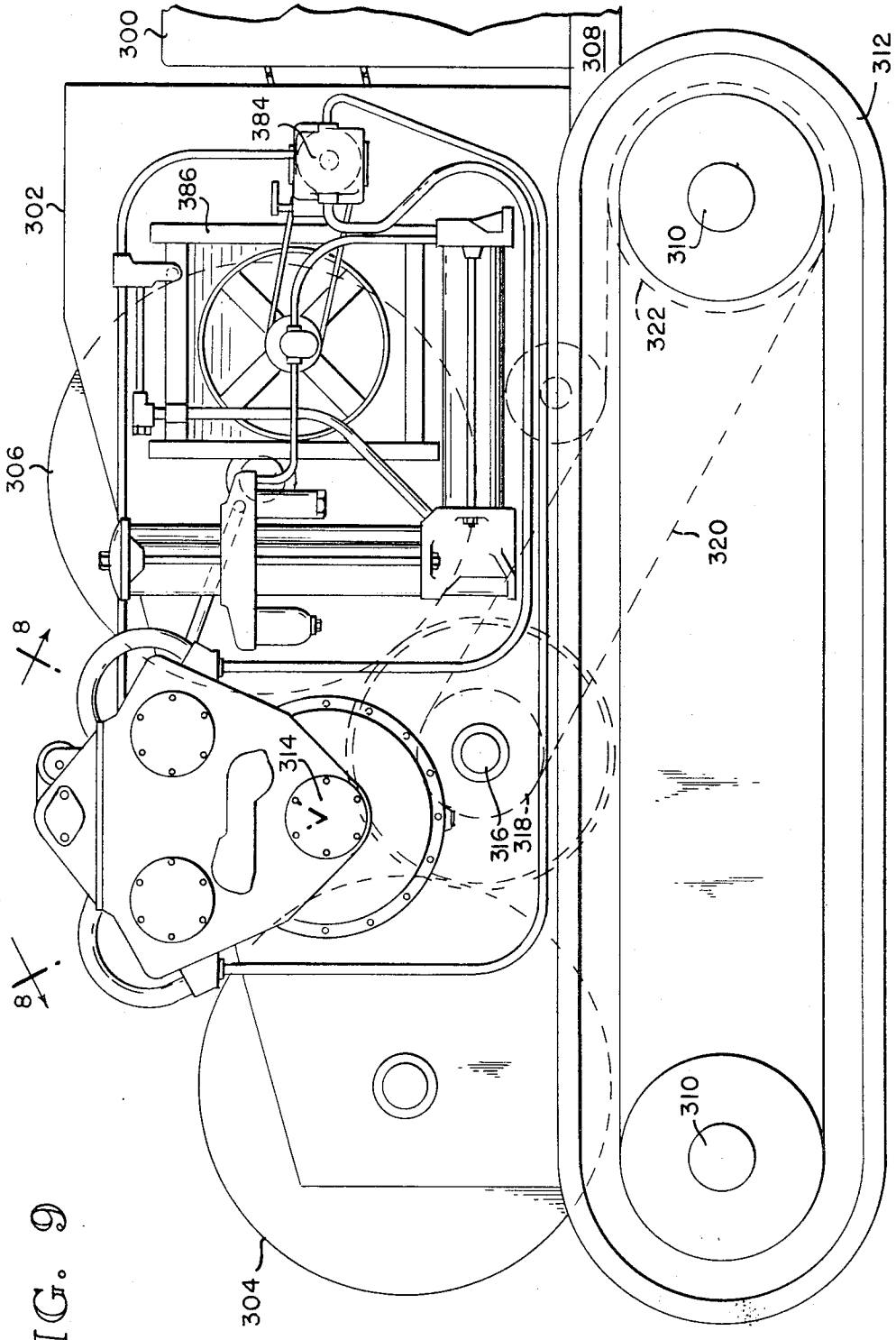


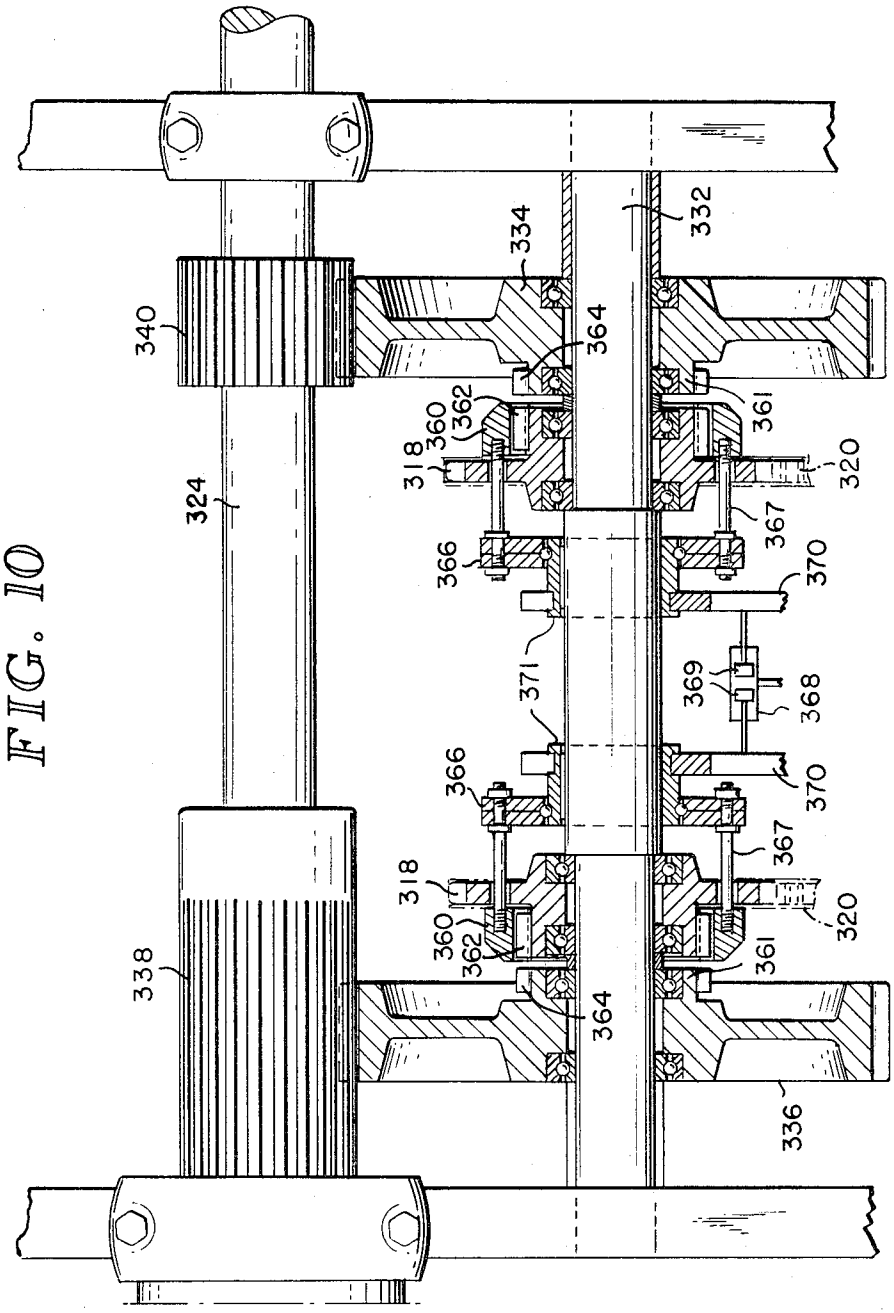
FIG. 9

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FIG. 10



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YARDER HAVING AN INFINITE RATIO DRIVING INTERLOCK FOR SPOOLING DRUMS

