

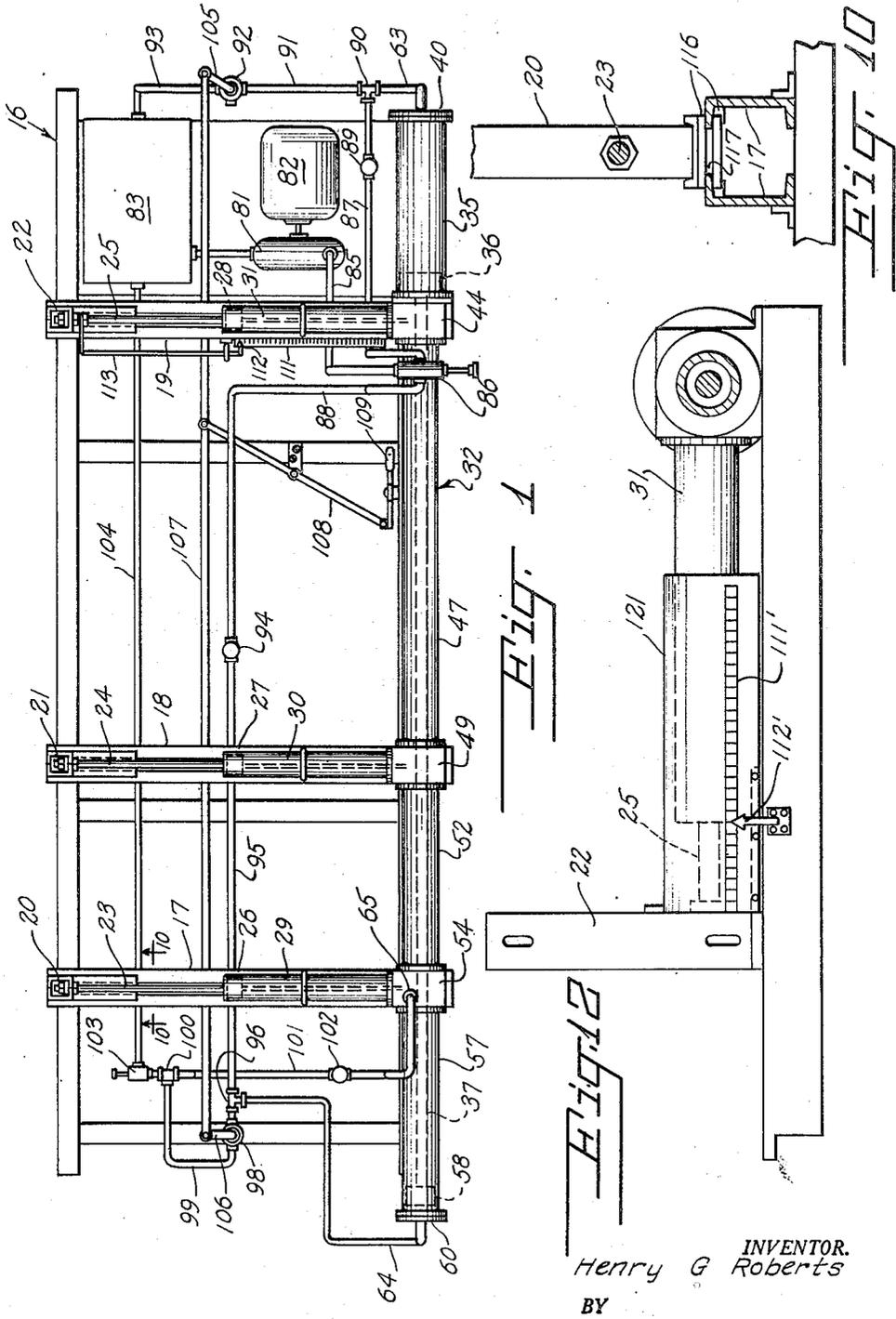
April 10, 1951

H. G. ROBERTS  
HYDRAULICALLY-OPERATED SET MECHANISM FOR THE  
HEAD BLOCK KNEES OF A SAWMILL CARRIAGE

2,548,067

Filed July 29, 1947

6 Sheets-Sheet 1



