Feb. 2, 1943. B. S. FERGUSON 2,309,759

LINE CONTROL MECHANISM

Filed Sept. 15, 1941 2 Sheets-Sheet 1

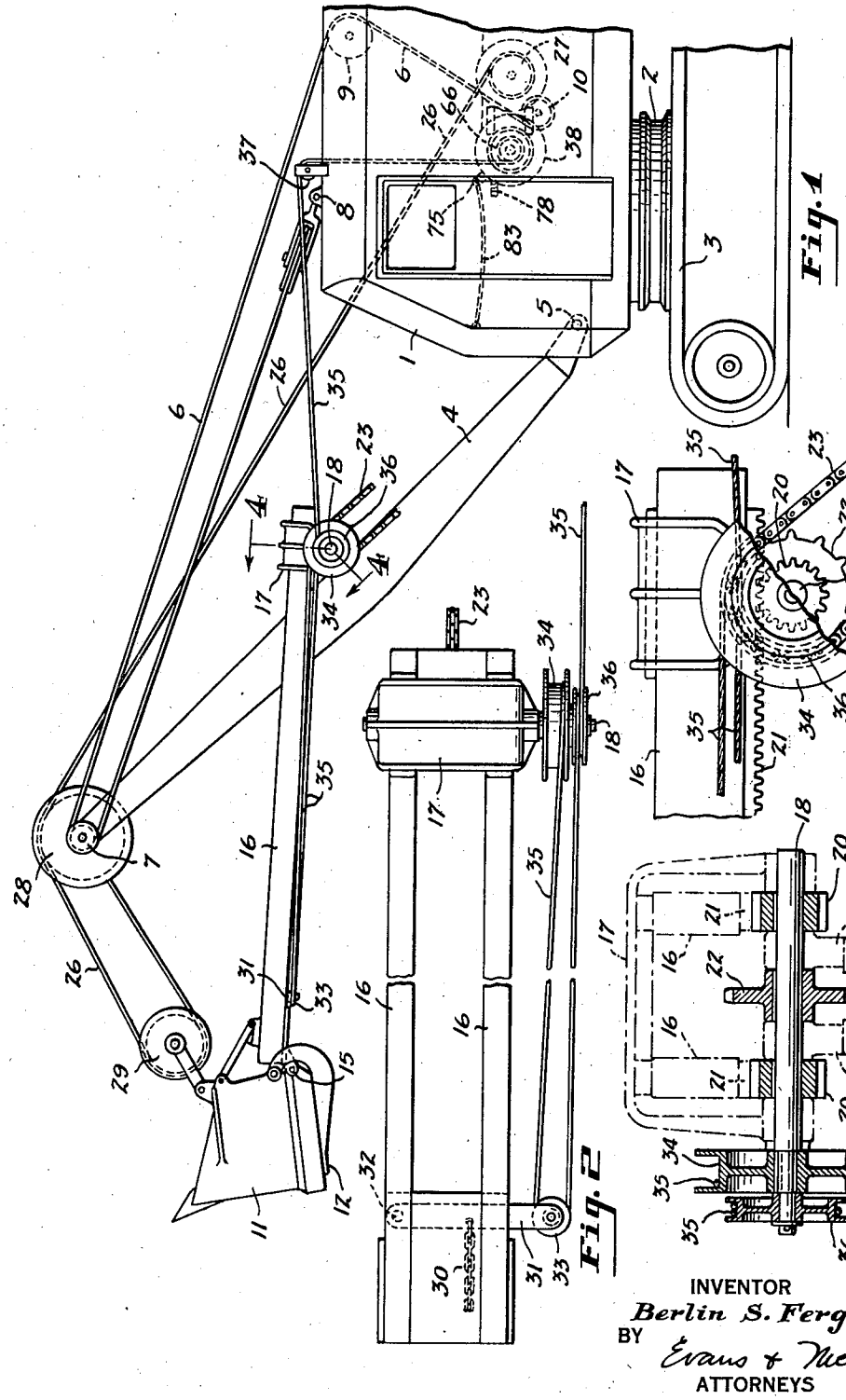