This invention relates to a yarder having an infinite ratio driving connection between two cable winding drums. Exemplifying the type of drums to which this invention lends itself are the main and haulback drums of a logging yarder. The function of these drums is to spool the interconnected and closed loop main and haulback portions of the log hauling cables, the haulback cable being strung between the yarder and a tail block located at the extreme outer limit of the area being logged. Choker cables are connected by means of butt rigging between the log hauling or main line and a turn of logs, and the main line spooling drum is powered for the inhaul run of the mainline and the attached turn of logs. The diameter of the main drum, during the inhaul run changes from a bare to a full wrap thereby changing the diameter and the relative linear cable velocity. It is of course necessary that the cable be paid out from the other or haulback drum as it is taken in by the main drum and paid out from the main drum when obtaining an outhaul run of the choker carrying mainline cable.

It is important that little or no slack be permitted in the trailing portion of the cables, whether such be the haulback section or the mainline. If the cable is pulling a turn of logs to the landing, a tight haulback section assures that contact between turns of logs and ground will be at a minimum, and in any downhill travel prevents the logs from running and becoming unhooked from the choker. If the mainline is trailing, i.e. travelling its outhaul run, a tight line minimizes the possibility of the butt rigging and chokers becoming entangled with brush, down logs and stumps.

The purpose of the interlock between the two drums is to obtain for each drum at all times a speed which, reflecting the condition of its own wrap diameter by comparison with the other drum's wrap diameter, gives to both drums substantially the same linear line speed for the then-existing spooling surface. Some yarders govern the relative line speeds of their main and haulback drums by means of "braking" clutches used in association with reduction gearing, and the operator selectively slips the clutches to the degree necessary to maintain relatively taut cables. Other yarders, looking to an elimination of the clutches, have interlocked the drums by a system which includes a planetary gear set, and as an adjunct to the planetary gear set provide a power source, independent of the power which drives the drums as a means of increasing or decreasing at will the ratio between driving and driven ends of the planetary gear set.

One of the objects of the present invention is to provide improved control of the rotative speed relationship between the main drum and the haulback drum by providing a pump drive in conjunction with a hydraulic motor which produces a controlled rotative relationship between the two drums and yet allows for an infinite variation in this relationship.

In accordance with this object and as a feature of the present invention, there is provided a variable volume hydraulic pump driven directly from the input drive to the main drum thereby always maintaining a constant relationship with the main drum speed. The pump serves as a power source for a hydraulic motor through which the haulback drum speed is controlled. Since the main drum is directly driven, this combination allows

an infinite change in the relative drive speed between the main drum and the haulback drum.

It should be noted that when the wrap diameter of the haulback drum is smaller than the wrap diameter of the main drum, the pump or pumps act to supply oil to the hydraulic motor in order to increase the relative speed of the haulback drum and maintain substantially the same linear line speeds on both the main and haulback cables. However, when the wrap diameter of the haulback drum is greater than that of the main drum the motor is caused by the haulback drum to act as a pump and the pump or pumps are hydraulically driven as a motor or motors. It may be seen, therefore, that in the description and in the claims that follow, the terms pump and motor may be interchangeable depending upon the phase of the interlock cycle envisioned. Throughout this application reference to the hydraulic units is based on an assumed condition where the haulback drum has a smaller wrap diameter than the main drum.

Another object of the present invention is to eliminate the requirement for a planetary gear set and to simplify the interlock mechanism by the direct application of a fixed volume hydraulic motor to achieve an infinitely variable rotative speed relationship between the main drum and the haulback drum.

In accordance with this object and as a feature of the present invention, there is provided a fixed volume hydraulic motor wherein the motor body is interconnected to the input drive and the main drum; and the motor shaft is interconnected to the haulback drum. It may be seen that when the internal rotor elements of the motor are stopped, the motor shaft and body would rotate together as one and similarly the main and haulback drums would rotate at the same speed.