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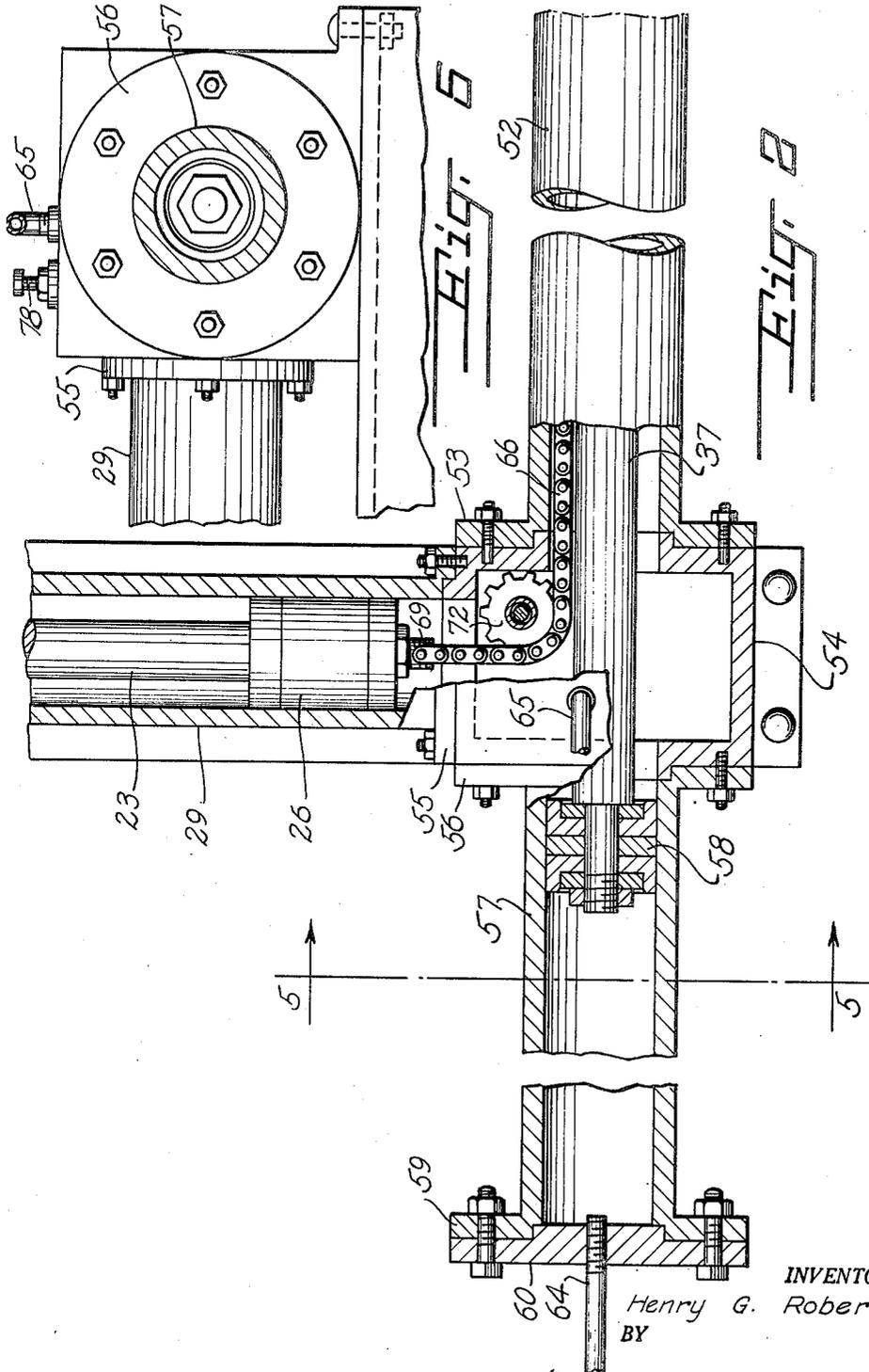
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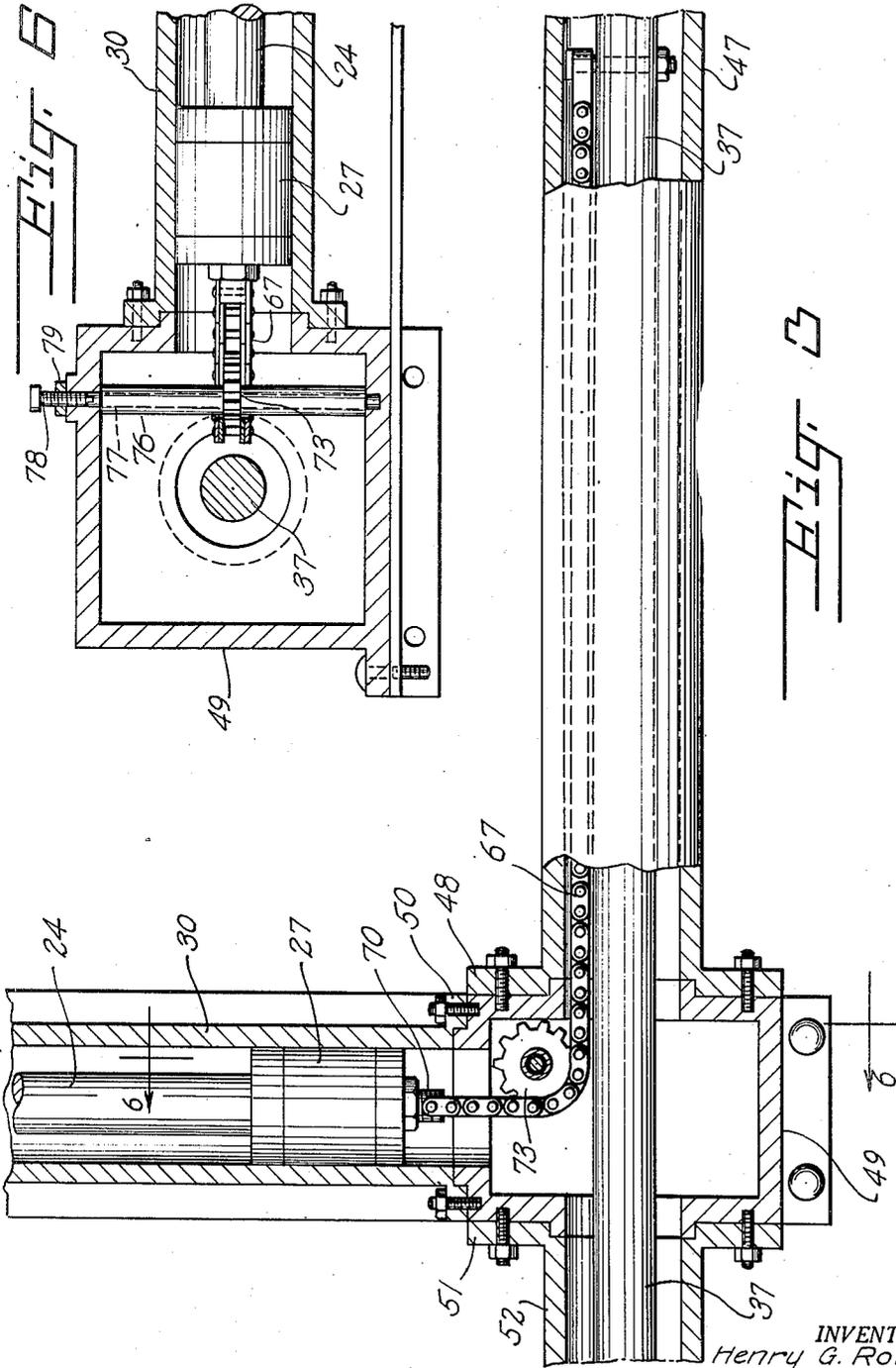
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