Sept. 23, 1924. 1,509,685

R. MOORE

LIMIT DEVICE FOR HOISTING MACHINES

Filed Nov. 29, 1919 7 Sheets-Sheet 1

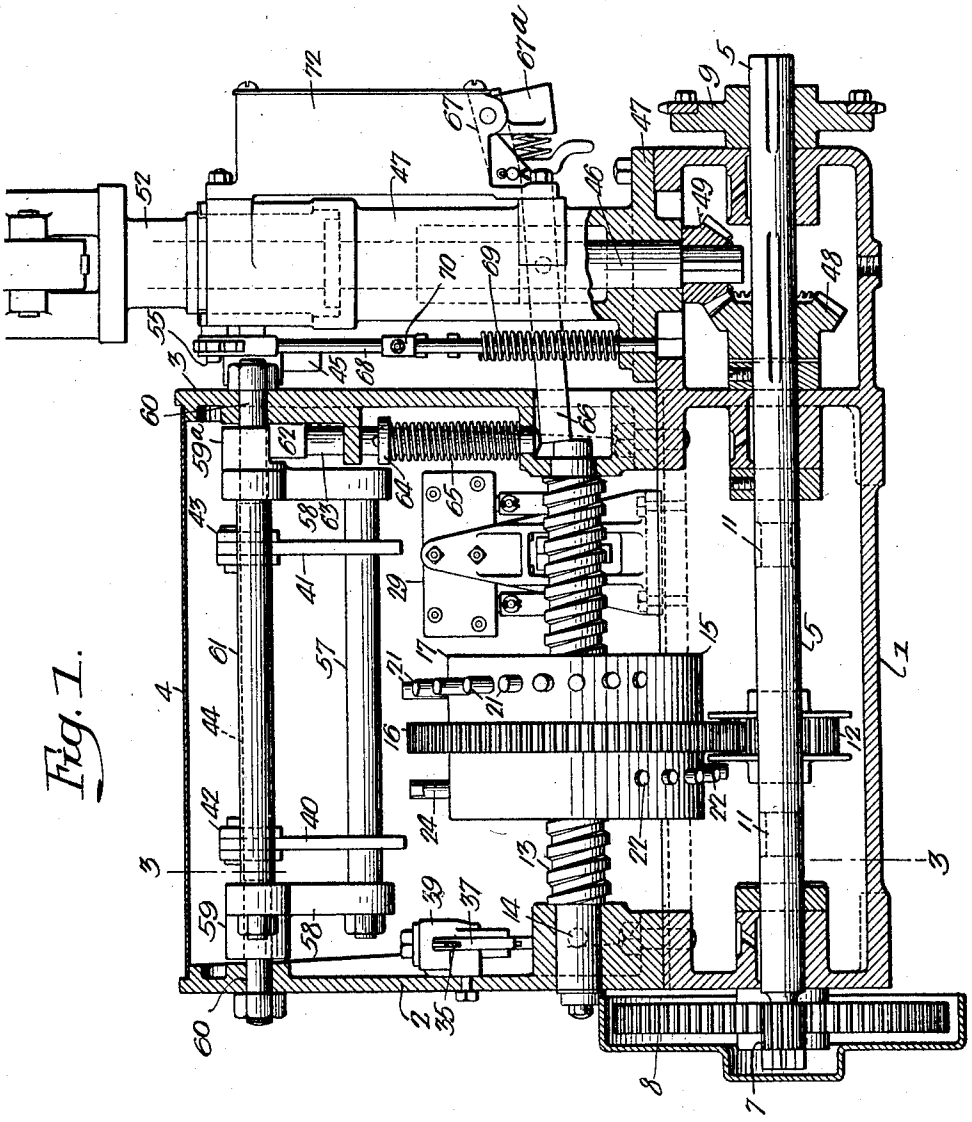


Fig. 1.

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LIMIT DEVICE FOR HOISTING MACHINES

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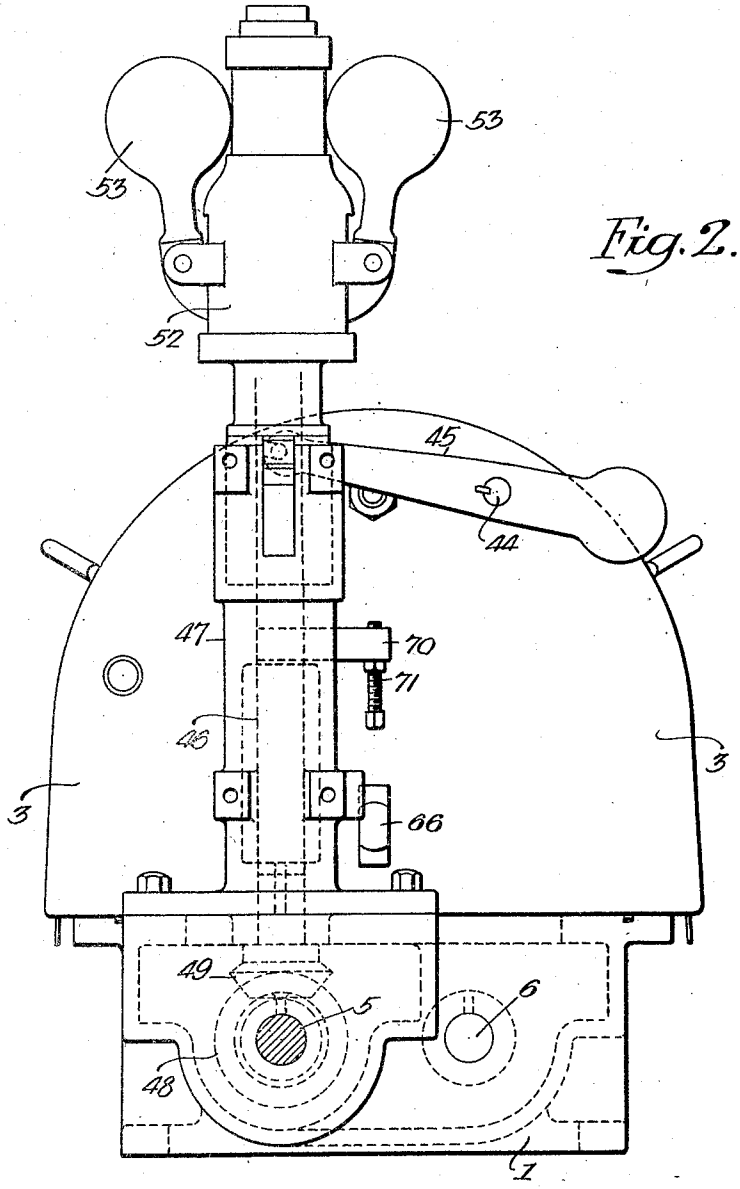


