Jan. 9, 1945. H. S. MOORE ET AL 2,367,041

POWER OPERATED HOIST

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Fig. 1.

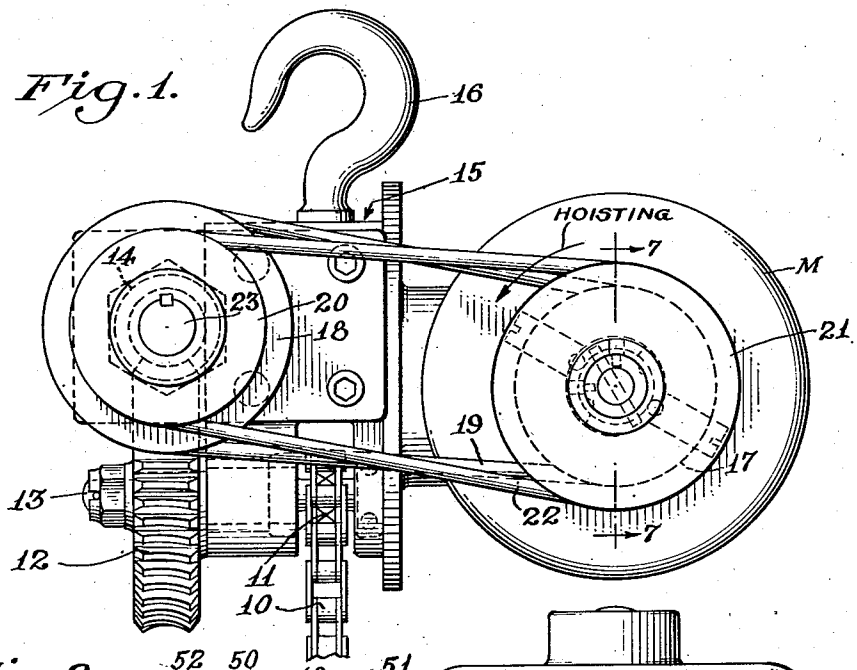
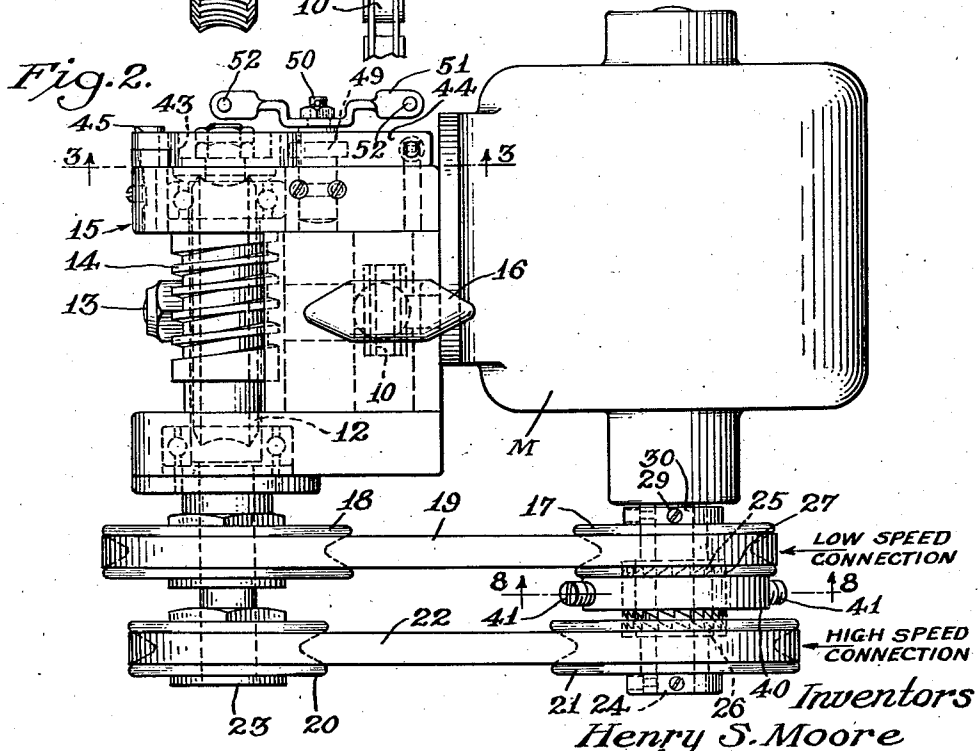


Fig. 2.



Inventors
Henry S. Moore
Francis T. Whelan
BY
Parker, Carlson, Pitzner & Hubbard
Attorneys.

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Fig. 3.