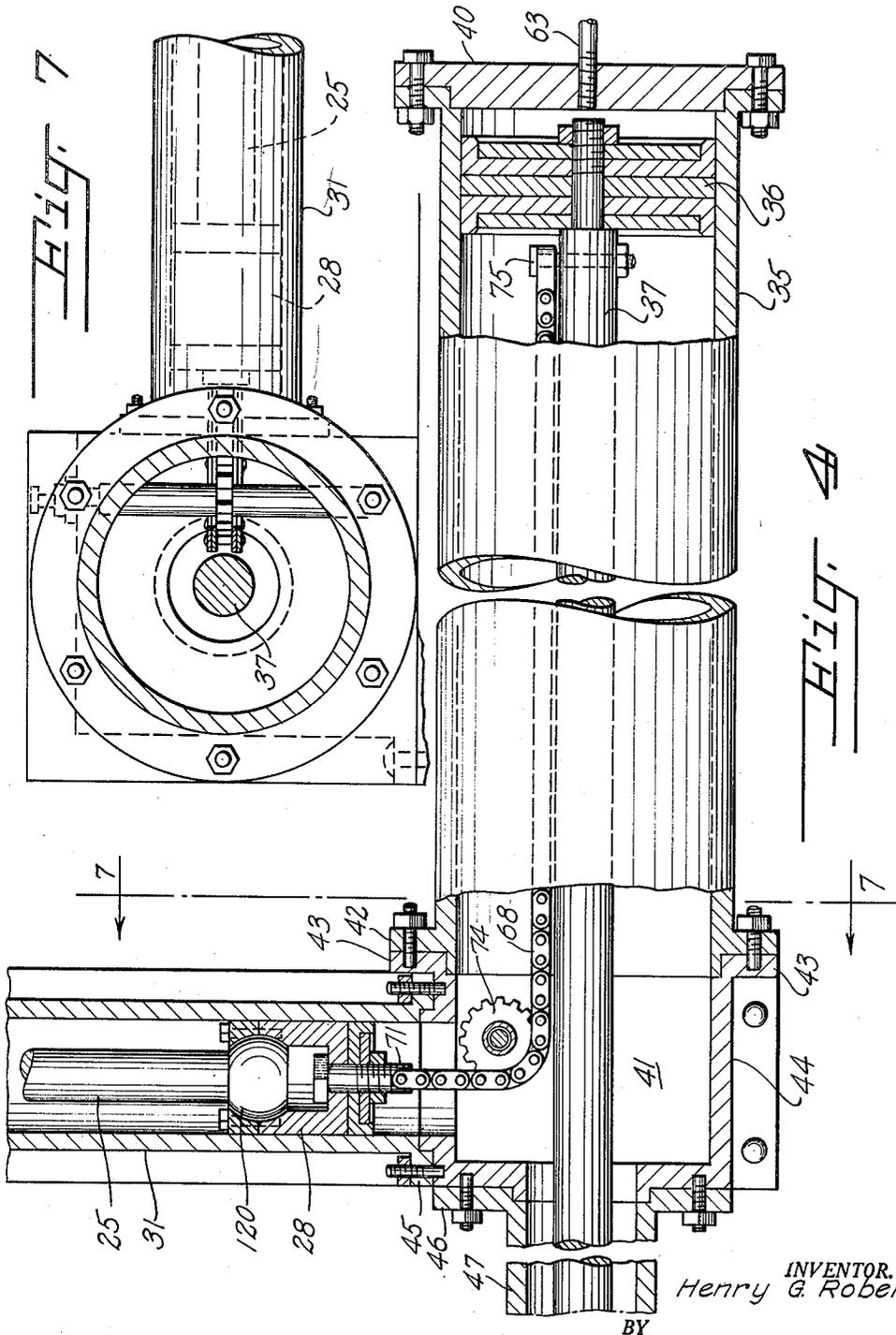
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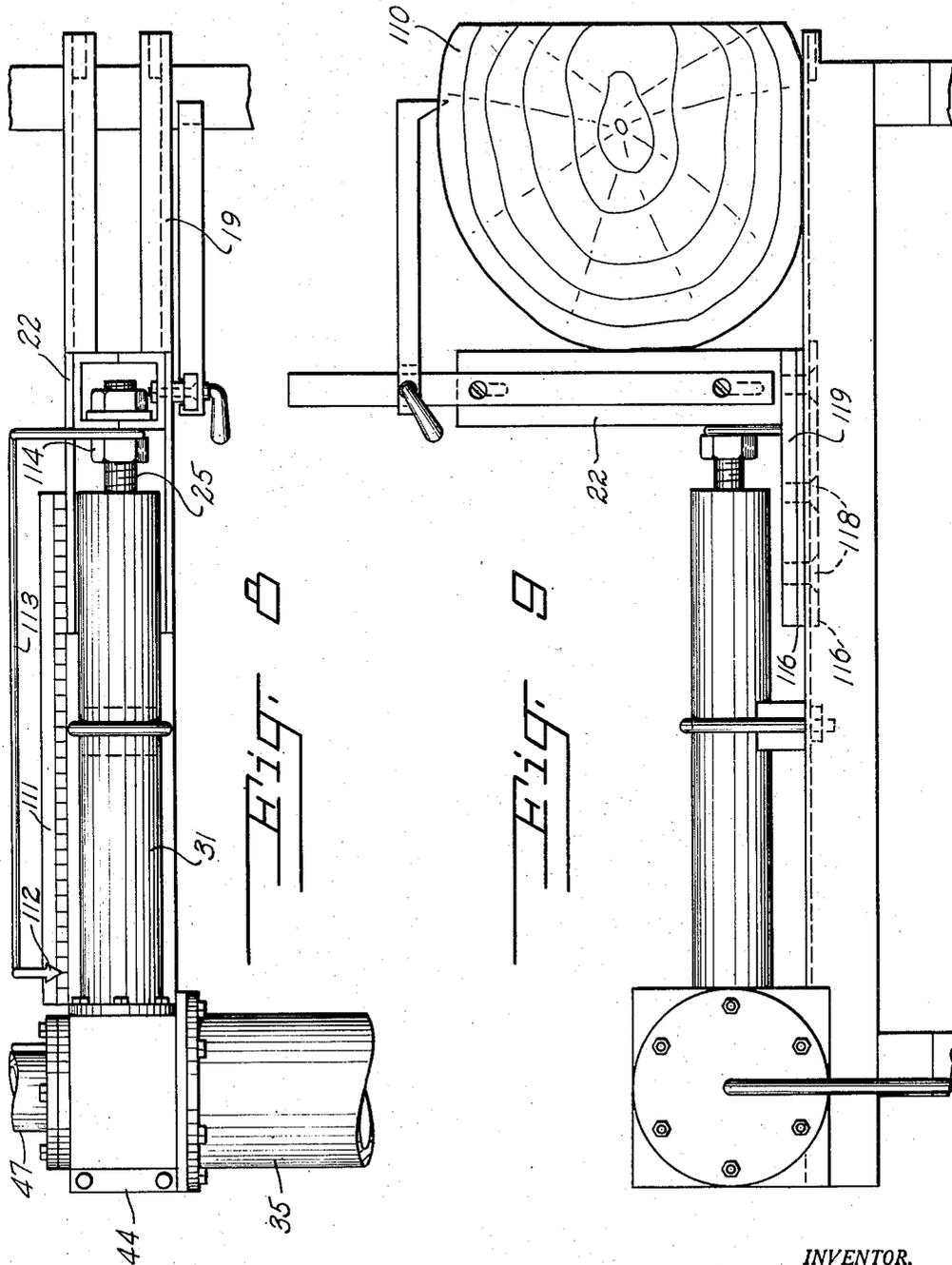
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6 Sheets-Sheet 5