Fig. 1

Fig. 3

Fig. 2

Fig. 4

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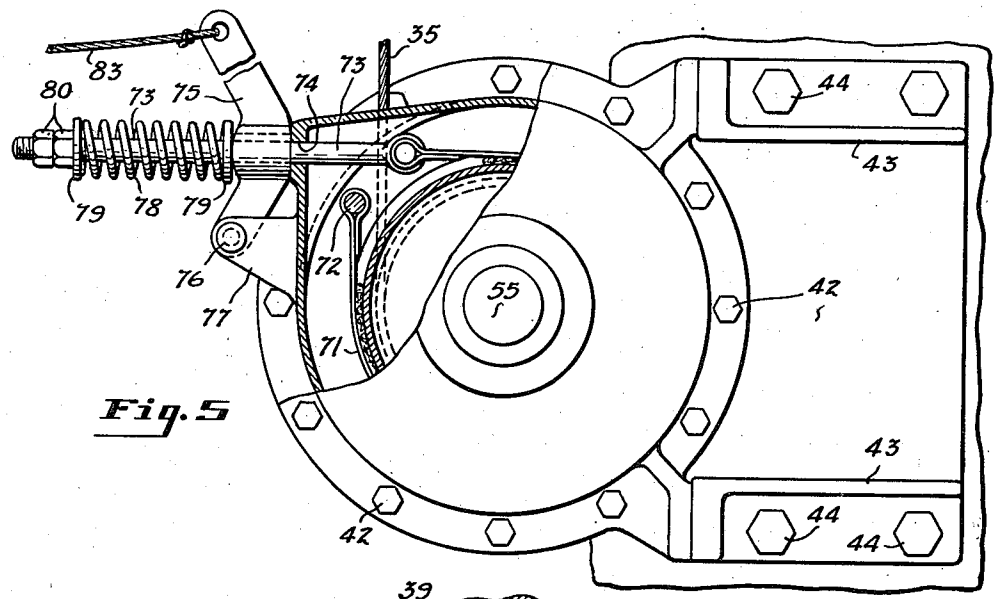