Fig. 2.

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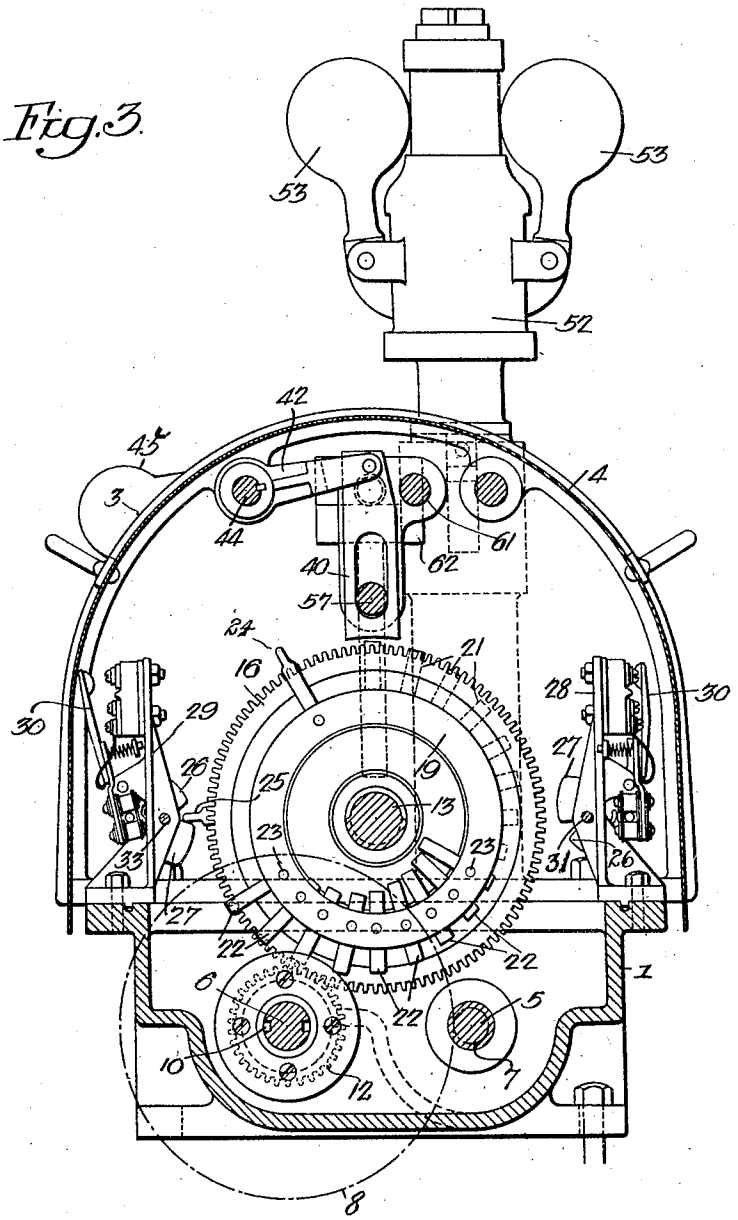
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LIMIT DEVICE FOR HOISTING MACHINES

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Fig. 3.



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LIMIT DEVICE FOR HOISTING MACHINES

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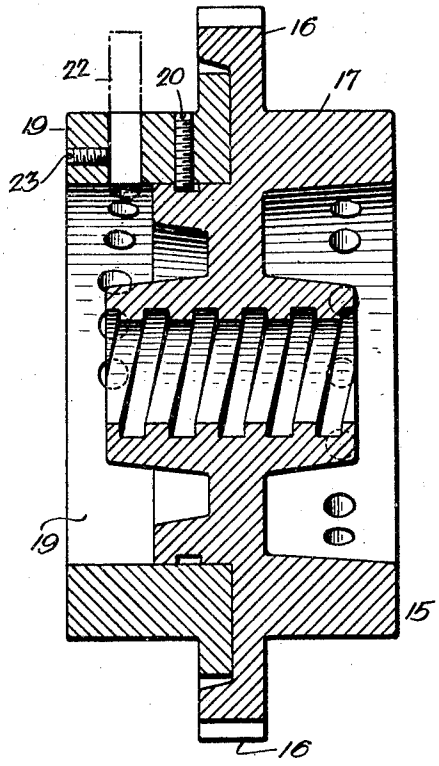
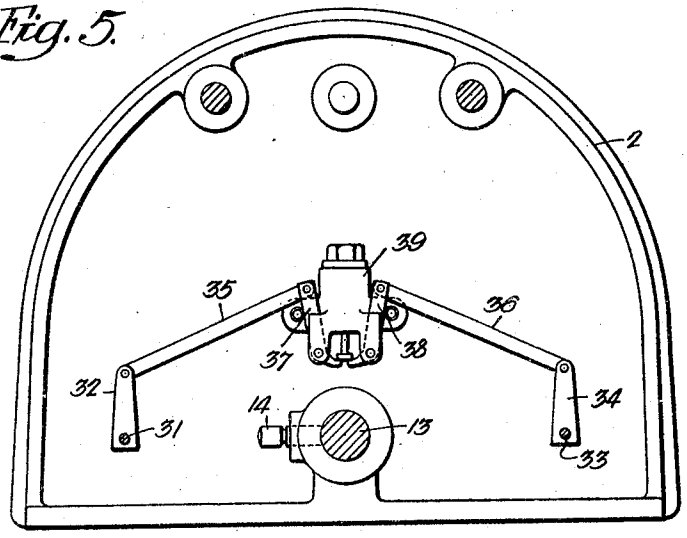


