

[54] **SKYLINE CLAMP FOR LOGGING CARRIAGE**

[76] Inventors: **Norman E. Junes**, 3 Box 148, Astoria, Oreg. 97103; **William R. Stanyer**, 1715 Franklin, Seaside, Oreg. 97138

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[58] Field of Search 212/99, 103, 107, 111, 212/24, 89, 96, 115, 97, 98; 254/148

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Primary Examiner—Stanley H. Tollberg

Attorney, Agent, or Firm—Lee R. Schermerhorn

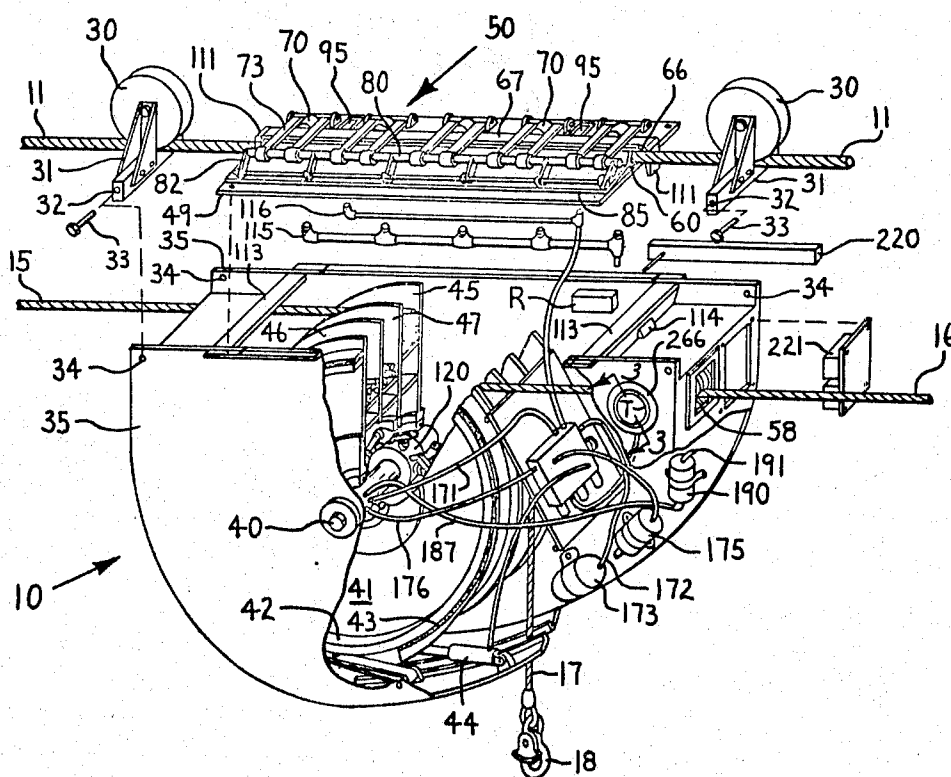
[57] **ABSTRACT**

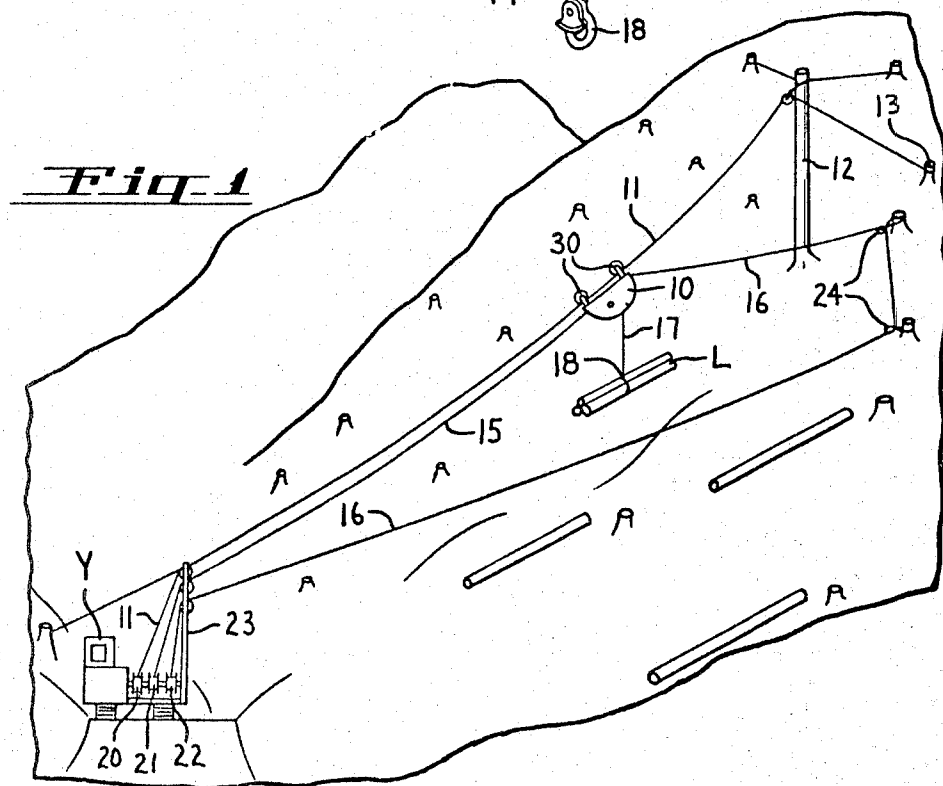
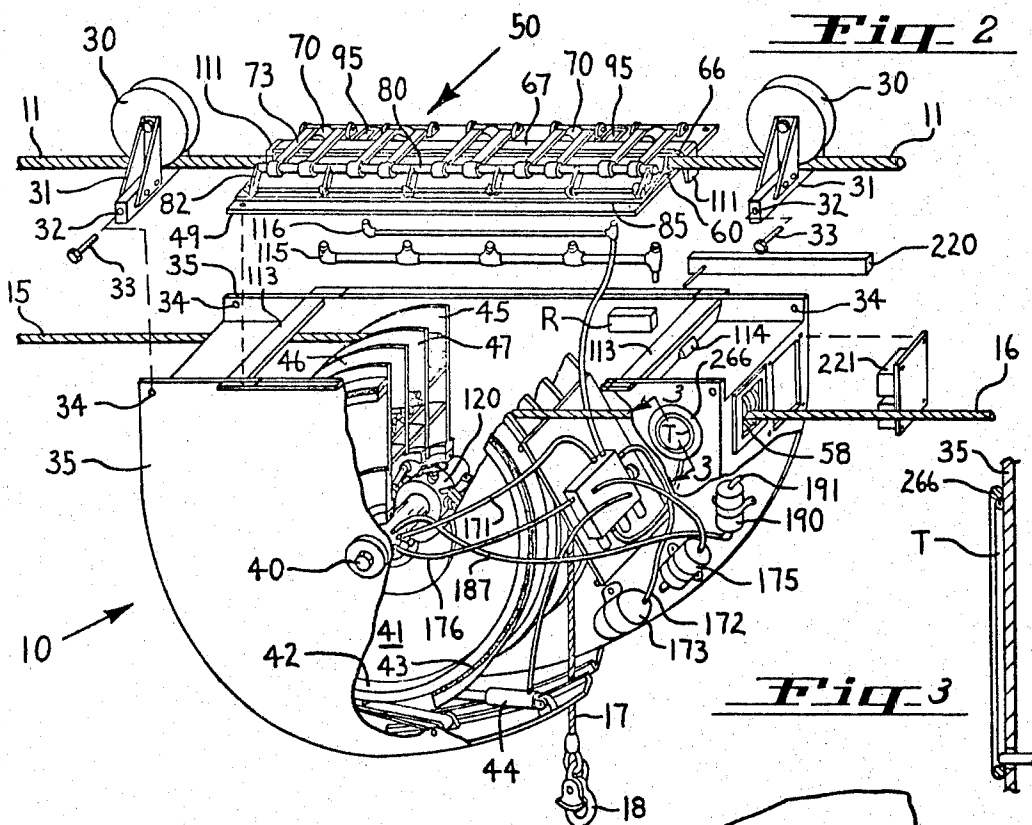
The carriage is moved back and forth on a skyline by which drums on a yarder at one end of the skyline. The carriage contains a three-section cable drum having individual sections for a main line, a haulback line and a hoisting line. A hydraulic brake in the carriage operates on the three-section drum and a hydraulic