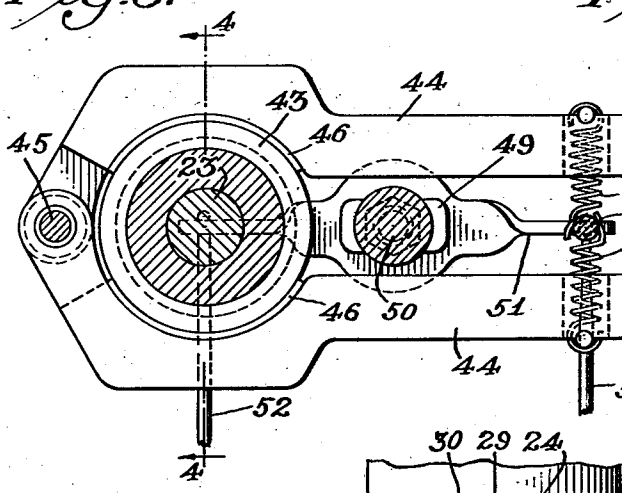


Fig. 4.

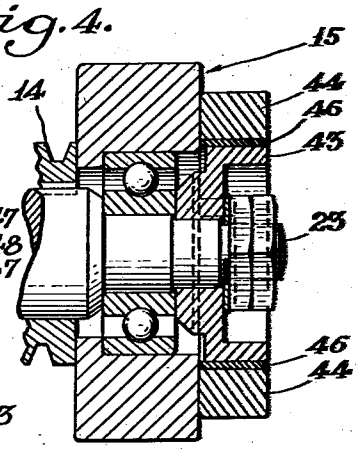


Fig. 5.

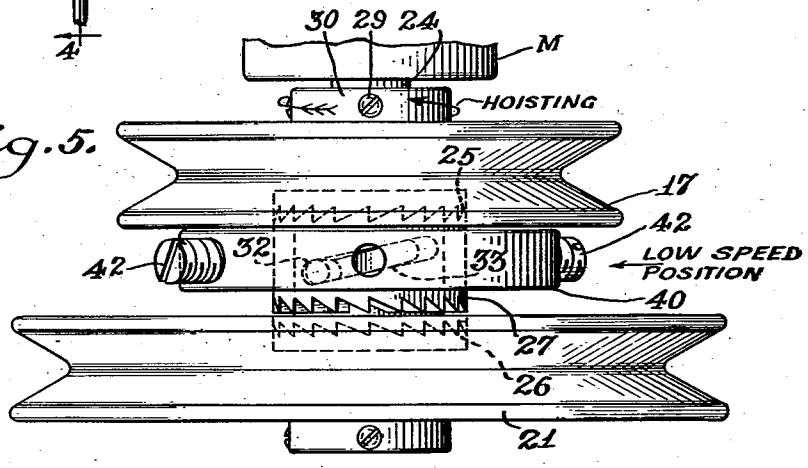
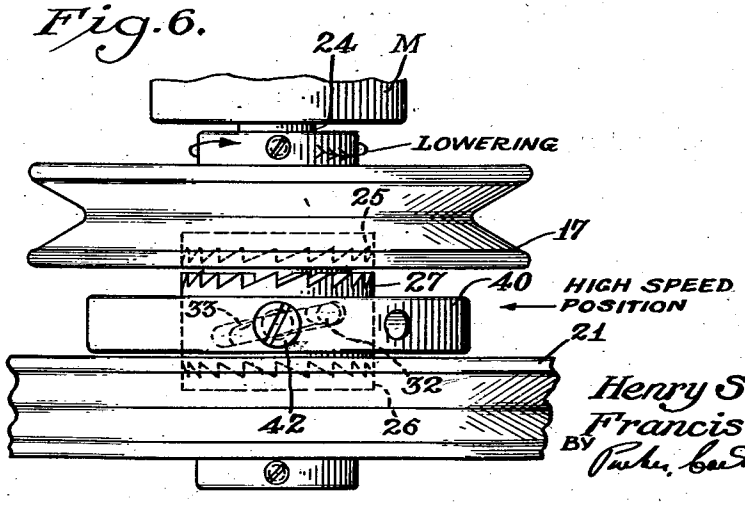


Fig. 6.



Inventors
Henry S. Moore
Francis T. Whelan
BY Parker, Carlson, Fitzgerald & Hubbard
Attorneys.

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POWER OPERATED HOIST

Filed Jan. 19, 1942 3 Sheets-Sheet 3

Fig. 7.