Fig. 5

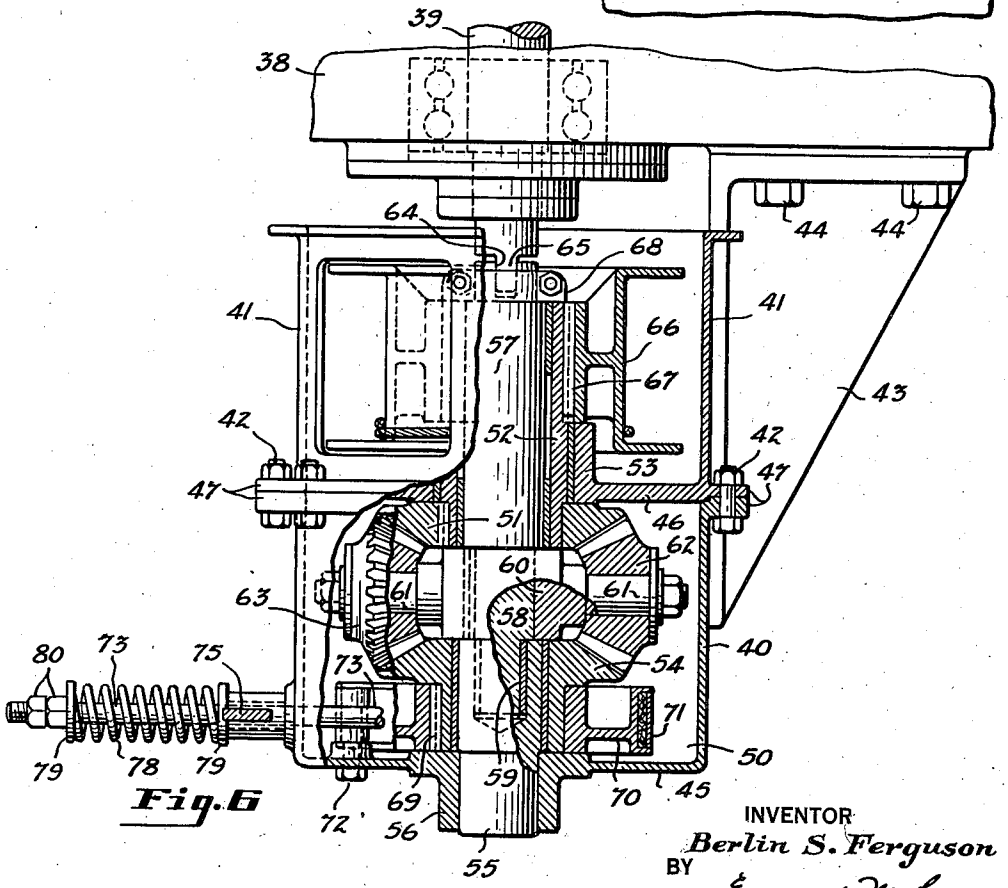


Fig. 6

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LINE CONTROL MECHANISM

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14 Claims. (Cl. 214—146)

This invention relates to excavating apparatus and the like, and more particularly to means for controlling a line such as that which is used in dumping the door of a dipper or shovel or that which is alternately paid out and retracted in operating a drag line apparatus or a clam shell bucket.

It is an object of the invention to provide an improved line control device which is actuable from a constantly rotating shaft to maintain a substantially constant or uniform tension in a line of an excavating apparatus or to apply a sudden jerk or tension to the line under the control of the operator.

Another object is to provide a device of the character mentioned in which a frictional drive means is employed that may be substantially completely enclosed in a casing or housing so as to exclude dirt and dust therefrom and to facilitate maintenance of adequate lubrication of the moving parts.

Another object is to provide a line control device wherein planetary gears are employed to transmit the driving torque from a constantly rotating shaft to a drum for reeling in and paying out the cable or line.

A still further object of the invention is to provide an improved line control device which is simple in design and construction and relatively inexpensive to manufacture. Other objects and advantages will become apparent from the following detailed description of a suitable embodiment of the invention made in connection with the accompanying drawings, wherein:

Figure 1 is a somewhat diagrammatic side elevational view, with parts removed and with parts broken away, of a power shovel embodying the line control of the present invention;

Fig. 2 is a foreshortened plan view, with parts removed, of the dipper stick and associated parts shown in Fig. 1;

Fig. 3 is an elevational detail, with parts broken away, showing the mechanism employed in actuating the dipper stick;

Fig. 4 is a somewhat diagrammatic sectional detail taken substantially on the line 4—4 of Fig. 1;

Fig. 5 is an end elevational view, with parts broken away and partly in section, of the line control device or unit of the present invention; and

Fig. 6 is a plan view, partly in section and with parts broken away, of the line control device shown in Fig. 5.

Referring to the drawings by numerals indicating like parts throughout the several veiws, the principles of the present invention are shown in connection with a conventional type of power shovel which comprises a carriage 1 mounted by means of turntable mechanism 2 to turn upon running gear 3, which may be of the caterpillar or endless tread band type. A boom 4 is pivoted to the carriage 1 at 5 and extends upwardly and forwardly from the carriage, being supported by a cable 6 trained around a sheave 7 mounted on the outer end of the boom. One end of the cable 6 is anchored to the top of the carriage 1 at 8 and the other end of the cable is passed over a sheave 9 in the top of the carriage and thence around a drum 10 to which it is secured. The drum 10 may be suitably rotated by means of the usual drive mechanism of the excavator to pay out or retract the cable 6, thereby raising and lowering the boom as desired.