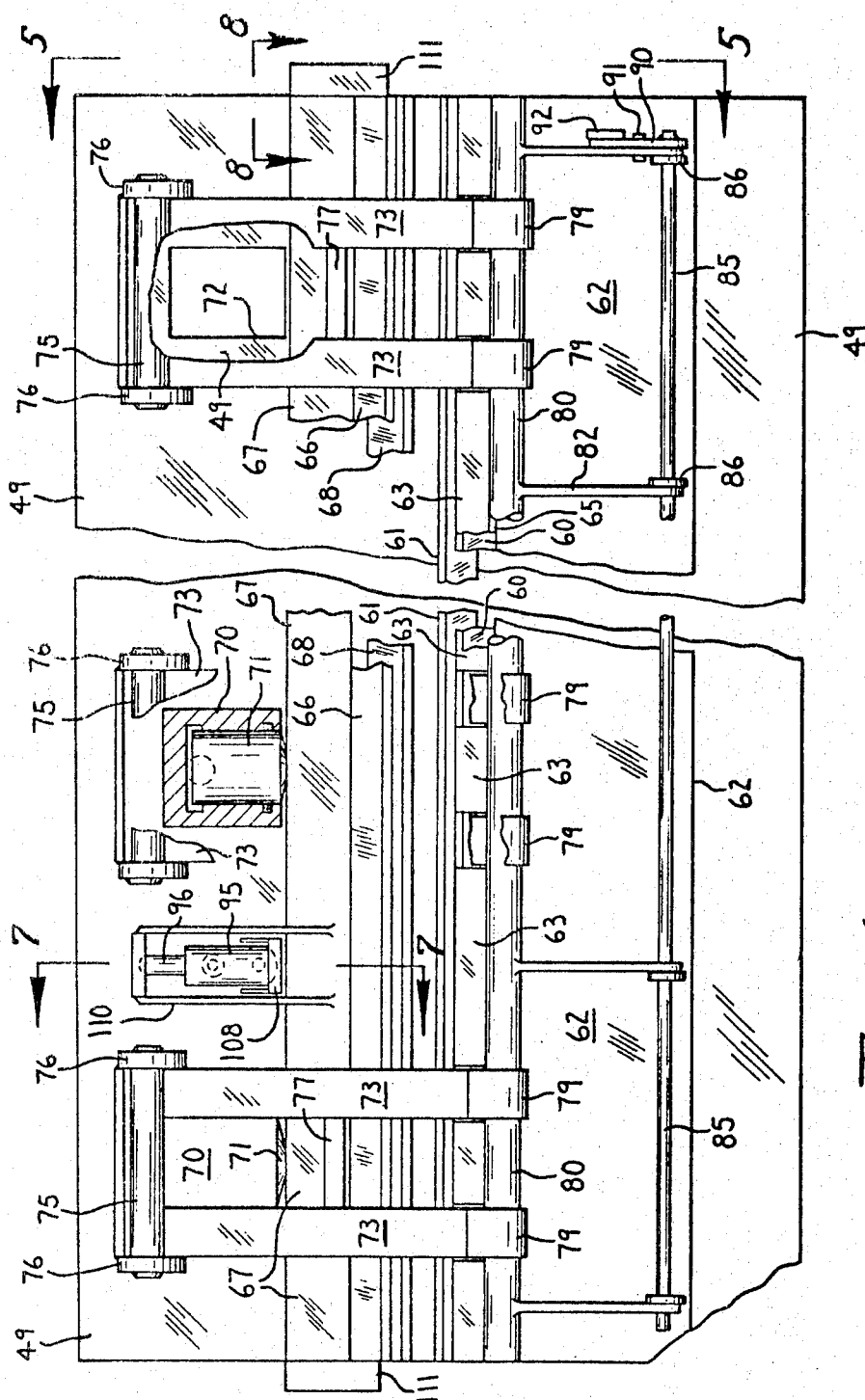
clamp operates on the skyline. When the carriage drum brake is set and the skyline clamp released, the yarder winch drums pull the carriage out by winding in the haulback line and slacking off the main line. The yarder winch drums pull the carriage in by winding in the main line and slacking off the haulback line. When a turn of logs is to be lifted by the carriage for travel back to the yarder, the skyline clamp is set and the carriage drum brake released. The logs are lifted by causing the yarder main line winch to pull in the main line while the haulback line is slacked at the yarder.

The skyline clamp and drum brake in the carriage are actuated by a special leak-proof hydraulic system. A hydrostatic transformer provides a high pressure source of hydraulic fluid for the clamp. The hydraulic system is supplied by a bi-rotational pump operated by rotation of the carriage cable drum and pressurized oil is stored in an accumulator when the pump is not operating. Valves for actuating and releasing the brake and clamp are radio controlled by an operator at the yarder. To facilitate putting the carriage on the skyline and removing it from the skyline, the skyline clamp is made accessible by a hinged frame so that the skyline does not have to be threaded lengthwise through the clamp shoes. A movable clamp shoe extending substantially the length of the carriage is actuated by a plurality of hydraulic cylinders spaced along the shoe to provide quick and positive clamp and release movements and avoid sliding wear on the skyline cable.