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# UNITED STATES PATENT OFFICE

2,548,067

## HYDRAULICALLY OPERATED SET MECHANISM FOR THE HEAD BLOCK KNEES OF A SAWMILL CARRIAGE

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Application July 29, 1947, Serial No. 764,310

4 Claims. (Cl. 60—97)

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This invention relates to hydraulically-operated set mechanism for the head block knees of a saw mill carriage, and contemplates a construction by which both the setting and receding movements of the knees will be effected hydraulically.

It is among the objects of the invention to provide a construction of the type described which will set up the logs with great accuracy and thus eliminate variations in the thickness of the boards. It is well known that where the setting up of logs is effected through conventional rack and pinion construction, screw shafts, and equivalent mechanism, or where the setting up is effected pneumatically but controlled by such mechanism, substantial variations occur in the thickness of the boards cut, due to lost motion and back lash in the mechanical parts.

In order to obviate such difficulties, and eliminate variations in the thickness of the boards due to such causes, the present invention provides a construction in which there are no exposed parts which can develop lost motion in an endwise direction, and in which the setting is effected with great accuracy.

It is a further object of the invention to provide set mechanism of the type described which will actuate all of the knees of a multi-block carriage simultaneously and with equal accuracy.

A further object of the invention resides in the provision, in a mechanism of the type described, of a construction permitting some lateral displacement of the knees, thus giving some flexibility to the parts of the mechanism subjected to shock when a log is rolled when the carriage.

Further objects of the invention reside in the provision of means for quickly receding the head block knees.

A further object of the invention resides in the provision of a mechanism of the type described in which certain wearing parts, such as the slides for the knees are readily removable and interchangeable.

The foregoing and other objects and features of the invention will be made fully apparent to those skilled in the art from a consideration of the following detailed description, taken in conjunction with the accompanying drawings, in which:

Figure 1 shows a top plan view of a saw mill carriage having the hydraulically-operated set works of the present invention mounted thereon.

Figures 2, 3, and 4 are sectional views, with parts in elevation, of the hydraulic actuating

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mechanism at the rear end, at an intermediate section, and at the front end thereof, respectively, and when arranged in alignment from left to right represent such a view of the complete actuating mechanism.

Figure 5 shows a section taken on the line 5—5 of Figure 2.

Figure 6 shows a section taken on the line 6—6 of Figure 3.

Figure 7 shows a section taken on the line 7—7 of Figure 4.

Figure 8 shows a top plan view of the portion of the set works at the front end of the carriage.

Figure 9 shows the parts of Figure 8 in side elevation.

Figure 10 shows a transverse section, taken on the line 10—10 of Figure 1, through one of the head blocks, and looking toward the knees.

Figure 11 shows a diagram of the hydraulic system.

Figure 12 is a side elevational view illustrating the application of a dust hood to protect certain parts of the mechanism, and showing a modified form of the set indicating means.

In the drawings, numeral 16 indicates generally a saw mill carriage, which, it will be understood, is mounted to travel in the usual manner with reference to the saw of the mill. A plurality of head blocks 17, 18, and 19 extend transversely of the carriage 16 in the usual manner. In this instance, three head blocks are shown. However, it will be understood that the invention is equally applicable to a saw mill carriage having any desired number of head blocks. On the head blocks, knees 20, 21 and 22 are slidably supported in a manner which will hereinafter be made apparent.