When the rotor elements of the motor are caused to rotate in one direction or the other by means of hydraulic fluid under pressure, the motor shaft will be caused to rotate faster or slower in relation to the speed of the motor body. Similarly, the haulback drum will therefore be caused to rotate either faster or slower than the main drum.

It is yet another object of the present invention to prevent damage to the components of the interlock mechanism, and in particular to the hydraulic components, caused by sudden uncontrolled overspeed precipitated by an unexpected load upon the yarder.

In accordance with this object and as a feature of the present invention, a governor is functionally connected to the hydraulic motor in such a manner as to measure the speed of the rotor elements of the motor. The governor is designed to automatically apply brakes or to slip the clutch on either or both haulback and main drums thus holding the rotor elements within their rated speed and preventing motor and/or other damage to the interlock mechanism.

A further object of the present invention is to provide a means of supplementing the high pressure oil supply to the motor so as to improve the range of interlock. By so doing, the rotor element speed may be maintained to an acceptable level regardless of the main pump speed or even when the main pump is stopped.

In accordance with this object and as a feature of the present invention, there is provided an auxiliary variable displacement pump which is directly connected to a prime mover and operating whenever the prime mover is running and thereby providing a supply of oil

to the high pressure side of the hydraulic system regardless of the speed of the input to the interlock unit so as to assure a consistent relationship unhindered by volumetric decrease from the main pump.

Yet another object of the present invention is to provide a motivating control means for mobile yarder wherein the source of power for the motivating means is the prime mover and the controls for the variable driving of the tracks is interrelated to the hydraulic pump and motor associated with the haulback drum.

The above and other features of the invention including various novel details of construction and combinations of parts will now be more particularly described with reference to the accompanying drawings and pointed out in the claims.

It will be understood that the particular machine embodying the invention is shown by way of illustration only and not as a limitation of the invention. Principles and features of this invention may be employed in varied and numerous embodiments without departing from the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of a yarder mechanism incorporating applicant's inventive concept;

FIG. 2 is a schematic view of the gears as seen along lines 2—2 of FIG. 1;

FIG. 3 is a schematic view of the gears as seen along lines 3—3 of FIG. 1;

FIG. 4 is a section along lines 4—4 of FIG. 1 illustrating the shaft and gear relationship;

FIG. 5 is a plan view of another embodiment incorporating applicant's inventive concept;

FIG. 6 is an enlarged portion of that area encircled in FIG. 5;

FIG. 7 is a schematic view of the gearing of FIG. 6;

FIG. 8 is a view partially in section of another embodiment of applicant's invention;

FIG. 9 is a side elevation of applicant's novel yarder mounted upon a tracked vehicle; and

FIG. 10 is a mobile drive engaging mechanism as used in the species shown in FIG. 9.

As the preferred embodiment of the present invention there is provided a variable volume hydraulic pump driven directly from the input drive to the main drum so that the pump will be effected by changes in input speed and direction of rotation thereby maintaining a constant relationship with the input speed and main drum speed and direction of rotation. If such a relationship were not maintained, as would be the case if the pump was driven by the prime mover, undesireable excessive control adjustments to the interlock mechanism would be necessary each time the input speed or direction of rotation is changed. The pump serves as a power source which controls the speed and direction of rotation of a hydraulic motor, and the motor acts thereby to vary the speed of the haulback drum, faster or slower, in relation to the speed of the directly driven main drum. An additional, important reason for this drive of the pump is that during certain periods of the interlock cycle of operation, a regenerative condition occurs whereby the motor acts as a pump and the pump is driven by the hydraulics as a motor. By connecting the pump to the input drive, the regenerative forces are put directly back into the main drum whereas if the pump were driven by the prime mover, the regenerative forces would be fed back through the prime mover and the complete primary drive, causing an overloading far beyond the capacity of the components, (prime mover, transmission, torque converter, chain drive).