6 Claims, 20 Drawing Figures







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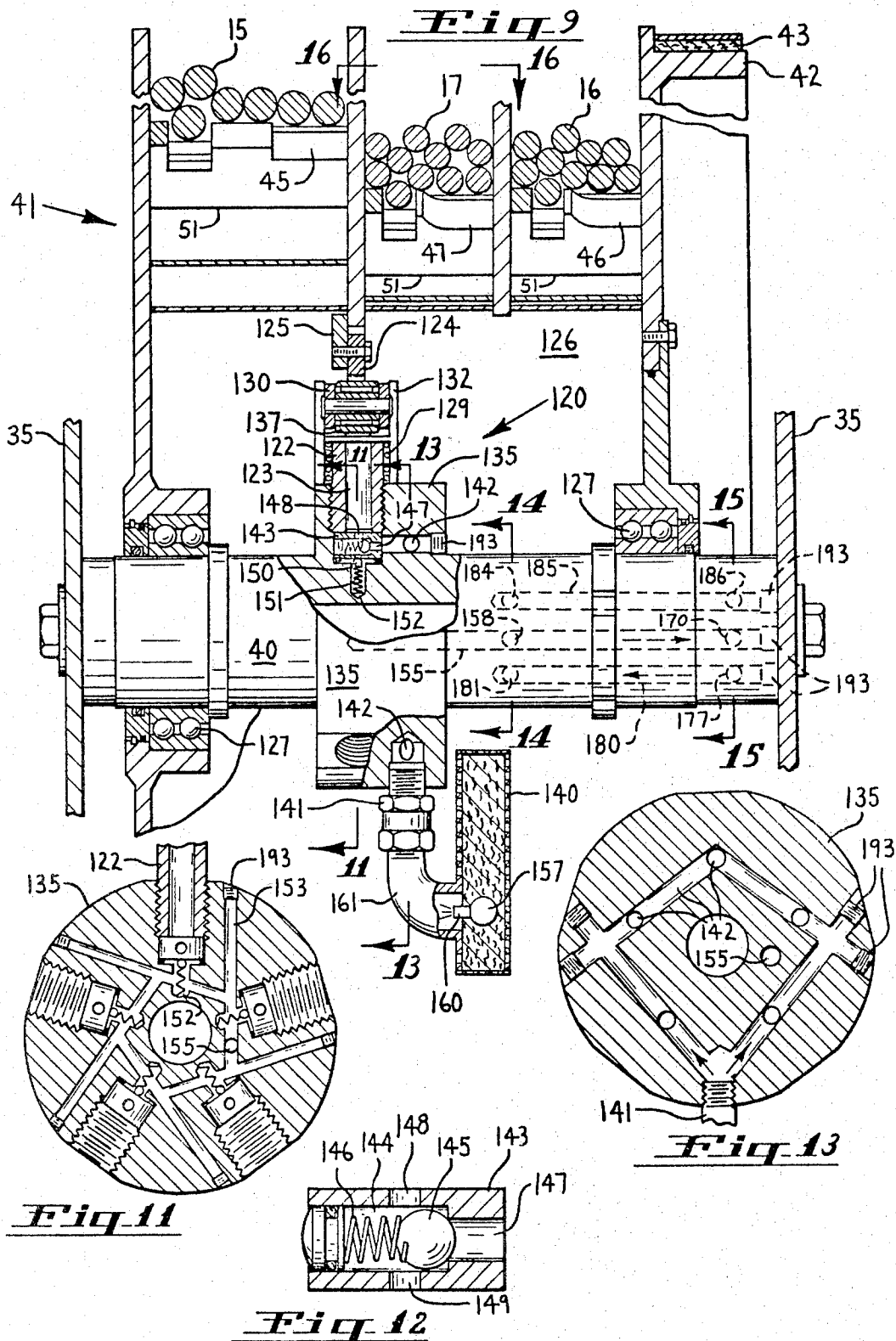
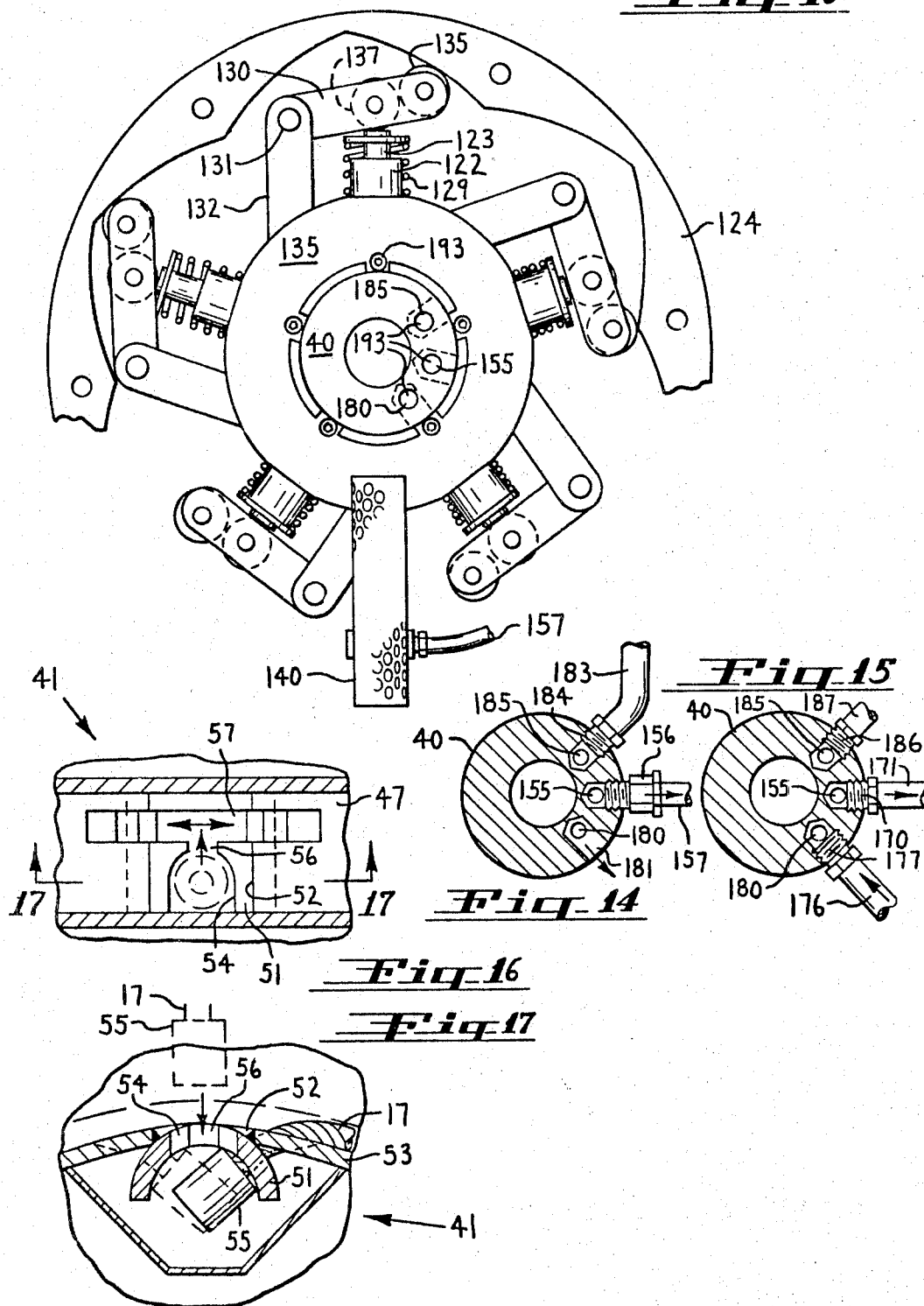


Fig 10



SKYLINE CLAMP FOR LOGGING CARRIAGE

CROSS-REFERENCE TO RELATED APPLICATION

This application is a division of our co-pending application Ser. No. 153,984 filed June 17, 1971, on Skyline Logging Carriage.

BACKGROUND OF THE INVENTION

This invention relates to a skyline logging carriage for yarding logs in a logging operation.

Two primary objectives in a logging operation are speed and safety. The main objections to previous logging carriages are that they have not been able to provide speed with safety. Earlier carriages were held in position on the skyline by the main line if logging uphill or by the haulback line if logging downhill. A failure of the holding line would allow the carriage to run free on the skyline by gravity, resulting in a major disaster at the lower end of the line.