The knees 20, 21, and 22 are set and receded by piston rods 23, 24, and 25, which rods are simultaneously actuated by pistons 26, 27, and 28, reciprocable in cylinders 29, 30, and 31 of a unitary hydraulic setting and receding mechanism indicated generally at 32.

The hydraulic setting and receding mechanism is shown in detail in Figures 2, 3, and 4, and includes a cylinder 35 (see Figure 4) having a double-acting piston 36 reciprocable therein, which piston is connected to one end of a rod 37, which rod, as will hereinafter appear, extends for the major portion of the length of the mechanism. The outer end of the cylinder 35 is closed by a cylinder head 40, and a flange 42 on the inner end thereof is secured to a flange 43 of a header 44. It will be understood that

the joint between the flanges 42 and 43 will be made fluid tight, as will other similar joints, hereinafter to be described, throughout the system. It will be seen that that portion of the cylinder space of the cylinder 35 to the rear of the piston 36 is in full open communication with a chamber 41 formed in the header 44.

The inner end of the cylinder 31 also opens into the chamber 41 of the header 44, the cylinder 31 being provided with flanged ends 45 for securing said cylinder to a side face of the header with the cylinder 31 extending at a right angle to the cylinder 35. The flanged end 46 of a tubular member 47 is secured about a central opening in the face of the header 44 opposite that to which the cylinder 35 is secured. The tube 47 has an internal diameter which is substantially larger than the external diameter of the rod 37, and the tube is substantially coaxial with the rod so that a relatively large annular passage is provided therebetween.

The tubular member 47 extends longitudinally of the carriage 16 to a point adjacent the cylinder 30, where it is connected at the flanged end 48 thereof to a header 49, see Figure 3. The inner end of the cylinder 30 is connected at the flanged end 50 thereof to an adjacent face of the header and is in open communication with the interior thereof. The flanged end 51 of a tubular member 52 is secured to the face of the header 49 opposite to that to which the tubular member 47 is secured, and extends in alignment therewith. The tubular member 52 is of the same diameter as the tubular member 47, providing a similar annular passage with the rod 37 which extends therethrough. The tubular member 52 extends to a header 54 at the inner end of the cylinder 29 and is secured to one face of this header by a flange 53, see Figure 2. The inner end of the cylinder 29 is also secured to an adjacent face of this header through a flange 55. The flanged end 56 of a cylinder 57 secures this cylinder on the side of the header 54 opposite to the side to which the tubular member 52 is attached and in alignment with said tubular member. The rod 37 extends through the header 54 and has a reduced end portion secured through a piston 58 reciprocative in the cylinder 57. The outer end of the cylinder 57 is provided with a flange 59 and this end is closed by a head 60 secured to said flange.

A fluid pressure supply and exhaust pipe 63 passes through the head 40 of the cylinder 35 for connecting the cylinder space between the outer face of the piston 36 and the cylinder head 40 alternatively with the source of fluid pressure and a suitable exhaust tank in a manner hereinafter to be described. A similar passage 64 through the cylinder head 60 connects the interior of the cylinder 57 on the outer side of the piston 58 with said source of supply and with said exhaust tank alternatively in a manner to be described. The interior of the hydraulic setting mechanism between the inner faces of the pistons 36 and 58 is filled with fluid, preferably oil, maintained under a substantially constant pressure, as will hereinafter be described. The connection 65 for supplying fluid pressure to this portion of the mechanism is shown as being made to the header 54, see Figures 2 and 5. Obviously, this connection can be made at any convenient point in the system.

The pistons 26, 27, and 28 are connected to the rod 37 through sprocket chains 66, 67, and 68, respectively. The connection between the

sprocket chains and the pistons is made through piston bolts 69, 70, and 71, and the chains, riding on idle sprockets 72, 73, and 74 in the headers 54, 49, and 44, respectively, extend along the shaft 37 in the direction of the piston 36 for a distance at least equal to the stroke of said pistons when the same are at the inner ends of their respective cylinders. The chains are secured to the rod 37 by bolts 75 extending through said rod.

In order to limit wear and resulting lost motion, the sprockets 72, 73, and 74 are preferably mounted in a manner shown in Figure 6. As shown in this figure, the sprocket 73 is fixed on a tubular sleeve 76 extending vertically across the header 49. The sleeve 76 is rotatably mounted on a shaft 77 supported in the upper and lower walls of the header. The shaft 77 is removably mounted in the header 49, but is secured against rotation by means of a screw 78 having a tongue at the end thereof engaged in a groove in the upper end of the shaft 77. Rotation of the screw 78 is prevented by a lock nut 79. By this construction, a wide bearing surface is provided for the rotating sprocket 73, and this surface is continuously lubricated by the oil in the interior of the mechanism. It will be understood that the other sprockets 72 and 74 are mounted in the same manner.

In the construction described in the foregoing, it will be observed that the piston 36 is much larger than the pistons 26, 27, 28 and 58. The effective area of the inner face of the piston 36 is made equal to the sum of the effective areas of the inner faces of the pistons 26, 27, and 28 and 58. It will be seen that when the piston 36 moves inwardly, tending to decrease the volumetric capacity of the closed interior chamber of the mechanism, the pistons 26, 27, 28, and 58 move outwardly from this closed chamber, tending to increase the volume thereof. Since the effective areas of the pistons moving outwardly are the same as the effective area of the piston moving inwardly and the strokes are the same, the total volumetric capacity of the interior chamber of the mechanism is constant.

