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MEANS FOR VARYING THE STROKE OF PUMP RODS OR LIKE RECIPROCATING MEMBERS

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2 Sheets-Sheet 2

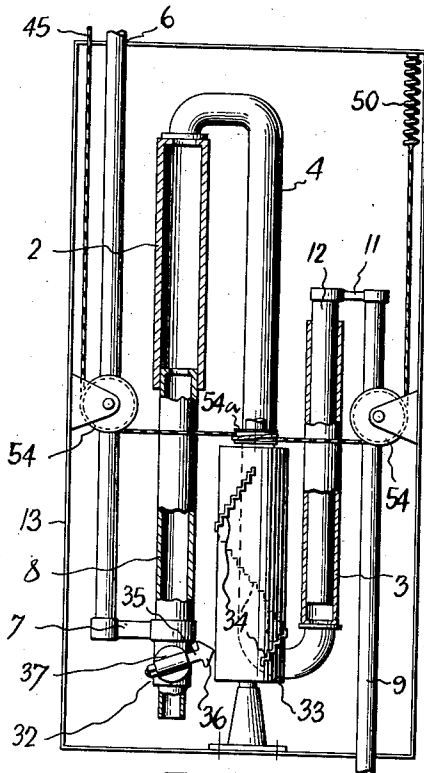


Fig. 5.

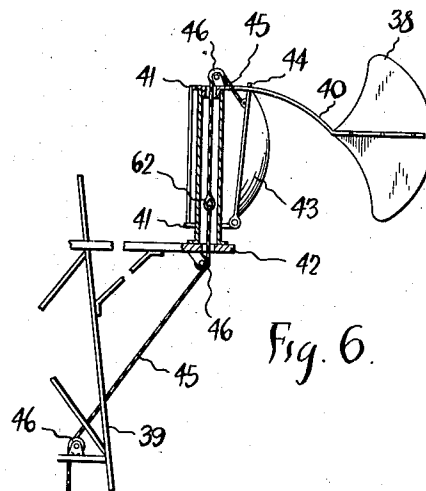


Fig. 6.

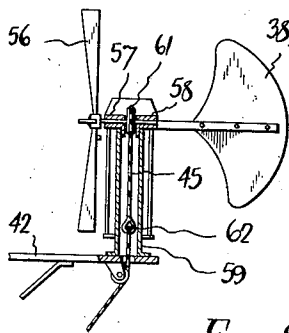


Fig. 8.

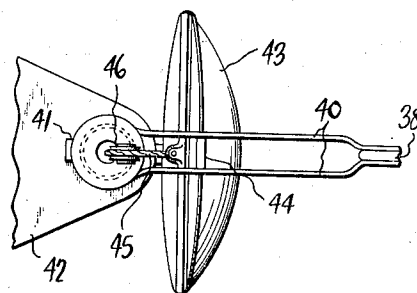


Fig. 7.

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MEANS FOR VARYING THE STROKE OF
PUMP RODS OR LIKE RECIPROCATING
MEMBERSErnest Francis Naismith McGauchie, Bendigo,
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This invention relates to means for varying the stroke of pump rods or like reciprocating members and is particularly concerned with, although not limited to, the pump rods of wind-

5 mills.

It has been proposed to provide a means for automatically varying the stroke of a windmill pump rod in accordance with variations in the force or velocity of the wind, such proposal involving a pump rod having two sections connected respectively to the wind driven gear of the mill and the pump, and adjustably interconnected by ratchet and pawl mechanism which is controlled by the water being pumped. Such proposal provides for the effective stroke of the pump rod being reduced in length to below normal but does not permit of the stroke being increased in length above normal. Thus although the proposal may be advantageous in enabling the pump to operate at a reduced stroke during comparatively light winds it does not have the effect of increasing the stroke beyond normal under conditions when the wind velocity is sufficient to supply the necessary power.

It has also been proposed to interconnect the sections of a pump rod by hydraulic means arranged to permit of an increase in the length of stroke under certain conditions, but such proposal does not make provision for a reduction of stroke when the power available is relatively low.

One of the objects of the present invention is to provide improved hydraulic or fluid operated means whereby the stroke of a pump rod or like reciprocating part may be variably increased as well as variably decreased beyond normal according to circumstances. As applied to the pump rods of windmills the invention has the important advantages of enabling the pump rod stroke to be reduced in length below normal during light winds and to be increased in length above normal during comparatively strong or high winds.