Attempts have been made to apply a brake on the skyline but these carriages have been unsuccessful because of excessive wear on the skyline and failure to hold positively. The existence of a skyline brake made it difficult to put the carriage on the skyline and to remove it from the skyline whenever the skyline had to be shifted from one logging area to another. In some systems the cables become entangled and create a hazard as well as slowing up the work.

Attempts have been made to install a hoisting engine in the carriage but without success. An engine requires frequent service thereby entailing loss of time and adding to the care and maintenance of the system. Also, an internal combustion engine suitable for the purpose will not operate satisfactorily in steeply inclined or up-ended position, or turned on its side, as frequently occur in logging operations. When a carriage with an engine is dropped, a serious fire hazard is created during dry conditions.

Objects of the invention are, therefore, to provide an improved skyline carriage, to provide a carriage that will speed up logging operations without sacrificing safety, to provide a carriage that is safe in downhill logging, to provide a carriage that is more efficient overall than existing carriages, to provide a carriage that is easy to put on the skyline and take off from the skyline, to provide an improved high pressure hydraulic system, to provide an improved leak-proof multiple valve unit, to provide an improved skyline clamp, to provide an improved hydrostatic transformer, and to provide an improved bi-rotational pump.

SUMMARY OF THE INVENTION

The present carriage has a three-section drum for a main line, haulback line and hoisting line. The carriage is moved back and forth on a skyline by a yarder at one end of the skyline. A winch drum on the yarder pulls the carriage in by winding in the main line and a winch drum on the yarder pulls the carriage out by winding in the haulback line. During these operations a hydraulic brake prevents rotation of the cable drum in the carriage.

When a turn of logs is to be raised up to the carriage or lowered from the carriage, a hydraulic clamp is applied to the skyline to hold the carriage stationary and the drum brake is released. Then, when the yarder pulls

in the main line and pays out the haulback line, the logs are raised by the hoisting cable on the carriage cable drum and, when the yarder pays out the main line and winds in the haulback line, the logs are lowered. An improved skyline clamp is provided which does not damage the skyline.

A novel hydraulic system supplies the drum brake and skyline clamp under radio control. A novel hydrostatic transformer automatically intensifies hydraulic pressure three and one-half times for the skyline clamp. A novel leak-proof multiple valve unit is provided and a novel pump is operated by rotation of the carriage cable drum in either direction.

Putting the carriage on the skyline and taking it off is facilitated by a novel arrangement of the skyline clamp. The skyline cable may be readily inserted in and removed from the clamp jaws without threading the end of the skyline through the clamp mechanism.

The invention will be better understood and additional objects and advantages will become apparent from the following description of the preferred embodiment illustrated in the accompanying drawings. Various changes may be made in the details of construction and arrangement of parts and certain features may be used without others. All such modifications within the scope of the appended claims are included in the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a logging operation employing the invention;

FIG. 2 is an isometric exploded view with parts broken away, showing the skyline carriage in FIG. 1;

FIG. 3 is a view on the line 3—3 in FIG. 2;

FIG. 4 is a top plan view of the carriage with parts broken away;

FIG. 5 is a view on the line 5—5 in FIG. 4, showing the skyline clamp in operative position;

FIG. 6 is a similar view, showing the overarm assembly raised and the movable clamp jaw partially removed;

FIG. 7 is a view on the line 7—7 in FIG. 4;

FIG. 8 is a view on the line 8—8 in FIG. 4;

FIG. 9 is a fragmentary sectional view of the carriage with parts in elevation, showing the cable drum and hydraulic pump;

FIG. 10 is an axial view of the pump in FIG. 9;

FIG. 11 is a view on the line 11—11 in FIG. 9;

FIG. 12 is an enlarged sectional view of a portion of FIG. 9, showing the pump inlet valve;

FIG. 13 is a view on the line 13—13 in FIG. 9;

FIG. 14 is a view on the line 14—14 in FIG. 9;

FIG. 15 is a view on the line 15—15 in FIG. 9;

FIG. 16 is a view on the line 16—16 in FIG. 9;

FIG. 17 is a view on the line 17—17 in FIG. 16;

FIG. 18 is a schematic diagram of the hydraulic and electric system;

FIG. 19 shows sectional views of the multiple valve unit and hydrostatic transformer including other parts of the hydraulic system in FIG. 18; and

FIG. 20 is a sectional view of a modification of the multiple valve unit in FIG. 17.

DESCRIPTION OF THE PREFERRED EMBODIMENT

General Description and Mode of Operation

FIG. 1 illustrates a downhill logging operation which

can be carried out safely with the present equipment but which cannot be carried out safely with any other known equipment. Carriage 10 runs back and forth on an inclined skyline 11 to carry a turn of logs L down to the yarder Y which is accessible to some means of transportation for hauling the logs away. The remote end of skyline 11 is supported in elevated position by a sheave on tail tree 12 with the end of the skyline anchored to a tail hold stump 13. Tail tree 12 is situated on considerably higher ground than the yarder Y whereby the skyline 11 is steeply inclined downhill from the tail tree to the yarder. This topographic feature has heretofore presented a great hazard in the operation of conventional equipment.

Connected with carriage 10 are a main line 15, a haulback line 16 and a hoisting line 17 equipped with a choker hook 18. The yarder Y is equipped with a winch drum 20 to raise and tension the skyline 11, a winch drum 21 to pull in and pay out the main line 15, and a winch drum 22 to pull in and pay out the haulback line 16. These lines are guided to the yarder winch drums by sheaves on a mast 23 on the yarder. Haulback line 16 is returned to the yarder through pulley blocks 24 on stumps at one side of the working area so that the haulback line is kept clear of the working area and at a distance from skyline 11 and main line 15 to prevent entanglement of the cables and danger to workmen.

Referring now to FIG. 2, carriage 10 is supported for travel on skyline 11 by a pair of rider sheaves 30. Each rider sheave is mounted in a bracket 31 having a transverse horizontal bore 32 on each side to receive a pivot bolt 33. The pivot bolts 33 are mounted in holes 34 in the opposite side plates 35 of the carriage frame. This provides a yieldable pivotal suspension in the event that the carriage or sheaves 30 bump into a tree or other obstruction during travel on the skyline.

Side plates 35 also support a stationary transverse shaft 40 which carries a three-section cable drum 41. One end of the cable drum 41 is equipped with a brake drum 42 having a brake band 43. The brake band may be tightened to prevent rotation of cable drum 41 by a hydraulic brake cylinder 44.

Cable drum 41 has an end section 45 receiving and anchoring one end of main line 15, an opposite end section 46 receiving and anchoring one end of haulback line 16 and a center section 47 receiving and anchoring the upper end of hoisting line 17. The carriage has a lid or top plate 49 carrying a skyline clamp generally designated by the numeral 50. The brake 43 and clamp 50 are controlled by radio as will presently be explained.

As shown in FIGS. 9, 16 and 17, an arcuate plate 51 of short radius curvature is welded into an opening 52 in winding drum plate 53. Plate 51 has an axial keyhole slot with a wide portion 54 to receive the cable and ferrule 55 and a narrow portion 56 to pass the cable into a circumferential slot 57 which anchors the ferrule. In case the drum rotation should overrun the length of the cable, the cable will readily swing to the opposite end of slot 57 and start winding up again without kinking the cable.