Fig. 4.

Fig. 5.



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LIMIT DEVICE FOR HOISTING MACHINES

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Fig. 6

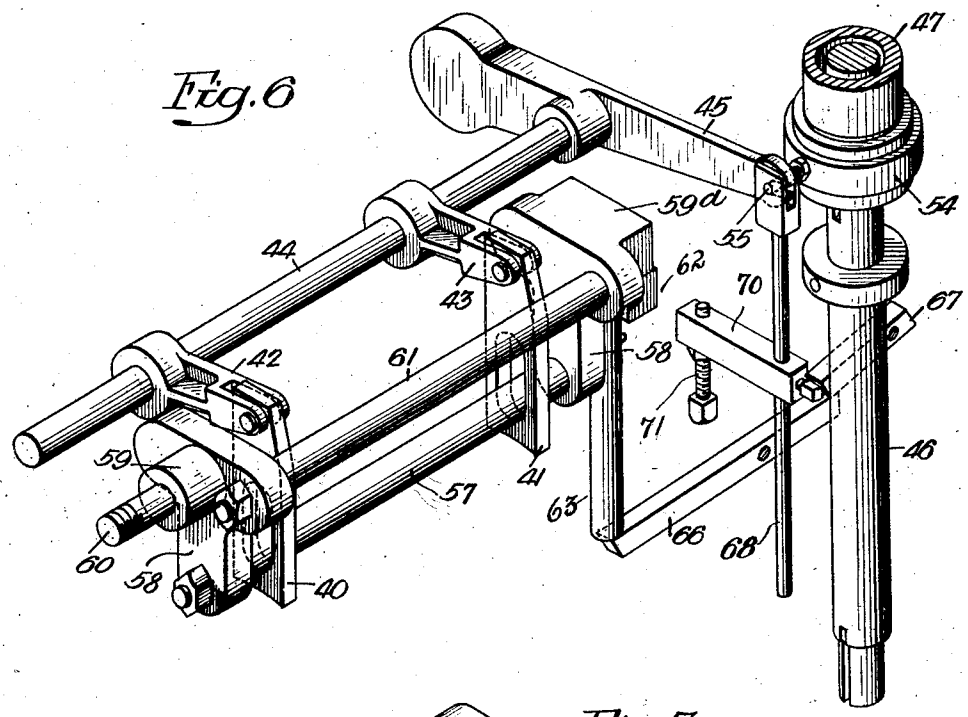
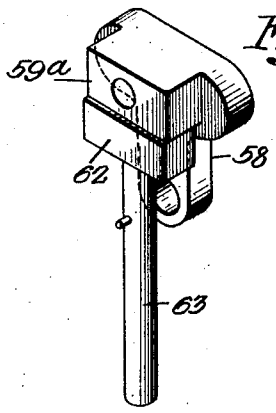


Fig. 7.



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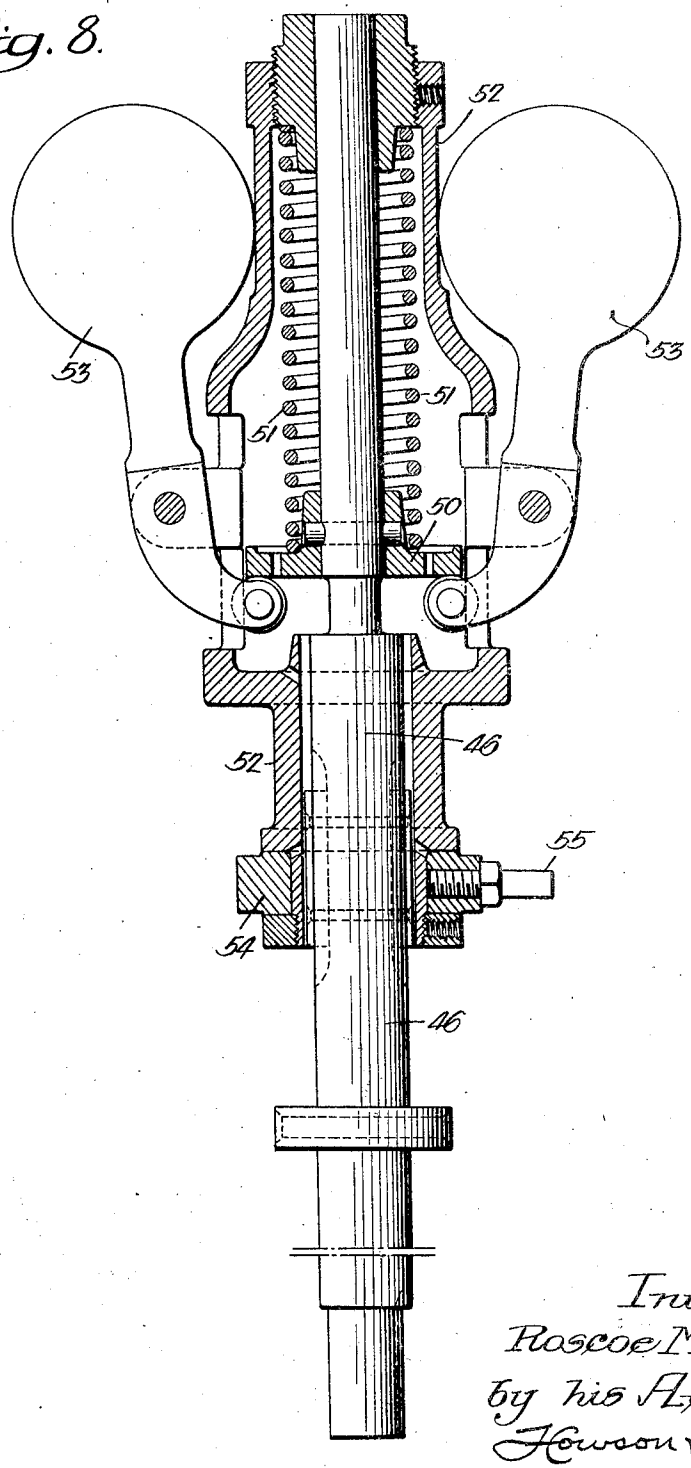
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Fig. 8.