A dipper or scoop 11 of conventional construction and having a bottom drop or dump door or gate 12 pivoted at 15 is mounted on the end of a stick or arm consisting of spaced parallel members 16 which straddle the boom 4. The stick members 16 are guided in an inverted U-shaped yoke 17, the ends of which are loosely mounted on a rotatable shaft 18 journaled in spaced portions 19 of an upstanding bracket secured to a central portion of the boom 4. Secured on the shaft 18 between the bracket portions 19 and the end portions of the yoke or guide 17 are pinions 20 which engage racks 21 secured to the underside of the stick members 16. Thus, as the shaft 18 is rotated, the pinions 20 by engagement with the rack 21 are operated to move the dipper stick longitudinally in the guide yoke 17. For driving the shaft 18 a sprocket 22 is secured thereon between the bracket portions 19 and is connected by an endless chain or belt 23 with drive mechanism 38 of the shovel. The shovel or excavator drive mechanism is conventional and suitable controls are provided so that the shaft 18 may be rotated in either clockwise or counterclockwise direction, as viewed in Figs. 1 and 3, to draw in or project the dipper stick 16 as desired by the operator. Other well known means might be used for actuating the dipper stick, if desired.

To raise and lower the scoop or shovel, a cable 26 operable by means of a drum 27 rotated by the drive mechanism 38 of the apparatus is trained over a sheave 28 on the outer end of the boom 4 and thence around a sheave 29 attached to the shovel or bucket 11 and the end of the cable is then connected to the end of the boom 4. Suitable controls (not shown) are provided

for operating the drive mechanism 38 to rotate the drum 27 in reverse and forward directions for the purpose of paying out and retracting the cable 26, thereby raising and lowering the dipper or scoop 11 in accordance with well known practice.

The bottom or door 12 of the dipper is retained in closed position, shown in Fig. 1, by means of a latch (not shown). This latch may be of conventional construction and is arranged to be actuated by means of a chain 30, so that when the chain is jerked or drawn to the right as viewed in Fig. 2, the latch is adapted to release the bottom or door 12, which swings downwardly and gravitationally on the pivot 15 to dump the contents of the bucket or scoop. The chain 30 is connected to the mid-portion of an arm or lever 31, having one end pivoted to one of the stick members 16 at 32 and having a sheave or pulley 33 journaled in its other end.

The present invention is particularly directed to the apparatus for actuating the pivoted arm 31 which controls the release of the door 12. Mounted on a projecting end of the shaft 18 to turn with the latter is a narrow drum 34 to which is secured one end of a dipper latch control cable or line 35. This cable extends forwardly from the drum 34 around the sheave or pulley 33 on the pivoted arm 31 and thence rearwardly to the carriage 1, passing over and taking one turn around a guide sheave or pulley 36 which is loosely mounted on the end of the shaft 18 adjacent the driven drum or pulley 34. At the top of the carriage 1 the line or cable 35 is guided over a pulley or sheave 37 and extends thence downwardly to the line control device, to be later described.

One feature of the invention is the relationship between the drum 34 and the pinions 20 that control the movement of the dipper stick members 16. The diameter of the drum 34 is twice the pitch diameter of the pinions 20 so that the drum, which rotates with the shaft 18 and in unison with the pinions 20, pays out or winds up a length of the cable or line 35 which is twice the corresponding movement of the dipper stick members 16. By this arrangement, if the carriage end of the cable or line 35 is held taut but stationary, the drum 34 will reel in and pay out the exact amount or length of line required to compensate for the change in distance between the shaft 18 and the sheave 33 during each movement of the dipper stick members under the influence of the pinions 20, thereby preventing sag in the control line.

Within the carriage or cab 1 is housed the driving mechanism 38 for the apparatus. As previously mentioned, this driving mechanism actuates the cables 6 and 26 in accordance with standard practice. Included in the driving mechanism is a constantly rotating shaft 39 which operates the line control device shown in Figs. 5 and 6. This device comprises casings 40 and 41 having circumferential flanges abutting against one another and connected together by bolts 42. These casings are supported by means of brackets 43 connected to the supporting structure of the driving mechanism 38 by means of bolts 44.

The casings 40 and 41 may be of substantially cylindrical form, one end of the outer casing 40 being closed by an integral circular wall 45 and the other casing having an integral end member 46 approximately in the plane of the flanges 47, which forms a partition between the interiors of the two casings.