FIG. 17 shows the normal position of cable 17 and ferrule 55 in full lines. The step of inserting the ferrule in wide slot portion 54 is shown in broken lines and the reverse winding position of the cable and ferrule is also shown in broken lines. The other two cables 15 and 16 are anchored in the same manner in drum sections 45

and 46. Cable 16 is guided by the fairlead 58 in FIG. 2.

When it is desired to pull the carriage 10 out toward tail tree 12, cable drum brake 43 is set and skyline clamp 50 is released. The carriage is pulled out by pulling in haulback line 16 by means of yarder haulback winch drum 22 and paying out main line 15 from yarder main line winch drum 21. When the carriage has reached a point where it is desired to pick up a turn of logs, the skyline clamp 50 is set and cable drum brake 43 is released. Then, by pulling in more haulback line 16 on yarder winch drum 22 and paying out more main line 15 from yarder winch drum 21, the carriage cable drum 41 is rotated in a clockwise direction in FIG. 2 to lower the hoisting cable 17 and choker hook 18.

When the choker hook 18 on hoisting cable 17 has been secured to a turn of logs, the logs are raised by rotating carriage cable drum 41 counterclockwise with clamp 50 applied on skyline 11. This is accomplished by pulling in main line 15 on yarder winch drum 21 and paying out haulback line 16 from yarder winch drum 22. When the logs have been raised sufficiently as shown in FIG. 1, carriage drum brake 43 is applied to prevent rotation of drum 41 and skyline clamp 50 is released.

In the downhill logging operation in FIG. 1, the carriage 10 with its turn of logs will travel back to the yarder by gravity, yarder haulback winch drum 22 paying out haulback line 16 at a rate to control the speed of the carriage. At the same time, slack in main line 15 is taken up on yarder main line winch drum 21. In logging on the level or uphill, the carriage is pulled back to the yarder by main line winch drum 21.

When the carriage reaches its unloading point adjacent the yarder, in downhill logging as shown in FIG. 1, its movement is arrested by braking the yarder haulback winch drum 22 until the carriage comes to rest. Then skyline clamp 50 is set and carriage drum brake 43 is released. Paying out main line 15 from yarder main line winch drum 21 allows carriage drum 41 to rotate clockwise in FIG. 2 and lower the turn of logs on hoisting line 17. Thus, the movements of carriage 10 on skyline 11 and the raising and lowering of hoisting line 17 are controlled through yarder winch drums 21 and 22 and drum brake 43 and skyline clamp 50 on the carriage.

Skyline Clamp

Referring now to FIGS. 2 and 4 to 8, carriage lid plate 49 is securely fastened to the carriage by bolts and dowels. The lid plate is removable as shown in FIG. 2 for access to the mechanism inside the carriage. As best shown in FIG. 6, the stationary clamp jaw 60 comprises a long angle iron equipped with a similar angle iron liner 61 which engages the skyline cable 11. These parts are welded to lid plate 49 and also to an inclined thrust plate 62. Welded on top of jaw 60 is a horizontal pivot plate 63 having a rounded pivot edge or tongue 65. The parts 60, 61, 62 extend approximately the entire length of lid plate 49. There are a number of the pivot plates 63, each of relatively short length as will presently be explained.

Movable clamp jaw 66 comprises an angle iron welded to a thrust bar 67 and equipped with an angle iron liner 68. These parts extend approximately the full length of lid plate 49. Clamping pressure is applied at intervals along thrust bar 67 by a plurality of hydraulic

cylinder and piston units **70, 71**. Each unit nestles loosely in a hole **72** in lid plate **49** with piston **71** engaging an edge of thrust bar **67** as shown in FIG. **4**. Holes **72** are rectangular and of less width than cylinders **70** whereby the side edges of the holes support the cylinder and piston units with the lower sides thereof projecting through plate **49**.

Movable jaw **66** and clamp cylinders **70** are secured in assembled relation by pairs of overarms **73** as shown in FIGS. **4** and **5**. The arms **73** of each pair are spaced apart the same distance as the width of the underlying hole **72** to hold the cylinders loosely in the holes. Each pair of overarms **73** is welded at one end to a hinge pin **75** which is mounted for rotation in hinge ears **76** on lid plate **49**. A block **77** spans the overarms **73** and overlies thrust bar **67** to prevent uplift of jaw **66** when the overarms are in closed position as shown in FIG. **5**. Clamp cylinders **70** have flat head ends which abut against hinge pins **75** and the ends of holes **72** to sustain the thrust reaction under clamping pressure.

The swinging ends of overarms **73** are connected with short oval bushings **79** which contain a round bar **80** extending approximately the length of lid plate **49**. Bar **80** contains a longitudinal groove **81** to fit the tongue **65** as shown in FIG. **5**. Lever arms **82** are provided for rotating bar **80** clockwise as shown in broken lines in FIG. **5** to disengage groove **81** from the tongue **65** so that all the overarms **73** may be swung clockwise in unison on their pivot bolts **75** as shown in FIG. **6**. Thus, tongue **65** and groove **81** form a quick releasable toggle joint for holding the overarms **73** securely in operative position in FIG. **5**. The overarms swing down into the plane of pivot plates **63** in open intervals between the pivot plates.

Referring now to FIG. **4**, the overarms **73** are secured in operative position by a rod **85** extending approximately the length of lid plate **49** which is inserted through a series of apertured ears **86** upstanding on thrust plate **62**. Rod **85** also extends through an opening **87** (FIG. **6**) in the end of each lever **82**. As shown in FIGS. **4** and **5**, a lock arm **90** having an opening **91** is welded on one end of rod **85**. In locked position the end of arm **90** is disposed between the end lever arm **82** and an upstanding ear **92** on thrust plate **62**. This end lever arm **82** has an opening **93** (FIG. **6**) to register with the opening **91** whereby a pin **94** inserted through openings **91** and **93** secures rod **85** and lock arm **90** in locked position.

Movable jaw **66** is retracted by retractor cylinder and piston units **95, 96** in FIGS. **4** and **7**. There is a pair of these retractor units, each cylinder **95** being flexibly mounted in lid plate **49** by a bolt **97** welded at one end to the under side of the cylinder. Bolt **97** extends through a large hole **98** in lid plate **49** and cylinder **95** is supported at the proper height above the plate by upper and lower stacks of resilient rubber washers **99** clamped against opposite sides of the plate by a nut **100**. Hydraulic fluid is supplied to cylinder **95** by a nipple **105** welded on the under side of the cylinder and extending through an enlarged hole **106** in lid plate **49**.

The head end of cylinder **95** is rounded to fit a rounded depression **107** in an abutment block **108** welded on lid plate **49**. In a similar manner, the outer end of piston **96** is rounded to fit a rounded depression **109** in the cross member of a U-shaped yoke or stirrup **110**, the ends of which are welded to the thrust bar **67**.

Extension of pistons **96** in the two retractor cylinders **95** act through the two yokes **110** to retract thrust bar **67** and movable clamp jaw **66** to the right in FIG. **7**.

Thus, the series of clamp cylinder and piston units **70, 71** and the pair of retractor cylinder and piston units **95, 96** are all loosely and flexibly mounted to adjust themselves to the position of movable clamp jaw **66**. Any slight endwise movement of clamp jaw **66** does not impose side loading on the pistons.