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LIMIT DEVICE FOR HOISTING MACHINES

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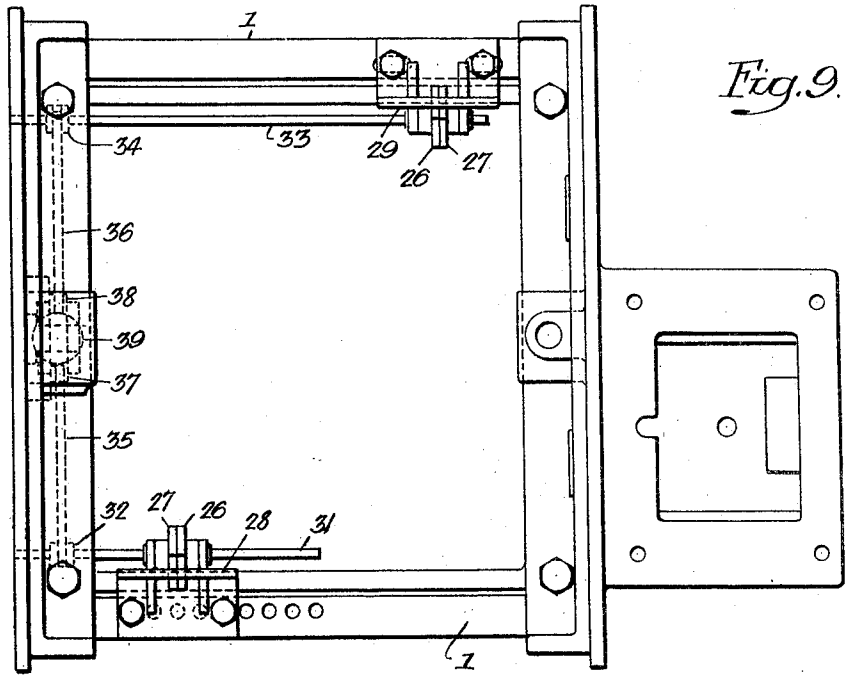


Fig. 9.

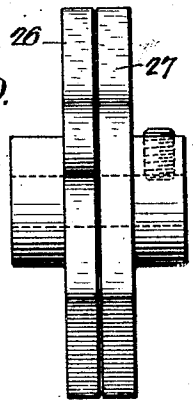


Fig. 10.

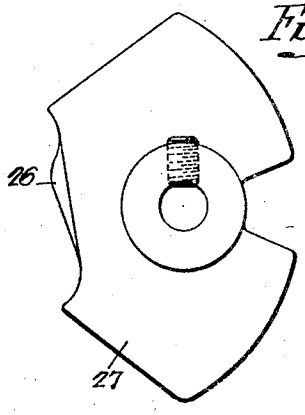


Fig. 11.

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Patented Sept. 23, 1924. 1,509,685

UNITED STATES PATENT OFFICE.

ROSCOE MOORE, OF WILKES-BARRE, PENNSYLVANIA.

LIMIT DEVICE FOR HOISTING MACHINES.

Application filed November 29, 1919. Serial No. 341,438.

To all whom it may concern:

Be it known that I, ROSCOE MOORE, a citizen of the United States, residing in Wilkes-Barre, Pennsylvania, have invented Limit Devices for Hoisting Machines, of which the following is a specification.

One object of my invention is to provide automatic mechanism particularly adapted for use in connection with a single drum electric hoist having either a single cage, a skip or a train, a single drum hoist having two cages, skips or trains one of which is raised while the other is lowered, with a double drum hoist having both of its drums keyed to a common shaft or in fact with any hoist in which the cages have fixed relative motion;—the arrangement of parts being such as to also permit of the use of my device with hoists having loose drums in which the relative motion is changed in order to hoist from various levels.

Another object of the invention is to provide a limit device so associated with a hoist as to prevent over-travel thereof in either direction as well as make it impossible to start the hoist in the wrong direction.

I further desire to provide apparatus of the class above noted which shall prevent a hoist being operated above a predetermined maximum speed and shall be capable of preventing said hoist approaching its limit of travel without slowing down at the rate necessary to insure its complete stoppage at said limit;—the invention contemplating means whereby the brake is prevented from violently setting in case power should fail while the hoist is moving within its predetermined travel limits or in case of overspeed, although it is caused to quickly set when the limits of travel are reached.