The variation of stroke may be automatically controlled in accordance with varying conditions such as, in the case of windmills, the fluctuations in the velocity of the wind. It thus becomes possible for the pump to be operated at all times at a stroke which will ensure the maximum amount of work being effected.

A further object of the invention is to provide stroke varying means of simple and effective construction which may be readily applied to existing plants or installations with a minimum of alteration and expense.

According to this invention the pump rod is

formed in two sections, namely, driving and driven sections, that are operatively interconnected by differential plungers, i. e., plungers of different diameter and stroke operating within intercommunicating major and minor cylinders, the major cylinder within which the driving plunger operates having one or more fluid outlets with which are associated valve means capable of being automatically controlled in accordance with the power applied to the driving section of the rod, whereby the length of stroke of the driven section will be varied both above and below normal according to fluctuations in the power available. Hydraulic fluid, such as a suitable oil is preferably employed in the cylinders.

The ratio between the differential cylinders, and the arrangement of the valve controlled fluid outlet or outlets is such as to enable the minor or driven plunger, which is connected to the driven section of the rod, to have a travel which is greater or less than the major or driving plunger, thus permitting of both an increase and a reduction in the normal length of stroke of the pump plunger.

The above and other objects and features of the invention will, however, be more readily appreciated from the following description of certain embodiments of the invention, it being understood that various modifications refinements and/or additions may be incorporated without departing from the spirit and scope of the invention as defined by the appended claims.

Referring to the drawings which form part of this specification—

Figure 1 is a front elevation of stroke varying means particularly applicable to the pump rods of windmills according to one embodiment of the invention.

Figure 2 is a side elevation of Figure 1.

Figures 3, 4 and 5 are somewhat diagrammatic views illustrating certain alternatives.

Figure 6 is a side elevation of a device for automatically controlling the valves seen in the preceding figures according to fluctuations in wind power.

Figure 7 is a plan of Figure 6.

Figure 8 is a side elevation of an alternative automatic control device.

The major and minor cylinders 2, 3, may be arranged side by side and free communication provided between the top of the major cylinder and the bottom of the minor cylinder by way of a transfer pipe 4 preferably of larger diameter than shown in Figs. 1 and 2. Other suitable means of communication may be adopted. The

driving section 6 of the pump rod may have suitable guides or bearings and at its lower end may have an outstanding arm 7 to which is attached the lower end of a major plunger 8 that operates within the major cylinder, and has a similar length of stroke to that of the prime mover such for instance as the reciprocating member on the working head of a windmill.

The driven section 9 of the pump rod may also have suitable guides or bearings and be provided at its upper end with an outstanding arm 11 to which is attached the upper end of a minor plunger 12 that operates within the minor cylinder.

The cylinders may be held stationary within an oil tight casing 13 by any suitable means and this casing is preferably charged with oil to such a level as indicated at 14 that the cylinders and a valve to be referred to hereinafter will at all times be submerged in oil. The casing may be suitably supported upon the tower of a windmill and may have dust excluding means or a filtering device to prevent the entrance of impurities.

It will be evident from the foregoing that the two sections of the pump rod are interconnected by the two plungers and the body of the working fluid that is disposed between the plungers.

The major cylinder is provided with a valve controlled or regulable outlet or outlets so arranged that a variable quantity of the working fluid may escape from the active system according to conditions of operation and thus vary the extent and speed of movement of the minor plunger relative to that of the major plunger.

Referring to Figs. 1 and 2 it will be seen that the major cylinder is provided with a series of ports 16, arranged at different appropriate heights or levels and that pipes 17a, 17b, 17c, 17d lead from these ports to the casing 18 of a rotary valve 19 adapted to be automatically operated as hereinafter described, according to variations in the power available to actuate the driving section of the pump rod.

If the escape of fluid from all of the ports 16 is prevented, due to the valve 19 being in its maximum closing position, then the highest driving ratio between the major and minor plungers will be established and the length of stroke of the driven section 9 of the pump rod will be increased to maximum.

If the valve 19 is in such position as to permit of free escape of fluid from all ports of the major cylinder then there will be comparatively little displacement of the fluid from the major into the minor cylinder and the length of stroke of the driven section of the pump rod will be reduced to minimum.

