Feb. 9, 1960 R. E. SMITH ET AL 2,924,430

AIR HOIST

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Fig. 1

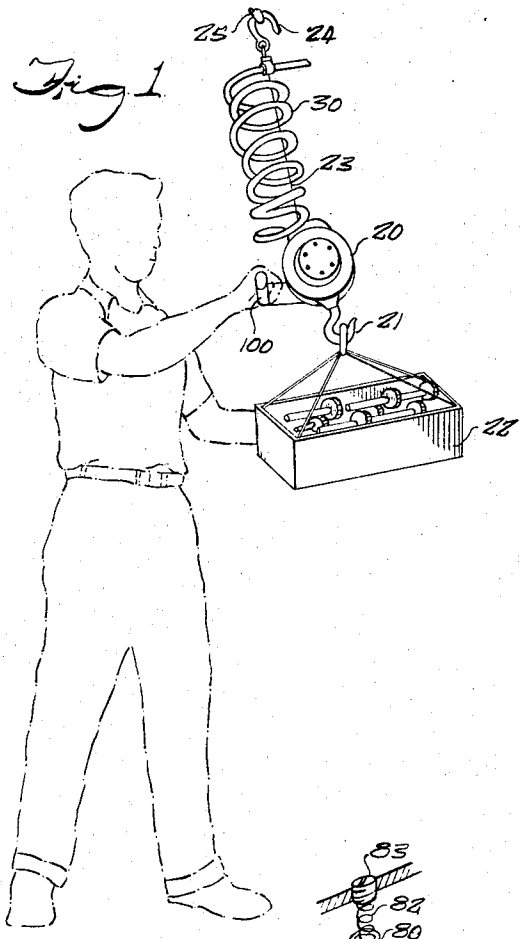
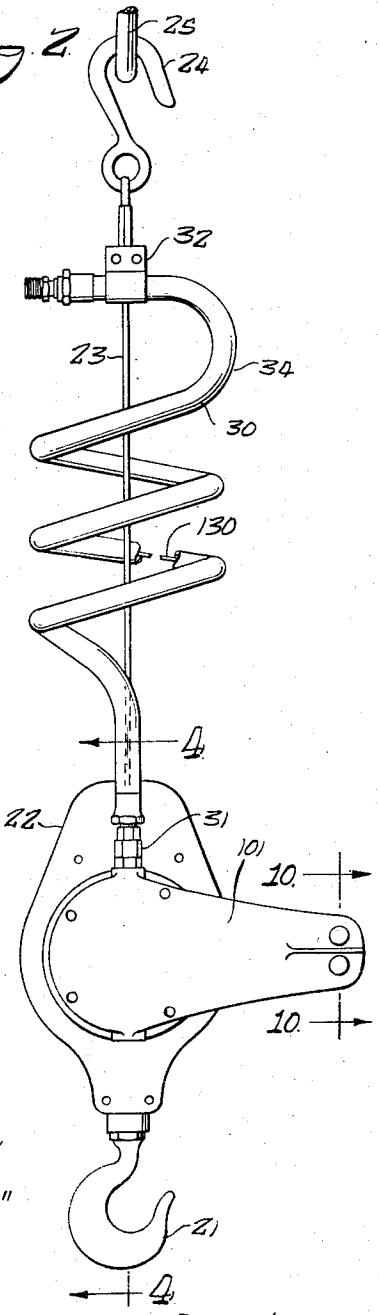