These objects and other advantageous ends I attain as hereinafter set forth, reference being had to the accompanying drawings, in which,

Fig. 1 is a side elevation, partly in section, illustrating the apparatus constituting my invention, the cover being removed;

Fig. 2 is an end elevation of the device shown in Fig. 1,—the cover being shown in place;

Fig. 3 is a transverse section on the line 3—3, Fig. 1;

Fig. 4 is a transverse vertical section on a somewhat enlarged scale, illustrating the detail construction of the drum employed as part of my device;

Fig. 5 is a front elevation partly in vertical section, illustrating the cam actuated air valve;

Fig. 6 is a perspective view illustrating the detail construction of the drum actuated cradle and certain of its associated parts;

Fig. 7 is a perspective view of certain details of the switch tripping mechanism;

Fig. 8 is a central vertical section of the form of centrifugal governing device preferably utilized as part of my invention;

Fig. 9 is a plan of the base portion of my limit mechanism, showing the switch brackets and certain of their associated parts; and

Figs. 10 and 11 are respectively a front and side elevation of one pair of the drum actuated cams.

In the above drawings 1 represents a frame or base structure having vertical housings 2 and 3 mounted upon its ends designed to receive a substantially semi-cylindrical sheet metal casing 4. Extending longitudinally through the base and mounted in suitable bearings therein are two parallel shafts 5 and 6, of which the first has keyed or otherwise suitably fixed on one of its ends a sprocket 9 or other suitable gear driven from the drum of the hoist whose operation is to be regulated or from some other part having motion co-incident with that of said drum.

The shaft 5 of my limit device has fixed to its second end a pinion 7 meshing with a spur gear 8 fixed to the second longitudinally extending shaft 6 and the latter within the main chamber of the base is formed with keyways 10 terminating at its ends in annular grooves or recesses 11. Slidably mounted on this portion of said shaft 6 is a shrouded pinion 12 having a spline which slides in the keyways 10 so that the pinion turns with the shaft except when by reason of excessive travel in either direction the spline moves into one of the annular recesses 11, when obviously no movement can be transmitted to the spline or to said pinion.

Above and parallel with the driving shafts 5 and 6 is mounted a screw shaft 13 whose ends are normally held from rotation in the housings 2 and 3 by a set screw 14 (Fig. 1) which may be slacked off to permit said shaft being turned to adjust the longitudinal position of a travelling drum 15 rotatably mounted upon it. This drum has a hub threaded to receive the threads of said shaft

and includes a cylindrical body 17 having fixed to or formed integral with it a spur gear 16 which meshes with the shrouded pinion 12.

As shown in Fig. 4, the body 17 of the drum has adjustably connected to it a second cylindrical portion 19 and the construction is preferably such that the cylindrical portions 17 and 19 extend on opposite sides of the gear 16. For this purpose said drum body 17 includes a projecting part upon which the portion 19 is carried and has an annular groove for the reception of one or more set screws 20 carried by the portion 19 whereby said portion with its supported elements may be rigidly fastened in any adjusted position relatively to the portion 17 and its associated parts. The portion 17 of the drum has projecting radially from its cylindrical surface a series of pins 21, and a second series of similar pins 22 likewise projects radially from the cylindrical surface of the portion 19; the pins of each series being respectively arranged on lines extending spirally around the portions of the drum in which they are mounted and projecting for progressively increasing distances beyond the drum surface. The pins are adjustably held at any given heights above the drum surface by set screws 23 threaded into drum portions 17 and 19 as the case may be, in lines at right angles to the several pins.

In addition the two drum portions 17 and 19 have projecting respectively from their cylindrical surfaces two other pins 24 and 25 (Fig. 3) having flat sided ends and designed to respectively cooperate with the cams 26 and 27 of two pairs rotatably supported by switch brackets 28 and 29. The first of these switch brackets 28 is mounted adjacent the housing 2 upon the top face of the base 1 at one side of the screw shaft 13 and the second bracket 29 is likewise mounted on top of the base 1 adjacent the housing 3, diametrically opposite said first bracket. Each of these brackets supports an electric switch 30 whose operation is controlled by the cam 26.

The two cams 26 and 27 of the bracket 28 are mounted upon a shaft 31,—the cam 26 being loose while the cam 27 is fixed to said shaft, and the shaft is supported partially by and projects through the housing 2, having fixed to it within the latter, an arm 32. The cam 26 of the bracket 29 is similarly loosely mounted upon a shaft 33 projecting through the housing 2 and the adjacent cam 27 is likewise fixed to said shaft which adjacent the inner face of said housing has fixed to it a second arm 34. Through links 35 and 36, these two arms 32 and 34 are respectively connected to bell crank levers 37 and 38 both operative upon a stem connected to the movable member of a valve 39 controlling the auxiliary exhaust valve of the brake of the hoist to be governed whereby a rapid application of said brake to the hoist is caused to occur when said valve is actuated by either of the cams 27 through the elements above described.

Each of the brackets 28 and 29 is so positioned upon the base structure 1 that its pair of cams 26 and 27 will be engaged by one of the pins 24 or 25, as the case may be, when the travelling drum 15 moves to a position immediately adjacent either end of its possible limit of travel;—the arrangement being such that such engagement causes opening of one of the switches 30 and operation of the air valve 39, somewhat before the continued rotation of the pinion 12 would cause its key or spline to enter one of the annular recesses of the shaft 6. It is particularly to be noted that both cams 26 and 27 of each pair have such a form that regardless of their position, no damage to the mechanism can occur even though the switches 30 or the valve 39 should be operated by hand so that said cams occupy the wrong positions for normal operation by the pins 24 and 25 and the cams are properly set by said pins irrespective of their positions.