Chamber 50 within the casing 40 contains a planetary gear train or system which includes a first ring gear 51 secured to one end of a quill or sleeve 52 journaled in a tubular or bearing portion 53 formed centrally of the partition member 46. Disposed in spaced confronting relation to the ring gear 51 is a second ring gear 54 rotatably mounted on a stub shaft 55 secured as by a press fit in a hollow socket portion 56 formed centrally of the casing end wall 45. Extending through the quill or sleeve 52 and rotatable therein is a shaft 57 which has a reduced diameter end portion 58 rotatably received within a socket 59 formed in the inner end of the stub shaft 55. Secured on the shaft 57 for rotation therewith between the ring gears 51 and 54 is a cross arm or member 60 provided at its end with spindles 61 which rotatably receive planetary gears 62 and 63. These planetary gears are freely rotatable on the spindle 61 and mesh with the ring gears 51 and 54, so that when the shaft 57 is rotated one or both of the ring gears 51 and 54 are rotated in the same direction as the shaft.

The line control device is so mounted on the frame of the driving mechanism 38 that the shaft 57 is in axial alignment with the constantly rotating shaft 39 previously mentioned. The end of the shaft 57 is provided with a transverse slot 64 which receives an axially extending transverse tongue 65 formed on the end of the shaft 39 to establish a driving connection between the shafts.

Mounted within the casing 41 on the end of the sleeve or quill 52 to turn with the latter is a line retrieving and holding drum 66. The drum 66 is drivingly connected to the sleeve 52 as by a key 67 and a split collar 68 on the end of the shaft 57 may be provided to retain the drum 66 in place.

Mounted on an axial extension of the second ring gear 54 to turn therewith (see key 69) is a brake wheel or drum 70 disposed within the chamber 50. This brake drum is embraced by a brake band 71 having one end secured to a pin 72 extending inwardly into the chamber 50 from the wall 45 of the casing 40 and having the other end connected to a rod 73 which extends through and is guided in a circular opening 74 in a side portion of the shell or casing 40. An actuating arm 75 is provided with an opening which loosely receives the rod 73 for movement of the arm thereover and one end of the arm is pivoted at 76 to an ear or ears 77 formed on the casing 40. The rod 73 extends beyond the actuating arm 75 and receives a helical compression spring 78 which may be compressed between washers 79 by means of adjustable lock nuts 80. The spring 78 tends to draw the rod 73 to the left as viewed in Fig. 5, thereby maintaining a tension in the brake band 71 which resists turning of the drum 70. By means of the lock nuts 80 the force exerted on the rod 73 by the spring 78 may be varied to increase the braking effect of the band 71 on the drum 70. Upon actuating the lever 71 as by means of a rope or cable 83, the braking force may be momentarily increased by the operator.

In operation the constantly rotating shaft 39 drives the planetary gears 62 and 63 around their circular orbit, the planetary gears being in mesh with the ring gears 51 and 54 as previously mentioned. Now if the resistance to rotation of