At intermediate positions of the valve there will be, by providing an appropriate number of the ports 16 and associated pipes, a practically infinitely variable escape of fluid from the active system, thus affording practically infinite variation in ratio between the major and minor plungers and consequently the driving and driven sections of the pump rod. When the power available increases, the control valve acts to cut off or close the ports 16 from the top of the major cylinder downwardly.

The foregoing phases are described with relation to the upward movement of the plungers and upward movements of the pump rod sections. On the downward movements of such parts any fluid that has escaped from the major cylinder will be induced to return thereto, through those ports which are not closed, by the suction effect

of the major plunger. To permit of such replenishment of the major cylinder the valve casing may have a port 21 which is permanently open.

Referring now to the modification illustrated in Fig. 3, a slide valve 22 is employed instead of a rotary valve and may be of circular or other cross section to work within a corresponding passage 23 into which the ports 16 of the major cylinder open. Means for operating the valve 22 will be described hereinafter.

Referring to Fig. 4, which illustrates a modification that may be preferred in many cases on account of its extreme simplicity and reliability, it will be seen that the major plunger 8 is hollow and has openings 24 at each end and accommodates a piston valve 26, of the type sometimes known as a "Penny" valve. This valve is a close sliding fit within the hollow plunger and may have longitudinal flutings around its periphery to permit passage of oil along the flutings except when the valve is resting upon its seating 28 at the bottom of the plunger. The descent of the valve 26 is limited by a rod 29 that upstands freely within the plunger 8 and may be vertically adjusted by means to be described hereinafter. It will be seen that according to the vertical adjustment of rod 29 the valve 26 will come to rest upon and be picked up by its seating 28 at the bottom of the plunger at various positions of the upstroke of the plunger, which is shown in its lowered position in Fig. 4 with the valve 26 near the top of the plunger. Under such conditions the greater portion of the upstroke of the plunger 8 would be idle as oil would escape from the major cylinder by way of the valve flutings and the open bottom of the hollow plunger. As soon as the bottom of the plunger reaches the valve, the bottom of the plunger is closed by the valve and during the remainder of the upstroke, oil would be forced from the major cylinder into the minor cylinder. It will be evident that the lower the position of rod 29 the greater will be the effective upstroke of the major plunger and consequently the greater the stroke of the driven section of the pump rod.

One or more stops 31 may upstand from the valve 26 to prevent it from closing the top of the hollow plunger.

Referring now to the modification illustrated in Fig. 5, the major plunger 8 is again hollow and open at both ends. At some suitable position preferably adjacent its lower end it is provided with a valve 32 such as a semi-rotary ported plug valve whereby the interior of the plunger may be opened or closed to the body of oil in the casing 13, and provision is made for closing the valve at varying positions in the upstroke of the major plunger and for opening the valve on the downstroke. In the form illustrated such provision comprises a rotary drum 33 provided around its periphery with an outstanding rib or fin 34 generally of helical formation and of one, or nearly one, complete convolution. This rib or fin is arranged in the path of travel of an arrow-like striker or head 36 at the outer end of an operating arm 35 capable of limited lengthwise sliding movement through a rotary collar 37 to which the plug of the valve 32 is connected. The drum is adjusted by being turned as hereinafter described which causes its rib or fin 34 to be engaged by the head 36 of valve arm 35 at different periods during the up and down strokes of the major plunger according to the precise adjustment of the drum.

During the upstroke the arrow-like head 36 engages the rib or fin 34 which partially turns the arm 35 so as to close the valve, the arm then yielding lengthwise against the influence of a spring (not shown) so that the head 36 may ride over the rib and then be projected outwardly into engagement with the periphery of the drum so as to maintain the valve closed. The reverse action takes place during the downstroke of the major plunger. When the drum 33 is brought into its maximum position by the control device, the head 36 of the valve arm 35 will not be engaged by the rib 34 and will therefore remain in a closed position until the drum is returned to thereby bring the rib into the path of the head of valve arm 35.

The major and minor plungers may be provided with cup leathers, rings or other fluid tight devices if so desired, but by accurately grinding and/or lapping the plungers such devices may not be required. The major and minor cylinders may be provided with packed glands or stuffing boxes 30 for the respective plungers and another gland or stuffing box 30 may be provided at the bottom of the casing 13 for the driven section 9 of the pump rod.

In all embodiments a spring may, if so desired, be provided to assist the downstroke of the pump rod but this will not usually be necessary as the weight of the pump rod is generally adequate to ensure its return by gravity.