The two series of spirally arranged pins 21 and 22 on the drum 15 are designed to respectively cooperate with a pair of depending slotted links 40 and 41 hung respectively from arms 42 and 43 slidable adjustable on a shaft 44 journalled in the housings 2 and 3 and projecting outside of and beyond the housing 3 where it has fixed to it a balanced arm 45. The position of arm 45 and hence of the links 40 and 41 is dependent upon a centrifugal governor (Fig. 8) consisting of a vertically extending spindle 46 mounted within a frame 47 supported upon an extension of the base structure 1 and driven through bevelled gears 48 and 49 from the shaft 5. A plate 50 is fixed to the upper portion of the spindle 46 and carries a spring 51 supporting a housing 52 vertically guided on and splined to said spindle. This housing or frame has pivoted to it a pair of governor balls 53 carried by arms extending under the plate 50 and provided with rollers engaging the latter so that said balls are normally maintained in the elevated positions shown in Fig. 6 when the device is not in operation.

The lower part of the housing 52 has journalled upon it a yoke 54 having a projecting pin 55 which engages the end of the balance lever 45 and the arrangement is such that when the spindle 46 is turned and the balls 53 under the action of centrifugal force are caused to move down and outwardly, said housing 52 with the pin 55 of the yoke are also moved downwardly, thus turning the shaft 44 and lowering the links 40 and 41. Each of the links 40 and 41 has formed in it a vertically extending slot

through which passes a rod 57 forming part of a cradle whose end members 58 are T-shaped and have hubs 59 and 59ª projecting laterally from them at the center of their head or cross members. These hubs are rotatable upon studs 60 respectively fixed in the end housings 2 and 3 of the main frame and said members are further braced or held together by a second rod 61 extending between said head or cross members.

The hub 59ª of that one of the end members 58 of the cradle adjacent the arm 45 has its under side plane or flat (Fig. 7) and normally engages the flat laterally extended head 62 of a rod 63 vertically guided in lugs projecting inwardly from the end housing 3;—there being a collar 64 pinned to said rod and a spring 65 mounted on the latter between this collar and one of the lugs, through which the rod is guided, so that its head is normally pressed toward and maintained in engagement with the hub 59ª of the end member 58.

The lower end of the rod 63 terminates adjacent or in engagement with one end of a lever 66 pivoted to the spindle-guiding frame 47 and is operatively connected with a second or trip lever 67 forming part of or associated with the overspeed switch 72 of the hoist. This latter normally controls the circuits of the no-voltage contactor on the control panel for the hoist and said contactor in turn governs the operation of the brake controlling magnet and main switch circuits.

The governor above described is so constructed and designed that under operating conditions it imparts a movement to its yoke 54 approximately proportional to its speed of revolution and this motion is transmitted through said yoke through the pin 55 to the balance lever 45. This pin also engages the head of a vertical stem 68 slidably guided in a suitable opening formed in the structure 47 and having on it a spring 69 whose upper end acts upon an arm 70 fixed on said stem. This arm projects horizontally and at its outer end carries an adjustable abutment in the form of a screw or stud 71. Said spring is compressed sufficiently to allow the screw 71 to engage the switch lever 66 when the speed of the hoist and hence of the governor reaches a prohibitive value at any point of its operation between the beginning of the slowing down periods, in which case the overspeed switch 72 is opened as previously described.

Under operating conditions the drum shaft of the hoist to be controlled, through the sprocket 9, turns the shaft 5 and through the gears 7 and 8 operates the shaft 6 at a materially slower speed. As a consequence the pin drum 17—19 is turned through the shrouded pinion 12 and the gear 16,—moving bodily between the two housings 2 and 3 upon the screw 13. The rotation of the shaft 5 through the gears 48 and 49 also turns the governor spindle 46 and with it the housing 52 and balls 53 so that these latter move down and outwardly, also forcing down said housing with the yoke 54. Through the pin 55 the adjacent end of the balance arm 45 is moved down, turning the shaft 44 and to a greater or less extent swinging down the arms 42 and 43 so that the two links 40 and 41 depending from these arms are thus lowered and if the speed of the hoist is sufficiently high, said links may be so far dropped as to be engaged by one or the other series of the drum pins 21 or 22.

The various parts of my device are so designed and adjusted that if this abnormal high speed of operation occurs when the cage, skip, car or other element moved by the hoist is approaching its limit of travel in one direction and when the speed of the hoist should be reduced at a definite predetermined safe rate, the link 41, for example, will come into engagement with one of the pins 22, with the result that the rotation of the pin drum will swing said link 41 on the pivot whereby it is connected to the arm 43 and in turn swing the cradle 58—57—61 on its supporting pivot pins 60. One of the end members 58 of this cradle is thus caused to act upon the head 62 of the rod 63, forcing it down against the action of its spring 65 and causing its lower end to force down one arm of the lever 66. The opposite end of said lever is thus moved up and is caused to press the adjacent end of the trip lever 67, thereby causing the latter to open the overspeed switch 72. The main switch circuits of the hoist motor are thus opened and the main brake of the hoist is applied in such manner that the motion of the hoist-operated car, skip, etc. is gradually arrested, thereby preventing the serious damage which would ordinarily result from the high speed of operation at this particular point.

Similarly, if the abnormal speed of operation occurs when the skip, car, train or other hoist-operated element is approaching the other end of its limit of travel, as might occur from ignorance or carelessness on the part of the hoist operator, the above described operation of the governor will as before cause lowering of the links 40 and 41, although since the pin drum 17—19 is at the opposite end of the screw 13, the first of these links will engage one of the pins 21 with a consequent gradual stoppage of the hoist above described.