The mechanism described in the foregoing is supplied with a suitable motive fluid, such as oil under pressure, from a hydraulic system, a diagram of which is shown in Figure 11. The system comprises a pump 81 adapted to be driven by a motor 82, or other prime mover, to draw oil from a supply tank 83 through a suction pipe 84 and discharge the same under pressure through a pipe 85 to a three-way valve 86. The valve 86 is adapted to be manually actuated to permit the oil to flow to either a passage 87 or a passage 88, but not to both simultaneously. The passage 87 is connected through a check valve 89 to one branch of a T 90. Another branch of the T 90 is connected to the inlet and exhaust pipe 63 of the cylinder 35, and the third branch of the T 90 is connected by a pipe 91 to a manually-controlled valve 92, and thence by way of pipe 93 to the supply tank 83.

The other passage 88 leading from the three-way valve 86 is connected through a check valve 94 and a pipe 95 to one branch of a T 96. A second branch of the T 96 is connected to the inlet and exhaust pipe 64 of the cylinder 57. The third branch of the T 96 is connected to a manually-operable valve 98 and thence by way of a pipe 99 to one branch of a T 100. A second branch of the T 100 is connected by a pipe 101 to a check valve 102, the opposite side of which

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check valve is connected to the pipe 65 leading to the interior chamber of the mechanism through the header 54. The third branch of the T 100 is connected to a relief valve 103 opening in a direction to permit the flow of oil to a return pipe 104 when the pressure on the intake side of said valve 103 exceeds a predetermined pressure. The return pipe 104 leads back to the supply tank 83.

The valves 92 and 98 are connected for simultaneous actuation in such a manner that when one is opened the other will be closed. To this end (see Figures 1 and 11) the stem of the valve 92 is provided with an arm 105, and the stem of the valve 98 is provided with an arm 106, and the two arms are connected by a rod 107 for joint operation through a lever 108 adapted to be manually actuated through a hand lever 109.

In the operation of the device described in the foregoing, assuming the parts are in the positions shown in Figure 1, the knees 20, 21, and 22 being at the outer ends of the head blocks 17, 18, and 19, the pistons 26, 27, and 28 will be at the outer ends of their strokes, that is, adjacent the open ends of the cylinders 29, 30, and 31. In this position, the piston 36 is at the inner end of its stroke, that is, adjacent the header 44, and the piston 58 is at the outer end of its stroke, that is, adjacent the cylinder head 60. The three-way valve 86 is now operated so that the pipe 88 is in open communication with the discharge pipe 85 of the pump 81, and communication between this discharge pipe 85 and the pipe 87 is closed. Simultaneously the rod 107 is actuated through the levers 109 and 108 to close the valve 98 and to open the valve 92. Oil under pressure is now supplied by the pipe 88, pipe 95, and pipe 64 to apply fluid pressure to the working face (left hand side) of the piston 58. This piston is now driven to the right, and the piston 36 being connected to the piston 58 by the rod 37 is likewise driven to the right, forcing the oil in the cylinder 35 out through the passage 63, the pipe 91, and the open valve 92 to the supply tank 83. The pistons 26, 27, and 28 being connected to the rod 37 by the chains 66, 67, and 68, these pistons are drawn inwardly, that is toward the headers 54, 49, and 44, until the piston 58 has been forced to the inner end of its stroke, as shown in Figure 2, in which position the piston 36 will be at the outer end of its stroke, as shown in Figure 4, and the pistons 26, 27, and 28 will be adjacent the header ends of the cylinders 17, 18, and 19, respectively. Since the only work performed by the piston 58 is that required to recede the knees 20, 21, and 22, and to exhaust the oil in the cylinder 35 back to the supply tank 83, the piston 58 can be forced quickly to the inner end of its stroke, and, accordingly, the knees 20, 21, and 22 will be as quickly receded. When the knees have been receded, they are in position closely adjacent the open ends of the cylinders 29, 30, and 31.

When the knees have reached their fully receded positions, the operator discontinues the supply of motive fluid to the cylinder 57, the parts remaining at rest while a log is rolled upon the carriage. In order to so discontinue the supply of motive fluid to the cylinder 57 while the piston 36 of the cylinder 35 remains at rest, the operator has only to move the lever 109 back into the position shown in Figure 1, in which the valve 92 is closed and the valve 98 is opened. The motive fluid now flows back to the tank 83 through the relief valve 103. Alternatively, the

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operator may leave the valve 92 open and the valve 98 closed, but turn the three-way valve 86 so that the fluid flows through the pipe 87. The fluid thus returns to the tank 83 without exerting material force upon the outer or working face of the piston 36 as the pump 81 idles. In either case, after the log has been positioned on the carriage, the valve 92 will either be closed or will now be closed by the operator, and the valve 98 will be opened. The valve 86 is actuated to connect the pipe 87 to the discharge pipe 85 of the pump 81, and, accordingly, motive fluid will be supplied to the interior of the cylinder 35 through the pipe 63, forcing the piston 36 inwardly. As the piston 36 moves to the left from the position shown in Figure 4, on its working stroke, the piston 58 moves to the left from the position shown in Figure 2, on its exhaust stroke, the oil being exhausted through the pipe 64, the open valve 98, and thence to the supply tank 83 through the relief valve 103. Simultaneously with the movement of the pistons 36 and 58 to the left, the pistons 26, 27, and 28 must move outwardly in the cylinders 29, 30, and 31, and, accordingly, force the rods 23, 24, and 25 outwardly. The outward movement of the pistons 26, 27, and 28 will correspond exactly to the distance through which the pistons 36 and 58 move, for since the pistons 26, 27, and 28 are connected to the rod 37 through the sprocket chains 66, 67, and 68, the pistons 26, 27, and 28 can move no further than the distance through which the rod 37 moves. However each of the pistons 26, 27, and 28 must move as far as permitted by the chains 66, 67, and 68, for should one of the pistons, say 26, meeting with a greater resistance than the other pistons, tend to stop, or lag behind the other pistons in its outward movement, this stopping or lagging of the piston 26 would decrease the volumetric capacity of the interior pressure chamber of the system. The inner face of the piston 26 constitutes a portion of the surrounding wall of this interior chamber. Since the interior chamber is filled with oil at a pressure determined by the setting of the relief valve 103, and since this oil cannot flow back out of the interior chamber due to the check valve 102, any decrease in the effective volumetric capacity of this interior chamber would build up a high pressure. It will thus be seen that each of the pistons 26, 27, and 28 must move outwardly at the same rate and for the same distance as the piston 36 moves to the left.