Fig. 2



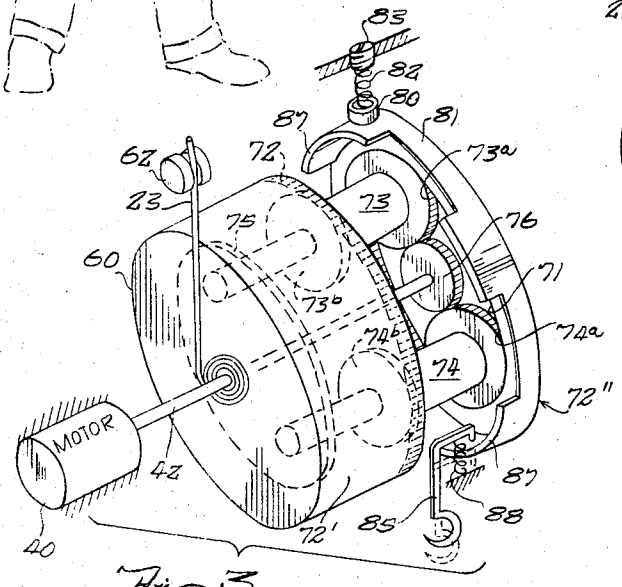


Fig. 3

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AIR HOIST

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Fig. 4

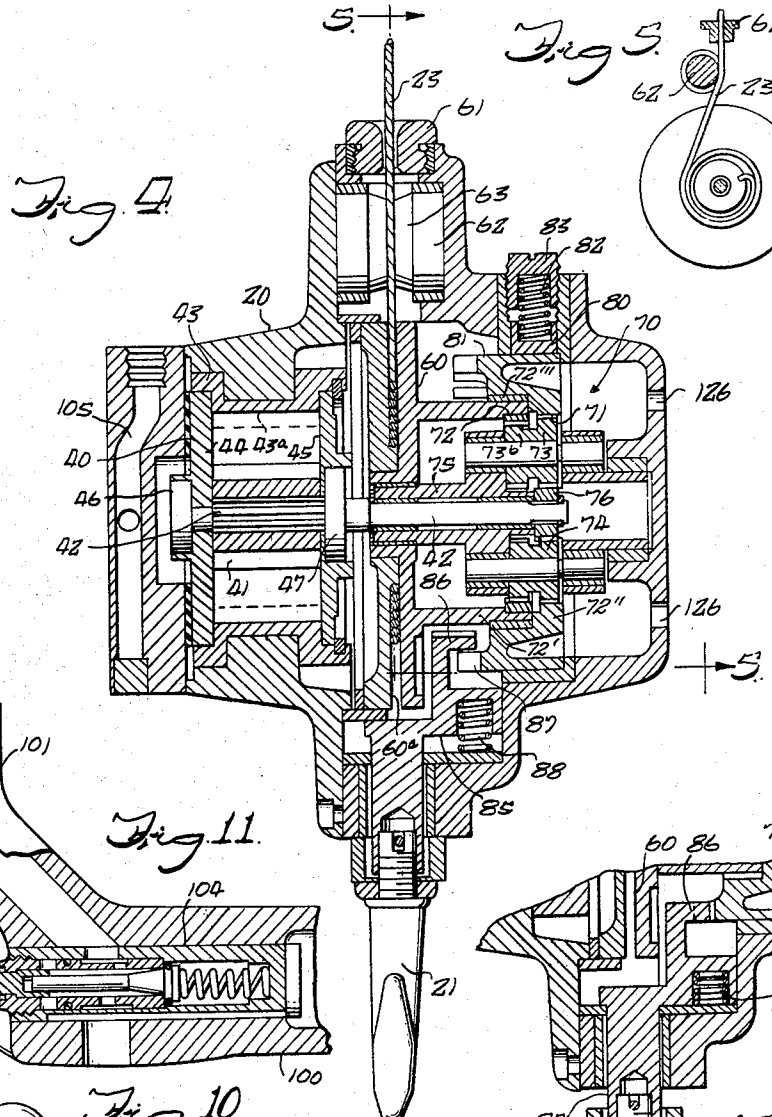


Fig. 5

Fig. 11

Fig. 6

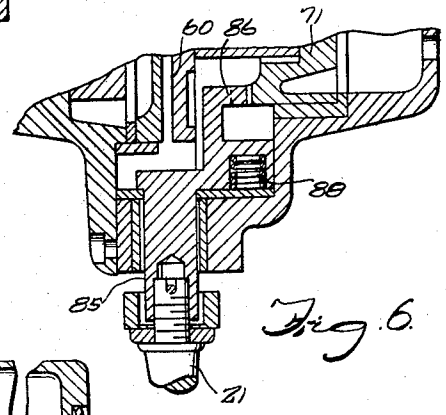
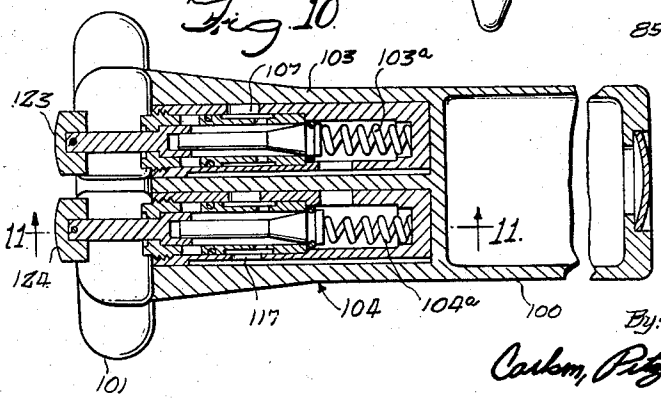


Fig. 10



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AIR HOIST

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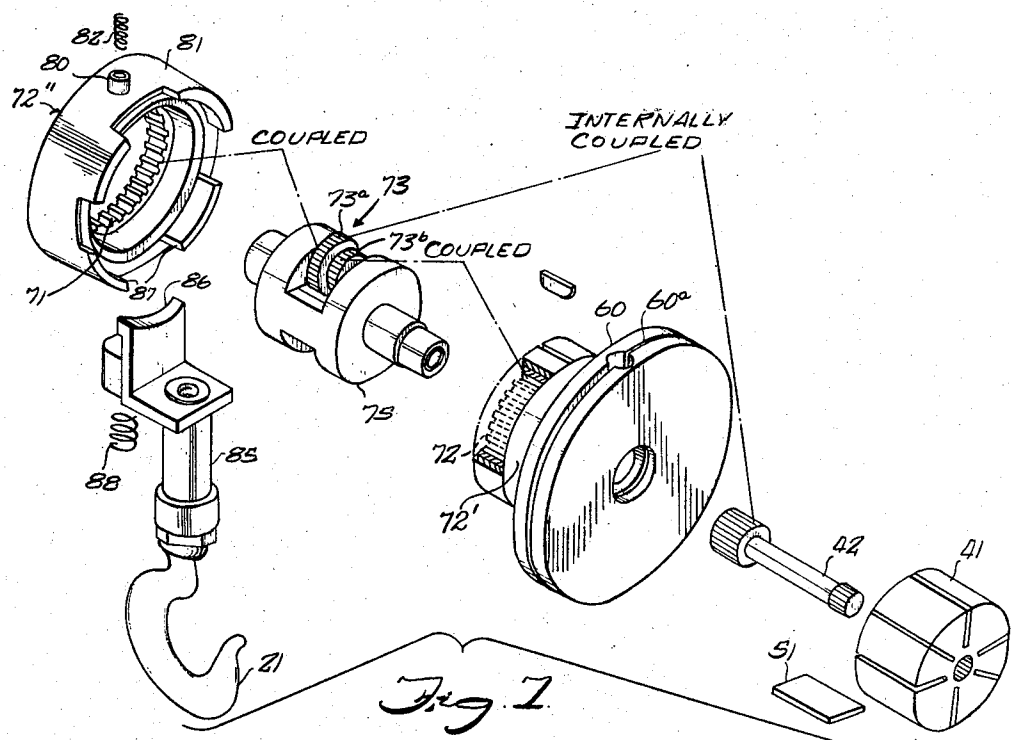


Fig. 1

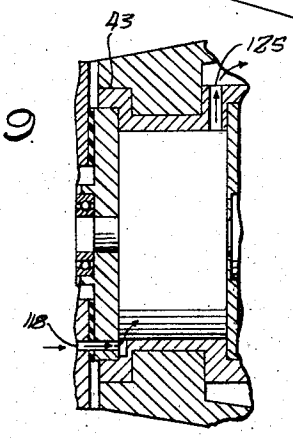
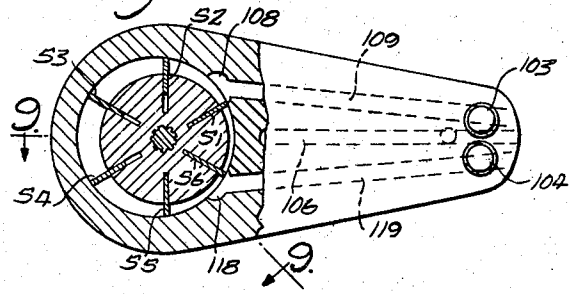