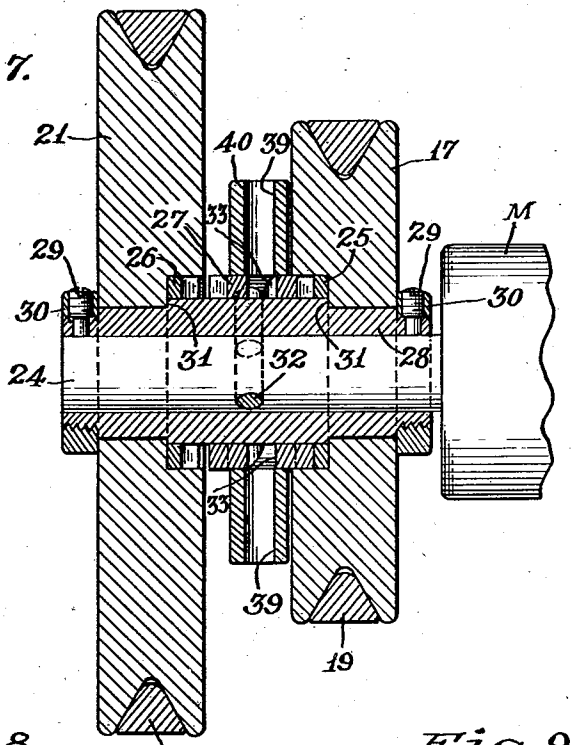


Fig. 8.

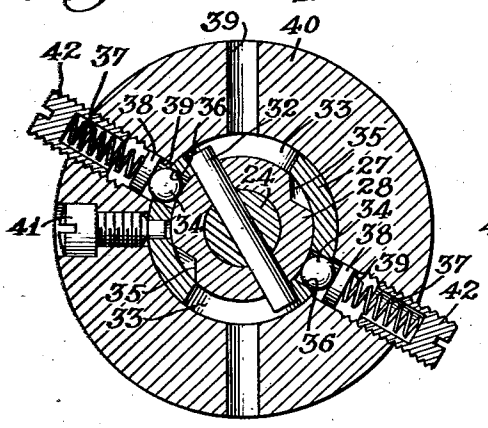
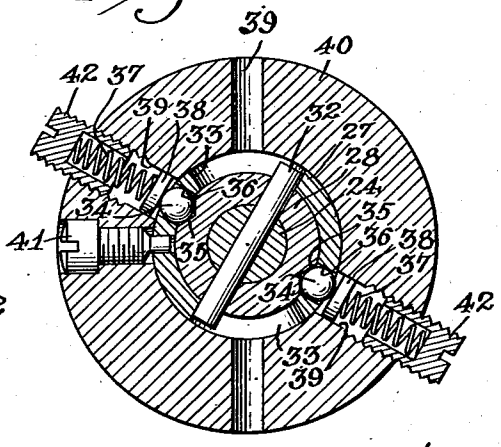


Fig. 9.



Inventors
Henry S. Moore
Francis T. Whelan
By
Parker, Carlson, Pegram & Hall
Attorneys.

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UNITED STATES PATENT OFFICE

2,367,041

POWER OPERATED HOIST

Henry S. Moore and Francis T. Whelan, Bridgeport, Conn., assignors to Manning, Maxwell & Moore, Inc., Muskegon, Mich., a corporation of New Jersey

Application January 19, 1942, Serial No. 427,284

5 Claims. (Cl. 254—168)

The present invention relates to power operated hoists.

One object of the present invention is to provide in a power operated hoist improved means for effecting operation of the same at automatically selected and respectively different speeds in accordance with desired operating conditions. For example, the arrangement may desirably be such as to accomplish low speed hoisting and high speed lowering, whereby the overall operating time for the hoist in handling a load is minimized, although without danger of overloading the hoist drive motor.

Another object is to provide a power operated hoist comprising an automatically operable speed-change mechanism of such character that it is not only automatically set in a high speed position for lowering, but also automatically shifted to a low speed position for hoisting when the load exceeds a predetermined maximum value, hoisting otherwise being effected at high speed.

Still another object is to provide a power-operated hoist as characterized in the immediately preceding statement of object, and in which the automatic speed-changing arrangement is such that once the low speed setting has been effected during hoisting of a heavy load, the setting cannot inadvertently change to high speed even though the effective strain on the hoist line should diminish after the inertia of the load has been overcome in raising the same.

A further object of the invention is to provide a hoist of the general character indicated above, which is rugged in construction and low in cost despite the inclusion therein of an automatic speed-change mechanism.

The invention also resides in a novel organization and combination of the parts by virtue of which it is possible to utilize a low efficiency worm not only as an element of a speed reduction mechanism, but also as a load brake for the hoist, whereby the difficulties attendant upon an attempt to accommodate a conventional load brake for both low and high speed hoist operation are obviated.