the two ring gears is equal, they will be rotated by the ring gears in unison and at equal rotational speeds, the planetary gears **62** and **63** being relatively stationary on the spindles **61**. If, however, one of the ring gears **51** or **54** should become more resistant to rotation than the other, such other would be rotated by the planetary gear train at a faster rotational velocity. Furthermore, if one of the ring gears should be prevented from any rotation whatsoever, the other ring gear would rotate at twice the rotational velocity of the cross member **60** and the shaft **57**. It is thus apparent that the line control device of the present invention provides a unique means for maintaining a substantially constant tension in the line of cable **35** and for optionally jerking or pulling on the line with an increased and variable force for the purpose of reeling the line in, as when releasing the latch controlling the dump door **12** or when the line control device is used as a winder in connection with a tag line or when it is used for the purpose of swinging a clam shell bucket in accordance with well known practice. For example, when using the apparatus in connection with a power shovel as shown in the drawings, the adjusting lock nuts **80** are set so that the tension in the brake band **71** causes the latter to grip the brake drum **70** with sufficient force to cause a braking action on the ring gear **54**, but not with a sufficient force to lock the brake drum and ring gear against any rotation. The amount of force exerted on the brake band **71** by the spring **78** is adjusted so that the resulting torque exerted on the line control drum **66** is just sufficient to prevent sagging of the dipper dumping line **35**. During normal operation of the shovel there is no movement of the portion of the line or cable **35** between the guide sheave or pulley **36** and the control drum **66**, it being understood that the variations in length of the line resulting from operation of the dipper stick are accommodated by the rotation of the compensating drum **34**. Now when it becomes necessary to draw or jerk on the cable **35** to release the latch that holds the dipper door **12**, the operator can either pull directly on the line **35** or, if desired, he can actuate the arm or lever **75** by means of the cable **83**. In the event that the latter procedure is followed, the movement of the arm **75** compresses the spring **78**, thereby increasing the force exerted on the band **71**. The increased braking force thus applied to the drum **70** tends to retard the movement of the ring gear **54**, which increases the torque on the line control drum **66**. This increased torque on the drum **66** imparts a jerk or increased tension in the line **35** which is operative to release the dipper door control latch.

The guide sheave or pulley **36** on the rack shaft **18** prevents up and down movement and sagging of the control cable **35** during raising and lowering of the dipper or bucket **11** by means of the cable **26**. Thus, the use of the guide sheave **36** prevents constant reeling in and paying out of the portion of the line **35** between the dipper rack shaft **18** and the carriage **1** of the excavator.

When it is desired to use the line control device shown in Figs. 5 and 6 for swinging a clam shell bucket or operating a drag line in accordance with customary practice in excavating work, the line **35** may be disconnected from the compensating drum **34** and suitably trained over sheaves (not shown) and connected to the desired excavating devices. In such case the control device of the present invention is used to reel in and pay out the line **35**, the reeling in being accomplished by actuation of the lever **75** which compresses the spring **78** to increase the braking force on the drum **70** and thereby increase the torque on the line drum or reel **66**. The adjusting lock nuts **80** are set so that the normal braking force on the drum **70** is sufficient to create a torque on the drum **66** through the planetary gear train sufficient to reel in slack in the line **35** but insufficient to prevent the line **2** from being drawn out in the normal swinging of the clam shell bucket or paying out of the tag line.

The casing **40** completely encloses the planetary gear train and the brake drum **70**, together with their associated parts, so that if desired the chamber **50** may be partially filled with a lubricating grease or oil (not indicated) which maintains the driving parts of the line control device lubricated at all times. Thus, the brake drum **70** and brake band **71** may be made to run in an oil bath so that the operating characteristics can be improved and excessive heat and wear of the parts avoided. Furthermore, since by locking the brake drum **70** upon the application of sufficient force through the spring **78**, the line control drum can be made to operate at twice the speed of the constantly rotating shaft **39**, the apparatus of the present invention can be conveniently used with drive mechanisms having shafts that operate at relatively low speeds.

The principles of the present invention may be utilized in various ways, numerous modifications and alterations being contemplated, substitution of parts and changes in construction being resorted to as desired, it being understood that the embodiments shown in the drawings and described above are given merely for purposes of explanation and illustration without intending to limit the scope of the claims to the specific details disclosed.

What I claim is:

1. In line retrieving apparatus including a line drum, the combination with a rotating shaft of a planetary gear mounted on and actuated thereby for orbital movement about the rotational axis of the shaft, ring gears engaging the planetary gear and means rotatably mounting said ring gears, one of said ring gears having driving connection with said line drum and another of said ring gears having brake means associated therewith for retarding its rotation, and means operable to apply said brake means.

2. In line retrieving apparatus including a line drum, the combination with a rotating shaft of a planetary gear mounted on and actuated thereby for orbital movement about the rotational axis of the shaft, ring gears engaging the planetary gear and means rotatably mounting said ring gears, one of said ring gears having driving connection with said line drum, a brake drum, means establishing a driving connection between said brake drum and another of said ring gears, and friction means having variable frictional engagement with said brake drum whereby a torque can be imposed on the line drum approximately proportional to the frictional engagement between the brake drum and the friction means for recovering and paying out a line under a substantially constant tension.