Fig. 9

Fig. 8



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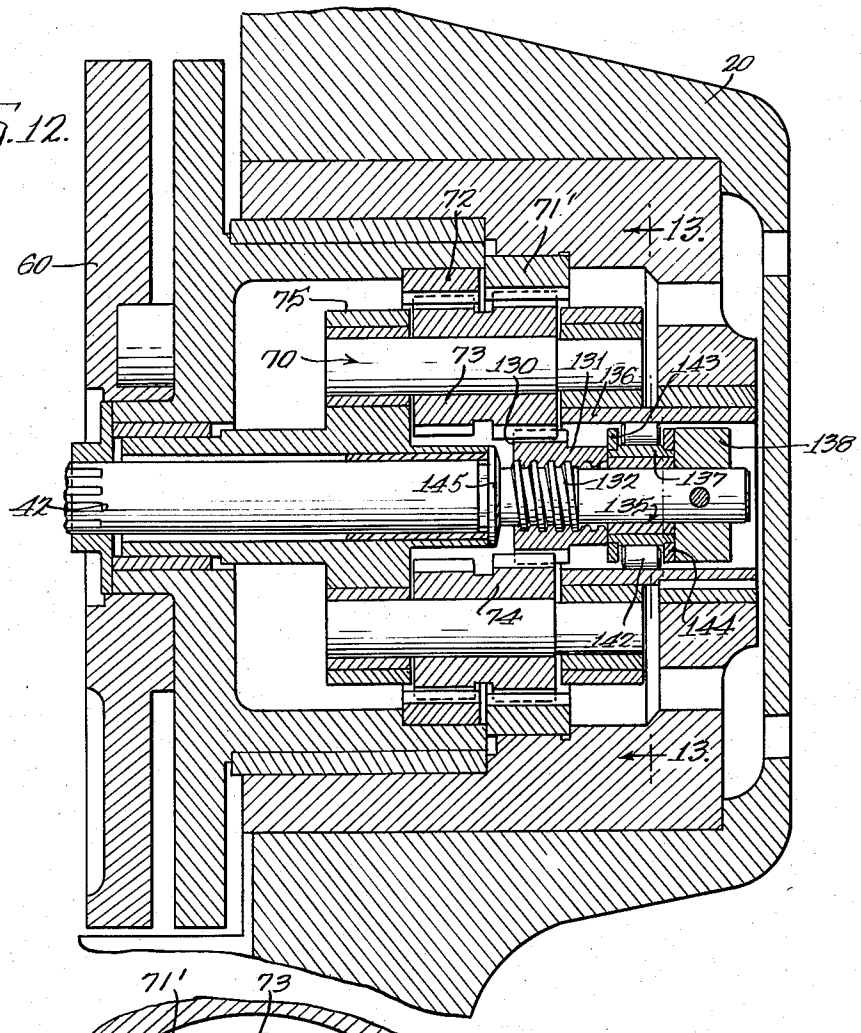
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AIR HOIST

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Fig. 12.



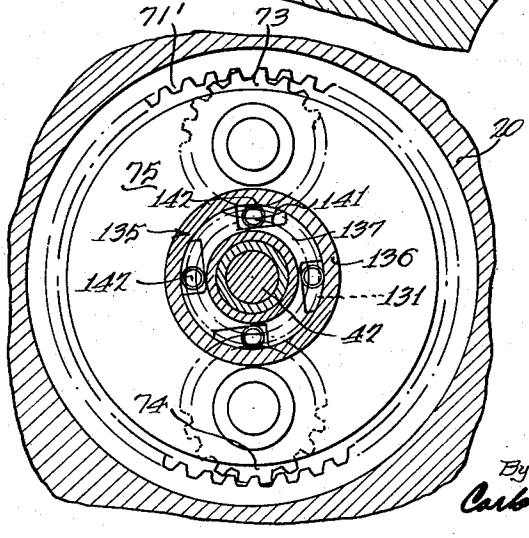


Fig. 13.

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United States Patent Office

2,924,430

Patented Feb. 9, 1960

2,924,430

AIR HOIST

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Application January 24, 1957, Serial No. 636,169

9 Claims. (Cl. 254—168)

This is a continuation-in-part of co-pending application Serial No. 513,126, filed June 3, 1955, of Ralph E. Smith.

The present invention relates to hoists and more particularly to a light-duty hoist as illustrated in the said copending application, with a load brake embodied in the unit.

It is an object of the present invention to provide an improved hoist in which the power unit, together with its associated hook, is suspended at the lower end of a fixedly anchored supporting cable, the hoist being referred to herein for convenience as of the "inverted" type. It is another object of the invention to provide a hoist of the above type which is ideally suited for picking up loads under manual guidance which are relatively small, say, on the order of ten pounds to about two hundred pounds and for enabling such loads to be swung from the point of overhead support laterally through a useful range. It is a related object to provide a hoist in which the load may be easily controlled in its vertical movement and guided horizontally for accurate placement as required in the lifting of work pieces from the floor or platform to a position on a bench or a machine. It is still another object to provide a hoist which enables one hand to be used both for guiding and for determining direction and rate of lifting or lowering, the other hand being free to control other parts or machinery.

It is a further object to provide a hoist which is especially useful for repetitious operations involving the picking up and putting down of loads formerly requiring the services of a husky workman. It is a related object to provide a hoist which enables women to take care of production jobs formerly requiring men and which enables either a man or woman to work more comfortably and without fatigue.

It is a still further object to provide a hoist which may be drawn downwardly by application of light manual pressure for hooking on to a load and which makes use of the natural bending and lifting motion of the body without, however, requiring the normal lifting effort, permitting the operator to follow his natural impulse to reach down quickly to pick up a work piece. It is an object to provide a manually manipulated hoist of the inverted type, i.e., having a combined hook and power unit, which may be drawn downwardly without applying motive power and with an easy free-wheeling action simulating a condition of perfect counterbalance.