Further objects and advantages of the invention will become apparent as the following description proceeds, taken in connection with the accompanying drawings in which:

Figure 1 is a side elevation of a portable electric hoist embodying the invention.

Fig. 2 is a plan view of the hoist shown in Fig. 1.

Fig. 3 is an enlarged sectional view of the motor brake for the hoist, the view being taken substantially along the line 3—3 in Fig. 2.

Fig. 4 is a detail transverse sectional view taken substantially along the line 4—4 in Fig. 3.

Figs. 5 and 6 are enlarged plan views of the speed selector clutch mechanism of the hoist, showing the same engaged, respectively, for hoisting and lowering.

Fig. 7 is a longitudinal sectional view through the speed selector clutch mechanism and associated pulleys.

Fig. 8 is a transverse sectional view through the selector clutch mechanism, taken substantially along the line 8—8 in Fig. 2. In this figure the clutch parts are shown as positioned for low speed operation.

Fig. 9 is a view similar to Fig. 8 but showing the position of the clutch parts when engaged for high speed operation.

While the invention is susceptible of various modifications and alternative constructions, we have shown in the drawings and will herein describe in detail the preferred embodiment, but it is to be understood that we do not thereby intend to limit the invention to the specific form disclosed, but intend to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

For purposes of illustration and exemplification of its various novel features, the invention has been shown herein as embodied in a hoist of the portable type. This hoist comprises a hoist line, in the form of a roller chain 10, led over a revoluble hoisting member or sprocket 11. In accordance with ordinary practice today, one end of the chain 10 may be anchored to the hoist frame and the other end arranged to depend freely from the sprocket with a hook on it for attachment to a load, these details of the chain arrangement not being shown since they are already well known.

A reversible electric motor M serves to drive the sprocket 11. Since the speed of commercially available fractional horsepower motors of the class contemplated is commonly higher than the desirable sprocket speed for the hoist, a speed reduction mechanism is interposed between the motor and sprocket. In the present instance this speed reducer is of the worm type in order that a low efficiency worm may be used in lieu of a load brake for a reason which will appear more fully below. In particular, a worm wheel 12 (Figs. 1 and 2) is fixed to one end of a shaft 13, which has the sprocket 11 fixed on its other

end. Meshing with this worm wheel 12 is a worm 14, the latter being rigid with a shaft 23. The worm shaft 23 and worm wheel shaft 13 are journaled by suitable anti-friction bearings in a frame, designated generally as 15, and to one side of which the motor M is also fixed. This whole assembly may be supported in any suitable manner, as for example by a suspension hook 16 on the upper side of the frame.

In accordance with one aspect of the present invention, a speed-change and torque multiplication mechanism or transmission is interposed between the motor M and the hoisting member or sprocket 11 and is automatically operable in such manner that the speed of the sprocket is controlled in accordance with certain operating conditions in the hoist. For example, the illustrated arrangement is such that the hoist is automatically conditioned for high speed lowering and slow speed hoisting with the further refinement, however, that if the load being hoisted does not exceed a predetermined value, the hoisting of the same will be effected at the same high speed used for lowering.

A two-setting or two-speed speed-change and torque multiplication transmission is, to accomplish the type of operation noted, interposed between the motor M and the worm 14 for completing a connection from motor to sprocket. In the present instance this transmission is of the belted pulley type since the use of flexible belts permits of a maximum tolerance in the relative positioning of the motor shaft and worm, whereby the cost of manufacture is minimized in that respect. Also the belts afford some slight slippage, if any be required, in shifting the setting of the speed-change mechanism, whereby undue strain on the clutch teeth of the speed-change device is avoided. As to the details of the illustrated transmission, it comprises a low speed connection made up of a pair of pulleys 17, 18 joined by an endless flexible belt 19, and a high speed connection made up of a pair of pulleys 20, 21 joined by a second endless flexible belt 22. It will be observed upon reference to Figs. 1 and 2 that the pulley 17 is smaller than the pulley 18 and that the pulley 21 is larger than the pulley 20. Any particular set of speed ratios can, of course, be achieved by suitable ratioing of pulley diameters.

The general plan followed is to connect the motor M to the worm 14 through alternative ones of the speed ratio connections in the speed-change transmission. For this purpose the driven pulleys 18 and 20 are both rigidly connected to the worm shaft 23, while the other pulleys 17 and 21 are loosely journaled on the shaft 24 of the motor M and are arranged to be alternatively coupled to this motor shaft. To effect such alternative coupling of the pulleys 17 and 21 to the motor shaft 24, a selector clutch mechanism is utilized, this clutch mechanism being arranged for automatic actuation in the manner set forth below.