As seen in FIGS. 1–4, one species of a mechanism incorporating applicant's inventive concept is mounted upon frame members 2 and comprises a prime mover 4, a transmission 5 and a drive shaft 6 extending from the transmission and mounting sprocket 8. Likewise mounted on the main frame 2 are a pair of cable drums, a main drum 10 supported by a shaft 12 which shaft is in turn mounted to the frame 2 by means of the journal mountings 14—14, and a haulback drum 16 supported by a shaft 18 which likewise in turn is mounted to the frame 2 by means of the journal mountings 20—20.

Similarly attached to the frame member 2 is a shaft 24 journalled in assemblies 26—26 and which extends beyond the frame members on both sides. The shaft 24 has keyed thereto a sprocket 28 which is on the same side of the frame as the sprocket 8. Sprocket 28 is functionally interconnected to sprocket 8 by means of a chain 30.

Journalled to the frame 2 and mounted slightly below and to the left of the shaft 24, as seen in FIG. 1, is a shaft 32 which mounts a pair of idler gears 34 and 36 located adjacent opposite ends thereof. Keyed to shaft 24 is a gear 40 which meshes with idler gear 34 and which in turn meshes with and drives the gear 42 rigidly keyed to and providing the drive for the main drum 10.

As best seen in FIG. 4, the shaft 24 driven by the prime mover has keyed thereto gear 44 which meshes with idler gear 46 which in turn meshes with the driving gear 48 keyed to a shaft 50. The shaft 50 is journalled to frame 2 and extends the full width thereof. At the opposite end of shaft 50 from gear 48 is a variable volume hydraulic pump 54 directly driven by shaft 50. Hydraulic connections 56 connect the pump 54 to a fixed volume hydraulic motor 68. The hydraulic motor 68 is of the rotational type wherein the casing is directly bolted to a flange 70 which is integral with stub shaft 72 which has gear 38 cut into its exterior surface.

The rotor (not shown) of the hydraulic motor is directly splined to shaft 24 which is, as noted above, keyed to gear 40. It is to be noted that shaft 24 is separated from and allowed to be rotated independently of shaft 72 by virtue of bearings 74—74.

Since the hydraulic motor 68 is of the rotational type, a rotary seal 76 forms the conjunction between the hydraulic lines 56 and the hydraulic motor 68.

The interconnection, as above described, between the input drive, the pump, motor and haulback drums allows an operator, by varying the volume output of the pump to alter the relative speed of the two drums.

Since the rotor of the motor is splined to shaft 24, the input shaft, the entire motor including the casing will rotate at the same speed, thus the main and haulback drum in the illustrative mechanism will rotate at the same speed. The operator can vary the relative rate of rotation between the main and the haulback drums by simply altering the swash plate in the hydraulic pump.

The driving connections to the haulback drum are shown schematically in FIG. 2 wherein gear 38 drives the idler gear 36 which in turn drives gear 78 keyed to haulback drum 16.

The driving connections to the main drum are shown schematically in FIG. 3 wherein gear 40 drives idler gear 34 which in turn drives main drum 42.

Another possible arrangement of mechanisms incorporating applicant's invention is shown in FIGS. 5, 6 and 7. Referring specifically to FIG. 5, the prime mover drives through a chain as in the previous species which is in turn meshed with a sprocket 102 bolted to the rotatable hydraulic motor casing 104. Likewise forming a portion of sprocket 102 is a hub having a gear 106 which drives gear 108 directly connected via shaft 109 to a governor 110. As shown in FIG. 5, gear 106 likewise drives idler gear 112 which in turn drives a hydraulic pump 118. The pump 118 provides a motivating force for the hydraulic motor 104 and is appropriately connected thereto in much the same manner as previously described with regard to FIG. 4.