It is an important object of the present invention to provide an inverted hoist which may free-wheel downwardly into a load engaging position but which causes positive lifting of the load simply by pressing the "raise" control button and without any intentional clutching or engaging action on the part of the operator. It is another object to provide an inverted hoist in which power engagement is not only automatic but direct and positive, insuring against reversion to the free-wheeling condition or dropping of load. For this and other reasons which will be apparent as the discussion proceeds it is an object of the

invention to provide a hoist which is safe and foolproof in operation and which may be manipulated safely by an operator without training or skill. It is yet another object of the invention, related to the foregoing, to provide a hoist in which the cable remains taut at all times and under all conditions thereby avoiding the difficulties of snarling which so frequently accompany use of a cable-type hoist by inexperienced hands.

It is furthermore an object to provide a hoist which is light and compact and which is sufficiently inexpensive as to justify use by a single operator at a single working position at a bench, machine, or station in a production line. It is an object to provide a hoist of the above type which makes use of an efficient high-speed motor and in which speed reduction to normal and safe lifting speeds is brought about by a novel arrangement of speed reducing elements having a minimum number of parts. It is an object to provide a hoist which is not only rapid and efficient in operation but which is easy to install, requiring no overhead tracks or the like, and which may be easily and quickly transferred or removed for bench work when servicing becomes necessary.

It is another object of the invention to provide a hoist having a load brake operative to sustain the load when the motor is "off," or when the load exceeds the power available from the motor when the motor is "on." A related object is to provide load brake means for preventing the load from overrunning the motor, for example, during the operation of lowering a load with the hoist. More specifically, it is an object of the invention to provide a load brake particularly suited for an inverted type hoist, employing a reaction principle for preventing slip of the hoist under load.

In one of its aspects, it is an object of the invention to provide a hoist particularly suited for powering by a compressed air motor and in which the airline is constructed and arranged to follow the power unit of the hoist while remaining in an out-of-the-way position free of damage or entanglement with nearby objects. In this connection it is also an object to provide an air-operated hoist which requires little or no maintenance and in which all the parts are arranged for effective lubrication by oil in the exhaust air and in which the noise level is substantially lower than that normally associated with hoists of the air-driven type.

It is an object of the present invention to provide an improved hoist of the inverted type which remains in balance under all conditions and regardless of the amount of cable which has been payed out.

Other objects and advantages of the invention will become apparent upon reference to the attached detailed description and upon studying the drawings, in which:

Figure 1 is a general view of a hoist constructed in accordance with the present invention and showing the manner in which the hoist and load are manipulated in use.

Fig. 2 is an elevation of the hoist of Figure 1 together with its associated cable and conduit.

Fig. 3 is a diagram, partially schematic, for facilitating understanding of the internal mechanism.

Fig. 4 is a vertical section taken along the line 4—4 in Fig. 2.

Fig. 6 is a fragmentary view showing the position of the hook and associated latch when a load is applied.

Fig. 7 is an exploded perspective of the main elements in the reel driving mechanism.

Fig. 8 is a fragmentary view, partially schematic, of the motor and air supply conduits.

Fig. 9 is a section taken through the motor along the line 9—9 in Fig. 8, showing the motor inlet and exhaust passages.

Fig. 10 is a section taken through the handle along the line 10—10 in Fig. 2, showing the details of the valve construction.

Fig. 11 is a fragmentary view of the handle taken along the line 11—11 in Fig. 10.

Fig. 12 is a vertical section like that of Fig. 4 showing an alternative means for driving the hoist reel and embodying a load brake; and

Fig. 13 is a fragmentary section showing details of the load brake.

While the invention has been discussed in connection with the preferred embodiment, it will be understood we do not intend to limit the invention thereto but intend to cover all alternative constructions falling within the spirit and scope of the appended claims.

Turning to the drawings and particularly Figs. 1 and 2, there is shown a hoist constructed in accordance with the present invention having a body 20. Arranged at the bottom of the hoist body is a hook 21 for supporting a load 22. Extending upwardly from the hoist body and in line with the hook 21 is a supporting cable 23 having a hook 24 for engagement with a fixed overhead support 25. For the purpose of supplying power to the hoist body 20 a conduit 30 is provided encircling the cable 23. In the present instance the conduit is in the form of an air hose coupled to the hoist body at its lower end by a suitable fitting 31 and anchored to the upper end of the cable by a clamp or the like 32. Air is fed into the conduit 30 from any suitable high pressure source which preferably includes means for imparting lubricant to the air stream.

The internal mechanism of the hoist is shown in Fig. 4 which is a vertical section in the plane of the motor drive shaft; however, it will be helpful in referring to Fig. 4 to keep in mind Fig. 3 which illustrates the operation diagrammatically and Fig. 7 which shows some of the parts in perspective. Arranged at one side of the hoist body is an air motor 40 having a rotor 41 and shaft 42. The motor is of conventional rotary vane type. For the present, it will suffice to say that it includes a cylinder 43 mounting end plates 44 and 45, which plates carry bearings 46, 47 respectively, supporting the motor shaft 42. The rotor is of the usual slotted construction having blades 51, 56 (Fig. 8), the outer ends of which engage the eccentric inner surface 43*a* of the cylinder 43. More detailed reference will be made at a later point to the means for admitting air to and exhausting air from the motor. It will be understood by one skilled in the art that the air is admitted between the rotor and cylinder at a point where the inter-blade space is a minimum and the pressure, acting differentially on the blades, urges the rotor around to a point where the air is exhausted, the blades acting in concert to rotate the shaft 42 at high speed.

Prior to discussing the speed reduction gearing, reference may be made to the reel 60 on which the cable 23 is wound. In accordance with one of the aspects of the present invention, the reel 60 is of a disk shape having a relatively narrow slot 60*a* just slightly larger than the diameter of the cable so that the cable is wound upon the reel in spiral formation. For the purpose of leading the cable 23 from the hoist body, an annular guide or fair-lead 61 is provided which is substantially centered over the reel 60 as shown in Fig. 4. For maintaining the cable centered in the opposite direction a circular guide or roller 62 is provided having a slot 63, the root of which is aligned with the center of the fair-lead 61. Consequently, the cable tends to be fed into the fair-lead in aligned position regardless of the amount of cable stored on the reel 60.