The selector clutch mechanism comprises two driven elements 25, 26 and a driving element 27 (see Figs. 5, 6 and 7). The driven elements 25, 26 are steel collars rigidly fixed in complemental recesses in the opposed hub portions of the respective pulleys 17 and 21, while the driving element 27 is a steel sleeve telescoped over, and shiftable axially with respect to, the motor shaft 24. The mode of assembly of the parts can best be appreciated upon reference to Fig. 7. As there appears, a sleeve 28 is telescoped over the projecting end portion of the motor shaft 24 and rigidly fixed to it by a transverse pin 32 (for the latter pin see also Fig. 8). The sleeve 28 is shouldered, as indicated at 31, and the pulleys 17 and 21 are journaled for free rotation on the respective reduced end portions of the sleeve 28, being restrained against endwise displacement by the shoulders 31 and by nuts 30 threaded on the ends of the sleeve. Dog screws 29 hold the nuts 30 in position without such tightening of the latter as would impair pulley rotation. It will be observed that the driving element or sleeve 27 of the clutch is telescoped over, and slidable endwise upon, the inner sleeve 28.

Various forms of clutch teeth may be used, the preferred arrangement being illustrated herein in Figs. 5 and 6. As there shown, the driving and driven elements of the clutch have mating buttress form teeth. Each of the driven elements 25, 26 presents an annular series of teeth on the side thereof opposed to the driving element, while the driving element or sleeve 27 has two annular series of teeth on its respective opposite ends. The directions of motor shaft rotation for hoisting and lowering are indicated, respectively, in Figs. 5 and 6. Upon reference to the latter figures it will be seen that the leading faces of the driver teeth, which engage the driven element 25 during hoisting, are inclined, while the faces of the driver teeth, which engage the driven element 26 during lowering, are straight. Such shape of the teeth has been found to be desirable, in order to insure positive and accurate operation as pointed out more fully below.

As a means of automatically shifting the clutch driver sleeve 27 axially, the transverse pin 32 is arranged with radially projecting ends received in helical slots 33 in the clutch driven sleeve 27. Thus, when the motor shaft 24 turns in a counterclockwise direction (as viewed from its outboard end) for hoisting (see Fig. 5) the ends of the pin 32 tend to ride along the slots 33 and thus urge the driver sleeve 27 into engagement with the driven clutch member 25 for coupling the pulley 17 to the motor shaft. Similarly, when the motor shaft 24 turns in an opposite or clockwise direction for lowering (see Fig. 6), the ends of the pin 32 tend to ride toward the opposite ends of the slots 32 and thus urge the clutch sleeve 27 into position to engage the driven element 26 for coupling the other pulley 21 to the motor shaft.

It is to be observed that the clutch mechanism described does not have any neutral position and, with the form of actuator disclosed, cannot have. In other words, the operation of the pin and slot actuator 32, 33 depends upon the presence of some resistance to rotation for the driver sleeve 27 for otherwise the slot walls cannot react against the pin to effect shifting of the sleeve. For this reason the sleeve is dimensioned so that the teeth on one end will engage those of the adjacent driven element before the teeth on the other end of the sleeve fully leave those of their adjacent driven element. The tooth shape herein shown accommodates such relation while minimizing danger of jamming or tooth breakage. As to this, note that when the driver 27 shifts into engagement with the driven element 25 it is under-running the same. Consequently, the flat sides of the teeth on the driven element 25 will strike the flat trailing tooth sides of the driver and the driven element will be slowed down to the driver speed of rotation. During this slowing down of

element 25 the other driven element 26 will tend to over-run the driver but in doing so its inclined tooth faces will be pressing against the inclined tooth faces on the driver 27 and thus cam it in the proper direction, namely, toward the driven element 25.

Similarly, when the driver sleeve 27 shifts from engagement with the driven element 25 to engagement with the element 26 it is overrunning the latter. Therefore, the teeth on 26 and 27 will engage on their flat faces to positively engage and speed up the driven element 26. The latter action will also tend to speed up the driven element 25 but that will do no harm even if it still has some slight engagement with driver 27, because the resultant tendency of element 25 to 27 to overrun the latter simply engages their inclined faces in a manner to cam the driver 27 in the proper direction for full engagement with element 26. It will thus be seen that for either case of shift of the driver 27, the driven element which it is leaving tends to cam it over into the full engagement with the other or newly engaged driven element.