FIG. 6 which is an enlarged section through the gear drive for the governor mechanism should be read in conjunction with FIG. 7 which is a schematic showing the same gear drive. It is to be noted that the drive for the governor mechanism is likewise a planetary gear system. Shaft 109, which is driven by the prime mover as noted above serves as the motivating force for the sun gear 150 which meshes with the first set of planetary gears 152. Planetary gears 152 in turn mesh with a second set of planetary gears 154. Gears 154 do not mesh with gear 150 but do mesh with a gear 156 forming a portion of the hub 158 of gear wheel 160. Gear 160 meshes with a gear wheel formed on the end of shaft 124 which as noted above is driven by the hydraulic motor 104. Both of the sets of planetary gears 152 and 154 are mounted in a carrier 170 which is in turn meshed with gear 172 connected by shaft 174 to the governor mechanism 176. The governor is thus activated by the rotor speed which is the speed differential between the speed of the two shafts 120, 124.

Yet another possible species of driving connection incorporating applicant's invention is shown in FIG. 8. Although not shown, it is to be understood that the mechanism would be placed in an environment similar to that shown in FIG. 1 wherein there is included a prime mover, frame, transmission and other elements essential to a functional apparatus.

Rotational input proceeds from the prime mover via shaft 200 to planet carrier 202. The opposite, or outboard, side of carrier 202 has mounted thereon extending in an axial direction a ring 220 having gears formed on the periphery thereof. The ring 220 drives an idler gear 222 meshed with gear 224 mounted upon a shaft 226 directly connected to the hydraulic pump 228. The pump via appropriate hydraulic connections provides a motivating source for a hydraulic motor 230. The hydraulic motor 230 in turn drives via shaft 232, gears 234, 236, 238 and shaft 240 which has teeth on the exterior and forms the sun gear of the planetary system. Shaft 240 is conventionally meshed with planet gear 204 which in turn mesh with ring gear 206 mounted upon hub 208 of hollow shaft 210 having exterior teeth adapted to drive the haulback drum.

In summary, the prime mover delivers rotary motion to shaft 200 and thus the main drum. Shaft 200 drives through the carrier 202 of the planetary to the pump 228 which in turn drives motor 230. Motor 230 drives the sun gear 240 of the planetary system and the planetary is used in a conventional fashion allowing a different rate of rotation for the main and the haulback drum depending upon the relative rate of rotation of the elements of the planetary system.

It is to be noted that directly connected to the gear 232 driven by hydraulic motor 230 is another gear train formed of gears 242 and 244, which drive a shaft leading directly to governor 246. The governor 246 is connected via a linkage to a variable pressure air valve 250 which is shown schematically; the details not being important to this invention. The variable pressure air valve 250 is connected to either a clutch or brake mechanism whereby if a significant uncontrolled overspeed of the haulback drum is caused by unexpected load on the yarder, disengagement of the interconnection between the drum and shaft may be accomplished by release of the clutch, or on the other hand, the drum may be slowed to a more normal speed by application of a brake. The mechanism used to disengage the clutch or to apply the brake is considered to be well within the scope of one skilled in the art and will not be specifically described herein.

It is to be understood that although the preceding descriptive material has been directed to a stationary yarder, each of these concepts is equally well adapted to a mobile yarder which will now be described with reference to FIGS. 9 and 10.

As seen in FIG. 9, the interlocking yarder may be mounted on a mobile platform wherein the prime mover for the yarder mechanism is the power source to move the yarder and undercarriage from place to place. The mobile unit comprises a prime mover 300, a yarder mounting frame 302 upon which a portable spar tree or tower may be mounted together with a main drum 304 and a haulback drum 306. All of these members are appropriately mounted on a subframe 308 which is supported by a pair of axles 310.