In accordance with one of the important aspects of the present invention and in the embodiment of the invention the details of which are depicted in Figs. 3–6, a speed-reducing driving train is connected between the motor and the reel having a clutch for enabling free-wheeling of the reel together with means responsive to the presence of a load on the hook for automatically engaging the clutch to permit raising of the load. The invention in this form also contemplates, in association with the above, friction means for inhibiting the paying out of cable when the driving train is in its free-wheeling condition so that the body of the hoist is supported in fixed position on the cable, while permitting the hoist to be drawn quickly downward by light manual effort preparatory to engaging the load. In the present instance, the speed-reducing gearing employed between the motor shaft and the reel 60 is of the differential type and is indicated generally at 70. The gearing includes what may be termed, for convenience, a "fixed" ring gear 71 and a rotatable ring gear 72, the rotatable ring gear being mounted inside an annular sleeve 72′ which is integral with the reel 60 as shown. Such ring gears are arranged side by side with the teeth thereof spanned and in mesh with a pair of planetary or idler pinions 73, 74 mounted in a rotatable cage 75. The motor shaft 42 is centrally arranged within the cage 75 and includes a drive pinion 76 at its outer end for meshing with the idler pinions 73, 74. The annular sleeve 72′ is rotatably mounted within the annular member 72″ which surrounds the sleeve. In the present instance a bushing 72‴ which is held within the annular member, allows the annular sleeve to turn with a minimum of friction and, as shown, the "fixed" ring gear 71 is formed inside the annular member but spaced axially of the bushing.

To bring about the desired high ratio of speed reduction each of the idler pinions consists of two integral portions of unlike diameter arranged side by side, the two portions in the case of the idler pinion 73 being designated at 73*a* and 73*b*, respectively. The pitch diameter of the two ring gears correspondingly differs by a small amount. In a practical case, the pitch diameter of the fixed ring gear 71 may be 2.100 inches while the pitch diameter of the movable ring gear 72 is 2.033 inches. Upon rotation of the motor shaft in a given direction, the movable ring gear will tend to turn very slowly but with high torque in the same direction, provided that the fixed ring gear 71 remains fixed in position relative to the body of the hoist.

For the purpose of applying the controlled frictional drag to the cable under the free-wheeling condition so as to permit paying out of the cable when the hoist body is drawn manually downward, a friction drag is applied to the annular member 72″ and thus to the fixed ring gear 71. In the present instance, a friction shoe 80 is used, received in the wall of the hoist body as shown in Fig. 4 and riding on the periphery 81 of the annular member 72″. To adjust the amount of friction a coil spring 82 is provided having an adjusting screw 83. Since the driving train is non-reversible, i.e., non-retrograde, drawing the hoist body downwardly against the force of friction is accompanied by bodily rotation of the driving train including the two ring gears 71, 72, the differential cage 75 and rotor 41 of the motor.

In practicing the invention, means are further provided, as stated above, for positively clutching the driving train incident to applying a load to the hook 21. Such clutching means in the present instance includes a locking plunger 85 for locking the annular member 72″ and thus the fixed ring gear 71 in place, the plunger having a lug 86 which registers with spaced teeth 87 projecting from the face of the annular member. As shown in Fig. 4, the locking plunger 85 is mounted for limited vertical movement and is normally urged to the upper or disengaged position by means of a coil spring 88. Since the load hook 21 is secured to the lower end of the locking plunger 85, applying a load to the hook causes the locking member to be drawn downwardly into the position shown in Fig. 6, thereby causing the lug 86 to move into blocking relation with respect to one of the teeth 87 on the annular member. With the ring gear

71 locked in place, the path of power transfer is complete. Thus, rotation of the motor shaft 42 causes planetary rotation of the idler pinions 73, 74 relative to the fixed ring gear 71. And because of the difference in diameter of the two ring gears, the movable ring gear 72 is slowly advanced to reel in or pay out the cable depending upon direction of rotation of the motor.

In analyzing the operation of the driving train, it is helpful to consider it as a differential having an input element in the form of the motor shaft 42, an output element in the form of the movable ring gear 72 and a control element in the form of the annular member 72" and the fixed ring gear 71. When the fixed ring gear is locked in place, the path of power flow is complete and rotation of the motor shaft causes slow positive rotation of the reel. However, if the fixed ring gear 71 were permitted to spin freely, rotation of the motor shaft would simply cause idle rotation of the gearing and no torque would be applied to the reel. The presence of the friction shoe 80 establishes an intermediate condition, i.e, the gearing is locked in place for small values of transmitted torque but yields when a predetermined torque is exceeded. Thus, when no power is applied to the motor 40 and with the gearing stationary, sufficient reaction torque is transmitted to the reel 60 so that the body of the hoist is suspended at a fixed position relative to its supporting cable 23. The friction is adjusted by turning the adjusting screw 83 so that only light manual pressure is required in order to overcome the frictional drag and to move the body of the hoist downwardly relative to the cable for engagement of a load by the hook. Starting the motor to raise the hoist body is accompanied by movement of the lug 86 into locking position between the teeth 87 so that from that point on the fixed ring gear is positively locked in place relative to the body of the hoist. Continued rotation of the motor is thus effective, acting through the reduction gearing, to rotate the reel 60, thus winding up the cable 23 to raise the load. It will be apparent that with the ring gear 71 locked by the presence of the load, it will be impossible to restore the driving train to the unlocked condition until the load is removed from the hook. Such unlocking is generally brought about by reversing the rotation of the motor by the valving to be described below, whereupon the hoist is lowered for depositing of the load on a suitable support.

It is to be particularly noted that locking of the control element (ring gear 71) occurs automatically upon application of the load, thereby "taking over control" from the friction shoe and no intentional locking movement is required on the part of the operator.

It is part of the present invention to provide a novel guiding and valving arrangement thereby permitting the hoist to be completely controlled and positioned, both vertically and horizontally, by one hand of the operator leaving the other hand free to control the load itself or to control associated parts or machinery. In the present instance, the guiding arrangement includes a horizontally arranged handle 100 which is laterally spaced from the body of the hoist, being connected thereto by an integral arm or extension 101, the handle and arm being arranged at approximately right angles to form an elbow 102. Located at one end of the handle, in the present instance at the elbow 102, are air control valves 103, 104. Both of these valves are supplied with compressed air from the helical conduit 30, the air being fed into the body of the hoist through a passage 105 (Fig. 4) which is connected to a passage 106 provided centrally within the arm 101. For rotation of the motor in the "raise" direction the valve 103 has its outlet 107 connected to a motor inlet port 108 via a passage 109. In similar fashion, the valve 104 has its outlet 117 connected to inlet port 118 on the motor via a passage 119. The valves 103, 104 are controlled by buttons 123, 124 (Fig. 10). The specific valve construction does not per se form a part of the present invention. For one skilled in the art it will suffice to say that the valves are so arranged that the amount of air supplied to the motor is dependent upon the degree to which the valve buttons 123, 124 are depressed against the force of return springs 103*a*, 104*a*, respectively. Preferably also, the non-pressurized one of the two inlet ports is vented to provide what is termed in the art "secondary" exhaust.