When applied to windmills the means for automatically controlling the valve associated with the major cylinder may comprise a tail or wind vane 38 (see Figs. 6, 7 and 8) extending in a vertical plane at a suitable position near the top of the windmill tower 39 and beneath the mill head. This vane may be connected by a pair of curved arms 40 to a sleeve or like member 41 rotatable about a vertical axis and supported by a bracket 42 outstanding from the tower 39. The purpose of vane 38 is to keep another or controlling vane 43 in the wind and the axis of the sleeve or like member 41 should be spaced sufficiently outwards from the tower as to permit the vane 38 to swing completely around without fouling the tower. The controlling vane 43 may be of dished formation and extend in a plane at substantially right angles to that of vane 38. Vane 43 is pivotally connected at its lower end to the sleeve or like member 41 so that it may, under the influence of the wind, swing downwardly about its pivot. The curvature of the arms 40 should be struck from a point coincident to the pivotal connection of vane 43 so that swinging of the vane is guided by the arms 40. If so desired the guiding action may be assisted by a guide piece 44 projecting from the top of the vane between the two arms 40.

One end of a flexible operating line 45 is connected to the upper part of vane 43 and extends around a guide pulley 46 at the head of the sleeve 41 and thence downwardly through the sleeve and around other guides or pulleys 46 to the operating member of the valve associated with the major plunger. A spring, counterweight or the like may be associated with the valve operating member or the flexible line 45 to act in opposition to the swinging of the vane 43 due to wind pressure.

According to Figs. 1 and 2 the flexible line 45 is connected to the arm 47 of valve 19 with which a return spring 48 is associated.

According to Fig. 3 the flexible line 45 passes

around a guide pulley 49 within casing 13 and is connected to the lower end of slide valve 22 with which spring 51 is associated.

According to Fig. 4 the flexible line 45 passes around a guide pulley 52 and is connected to an upstanding extension 53 of rod 29 to which a return spring 53a is connected.

According to Fig. 5 the flexible line 45 extends around pulleys 54 one of which 54a is formed on or attached to the rotary drum 33, 10 and the adjacent end of the line 45 is connected to a return spring 50.

According to the modification illustrated in Fig. 8 the control vane 43 of Fig. 7 is replaced by a wind wheel or propeller 56 fast on a spindle 57 supported by a bearing bracket or the like 58 capable of rotation about a hollow standard 59 supported from the windmill tower and carrying a tail vane 38. The spindle 57 may also carry a wheel or pulley 61 to which the flexible line 45 20 is connected. Rotation of the propeller 56 may be restricted to about, or slightly less than, one revolution, as by means of a suitable stop so that the flexible line 45 has the desired amount of travel for the operation of the valve associated with the major cylinder or plunger. 25

In both Figs. 6 and 8 a swivel device 62 is shown interposed in line 45 to prevent twisting thereof owing to turning of the rotary sleeve 41 or the rotary bearing bracket 58. 30

In all embodiments it will be seen that the change in ratio between the driving and driven sections of the pump rod will be controlled automatically in accordance with fluctuations in wind power. The apparatus may be said to function as an automatic governor and, in addition to the advantages hereinbefore referred to, prevents the mill from "racing" by increasing the length of the stroke of the pump rod without increasing the speed of the mill. 40

It is to be understood that the major and minor cylinders need not be arranged side by side as aforesaid but that the minor cylinder may be arranged above and in longitudinal alignment with the major cylinder. 45

It is also to be understood that when applying the invention for purposes other than windmills, the control means for the valve or like device associated with the major cylinder, may be adapted for manual operation or for automatic operation in accordance with variations in the power applied to the driving section of the pump rod. 50

Having now described my invention what I claim as new and desire to secure by Letters Patent is: 55

1. A fluid operating means for varying the stroke of pump rods or like reciprocating members, comprising a reciprocating member having driving and driven sections, plungers on the respective sections, inter-communicating major and minor cylinders within which the plungers operate, the major cylinder being provided with one or more fluid outlets, and a control device governed by the power applied to the driving section of the reciprocating member for controlling said outlets, the outlets permitting free escape of liquid during a portion only of the stroke of the plunger in the major cylinder, the remaining portion of such stroke being beyond the influence of the fluid outlets. 70

2. A fluid operated means for varying the stroke of pump rods or like reciprocating members driven from a source of power subject to uncontrollable fluctuations, comprising a recip- 75

reciprocating member having driving and driven sections, major and minor cylinders, a plunger operating in each of the cylinders and connected respectively to the driving and driven sections of the reciprocating member, means whereby the power stroke of the plunger in the major cylinder is communicated to the minor cylinder for operating the plunger therein, and means whereby the operative stroke of the major plunger is automatically varied in length proportionally to fluctuations in the power applied to the driving section to thereby correspondingly effect the operative stroke of the minor plunger and of the driven section, said means controlling only a portion of the length of the operative stroke of the major plunger.