From the foregoing description it will be apparent that movable clamp jaw **66** includes as an integral part thereof, in addition to its liner **68**, the thrust bar **67** and the two retractor yokes **110**. This clamp jaw unit is bodily removable by opening the overarm assembly **73** as shown in FIG. **6**. There is sufficient clearance between thrust bar **67** and abutment block **108** in FIG. **7** to permit yoke **110** to be pulled manually farther to the right after piston **96** is fully extended in order to disengage depression **109** from the end of the piston.

Complete removal of the movable jaw unit facilitates various operations, such as mounting carriage on the skyline and removing it from the skyline, renewing the clamp jaw liners **61** and **68** when necessary, or changing the liners to fit a different size of skyline cable **11**. Clamp cylinders **70** are also removable by merely disconnecting their hydraulic fittings and retractor cylinders **95** are removable by detaching the hydraulic connections and unscrewing nuts **100**. These hydraulic connections comprise clamp cylinder manifold **115** and retractor cylinder manifold **116** in FIGS. **2** and **5**.

End thrust means are provided for preventing longitudinal movement of movable clamp jaw **16**. The opposite ends of movable jaw **66** and thrust bar **67** in FIG. **2** bear against abutment blocks **111** as further illustrated in FIGS. **4, 5, 6** and **8**. Each abutment block **111** is welded to lid plate **49** and a doubler plate **112**. Block **111** overhangs the edge of carriage shell plate **113** and engages a block **114** welded in a pocket of the carriage shell. The lower end of block **111** is tapered to facilitate installing and removing lid plate **49**.

Pump

A novel pump **120** is contained in cable drum **41** to pressure a hydraulic system for operating drum brake **43** and skyline clamp **50** as shown in FIGS. **9** to **15**. The pump is carried by the stationary shaft **40** mounted in carriage side plates **35**. The pump has five stationary cylinders **122** containing pistons **123** operated by a six lobed rotary cam ring **124**. Cam ring **124** is bolted to tabs **125** in the drum. The space within the drum not occupied by these parts forms an oil reservoir **126**. The drum rotates on bearings **127** on shaft **40** equipped with suitable seals to retain the oil supply in the reservoir.

The object of this arrangement is to provide a bi-rotational pump that operates equally well in either direction of rotation and produces high pressure oil efficiently at a low speed of drum rotation. This arrangement also provides a compact form of construction which does not require other valuable space for the pump and reservoir and provides maximum protection for the pump. Conventional birotational pumps are not efficient at low speeds to produce a high pressure output. They require a high ratio gear train in order to deliver enough oil at low speeds. Such a gear train requires space not available in a skyline carriage, the gear train is costly initially and would rotate the pump at de-

structively high speeds if the turn of logs was accidentally dropped.

The construction of the present pump is such that accidental high speed does not damage the pump. The pistons do not draw in a full charge of oil under an abnormal high speed condition. Each piston has a relatively small displacement but by operating the five pistons by six cam lobes an adequately large total displacement is obtained at low speeds. The pistons make 30 strokes per drum revolution. All the pistons are out of phase with each other and a relatively even discharge flow results. Piston leakage is of no consequence because any leakage merely returns to reservoir 126. Piston leakage is minimized by reason of the long bearing area between the piston and cylinder wall.

Referring now to FIG. 10, each piston 123 is urged outward by a compression spring 129 and is moved inward by a cam follower arm 130. Each arm 130 is pivotally mounted at 131 on a bracket 132 on a stationary housing block 135 which may be a part of shaft 40. The outer ends of arms 130 are equipped with cam follower rollers 136 which ride on the cam ring 124. Intermediate their ends, the arms 130 are equipped with rollers 137 which engage the ends of pistons 123. This arrangement eliminates any side loading on the pistons.

Oil enters the pump from reservoir 126 through inlet screen 140 and inlet connection 141 to inlet manifold 142 in block 135. (FIG. 13). At the inner end of each cylinder 122 there is a combined inlet and outlet valve unit 143. This valve unit has an axial chamber 144 containing an inlet check valve 145 normally closed by a spring 146 as shown in FIG. 12. An inlet port 147 communicates with inlet manifold 142 and a cylinder port 148 communicates with cylinder 122. Thus, as piston 123 moves outward, valve 145 opens to admit an inlet flow from manifold 142 through ports 147 and 148 into the cylinder.

As piston 123 moves inward, the cylinder discharges through port 148, chamber 144 and a port 149 normally closed by outlet check valve 150. Check valve 150 is seated by a spring 151 in a radial chamber 152. The five chambers 152 discharge into a discharge manifold 153 in FIG. 11 which communicates with a longitudinal discharge passageway 155 extending toward one end of shaft 40.

A pressure relief valve 156 mounted in port 158 in FIG. 14 prevents excessive pressure from developing in the pump discharge. A bypass line 157 delivers the excess unused flow to a nozzle 160 directed into inlet tube 161 in FIG. 9. This relief valve bypasses almost constantly and its discharge is used to supercharge inlet tube 161 and manifold 142. The jet from nozzle 160 carries with it additional oil from reservoir 126.

A port 170 in the outer end of pump discharge passageway 155 outside of drum 41 connects with a hydraulic line 171 carrying pump pressure to the multiple valve unit V in FIGS. 2 and 19. This pressure is transmitted at all times through line 172 to hydraulic accumulator 173 and to skyline clamp retract cylinders 95. Valve unit V controls the application of oil pressure to brake cylinder 44 and also controls the application of oil pressure to a hydrostatic transformer 175 which supplies a higher pressure to skyline clamp cylinders 70. Return flow is conveyed from valve unit V through line 176 to a port 177 in the outer end of a second longitudinal passageway 180 in shaft 40 as shown in FIGS.

9 and 15. This oil returns to cable drum reservoir 126 through port 181 in the inner end of passageway 180.

As the volume of oil changes in accumulator 173, the volume changes in cable drum reservoir 126. To prevent pressure or vacuum buildup in reservoir 126, breathing is provided through the stand pipe 183 shown in FIG. 14. Stand pipe 183 is screwed into a port 184 in the inner end of a third longitudinal passageway 185 in shaft 40. A port 186 in the outer end of passageway 185 is connected with a hydraulic line 187 to expansion tank 190 in FIG. 2. The expansion tank is vented to atmosphere through a port 191.

The ends of the various bore holes forming the oil manifolds and passageways just described are closed by plugs 193.

Hydraulic System

The hydraulic system is illustrated schematically in FIG. 18 in combination with the radio control system. The plurality of skyline clamp cylinders is represented by the single cylinder 70 and the plurality of clamp retractor cylinders is represented by the single cylinder 95. The control of these cylinders and brake cylinder 44 involves primarily multiple valve unit V and hydrostatic transformer 175. Valve unit V is associated with brake application solenoid valve SV1, brake release solenoid valve SV2, clamp application solenoid valve SV3 and clamp release solenoid valve SV4. These solenoid valves may be of the in-line type connected externally to valve unit V or they may be of the plug-in type which screw into ports in valve unit V and become an integral part thereof. The solenoid valves are controlled by four different signals received by radio receiver R through its antenna 220. The radio receiver and solenoid valves are energized from a battery 221.