In carrying out the invention, the primary exhaust from the motor 40 is vented into the body of the hoist through a vent opening 125 (Fig. 9) formed in the motor housing. In view of the turbulence and throttling effect which occurs at the motor, the pressurized exhaust air emitted from the motor into the hoist body contains finely vaporized lubricant which is dispersed throughout the interior of the hoist body, effectively lubricating all of the working parts. The exhaust air also serves to keep the hoist and its working parts cool even where used on a continuous basis, the exhaust air finally escaping through ports 126 (Fig. 4) provided in the side wall. It is found that one important by-product of the present arrangement is that the tortuous path through which the exhaust air must flow acts to muffle the sound of the air escaping from the motor so that the hoist operates much more quietly than conventional air hoists or other conventional air-operated devices.

The advantages of the above construction will be apparent upon considering a typical cycle of operation. The hoist will normally be stored in an upraised position out of the way of the operator but with the handle 100 easily accessible. In order to raise a load, for example, a box of machine parts, from the floor or a pallet, the operator simply grasps the handle, pulling the body 20 of the hoist downwardly as rapidly as desired. This requires only a light force determined by the adjustment of the friction drag 83. This downward, free-wheeling movement is accomplished without applying power to the motor. The operator may follow his natural impulse to reach quickly to the floor to raise the object without the hoist offering any impediment. The "feel" of the hoist under such conditions is just as though the hoist were accurately counterbalanced. The hook is quickly engaged with the load simply by pushing the body of the hoist a small amount laterally. The load may, if desired, be located at a distance of several feet from the point of suspension, the light weight of the hoist making it possible to swing the hoist pendulum-wise into engagement with the load. Following this, the "raise" button 123 is depressed. As we have seen above, this causes the hook to be shifted outwardly relative to the body of the hoist through a short distance and causes automatic engagement of the positive lock permitting transmission of the torque to the reel 60 which proceeds to wind up the cable 23 at a rate which is under the control of the operator. The speed may be easily controlled at the same time that the hand of the operator is guiding the body of the hoist to a position where the load is to be deposited. If necessary, the combined hoist and load may be swung pendulum-wise to the final location, with the free hand of the operator being used to either guide the load on to the position or to operate other parts or mechanisms. The effectiveness of the one hand control is brought out by the fact that the hoist may be efficiently and safely operated even when the operator is disabled and lacks the use of a second hand. After the load has been raised to the desired height, the "lower" button 124 is depressed which allows the load to settle into final position thereby freeing the hook 21.

Having understood the construction and operation, it will be apparent that the hoist remains constantly in a condition of balance, with the hook aligned with the cable at all times and regardless of the amount of cable which remains on the reel, and regardless of the amount

of loading. Nor is there any tendency for the cable to snare as in conventional hoists. The cable, since it is loaded by the weight of the hoist body, keeps taut, but, even in the event of momentary slackening, the turns on the reel maintain the desired spiral relationship for unwinding in orderly fashion.

An alternative form of drive for the hoist illustrated generally in Figs. 1 and 2, and embodying a load brake particularly suited for an inverted type hoist, is shown in Figs. 12 and 13. In general, the source of motive power and drive gearing is the same in this form of the invention as in the form illustrated in detail in Figs.3–9 and described above. Accordingly, employing the same reference numerals where appropriate, in Fig. 12 the pertinent portion of the drive for the hoist is shown incorporating a motor shaft **42** rotatably journalled in the hoist body **20** from which the load would be suspended as by a hook (not shown) in the manner depicted in Figure 1. As described above, this motor shaft turns a reel **60** for receiving a cable by means of a speed reducing drive. While in the form of the invention illustrated above a clutch was embodied for enabling freewheeling of the wheel, in the present instance this provision has been dispensed with. Thus here, the speed-reducing gearing employed between the motor shaft 42 and the reel **60** is of the differential type and is indicated generally at **70**. The gearing includes a rotatable ring gear **72** made integral with the reel **60** and a fixed ring gear **71'** non-rotatably mounted within the hoist body **20**. Such ring gears, moreover, are arrayed side by side with the teeth thereof spanned and in mesh with a pair of planetary or idler pinions **73, 74** mounted in a rotatable cage **75**. As in the above-described form of the invention, these pinions **73, 74** have portions of unlike diameter, with the two ring gears **72, 71'** having pitch diameters correspondingly different by a small amount. Here, to drive the idler pinions, the motor shaft **42** is coaxially arranged within the cage **75** and includes a drive pinion **130** at its outer end. In the present instance, however, the drive pinion **130** is part of an internally threaded spindle **131** which is mounted on a region of the motor shaft **42** having external threads **132** for coupling the shaft and spindle together. During both hoisting and lowering, the motor shaft **42** rotates the drive pinion **130**, which, in turn, being in mesh with the idler pinions **73, 74** rotates the same to turn the rotatable ring gear **72** in the same direction but with high torque. This movement of the ring gear **72** causes the reel **60** to turn, and depending upon the direction of movement, winds or unwinds the cable on the reel.

For the purpose of providing a load brake, to prevent slipping of the hoist due to load, a load-responsive clutch **135** is provided in the gear train, interposed between the motor shaft **42** and a hub **136** on the rotatable idler gear carrier or cage **75**. In the present instance, the clutch the invention employs is a roller type, as shown in Figs. 12 and 13. This clutch is arranged so as to couple the drive shaft and the idler gear cage whenever the hoist slips, so that reaction forces are developed in the gear drive to prevent unwinding movement of the reel. As illustrated, when the load brake functions to sustain the load, the clutch **135** provides a secondary coupling between the motor shaft **42** and the idler gear cage **75**, offering a different gear ratio than is employed in the path of transmission of power to the reel **60** and embodying the drive pinion **130** carried by the motor shaft and the idlers **73, 74** mounted in the idler gear cage. In the present instance when the load brake is effective, the load-responsive clutch **135** is engaged to couple the hub **136** of the idler gear cage **75** and the motor shaft **42**. This coupling offers a unitary gear ratio and as will be observed, the speed reducing drive couples these same members by means of the pinion **130** and the idlers **73, 74** at a predetermined gear ratio greater than 1:1. Accordingly, relative movement between these elements is effectively prevented at the instant of engagement of the clutch, and these elements are jammed at the position then existent. Furthermore, during such engagement, reaction forces are developed in opposite directions in the gear train and independently of any stationary part such as the hoist body, which effect is particularly suited for a load brake in an inverted type hoist for preventing reverse movement of the hoist reel or slip.