As so far described, the clutch actuating mechanism would be such that the low speed connection would always be effected for hoisting and the high speed connection always completed for lowering. When a light load is being lifted, however, it is often desirable to use the high speed connection, rather than the low speed connection, for hoisting. Provision has been made herein to effectuate such operation. In general, the arrangement is such that once the clutch driver 27 has been shifted into its high speed position, during a lowering operation, it is releasably retained in such position until a load exceeding a predetermined maximum is imposed on the hoist during a subsequent hoisting operation. Consequently, if the load which is subsequently raised does not exceed such maximum the hoisting of it will take place at high speed.

The means for releasably retaining the clutch driver 27 in its high speed position (i. e., in engagement with the driven element 26) comprises, in the present instance, spring urged detents in the form of balls 34 (Figs. 8 and 9). Recesses 35 are formed in the periphery of the motor shaft sleeve 28 and positioned so that the balls 34 will enter the same when the clutch driver 27 is in its high speed position. The detent balls 34 are loosely received in holes 36 drilled through the clutch driver sleeve 27. Consequently, when the balls 34 are lodged in the recesses 35, as shown in Fig. 9, they latch the clutch driver sleeve 27 against endwise movement. When, however, the balls 34 ride up out of the recesses 35 (Fig. 8) the sleeve is freed for endwise movement.

The balls 34 are yieldably urged toward engaging position by compression springs 37. These springs press against disks 38, which are slidably mounted in radial bores 39 formed in a collar 40 that encircles the clutch driver sleeve 27 and is secured to it by a dog screw 41. The springs 37 are lodged between the sliding disks or plungers 38 and the heads of hollow studs 42 which are threaded in the bores 39. The studs 42 can be threaded in or out of the bores to adjust the compression of the springs 37, and thus vary the maximum load on the hoist at which the clutch driver sleeve 27 will be released to shift to its low speed hoisting position.

When the motor shaft 24 is turning in a clockwise direction for lowering (see Fig. 6) the clutch driver 27 is shifted into engagement with the high speed connection pulley 21 and the detent balls 34 are thereupon lodged in the recesses 35 (as shown in Fig. 9). If, subsequently, the drive motor M is reversed to effect hoisting of the load, the engagement of the detent balls 34 with the recesses 35 tends to resist axial shifting of the clutch driver sleeve 27 and thus tends to retain the same in its high speed position. On the other hand, the action of the pin 32 on the sleeve 27 tends to shift the same to its opposite or low speed position when the motor shaft 24 is turning counterclockwise for hoisting. Consequently, this latter tendency of the sleeve 27 to shift into its low speed position will prevail only if the load on the hoist is sufficient that the resultant torque on the driver sleeve is great enough to overcome the action of the springs 37 in holding the detent balls 34 engaged with the recesses 35.

It is common in electric hoists of the general class here under consideration to provide both a motor brake and a load brake. In the present instance a more or less conventional motor brake has been provided (see Figs. 2, 3 and 4) but it would be quite a difficult matter to utilize a load brake of any of the ordinary forms because of the high speed lowering which is contemplated in the present hoist. This difficulty as to load brake design has been overcome in the present hoist by utilizing a low efficiency worm 14. In other words, the pitch of the thread for the worm 14 is such that the worm can drive the worm wheel but that the worm wheel cannot turn the worm. In this way the worm type speed reduction gearing itself is utilized to perform the primary function of a load brake, namely, to prevent acceleration of the motor by the load during during lowering (and also to aid in holding a load against descent when the hoist is stopped with the load elevated).

As noted above, the motor brake is of conventional form and, in accordance with usual practice, may be applied either to the motor shaft or one of the speed reduction gearing shafts. In the present instance it is applied to the worm shaft 23 (see Figs. 2, 3 and 4) and comprises a brake drum 43 fixed to such shaft. The brake is of the clasp type and comprises a pair of arms 44, pivoted on the hoist frame 15 at 45, and presenting brake shoes 46 embracing the periphery of the brake drum 43. The arms 44 are normally urged toward each other by tension springs 47 (Fig. 3) anchored at their outer ends to the respective brake arms and at their inner ends to a stationary pin 48.

In order to thrust the brake arms 44 apart and thus release the shoes 46 from the brake drum 43, a rectangular cam 49 with rounded corners is provided between the brake arms. This cam is fixed on the end of a controller rockshaft 50, having an actuator cross-arm 51 rigid therewith. The rockshaft 50 operates a reversing controller for the drive motor M (the controller being of conventional form and hence not shown). Pull cords 52, 53 depend from the opposite ends of the cross-arm 51. The usual centering spring (not shown) of the controller normally holds the rockshaft 50 in its neutral position, and in which position the controller maintains the motor M open-circuited. In such position for the rockshaft, the cam 49 is freed from the brake arms 44 so that the brake is applied and thus holds the rotatable elements of the hoist against turning, while the motor is idle. Pulling on the cords 52 or 53 serves, respectively, to turn the rock-

shaft 50 in opposite directions to shift the controller for connecting the motor for rotation in respectively opposite directions, and in either case turns the cam 49 to release the motor brake.