For a better understanding of the hydraulic system, reference is made to FIG. 19 showing the structural details of valve unit V and hydrostatic transformer 175. Oil from pump 120 flows through the previously mentioned discharge line 171 and a check valve 222 into the main inlet distribution manifold chamber A in valve unit V. Pump pressure in manifold A is communicated at all times through port 223 to clamp retractor cylinder 95, through port 224 and line 172 to pressure accumulator 173 and through port 225 and filter 226 to a port 227 in secondary distribution manifold chamber B. Thus, manifold B is also under pump pressure at all times.

Brake application solenoid valve SV1 is connected between a port 228 in manifold B and port 229 in brake fluid manifold C. Brake cylinder 44 is connected to a port 230 in manifold C. Thus, energization of solenoid valve SV1 opens the valve and applies oil pressure to brake cylinder 44 to tighten the brake 43 on brake drum 42 of the cable drum 41 in FIG. 2.

Brake 43 is released by energizing brake release solenoid valve SV2 to open the valve. This valve is connected between a port 231 in manifold C and a port 232 in relief manifold chamber F. Manifold F discharges through port 233 and the previously mentioned return line 176 to cable drum reservoir 126.

The skyline clamp 50 in FIG. 2 is applied by energizing clamp application solenoid valve SV3 to open the valve. This solenoid valve is connected between port 238 in manifold B and a port 239 in pilot fluid manifold

D. The introduction of oil pressure into manifold D does two things. First, it shifts piston valve 240 to the right to close an orifice 241 between working fluid manifold chamber E and relief manifold chamber F since there is no opposition to the movement of piston 240. Second, it moves piston 242 to the right causing stem 243 to unseat check valve 245 from an orifice 246 between manifolds A and E, introducing oil pressure into manifold E.

Check valves 222 and 245 are normally seated by a common compression spring 247. Piston 242 is considerably larger than orifice 246 so that the piston force applied through stem 243 exceeds the spring force plus fluid pressure force acting on check valve 245 in manifold A. Oil pressure in manifold E does not unseat piston valve 240 because of the small piston area exposed to pressure in manifold E after the valve has closed orifice 241.

Pressure in manifold E does not shift piston 242 back to the left because the oil is locked in, in manifold D, and pressures are, in effect, equal in manifolds A, E and D. Port 250 conveys the oil through line 251 to port 252 in the low pressure end of hydrostatic transformer 175. Skyline clamp cylinders 70 are connected to a port 253 in the high pressure end of the hydrostatic transformer, the operation of which will be presently described.

The skyline clamp is released by energizing clamp release solenoid valve SV4 to open the valve. This valve is connected between port 255 in pilot fluid manifold D and port 256 in relief manifold F. This permits pressure in manifold D to bleed off through manifold F to reservoir 126. Piston 242 is subjected to high pressure in manifold E across its entire face area while face area of piston 240 in manifold E is reduced by the area of orifice 241. Therefore, the pressure drop in manifold D closes check valve 245 first and then allows the pressure in manifold E to move piston 240 away from orifice 241. This immediately relieves the pressure in manifold E, permitting oil to return from the low pressure end of hydrostatic transformer 175 through line 251 to manifold E, thence through orifice 241 and chamber F to reservoir 126.

With the relief of fluid pressure from clamp cylinders 70, the continuously pressurized retractor cylinders 95 retract the movable clamp jaw 66. As the clamp jaw retracts, a considerable flow of oil from clamp cylinders 70 is displaced through hydrostatic transformer 175 and line 251 to manifold E and continues until all the displaced oil is exhausted from cylinders 70. This action must be completed quickly to prevent sliding wear on the skyline.

Hydrostatic transformer 175 operates as an automatic pressure intensifier to raise the pressure in clamp cylinders 70 and conserve oil. Assuming a pressure of 3,000 psi introduced into port 252, the clamp cylinders 70 will be supplied with oil from port 253 at a pressure of 10,000 psi. Hydrostatic transformer 175 accomplishes this without the use of heavy springs, external valves and complicated piping arrangements.

Piston 270 has a large end movable in a large cylinder 271 and a small end movable in a small cylinder 272. Thus, the large end of the piston operates in a chamber G in cylinder 271 and the small end of the piston operates in a chamber H in cylinder 272. Piston 270 contains a central passageway 273 equipped with a check valve 275 normally seated by a spring 276. An oil line

277 having a check valve 278 connects port 279 in chamber G with port 280 in manifold F of the valve unit V. An oil line 281 having a restrictor 282 connects a port 283 in chamber G with port 284 in manifold F. When piston 270 is fully retracted, check valve 275 is unseated by a fixed rod 274, not shown.

Check valve 278 and restrictor 282 control the oil in chamber G. The chamber G may fill rapidly with oil from manifold F when piston 270 is retracting upward but outflow when the piston is moving downward is restricted at 282. The pressure in chamber G is approximately atmospheric pressure at all times except for a brief period while clamp cylinders 70 are being actuated.

When manifold E in valve unit V is pressurized by the energization of solenoid valve SV3 as previously described, oil enters port 252 of hydrostatic transformer 175, thence flowing through passageway 273 of retracted piston 270 and chamber H into clamp cylinders 70. Thus, the movement of the pistons 71 in cylinders 70 necessary to close the movable clamp jaw 66 is produced by oil under system pressure flowing directly from working fluid manifold E without any pressure intensification. During this interval, piston 270 is restrained from moving because of the resistance to the outflow of oil from chamber G imposed by restrictor 282.

When pistons 71 under system pressure reach their limit of movement in clamped position, the oil flow through passageway 273 ceases and the difference in end areas on the upper and lower ends of piston 270 causes the piston to move downward until check valve 275 closes passageway 273. The piston comes to rest in an equilibrium position when the product of the oil pressure and piston area becomes equal on the large upper end and small lower end of the piston. This results in a high pressure in chamber H and cylinders 70 to exert a powerful clamping force against the movable clamp jaw 66.

It is to be emphasized that clamping is accomplished with system pressure first. Then, and only then, does pressure intensification take place. This conserves oil tremendously since all movement of the clamp jaw is taken up with system pressure first. If chamber H on to clamp cylinder 70 were a so-called "closed circuit," then piston displacement in chamber H would have to be larger and displacement in cylinder 271 must then be approximately $3\frac{1}{2}$ times that of chamber H. This would require an excessive volume of oil and a hydrostatic transformer of excessively large size.

When the pressure in manifold E is reduced to relief pressure by the opening of piston valve 240 in response to energization of solenoid valve SV4 as described above, oil flows out of the upper end of cylinder 271 through port 252, line 251, manifold E, orifice 241 and manifold F to reservoir. This allows piston 270 to move upward, gradually reducing the intensified pressure in chamber H to system pressure, to the point where rod 274 unseats check valve 275 and then permitting all the oil from cylinders 70 to return to reservoir. Constant pressure in retractor cylinders 95 causes clamp jaw 66 to retract and thus causes complete collapse of clamp cylinders 70 with all the oil being exhausted through chamber H, passageway 273 and port 252. During upward movement of piston 270, oil is drawn into chamber G through check valve 278 from relief manifold F.