3. In combination dipper dumping trip line and tag line winder apparatus, a line drum and

a brake drum, gear means including a planetary gear operatively connecting the drums, a constantly rotating shaft having connection with the gear means, friction means for engaging the brake drum, said connecting gear means being arranged so that the retrieving torque on the line drum varies directly with the frictional engagement between the brake drum and the friction means, resilient means for yieldingly holding the friction means in engagement with the brake drum to thereby create a substantially constant and uniform torque on the line drum for taking in the slack of a dipper dumping line and yieldingly paying out such line, and lever means for optionally and momentarily increasing the friction between the friction means and the brake drum to create a temporary increased torque on the line drum for jerking a dipper dumping line or reeling in a tag line.

4. A line controlling device comprising a housing structure having shaft means journaled therein for connection with a constantly rotating drive shaft, a line drum and a brake member rotatably mounted on the shaft means in the housing, planetary gear means mounted on the shaft means and having connection therewith for rotation in an orbital path about the rotational axis of the shaft means, ring gear means having connection with said line drum and said brake member and with the planetary gear means, and friction means in the housing and having means extending externally thereof operative to cause the friction means to engage the brake member and thereby retard rotation of the brake member on the shaft means.

5. A line controlling device comprising a housing structure having shaft means journaled therein for connection with a constantly rotating drive shaft, a line drum and a brake member rotatably mounted on the shaft means in the housing, planetary gear means mounted on the shaft means between the drum and said member and having connection with the shaft means for rotation in an orbital path about the rotational axis of the shaft means, ring gears having driving connection with said planetary gear means and secured to the drum and said member, and friction means and actuating means therefor to cause the friction means to engage the brake member.

6. A line controlling device comprising a housing structure having shaft means journaled therein for connection with a constantly rotating drive shaft, a line drum and a brake member rotatably mounted on the shaft means in the housing, planetary gear means mounted on the shaft means between the drum and said member, a first ring gear having a driving connection with said planetary gear means and secured to the drum, a second ring gear having a driving connection with said planetary gear means and secured to the brake member, stationary partition means in the housing and rigidly secured thereto, said partition means embracing the shaft means between said drum and the first ring gear to divide the housing interiorly into a drum chamber and a gear chamber, and friction means for engaging the brake member.

7. A dipper dumping line arrangement in a power shovel construction having a cab with a boom extending therefrom and a stick on the boom with a dipper on the stick comprising a sheave having connection with the dipper for dumping the same, shaft means on the boom having connection with the stick for projecting and retracting the latter, a drum secured on said shaft means for rotation therewith, a single continuous line secured to said drum and extending to and around said sheave and thence to the cab, said drum being of such size that the rotation thereof during the projecting and retracting of the stick pays out and reels in a length of line substantially twice the corresponding movement of the stick whereby a substantially uniform tension is maintained in the line for all positions of the stick relative to the boom, and means having connection with the cab end of the line for jerking the same to cause dumping of the dipper.

8. In a power shovel having a cab with a movable boom extending therefrom and a stick on the boom, means for projecting and retracting the stick relative to the boom including a rotatable shaft, a dipper on one end of the stick having a dump door, a movable sheave on the stick having connection with the dipper for releasing the door thereof, a drum on said shaft and rotatable therewith, a single continuous line having one end secured to said drum and extending therefrom to and around said sheave, thence to the cab, said drum being of such size that the rotation thereof incident to rotation of the shaft in projecting and retracting the stick pays out and reels in an amount of line corresponding in length to the movement of the stick whereby a substantially uniform tension is maintained in the line, means on the cab having connection with the other end of the line and adjustable to vary the tension therein, and means associated with said last named means for jerking the line to effect door releasing movement of said sheave.