The operation of the hoist as a whole will be apparent from the foregoing. By way of résumé, however, a typical cycle of operation will be described. In the event that at the end of the last operation the hoist was stopped with the load hook on the chain 10 in its lowered position, the clutch parts will be engaged as shown in Fig. 6 and the controller rock shaft 50 will be in its neutral position shown in Fig. 3 so that the motor is off and the motor brake applied. Under such circumstances the operator attaches a load to the chain 10 and pulls on the cord 52 (Fig. 3). The latter action turns the rockshaft 50 counterclockwise, thereby causing the cam 49 to thrust the arms 44 apart to release the motor brake, and at the same time closes contacts in the controller (not shown) to energize the motor M for rotation in a counterclockwise or hoisting direction (as viewed in Fig. 1).

Rotation of the motor shaft for hoisting causes the transverse pin 32 in it to act on the sides of the helical slots 33 to urge the clutch driver 27 from the position of Fig. 6 to that of Fig. 5. The engagement of the detent balls 34 with the recesses 35 resists such shifting of the driver 27, however, and consequently the clutch parts will remain engaged for high speed operation (Fig. 6) unless the load is of sufficient magnitude that the resultant torque on the pin 32 is great enough to overcome the holding action of the yieldably pressed detents. Therefore, the hoisting will take place at either a high or low speed, depending upon the magnitude of the load.

It is to be observed that if the load is sufficiently great to cause the clutch driver to shift to its low speed position when hoisting starts, the detent balls 34 will not only be disengaged but in addition, when once the balls are freed from the recesses 35, the detent actuator springs 37 have no tendency thereafter to shift the driver 27 back to its high speed position. This is, of course, for the reason that in the mechanism shown the springs 37 act in a direction transverse to the driver sleeve 27 rather than axially of it. By virtue of this arrangement the danger is obviated of an inadvertent shift of the driver 27 from low speed to high speed position during the actual hoisting operation, a shift which might otherwise take place (in the case of a constant bias on the driver 27 toward its high speed position) after the load had been broken away from its rest position and the torque load on the motor thus diminished.

After the load has been raised a desired distance, the operator releases the pull cord 52, whereupon the controller rockshaft 50 is restored to neutral by its centering spring, thus shutting off the motor and applying the motor brake. The motor brake and the low efficiency worm both aid in holding the worm shaft 23 against turning and, hence, in preventing inadvertent gravity descent of the suspended load.

To lower the suspended load, the operator pulls on the cord 53, thereby turning the rockshaft 50 clockwise (Fig. 4). As before, this releases the motor brake, but in this instance the motor is connected for rotation in an opposite or clockwise direction (as viewed in Fig. 1). During the resulting lowering the clutch driver 27 is in its high speed position shown in Fig. 6. If the preceding hoisting operation were made on a light load the driver 27 would already be in such high speed position and even if it were in low speed position during hoisting the coacting pin and slot 32, 33 would immediately shift it to the high speed position as soon as lowering rotation of the motor started.

During the lowering operation the low efficiency worm 14 constitutes a load brake of an advantageous type. That is to say, it prevents the descending load from acting as a driver and overspeeding the motor, since the low efficiency of the worm prevents its being turned by the worm wheel. With a load tending to revolve the worm wheel, however, only a small torque need be exerted on the worm to cause it to turn in the direction in which it is urged by the loaded worm wheel. Therefore the load on the motor M is quite light during lowering, no matter how heavy the load, and it is for this reason that lowering may always be carried out with the high speed connection in use without danger of overloading the motor. In hoisting, on the other hand, the motor has to assume the full load, and since substantially greater power is required for high speed hoisting than for low speed hoisting, the arrangement heretofore described is utilized which automatically compels slow speed hoisting (with maximum torque multiplication in the transmission) except in the case of light loads. It will thus be seen that the herein disclosed hoist is arranged in such manner as to provide for high speed operation whenever it is safe, from a motor load standpoint, but compels slow speed operation when the latter is necessary for motor protection. In this way the overall operating time for the hoist during a series of hoisting and lowering cycles is cut to the minimum compatible with safe motor operation. Moreover, the speed selection is effected entirely automatically so that no dependence in that regard is placed on the skill or judgment of the operator.

At the end of the desired amount of lowering, or at any time for that matter, the hoist is stopped simply by releasing the pull cords so that the rockshaft 50 (Fig. 4) is restored to neutral by its centering spring. As heretofore noted, this shuts off the motor M and applies the motor brake.