Referring specifically to Figs. 12 and 13, the load brake in the form illustrated incorporates a clutch having a roller cage **137** rotatably journalled on the motor drive shaft **42** between a brake flange **138** pinned on the end of the shaft and the threaded spindle **131** carrying the drive pinion **130**. As shown in Fig. 13, the roller cage **137** has on its periphery a plurality of camming slots **141** for rollers **142**, which, when urged into the shallow portions of the slots wedge against the inside of the idler gear cage hub **136** carried by the idler cage **75**. To prevent escape of these rollers, the roller cage **137** has portions of reduced diameter on both sides on which washers **143, 144** may be press fit, covering the ends of the camming slots. As mentioned hereinbefore, the threaded spindle **131** is coupled to the motor shaft **42** by means of its internal threads and the external threads **132** on the shaft, and these cooperating threads are of such hand as to advance the spindle **131** to bring the same into engagement with the clutch **135** during periods of positive drive by the hoist motor to raise a load. For this purpose, the external threads **132** on the motor shaft **42** are of right hand, when viewed from the left in Fig. 12, and the spindle **131** is provided internally with threads of the same hand.

In the operation of the load brake, when operated in the hoisting direction the motor shaft **42** rotates counterclockwise (viewed from the left in Fig. 12) which has the result of moving the threaded spindle **131** to the right with great force against the roller cage **137**. The threaded spindle **131** at the instant is stopped from further advancing movement and is effectively rigid with the shaft. Turning, it transmits motion and power by means of the drive pinion **130** to turn the idlers **73, 74** in the idler cage **75**. Moreover, the spindle **131** forces the roller cage **137** against the brake flange **138** pinned to the shaft, and friction causes the roller cage **137** to rotate with the motor shaft. Accordingly, with the motor shaft **42** rotating counterclockwise to raise the hoist and load, the roller cage **137** turns counterclockwise. Such movement of the roller cage as will be noted from Fig. 13, urges the rollers into the deep portions of the slots, and, consequently, the roller clutch is free-wheeling and disengaged.

Movement of the motor shaft to raise the load rotates the rotatable ring gear **72**, the idler gears **73, 74** and the idler cage **75** in one direction. Upon stopping the motor shaft, the load acting through the reel **60** tends to rotate these parts in the opposite direction. Such slipping movement of the reel **60** due to load occurring after the motor is "off," or in the event the load exceeds the power available from the motor when it is "on," causes the idler gear cage **75** to rotate slightly in a counterclockwise direction as viewed in Fig. 13, relative to the motor shaft **42**. Such movement engages the load-responsive clutch **135** by urging the rollers **142** into the shallow or camming portions of the slots **141** in the periphery of the roller cage, which movement results in the rollers wedging against the inside of the hub **136** on the idler cage **75**. Due to the weight of the load and the load-responsive clutch **135**, the idler gear cage **75** thus is effectively coupled directly to the motor shaft **42** by means of the wedged rollers and roller cage interposed between these elements. In order for the reel **60** to turn and unwind the cable, however, it is necessary that the motor shaft **42** turn. The motor shaft **42**, however, is effectively prevented from turning by virtue of the engaged roller clutch which jams the gear train. Slip

of the reel is translated into reaction forces which oppose in the gear train to prevent further movement.

To lower the hoist the motor shaft **42** is turned clockwise (viewed from the left in Fig. 12). To transmit this motion of the shaft **42** to the idlers **73, 74,** the threaded spindle **131** retracts until stopped by a peripheral flange **145** on the shaft. During such clockwise movement of the shaft, the clutch rollers **142** are maintained in the shallow camming portions of the slots on the roller cage **137** periphery and the roller cage turns with the idler cage **75**. However, since the roller cage is free to turn on the shaft **42** it offers no braking force. But, should the reel **60** overrun the motor due to load during lowering of the hoist, such movement has the effect of turning the drive pinion **130** faster than the shaft **42,** causing the threaded spindle **131** to advance into contact with the roller cage **137**. Since the rollers **142** are then jammed and the roller cage is turning with the idler cage as just above described, friction produced between the threaded spindle **131** and the roller cage **137** prevents such overrunning movement. The load brake thus has the effect of controlling or governing the rate of descent of the hoist, when it bears load, to accord with the rate the drive motor is driven. If, during the course of lowering the hoist, the drive motor is shut off, the load brake prevents further unwinding movement of the reel.

The arrangement described is particularly effective for machine operations and the like requiring the lifting of loads in the range of twenty to one hundred pounds which are conventionally handled by a machine operator, as well as loads somewhat greater than this for which the machine operator would normally have to call for assistance. It is feasible for the first time to install a hoist directly at a machine or work station, reducing operator fatigue and making it possible for women to handle jobs normally requiring the services of a man.

The invention has been described above as embodied in an air hoist, air being let in through the helically arranged conduit or air hose **30**. For the purpose of supporting the air hose with its convolutions spaced uniformly apart, a coiled spring **130** of steel or other suitable metal may be threaded into the hose. Such spring not only supports the hose itself, but may also provide additional counterbalancing for the body of the hoist. It will be apparent to one skilled in the art that a motor may be used which is driven by other motive power without departing from the invention. The conduit **30** may, for example, be an electric conduit supported and reinforced by a coiled spring **130**. In any event the upper end of the conduit is desirably anchored to the upper end of the cable **23**. The complete combination of hoist body, cable and conduit, therefore forms an easy, transportable unit weighing but a few pounds which may be carried from one work station to another simply by unhooking the hook **24**. So arranged, the conduit is out of the way, yet forms a barrier to warn others of the presence of the relatively thin steel cable when the hoist is in its lowered position.