The spiral arrangement of the pins 20 and 21 obviously permits the operation of the apparatus as described at any point during the slowing down portion of its operation in spite of the continued rotation and therefore the bodily movement of the

pin drum, and the progressively varied height of the pins of each series insures that the hoist shall be slowed down at the predetermined safe rate necessary at any particular point of the end parts of its cycle, since otherwise one of the pins will engage the adjacent link 40 or 41 and cause stoppage of the hoist.

At that point in the cycle of operations of the hoist at which slowing down should occur, its speed of operation is such that under proper conditions the links 40 and 41 are lowered to points immediately adjacent the cylindrical surface of the travelling drum where the pins of both series project but a short distance above the drum surface. As the hoist is slowed down and the governor balls 53 gradually rise the links 40 and 41 are gradually elevated so that the pins of the two series may properly be caused to project for the increased distances from the drum surface, until just before the hoist and its associated apparatus is brought to rest and the travelling drum has reached either of its limits of travel, the pins of the series 21 or 22 which are then immediately adjacent the end of one of the links 40 or 41 have a maximum projection.

With this mechanism it is obviously necessary that the speed of the hoist be decreased as it approaches either of its limits of operation at a predetermined safe rate, since otherwise even though its speed be considerably below that which is permissible between the approaches of its limits of travel, either of the links 40 or 41 will engage one of the pins of the drum and cause gradual stoppage; the successive pins being varied as to the amount of their projection so as to be capable of engaging the links when there is a predetermined departure of the speed from its safe rate.

If at any time the hoist is operated at an abnormal speed while the car, skip, etc. is moving between the approaches to its limits of travel, the links 40 and 41 can not coact with the pins 21 and 22, but the downward movement of the rod 68 under the action of the balance lever 45 will cause the abutment 71 on the arm 70 fixed to this rod to strike the lever 66, thus so turning it on its pivot or fulcrum as to operate the trip lever 67 of the overspeed switch 72 and cause gradual stoppage of the hoist as above described.

If for any reason the hoist should be continued in operation instead of being stopped after being properly slowed down, the continued rotation of the travelling or pin drum on the screw shaft 13 will cause one of its isolated pins as 24 to engage and actuate the cam 26 of the switch bracket 28. As a consequence the cam 26 causes opening of the electric switch 30 which with that mounted on the bracket 29 carries preferably the circuit to the brake controlling magnet of the hoist as well as that of direction contactors and of the main oil switch.

The operation of the cam 27 through the mechanism above described operates the air valve 39, resulting in a rapid application of the brake of the hoist through apparatus forming no part of the present invention, so that in the case of such operation of the hoist as would result in injurious overtravel, the actuating current is cut off from the hoist motor and the brake controlling magnet; it being understood that the action of the air valve 39 alone does not apply the brake but merely controls the speed of its application. The same result would occur to prevent overtravel at the opposite limit of operation of the hoist by reason of the engagement of the cams 26 and 27 of the bracket 29 by the pin 25; it being understood that in both cases both cams 26 and 27 of a set are necessarily engaged by the pin 24 or 25.

If when the traveling drum has been moved to one or the other end of its possible range of movement upon the screw shaft 13 it should be attempted to start the hoist in the wrong direction, this would obviously be impossible because of the immediate engagement of one or the other set of cams 26—27 by one of the pins 24 or 25 with the above noted cutting off of current from the hoist motor and application of the brakes.

In any case after the cutting off of current from the hoist motor and the application of the brakes due to the operation of my device the system may be restored to operative condition by the manual closure of the appropriate switch permitting the release of brakes and starting of the hoist in the opposite direction only in the well known manner. It is obvious that the hoist cannot be operated in the same direction in which overtravel occurred because the circuit to the contactor for that particular direction of rotation remains open at one of the switches 30.

In the case of the operation of the overspeed switch 72 under any of the conditions above described, the coming to rest of the governor causes raising of the links 40 and 41 after which said switch may be closed automatically or by operating the trip lever 67 through its handle 67a.

If for any reason whatever the shafts 5 and 6 should be continued in operation so that the shrouded pinion 12 would continue to turn the travelling drum upon the screw shaft 13 after it had been brought to its desirable limit of movement at either end of said shaft, the spline of said pinion enters one or the other of the annular recesses 11 of the shaft 6 thus preventing destruction of

the apparatus;—it being understood that the normal travel of the pinion 12 is less than the distance between these recesses. Obviously after moving into either of the extreme positions defined by said recesses the pinion 12 is replaced in its operative position by hand or by suitable mechanism.

When it is desired to bring the pin 25 of the travelling drum into position to properly cooperate with the cams of the switch bracket 29 for example, the set screw 14 is slacked off and the screw shaft 13 is turned by hand or otherwise until the drum has the desired adjustment, after which said screw 14 is tightened to prevent further movement of the shaft. Any angular adjustment is made by unmeshing the gear 8 and replacing it in the proper reactive position. In order thereafter to adjust the second pin 24 to bring it into proper angular relation with the cams 26 and 27 of the second bracket 28, the set screws 20 are backed off and the part 19 of the drum is moved to bring the pins which it carries into the desired relative positions. These set screws 20 are then again tightened. To bring the switch bracket 29 into proper alignment with the pin 25 which operates its cams 26 and 27 this bracket is shifted upon the base 1 which is provided with elongated slots so that when the bracket has been brought to the required position its holding bolts may be entered in said slots and thereafter tightened to rigidly hold in the given position. The series of pins 21 and 22 are brought into correct positions relatively to the slotted links 40 and 41 by virtue of their positions on the drum in relation to the pins 25 and 24.