Valve unit V has three primary features and advantages. First, it provides a leak-proof system for controlling the oil used for the skyline clamp. Second, it provides a compact and relatively simple manifold assembly for internally connecting many of the hydraulic lines and fittings which would otherwise require a complicated and cumbersome array of plumbing. Third, this valve unit keeps the high pressure line open to maintain pressure on the clamp cylinders until the action is reversed without having to keep the clamp application solenoid energized, thereby conserving battery power. Likewise, in the retracted position of the clamp, it keeps the hydraulic lines open to the reservoir until the action is reversed without a continuous drain on the batteries. Further, this valve unit prevents cross flow during the valving cycle. High pressure oil cannot flow into the low pressure line during the operation of the valving cycle.

If the system pressure is below normal for some reason when the skyline clamp is applied, as for example say 2,500 psi, this would produce a reduced clamp cylinder pressure of about 8,700 psi. But since valve unit V holds the pressure line open to the hydrostatic transformer, any pressure build-up in the system resulting from cable drum rotation is immediately transmitted to the clamp cylinders restoring their normal operating pressure. Each application of the skyline clamp causes a pressure drop in the system and subsequent drum rotation restores normal pressure. In normal use the cable drum is operated immediately after each application of the clamp. For example, merely lowering the hoisting line to pick up a load insures full clamp cylinder pressure when it is needed most, during the lifting of the load.

The nature of the carriage is such that only a limited amount of oil is available to operate the skyline clamp and cable drum brake. Therefore, the hydraulic system must be such that no oil can be lost. The clamp must not be subject to premature release because of leakage in the hydraulic system. The brake must not be subject to premature release regardless of how long the turn of logs hangs suspended in the air. Extreme danger would result if the brake or clamp were to release unexpectedly.

Since the pressures in manifolds D and E are substantially equal in both the applied and released positions of the clamp, leakage through or by pistons 240 and 242 is of no consequence. The construction of the four solenoid valves is such that in the deenergized positions, high pressures on the upstream sides of the valves tend to hold them tightly closed without leakage. The radio receiver R includes a timing device to hold the solenoid valves energized for a period of one second and then deenergize them. During this time interval the brake or clamp is fully applied or fully released without continued drain on the battery.

Valve unit V uses a minimum of oil for the pilot circuit in manifold D because pistons 240 and 242 move only enough to equalize pressures in manifolds D and E. After these pressures are equal, the pistons do not displace additional oil. In the clamp release function, again these pistons move only enough to equalize pressures in manifolds D and E. Thus, in both phases of the clamp operation there is no wasted oil in the pilot circuit operation.

The present hydraulic system is to be distinguished from systems controlled by conventional pilot-actuated

spool valves wherein a spool is shifted to control the main oil flow. Conventional spools necessarily entail tremendous leakage regardless of the excellence of their manufacture and regardless of the close tolerances obtained. The present system will hold its pressure for a period of weeks while standing idle and is then ready to resume operation without first pumping up the oil pressure.

The present hydraulic system also includes an additional and unique safety feature. Some yarders do not have enough power in their skyline drum to pick up the carriage and a turn of logs if suspended at the skyline midway point, making it necessary to hold the skyline drum with a dog if the yarder drum brake is not adequate to hold the drum from turning. Operating with such a yarder presents a serious hazard if the battery wire should break or the radio fail while the carriage is supporting a turn of logs near a midway position on the skyline. The present system is arranged to forestall serious trouble in such event.

In FIG. 19 a ring of small copper tubing T is connected to a port 265 in pilot fluid manifold chamber D of the valve unit V. As shown in FIGS. 2 and 3, the ring T is tucked into the inside corner of a ring 266 of steel rod which is welded to the outside of carriage side plate 35. Shooting into this target area with a small caliber rifle will splatter the bullet into the copper tube, rupturing it and releasing the pressure from manifold D thereby releasing the skyline clamp as is done in the usual manner. The release of pressure from manifold D does not release the cable drum brake 43 whereby the carriage with its turn of logs may still be moved along the skyline by the yarder winch drums 21 and 22.

Another feature of great importance is that it is impossible to apply the skyline clamp only partly on or partly off, which could allow it to slide on the skyline and cause destructive wear on the skyline cable. As previously mentioned, the radio receiver includes a time delay device that prevents deenergization of any energized solenoid valve for a period of one second. During this time interval, manifold D is either pressurized or de-pressurized, as the case may be, and the skyline clamp is either applied fully on or is completely released. It is impossible to apply the clamp only partly on or to release it only partly. It is at all times either fully applied or fully released.

In FIG. 20 the valve unit V₁ is a solenoid controlled three-way valve which is a modification of the valve unit V in FIG. 19, corresponding parts being identified by the same reference numerals. In this case, the single acting cylinder 270 is pressurized by energizing solenoid valve SV5 which performs the same function as SV3 in FIG. 19. Cylinder 270 is relieved of pressure by energizing solenoid valve SV6 which performs the same function as SV4 in FIG. 19. In FIG. 20 manifold chambers A₁, D₁, E₁, and F₁ correspond to manifold chambers A, D, E and F, respectively, in FIG. 19. With only small solenoid valves SV5 and SV6 to change the pressure in pilot fluid manifold chamber D₁, very large volumes of oil can be controlled in working fluid manifold chamber E₁ without leakage through the valve. The operation is not affected by dirty oil because pistons 240 and 242 are acted upon by the full oil system pressure which is adequate to move the pistons regardless of the presence of dirt in the oil. However, a filter as well as pressure accumulator may be employed with the valve unit V₁, if desired. Valve unit V₁ is of general

application to hydraulic systems for various purposes where the major features of valve unit V are of advantage.

Having now described our invention and in what manner the same may be used, what we claim as new and desire to protect by Letters Patent is:

1. In a skyline logging carriage, a skyline clamp comprising a stationary jaw and a movable jaw, means holding a plurality of hydraulic clamp cylinders loosely in position at intervals along said movable jaw to apply direct thrust against said movable jaw, and a pair of abutment blocks on the carriage engageable with opposite ends of said movable jaw to resist end thrust on said jaw.

2. A skyline logging carriage as defined in claim 1, including a plurality of hydraulic cylinders arranged to retract said movable jaw.

3. A skyline logging carriage as defined in claim 1, said holding means also holding said movable jaw loosely in operative position for transverse movement toward and away from the skyline and for lengthwise movement against one or the other of said abutment blocks, said holding means being releasable and said movable jaw being removable from the carriage when said holding means is released.

4. A skyline logging carriage as defined in claim 3, said holding means comprising a lid plate on the carriage having rectangular holes narrower than said clamp cylinders supporting said cylinders in horizontal position, said lid plate supporting said movable jaw for said transverse and lengthwise movements, and a hinged overarm assembly overlying said cylinders and movable jaw holding said cylinders and movable jaw loosely in operative positions.

5. A skyline logging carriage as defined in claim 1 including a hydraulic pressure system in the carriage, and a hydrostatic transformer connected with said pressure system and said clamp cylinders, said hydrostatic transformer operating said clamp cylinders at said system pressure in moving said movable jaw from a retracted to a clamped position and then operating as a pressure intensifier to increase the hydraulic pressure in the clamp cylinders to a pressure higher than said system pressure.

6. A skyline logging carriage as defined in claim 5 including retractor cylinders acting on said movable jaw at all times under said system pressure, said retractor cylinders being effective to retract said movable jaw when said clamp cylinders are not energized.

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