Sprocket wheels 322 are provided on opposite ends of each of the axles 310 a track 312 extends about the two sprockets 322 on the respective sides of the vehicle. The drive from the prime mover to the tracks is accomplished through gearing equivalent to that illustrated in FIGS. 1 and 4. Gears 338 and 340 (FIG. 10) are positioned on the shaft 324 which is the equivalent shaft and gears as 24, 38 to 40 (FIG. 1) respectively mesh with gears 336 and 334 which are positioned on the shaft 332. The gears 336 and 334 rotate freely on the shaft. Also mounted on the shaft 332 are drive sprocket 318 and a chain drive 320 extends between the sprockets 320 and sprockets not shown on one of the shafts 310 (FIG. 9) so as to provide the driving means for the tracks 312 (FIG. 9).

Illustrated in FIG. 10 is the means for clutching the sprockets 318 to the gears 336 and 334. This is accomplished by engaging or disengaging the gears 360 and 361 which are respectively associated with the gears 334 and 336 and the sprockets 318. The gears 361 are integral with the gears 334 and 336 and the gears 360 are keyed to the sprockets 318 and are axially movable into and from engagement with the gears 361. The gears 361 are provided with external teeth 364 and the gears 360 are ring gears having internal teeth 362. These teeth are caused to mesh or disengage by axial sliding movement through means of a double acting air cylinder 368 and pistons 369. The pistons are connected to the yokes 370 which in turn engage the slidable sleeves 371. Mounted on the sleeves are rotatable rings 366. Secured to and projecting from the rings are a plurality of threaded rods 367. The rods project through holes in the sprockets 318 and the outer ends of the rods are threaded into holes in the gears 360.

The application of air pressure to the pistons **369** moves the gear teeth **362** into engagement with the teeth **364** on the gears **361** and thereby causes the drive for the sprockets **318.** The rotation of the gear **338** and its associated gears and sprocket may also be driven and controlled by the hydraulic motor **68** (FIG. **1**) similar to the drive and control of the haulback drum **16** (FIG. **1**). A similar track drive control is also applicable to the modified structures illustrated in FIGS. **5** and **8.**

In order to assure adequate oil and operation of the hydraulic system under all required conditions, an oil charging system **386** is provided which includes a fixed volume, low pressure pump, an oil cooler, reservoir and appropriate filters and hydraulic connections. An auxiliary variable volume high pressure pump **384** is driven by the prime mover and acts to supply oil to the high pressure side of the hydraulic system to supplement the main pump which is subject to the speed variations of the input drive. Thus, the auxiliary pump enables the hydraulic motor to operate even when the input shaft to the main drum is not turning at a sufficient speed to operate the main pump.

It can be seen that proper adjustment of the fluid pump will assure that the proper tension is retained in closed loop during both the inhaul and return of the main line. This is accomplished through the interconnection between the drive for the main drum and the haulback drum through the pump and motor combination which allows an infinitely variable drive ratio without the need for expensive planetary systems.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. Mechanism for controlling the relative rotation of two shafts comprising, in combination with the two shafts, a main power plant, a secondary power plant comprising a pump and a rotatable hydraulic motor, a driving connection between the casing of the motor and one of said shafts, a driving connection between the rotor of the motor and the other of said shafts, a driving connection between the power plant and one of said shafts including controls for direction and speed of rotation, a direct driving connection between the main power plant and the pump of the secondary power plant assuring a constant relative rate of rotation between the input drive speed and the pump, appropriate fluidic connections between the pump and the hydraulic motor and a driving connection between the rotor of the hydraulic motor and the shaft connected thereto whereby the relative rate of rotation of the two shafts can be controlled by altering the speed of the hydraulic motor.

2. A mechanism as in claim **1** further including an auxiliary high pressure pump driven by the prime mover and connected to the hydraulic motor.

3. A mechanism as in claim **1** including a governor mechanism for preventing excessive rate of rotation which is damaging to said fluidic motor.

4. A mechanism as in claim **3** wherein the governor is operatively connected to the hydraulic motor.

* * * * *