9. In a power shovel having a cab with a movable boom extending therefrom and a stick on the boom, means for projecting and retracting the stick relative to the boom including a rotatable shaft, a dipper on one end of the stick having a dump door, a movable sheave on the stick having connection with the dipper for releasing the door thereof, a drum on said shaft and rotatable therewith, a single continuous line having one end secured to said drum and extending therefrom to and around said sheave, thence to the cab, said drum being of such size that the rotation thereof incident to rotation of the shaft in projecting and retracting the stick pays out and reels in an amount of line corresponidng in length to the movement of the stick whereby a substantially uniform tension is maintained in the line, means on the boom in adjacence to said drum for guiding the portion of the line extending to the cab, and means on the cab for jerking the line to effect door releasing movement of the sheave.

10. A unitary line control device for an excavating machine comprising a stationary housing providing a substantially enclosed chamber and having means for facile attachment thereof to the supporting structure of a machine in mounting the device on the latter, a shaft journaled in the housing, a planetary gear system disposed in the housing chamber for rotation about the axis of the shaft, a line drum carried by the housing externally of the chamber and mounted for rotation about said axis, means connecting the drum to one of the gears of said system, means connecting the shaft to another of the gears of said system, brake means having connection with still another of the gears of said system and actuable to vary the torque transmitted from the shaft to the drum through the

system, and said shaft being constructed and arranged for facile connection and disconnection thereof to a driving shaft of a machine in attaching and demounting the device.

11. A unitary line control device for an excavating machine comprising a stationary housing providing a substantially enclosed chamber and having means for facile attachment thereof to the supporting structure of a machine in mounting the device on the latter, a shaft and an embracing sleeve therefor extending through one end of the housing and into said chamber, said shaft being constructed and arranged for facile connection thereof to a driving shaft of a machine in attaching the device, a planetary gear system disposed in the housing chamber for rotation about the axis of the shaft, a line drum mounted on the sleeve externally of the chamber and means connecting the drum to one of the gears of said system, means connecting the shaft to another of the gears of said system, brake means in the chamber and having connection with still another of the gears of said system and actuable to vary the torque transmitted from the shaft to the drum through the system, and means extending through the housing and operable to actuate the brake means.

12. A unitary line control device for an excavating machine comprising a pair of casings disposed in end to end relation and including a partition secured to one of the casings and separating the interiors of the casings, a shaft journaled in the partition, a line drum carried by the shaft and disposed in one of the casings and a planetary gear system disposed in the other casing, said drum being rotatable on the shaft and being connected to one of the gears of the system for actuation thereby, means connecting another gear of the system to the shaft, brake means connected to still another gear of the system, and means for operating the brake to vary the torque transmitted from the shaft to the drum through said system.

13. A unitary line control device for an excavating machine comprising a pair of casings disposed in end to end relation and including a partition secured to one of the casings and separating the interiors of the casings, a shaft journaled in the partition, a line drum carried by the shaft and disposed in one of the casings and a planetary gear system disposed in the other casing, said drum being rotatable on the shaft and being connected to one of the gears of the system for actuation thereby, means connecting another gear of the system to the shaft, stub shaft means journaled in said other casing and aligned with said first mentioned shaft, brake means carried by the stub shaft means and connected to still another gear of the system, and means for operating the brake to vary the torque transmitted from the shaft to the drum through said system.

14. A unitary line control device for an excavating machine comprising a pair of casings disposmed in end to end relation and including a partition secured to one of the casings and separating the interiors of the casings, a shaft journaled in the partition, a line drum carried by the shaft and disposed in one of the casings and a planetary gear system disposed in the other casing, said drum being rotatable on the shaft and being connected to one of the gears of the system for actuation thereby, means connecting another gear of the system to the shaft, stub shaft means journaled in said other casing and aligned with said first mentioned shaft, a rotatable brake drum carried by the stub shaft means and disposed in said other casing, means connecting said brake drum to still another gear of the system, friction means for engaging said brake drum, and means extending out of said other casing and actuable to apply the friction means to the brake drum for varying the torque transmitted from the first mentioned shaft to the line drum through the planetary gear system.

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