3. A fluid operated means for varying the stroke of pump rods or like reciprocating members driven from a source of power subject to uncontrollable fluctuations, comprising a reciprocating member having driving and driven sections, a major cylinder, a minor cylinder, a major plunger in the major cylinder connected to one of the sections of the reciprocating member, a minor plunger in the minor cylinder, a fluid supply for both cylinders, intercommunication between the cylinders to cause an operative stroke of the major plunger to actuate the minor plunger, and means automatically controlled by and proportionally variable with the power operating the driving section of the reciprocating member to vent the major cylinder to vary the power effect of the major plunger on the minor plunger, a definite length of the power stroke of the major plunger being beyond the influence of the venting means.

4. A fluid operated means for varying the stroke of reciprocating members driven from a source of power subject to uncontrollable fluctuations, said reciprocating members being divided to provide driving sections and driven sections, a major cylinder, a minor cylinder, and a source of fluid to supply said cylinders, a major plunger in the major cylinder connected to one of the reciprocating member sections, a minor plunger in the minor cylinder connected to the other of said sections, means whereby the operative stroke of the major plunger compels the fluid in the major cylinder to operate the minor plunger, and means automatically controlled by and proportionally variable with the power operating on the driving section of the reciprocating member to vary the effective power stroke of the major plunger on the minor plunger, a definite final portion of said power stroke being wholly beyond the influence of said means.

5. A construction as defined in claim 4, wherein said means includes a plurality of vents opening from the major cylinder, and a valve governed by the power means for successively controlling said vents.

6. A construction as defined in claim 4, wherein said means includes a plurality of vents opening from the major cylinder, and a valve governed by the power means for successively controlling said vents, the respective vents pro-

gressively shortening the length of the effective power stroke of the major plunger.

7. A construction as defined in claim 4, wherein said means includes a plurality of vents opening from the major cylinder, and a valve governed by the power means for successively controlling said vents, said vents progressively decreasing the effective stroke of the major plunger for a length of such stroke materially short of the full stroke, whereby under full venting a material length of the power stroke of the major plunger remains effective on the minor plunger under all conditions.

8. A construction as defined in claim 4, wherein said means includes a plurality of vents opening from the major cylinder, and a slide valve governed by the power means for successively controlling said vents, the valve successively controlling the vents lengthwise the major cylinder.

9. A fluid operated means for varying the stroke of reciprocating members divided to provide a driving section and a driven section, driven from a source of power subject to uncontrollable fluctuations, said means including a major cylinder, a minor cylinder in communication therewith, a major plunger in the major cylinder and connected to one of the sections of the reciprocating member, said major cylinder being formed with one or more fluid outlets, means automatically controlled by and proportionally variable with the power applied to the driving section of the reciprocating member to regulate the flow of the fluid from said outlet or outlets, the major plunger being hollow and open at each end and provided at its outer end with a valve seating, a piston-like valve freely disposed within the major plunger and designed to cooperate with said seating, and a member projecting into the major plunger and adjustable lengthwise thereof to limit movement of said piston-like valve in relation to said seating.

10. A fluid operated means for varying the stroke of reciprocating members divided to provide a driving section and a driven section, driven from a source of power subject to uncontrollable fluctuations, said means including a major cylinder, a minor cylinder in communication therewith, a major plunger in the major cylinder and connected to one of the sections of the reciprocating member, said major cylinder being formed with one or more fluid outlets, means automatically controlled by and proportionally variable with the power applied to the driving section of the reciprocating member to regulate the flow of the fluid from said outlet or outlets, the major plunger being hollow and open at each end, a valve arranged in the outer end of the major plunger, and adjustable means for automatically closing the valve at variable periods during each stroke of the plunger in one direction, and automatically opening the valve during each stroke in the opposite direction.

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