It will be noted that if the length of the cage, skip or train travel is so short as to warrant less than a complete turn of drum 16, it is not necessary to cut a screw upon the shaft 13 and the series of pins 21 and 22 need not then be helically arranged; the screw shaft being used to make the apparatus suitable for great depths or lengths of travel.

The pins 21 and 22 could be made adjustable or secured in a different manner to that shown without departing from my invention.

The fact that the valve 39 during normal travel range of the hoist is always set for a slow application of the holding brake, precludes the possibility of a sudden application of the brake in case power to the brake controlling magnet should be cut off by overspeed or failure of the main source of current. This valve might be employed to control air or in fact any fluid under pressure such as oil, etc.

I claim:

1. A limit device consisting of a drum driven from a machine to be controlled; a series of pins longitudinally adjustable and helically arranged on said drum; speed responsive mechanism including an element mounted to cooperate with said pins; and a switch controlled by said mechanism.

2. A limit device consisting of a drum driven from a machine to be controlled; two series of pins helically arranged on said drum; speed responsive mechanism including an element actuated by said pins when the drum approaches either end of its path of movement under predetermined conditions; and a switch controlled by said element.

3. A limit device consisting of a drum driven from a machine to be controlled; a series of pins of different lengths arranged helically on said drum; speed responsive mechanism including an element mounted to cooperate with said pins; and a switch controlled by said mechanism.

4. A limit device consisting of a drum driven from a machine to be controlled; a series of helically arranged pins of progressively varying height mounted on said drum; sped responsive mechanism including an element mounted to cooperate with said pins; and a switch controlled by said element.

5. A limit device consisting of a rotary member driven from a machine to be controlled; a series of helically arranged pins carried by the drum; a centrifugal governor driven by said machine; a member controlled by said governor and movable thereby into position to be engaged by certain of the pins under predetermined speed conditions of said machine; and means controlled by said member for causing stoppage of the machine.

6. A limit device consisting of a screw shaft; a drum mounted thereon and driven from a machine to be controlled; a series of helically arranged pins carried by the drum; a speed responsive device actuated by the machine; a member governed by said device and positioned to be engaged by one of the pins under predetermined speed conditions of the machine; and mechanism governed by said member for controlling the operation of the machine.

7. The combination of a drum driven from a machine to be controlled; a helically arranged series of projections of progressively varied height carried by said drum; a member movable in two directions and mounted to cooperate with the projections of the drum; a speed responsive device actuated by the machine and connected to move said member in one direction; with controlling mechanism for the machine connected to be actuated when the member is moved by the projections in a second direction.

8. The combination of a supporting structure; a fixed threaded shaft mounted thereon; a drum threaded on said shaft; means

for turning the drum from the machine to be controlled; a series of projections of varying height mounted on the drum; a governor driven from the machine; a device for controlling the operation of said machine; and means controlled by the governor and actuated by the projections under predetermined conditions for controlling the operation of the device.

9. The combination in a limit device of a drum driven from a machine to be controlled and consisting of two relatively adjustable parts; two series of pins of progressively varying height respectively mounted on the parts of said drum; speed responsive mechanism including elements mounted to be capable of cooperating with said pins respectively at points adjacent the limits of movement of the drum; and a controlling device for the machine governed by said elements.

10. The combination of a travelling drum actuated by a machine to be controlled; at least one series of pins of progressively varying height mounted helically around the drum; a governor actuated by the machine; a switch for controlling the operation of the machine; at least one pendant swinging element connected to be moved in one direction by the governor so as to be brought into cooperative relation with the pins; with means for causing said element to actuate the switch when it is moved by the pins.

11. The combination of a supporting structure; an electric switch and a valve, for controlling the operation of the machine; cams operatively connected to said switch and valve respectively; a travelling drum driven from the machine; with a projection carried by the drum in position to actuate said cams when the drum has been moved to a predetermined extreme position.

12. The combination of a supporting structure; a threaded shaft mounted thereon; a drum rotatably mounted on said shaft and driven from a machine to be controlled, said drum including two relatively adjustable parts; pins respectively carried by said parts of the drum; and devices for controlling the machine, positioned to be engaged by said pins respectively when the drum is moved to either of its extreme allowable positions.

13. The combination of a device for controlling the operation of a machine; means for automatically causing operation of said device when the machine is approaching either end of its limits of travel at more than a predetermined speed; with means including a series of helically arranged pins for also causing operation of said device when the machine is operated at a predetermined abnormal speed between the approaches to its limits of travel.

14. The combination of a device for controlling the operation of a machine; means for automatically causing operation of said device when the machine is approaching either end of its limits of travel at more than a predetermined speed, consisting of a travelling drum and a governor both actuated by the machine and a swinging cradle including an element moved by the governor under predetermined speed conditions of the machine into position to be acted on by the travelling drum and thereby caused to operate said controlling device.

15. The combination of a device for controlling the operation of a machine; means for automatically causing operation of said device when the machine is approaching either end of its limits of travel at more than a predetermined speed, consisting of a travelling drum and a governor both actuated by the machine and a swinging cradle including an element moved by the governor under predetermined speed conditions of the machine into position to be acted on by the travelling drum and thereby caused to operate said controlling device; with means independent of the drum for causing operation of the controlling device under other speed conditions.

16. The combination of a switch for controlling a machine; a governor and a travelling drum both operated by the machine; a swinging cradle including an element moved by the governor into position to be moved by the drum under predetermined speed conditions of the machine and caused to operate the switch; with means for operating the switch from the governor independently of the drum and cradle.

In witness whereof I affix my signature.

ROSCOE MOORE.