It will be understood, of course, that in the ordinary setting-up operation, the piston 36 does not move continuously to the left in the manner in which the piston 58 is moved to the right in receding the head blocks. The manner in which the knees, and accordingly the logs indicated at 110, are set up will be apparent from a consideration of Figures 8 and 9. As shown in Figure 8, a scale or index 111 extends adjacent the cylinder 31 on the side thereof convenient to the operator at the valve 86 and hand lever 109. A pointer 112 adapted to overlie the scale 111, is formed at one end of a rod 113, which extends to and is secured on the knee 22. As shown, the rod 113 is connected to the knee 22 by one of the nuts 114 which secures the piston rod 25 to the knee. Obviously, any other suitable means for moving the pointer 112 relative to the scale 111 at a rate proportionate to the movement of the knee 22 may be adopted. The operator determines the setting of the knee 22 attendant to the setting of the logs 110 by observation of the posi-

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tion of the pointer 112 relative to the scale 111. Assuming, for example, that the log is to be set up for sawing two-inch boards, the operator observes the movement of the pointer 112 along the index 111 for an equivalent distance and then cuts off the supply of motive fluid through the pipe 87 by actuating the valve 86 to close this pipe and open the pipe 88. At this time, the operator does not actuate the hand lever 109, leaving the valve 92 closed and the valve 98 open. The fluid thus passes without great resistance through the pipe 88, the open valve 98, and the relief valve 103 to the tank 83, while the piston 36 is locked in set position, there being no escape of fluid from the cylinder 35 through the check valve 89 and the closed valve 92. In this manner, the log is set up after each passage through the mill, any tendency of the log to roll in either direction is eliminated due to the pressure of oil in the outer end of the cylinder 57, or the outer end of cylinder 35 until the log has been sawed, when the knees are again receded in the manner described.

It will be understood that variations may be made in the operation of the hydraulic system from that described. For example, when the valve 86 is actuated to close the pipe 87, upon the completion of a setting-up operation, it is not essential that the valve also open the passage 88 at this time. Thus, if the entrance to the pipe 87 is closed, and the entrance to the pipe 88 remains closed, a back pressure will be built up between the three-way valve 85 and the pump 81 in the pipe 85, which may be used to control the operation of the pump through any known pressure-control device.

It will be observed that in the construction described in the foregoing, there are no exposed moving parts which are subject to wear in a direction which would result in inaccuracies in the setting-up operation. As seen in Figures 9 and 10, the slides of the head blocks are subjected to wear in a vertical direction, and also to a lesser extent in a lateral direction. However, there are no parts which may wear in an endwise direction. The sliding portions of the head block knees may be formed of two cast iron plates 116, spaced by a plate 117 of lesser width than the plates 116. The plates are bolted together, as indicated at 119, and when said plates become worn, the same may be readily replaced. The bolts 118 extend not only through the plates 116 and 117, but also through the lower horizontal portion 119 of the head block knees. It will be understood that this horizontal portion is integral with the upright portion of the knee being either formed integrally therewith or secured thereto, as by welding.

As stated in the foregoing, there may be some vertical and some lateral play between the head block knees 20, 21, and 22, and their respective head blocks. Thus, although no endwise play is permitted, a certain flexibility in lateral and vertical directions is permissible. In order to prevent vertical and lateral displacement of the knees, which may occur when a log is rolled upon the carriage, from being transmitted through the rods 23, 24, and 25, into a twisting action upon the pistons 26, 27, and 28, the connection between the rods and pistons is formed with a ball-and-socket joint, as shown at 120 in Figure 4. This figure, which shows the ball-and-socket connection between the rod 25 and piston 28, will serve to illustrate a similar connection be-

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tween each of the rods and their respective pistons.

As stated in the foregoing, the ends of the cylinders 29 and 30 and 31 are open. This permits slight swinging of the rods 23, 24, and 25 in the manner described in the foregoing. In order to prevent dust from entering the ends of the cylinders, these may be provided with flexible coverings at the ends thereof, or dust hoods covering the rods 23, 24, and 25 may be secured to the knees in a manner to ride over the cylinders 29, 30, and 31. In Figure 12, such a hood 121 is shown attached to the knees 22 in a position to ride over the cylinder 31 and cover the rod 25 throughout the length of the movement thereof. The application of such hoods to the other knees will be self-evident. In the form of the invention shown in this figure, the indexing means is slightly modified. The scale 111' is formed on the side of the hood 121 and constitutes a movable-scale coacting with a fixed pointer 112'.

From the foregoing, it will be seen that the invention provides a complete hydraulic system for receding and setting the head block knees of a saw mill carriage. It will be apparent that since the invention provides a construction in which there are no exposed parts which can develop lost motion in an endwise direction, the invention attains its objective in eliminating variations in the thickness of boards due to lost motion and back lash in this direction. It will be apparent that no inaccuracy can be introduced into the system due to any leakage of fluid from the interior chamber formed in the mechanism 32, since any loss of fluid in this chamber is continuously replaced as a result of the action of the relief valve 103. Since the pistons 26, 27, and 28 directly actuate the knees 20, 21, and 22, they may be called knee-actuating pistons, and since the piston 36 is driven to effect the setting motion, and the piston 58 is driven to effect the receding motion, these pistons will be called the setting piston and the receding piston, respectively, in the following claims.