In the following claims the term "hook" has been used for convenience, and it will be understood that it is intended to cover any equivalent load-engaging means. The term cable is also intended to be generic to a flexible tension member of any well-known type.

We claim as our invention:

1. In a hoist having a shaft driven by power actuated means in forward and reverse directions, a reel for receiving a load bearing cable, and a step-down drive means for transmitting power from the shaft to the reel to wind and unwind the cable, said drive means including drive members coupled together for relative movement at predetermined speeds, a load brake for preventing slip of said reel due to load, said load brake comprising in combination, a normally disengaged clutch connected between certain drive members of said drive means and effective, when engaged, to couple said drive members against relative movement at said predetermined speeds, and means for engaging said clutch upon slip of the reel due to load, so that opposing reaction forces develop in the drive means jamming the same to prevent unwinding movement of the reel.

2. In a hoist having a shaft driven by power actuated means, a reel for receiving a load bearing cable and a step-down gear train for transmitting power from the shaft to the reel to rotate the latter and wind and unwind the cable, a load brake for preventing slip of said reel due to load, said load brake comprising in combination, a normally disengaged clutch connected between said shaft and one of the gears of said gear train and coupling the same against relative movement, and means for engaging said clutch upon slip of said reel due to load, for developing opposed reaction forces in the gear train jamming the gears to prevent unwinding movement of the reel.

3. In an inverted hoist having a shaft driven by power actuated means, a reel for receiving a load bearing cable for connection to a fixed overhead support, and a gear train having elements for transmitting power from the shaft to the reel to rotate the latter and wind and unwind the cable, a load brake for preventing slip of said reel due to load, said load brake comprising in combination, a normally disengaged clutch connected between said shaft and one of the elements of said gear train and effective, when engaged, to couple said shaft and said one element against relative movement, and means for engaging said clutch upon slip of said reel due to load, for jamming the gear train to prevent unwinding movement of the reel.

4. In an inverted hoist having a drive shaft driven by power actuated means, a reel for receiving a load bearing cable for connection to a fixed overhead support, and a gear train having drive elements for transmitting power from the shaft to the reel to rotate the latter and wind and unwind the cable, a load brake for preventing slip of said reel due to load, said load brake comprising in combination, a normally disengaged clutch connected between elements of said gear train for coupling said drive shaft to said reel by means of a secondary connection including said clutch offering a different speed ratio than said gear train, and means for engaging said clutch upon slip of said reel due to load, effectively jamming said gear train.

5. In an inverted hoist having a drive shaft operated by power actuated means, a reel for receiving a load bearing cable for connection to a fixed overhead support, and gear power means for transmitting drive from the shaft to the reel to wind and unwind the cable including a drive gear driven by said shaft, an idler gear meshing therewith, and drive elements coupling said idler gear to the reel, a load brake for preventing slip of said reel due load, said load brake comprising in combination, a normally disengaged clutch connected to said drive gear and one of said drive elements in said gear drive means for providing a secondary coupling between said drive and idler gears, and means for engaging said clutch upon slip of said reel, for jamming said drive and idler gears against relative movement to prevent unwinding movement of the reel.

6. In a hoist having a hoist body, a reel rotatably mounted therein and a motor mounted in said hoist body to one side of said reel, said motor having a motor shaft mounted coaxially of the reel and having one end extending to the other side thereof, a step-down drive connection between the said one end of the motor shaft and the reel for rotating said reel, said drive connection comprising in combination, idler gears and a cage for supporting said idler gears with said motor shaft coaxially arranged in said cage, a drive gear for coupling said one end of the shaft to said idler gears for driving the latter, and a load brake for preventing slipping movement of said reel due to load, comprising a clutch actuable upon such movement for connecting said cage and said shaft,

for developing opposing reaction forces in the step-down drive jamming the drive and idler gears against relative movement to prevent unwinding movement of the reel.

7. In a hoist having a hoist body, a reel rotatably mounted therein, and a motor mounted in said hoist body, a step-down drive connection for rotating said reel, said drive connection comprosing in combination, idler gears coupled for moving said reel, a cage for supporting said idler gears, a drive shaft coaxially arranged in said reel, a pinion carried by the drive shaft and meshing with said idler gears, means coupling said pinion and drive shaft, said drive shaft being positively driven by said motor in forward and reverse directions to rotate the reel and raise and lower a load, a load brake for preventing slipping movement of said reel due to load, comprising a clutch for connecting said drive shaft and said cage, and means actuable upon such slipping movement of said reel for engaging said clutch to directly connect said cage and said drive shaft and effectively jam said drive connection to prevent movement of said reel.

8. In a hoist the combination comprising, a hoist body, a reel rotatably mounted therein, a motor mounted in said hoist body, a step-down drive connection providing a primary coupling for rotating said reel, said drive connection comprising a shaft, said shaft being positively driven by said motor in forward and reverse directions, step-down gearing between said shaft and said reel to rotate the same and raise and lower a load, a load brake for preventing slipping movement of said reel due to load, comprising a clutch for connecting elements of said step down gearing, and means actuable upon such slipping movement engage said clutch to provide a secondary coupling offering a different gear ratio from said primary coupling and effectively jam said primary coupling to prevent movement of said reel.

9. In a hoist the combination comprising a hoist body having a hook on the underside of said body for carrying a load, a reel rotatably mounted therein, a cable having one end wound about said reel and having its other end arranged for connection to a fixed overhead support, a motor mounted in said hoist body to one side of said reel and having a step-down drive connection for rotating said reel, said drive connection comprising a fixed ring gear and a movable ring gear of slightly different diameter arranged adjacently and to the other side of said reel in said hoist body, said movable ring gear being coupled to said reel for movement therewith and said fixed ring gear being mounted in the hoist body as a differential member, idler gears spanning said ring gears and having portions of unlike diameters meshing therewith, a cage for supporting said idler gears, a shaft coaxially arranged in said reel and said cage for coupling said motor and said idler gears, and a load brake in said drive connection for preventing slipping movement of said reel due to load, including a clutch actuable upon such movement of said reel, for coupling said cage and said shaft by means of a secondary connection offering a different gear ratio than is employed in said step-down drive, for developing reaction forces in said drive to prevent movement of said reel.

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