What we claim as our invention:

1. A hoist comprising, in combination, a rotatable hoisting member, a reversible power actuated driving means, a speed-change torque multiplication transmission between said power actuated means and said hoisting member, said transmission including an element shiftable alternatively to two different positions for corresponding high and low speed settings of said transmission, means operable automatically in response to rotation of said reversible driving means in a lowering direction and with a load of predetermined magnitude for urging said element to its high speed position and also operable automatically in response to rotation of said driving means in an opposite or hoisting direction for urging said element to its other or low speed position, and means for releasably retaining said element against shifting from its high speed position except in response to a load above said predetermined magnitude while maintaining freedom of movement of said shiftable element to high speed position in response to rotation of driving means in a lowering direction.

2. A hoist comprising, in combination, a rotatable hoisting member, a reversible power actuated driving means, a speed-change torque

multiplication transmission between said power actuated means and said hoisting member, said transmission including an element shiftable alternatively to two different positions for corresponding high and low speed settings of said transmission, means operable automatically in response to rotation of said reversible driving means in a lowering direction for urging said element to its high speed position and also operable automatically in response to rotation of said driving means in an opposite or hoisting direction for urging said element to its other or low speed position, means including a spring-urged detent for releasably retaining said element in its high speed position against the urging of said automatically operable means until the load on said hoisting member reaches a predetermined maximum, and means for adjusting the setting of said spring-urged detent to vary the predetermined value of load at which the same releases to permit shifting of said element to its low speed position under the urging of said automatically operable means.

3. A hoist comprising, in combination, a reversible electric drive motor, means including a revoluble hoisting member rotatable in opposite directions for respectively raising and lowering a load, alternatively available high and low speed drive connections between said motor and hoisting member, shiftable coupling means operable selectively in alternative first and second positions thereof to render respective ones of said connections operative, means actuated in accordance with the direction of rotation of said motor for urging said coupling means to shift to said first position thereof to render said high speed connection operative during rotation of said motor for lowering and for urging said coupling means to shift to said second position thereof to render said low speed connection operative during rotation of said motor for hoisting, and means for yieldably restraining said coupling means from shifting from said first position to said second position thereof during hoisting until the load on said hoisting member exceeds a predetermined value.

4. A hoist comprising, in combination, a hoisting member rotatable in respective opposite directions to raise and lower a load, a reversible electric motor having a rotatable drive shaft, a two-setting speed-change torque multiplication transmission between said motor and hoisting member including high and low speed speed-change elements revolubly journaled on said motor shaft in spaced relation to each other and presenting clutch teeth on their opposed sides, a coupling sleeve telescoped on said shaft for movement axially thereof and having clutch teeth on its opposite ends engageable with the clutch teeth on respective ones of said speed-change elements, said clutch teeth on said coupling sleeve being of buttress form and each tooth having an inclined face and a straight face, the series of teeth on said coupling member presented to said first speed-change element being arranged so that the inclined teeth faces are leading during rotation of the sleeve for hoisting and the other series of teeth on said coupling sleeve being positioned so that the straight faces thereof are leading during rotation of said sleeve in the opposite direction for lowering, the teeth on said speed-change elements being of a shape complemental to the adjacent teeth on said coupling sleeve, and means connecting said sleeve to said shaft and operable in accordance with the direction of rotation of said shaft for urging said sleeve to move axially of the shaft in a direction to engage said high speed speed-change element during rotation of said shaft for lowering and in an opposite axial direction to engage said low speed speed-change element during rotation of said shaft for hoisting.

5. A hoist comprising, in combination, a rotatable hoisting member having a hoist line reeved thereover and operable in respective opposite directions of rotation thereof to raise and lower a load attached to the line, a reversible electric motor having a rotatable drive shaft, a two-setting speed-change torque multiplication transmission between said motor and hoisting member including first and second speed-change elements revolubly journaled on said motor shaft in spaced relation to each other and presenting clutch teeth on their opposed sides, a coupling sleeve telescoped on said shaft for movement axially thereof and having clutch teeth on its opposite ends engageable with the clutch teeth on respective ones of said speed-change elements, means coacting with said shaft urging said sleeve to move axially of the shaft in respective opposite directions corresponding to the direction of shaft rotation to thereby move into position to engage the sleeve teeth with those of a corresponding one of said speed-change elements and thereby to couple the latter to said sleeve, and means including a detent yieldable in a direction radially of the sleeve for holding the latter releasably against shifting movement from high speed position.

HENRY S. MOORE.
FRANCIS T. WHELAN.