While there has been herein described a preferred embodiment of the invention, other embodiments within the scope of the appended claims will be apparent to those skilled in the art from a consideration of the form shown and teachings hereof.

Having thus described the invention, I claim:

1. Fluid operated saw mill set works, comprising a longitudinal tube, a longitudinal rod mounted within the longitudinal tube and extending throughout the major portion of the length of the tube, the longitudinal tube having an inside diameter substantially greater than the diameter of the longitudinal rod, plungers secured to the longitudinal rod near its opposite ends and near the opposite ends of the longitudinal tube, the opposite ends of the longitudinal tube having openings outwardly of the plungers whereby fluid under pressure may be introduced into and exhausted from the ends of the longitudinal tube for shifting the longitudinal rod, a plurality of substantially horizontal transverse tubes connected with the longitudinal tube and having their bores in communication with the bore of the longitudinal tube, reciprocatory plungers mounted within the transverse tubes and having parts extending beyond the outer ends of the transverse tubes, and flexible elements connected with the reciprocatory plungers of the transverse tubes and with the longitudinal rod for retracting the reciprocatory plungers when the longi-

tudinal rod is shifted in one direction, the flexible elements extending within the longitudinal tube between such tube and the longitudinal rod, the longitudinal and transverse tubes being filled with fluid inwardly of their plungers.

2. Fluid operated saw mill set works, comprising a longitudinal tube, a longitudinal rod mounted within the longitudinal tube for reciprocation and extending throughout the major portion of the length of the tube, the tube having an inside diameter substantially greater than the diameter of the rod, a longitudinal cylinder secured to one end of the longitudinal tube, the tube and cylinder having their bores in communication, the inside diameter of the cylinder being larger than the inside diameter of the tube, a large piston mounted within the longitudinal cylinder for reciprocation and connected with the longitudinal rod, a small piston connected with the opposite end of the longitudinal rod for reciprocation within the longitudinal tube, the outer ends of the tube and cylinder having openings through which fluid under pressure may be introduced into and exhausted from the tube and cylinder outwardly of the large and small pistons, transverse cylinders connected with the longitudinal tube between its ends and having their bores in communication with the bore of the tube, reciprocatory plungers mounted within the transverse cylinders and having operating parts extending beyond the outer ends of the transverse cylinders, the combined effective areas of the plungers and small piston being substantially equal to the effective area of the large piston, the longitudinal tube and transverse cylinders being adapted to be filled with fluid inwardly of the large and small pistons and plungers, and flexible elements connected with the plungers and longitudinal rod and extending between the rod and longitudinal tube and serving to retract the plungers when the longitudinal rod is shifted in one direction.

3. Fluid operated saw mill set works, comprising a longitudinal tube, a longitudinal rod mounted within the longitudinal tube for reciprocation and extending throughout the major portion of the length of the tube, the tube having an inside diameter substantially greater than the diameter of the rod, a longitudinal cylinder secured to one end of the longitudinal tube, the tube and cylinder having their bores in communication, the inside diameter of the cylinder being larger than the inside diameter of the tube, a large piston mounted within the longitudinal cylinder for reciprocation and connected with the longitudinal rod, a small piston connected with the opposite end of the longitudinal rod for reciprocation within the longitudinal tube, the outer ends of the tube and cylinder having openings through which fluid under pressure may be introduced into and exhausted from the tube and cylinder outwardly of the large and small pistons, transverse cylinders connected with the longitudinal tube between its ends and having their bores in communication with the bore of the tube, reciprocatory plungers mounted within the transverse cylinders and having operating parts extending beyond the outer ends of the transverse cylinders, the combined effective areas of the

plungers and small piston being substantially equal to the effective area of the large piston, the longitudinal tube and transverse cylinders being adapted to be filled with fluid inwardly of the large and small pistons and plungers, sprocket wheels journaled within the longitudinal tube adjacent to the inner ends of the transverse cylinders, and sprocket chains engaging over the sprocket wheels and connected at their ends with the plungers and longitudinal rod, the sprocket chains extending between the longitudinal rod and tube and being completely enclosed by the tube and transverse cylinders, the sprocket chains serving to retract the plungers when the longitudinal rod is shifted in one direction.

4. Fluid operated saw mill set works, comprising longitudinally spaced sections of tubing, tubular headers connecting the ends of adjacent sections of tubing and forming therewith a continuous straight tubular chamber, one end section of tubing having a bore larger than the bores of the other sections of tubing, a longitudinal rod mounted within the tubular chamber for reciprocation and extending throughout substantially the entire length thereof, a large piston secured to one end of the rod and disposed within the section of tubing having the large bore, a small piston secured to the opposite end of the rod and disposed within the opposite end section of tubing, the tubular chamber having ends provided with openings whereby fluid under pressure may be introduced into and exhausted from the chamber outwardly of the large and small pistons, transverse cylinders connected with the headers and having their outer ends open and their bores in communication with the chamber, plungers mounted within the transverse cylinders for reciprocation and including plunger rods which extend through the outer open ends of the transverse cylinders for connection with head block knees, the combined effective areas of the plungers and small piston being equal to the effective area of the large piston, one header having an opening through which the chamber and transverse cylinders may be filled with fluid and maintained filled, and flexible elements connected with the plungers and longitudinal rod and arranged between the rod and bore of the chamber and serving to retract the plungers when the rod is shifted in one direction.

HENRY G. ROBERTS.

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