United States Patent [19]

Junes et al.

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[45] **Dec. 4, 1973**

[54] **SKYLINE LOGGING CARRIAGE**

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[52] **U.S. Cl.** **212/122**, 91/44, 254/D14, 212/89, 254/184

[51] **Int. Cl.** **B66c 21/00**

[58] **Field of Search** 212/122, 118, 83–89, 212/96, 97; 188/43, 44

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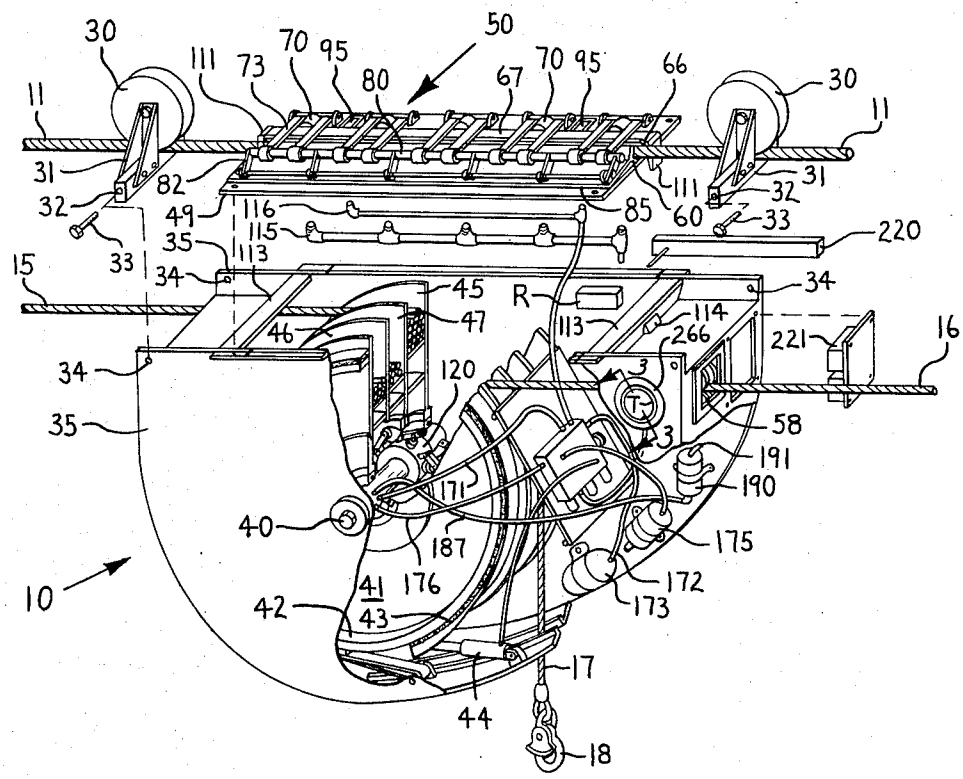
Primary Examiner—Harvey C. Hornsby,
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[57] **ABSTRACT**

The carriage is moved back and forth on a skyline by winch 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.

11 Claims, 23 Drawing Figures



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SHEET 1 OF 7

Fig 2

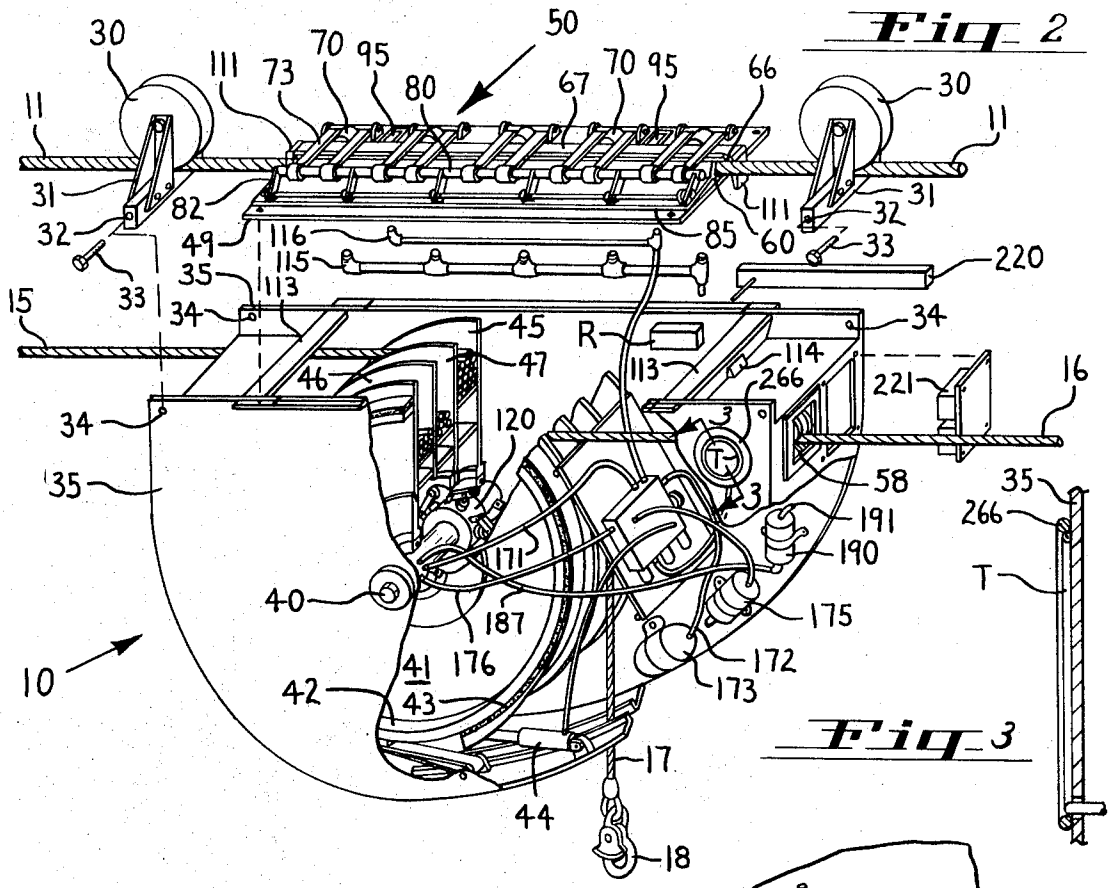
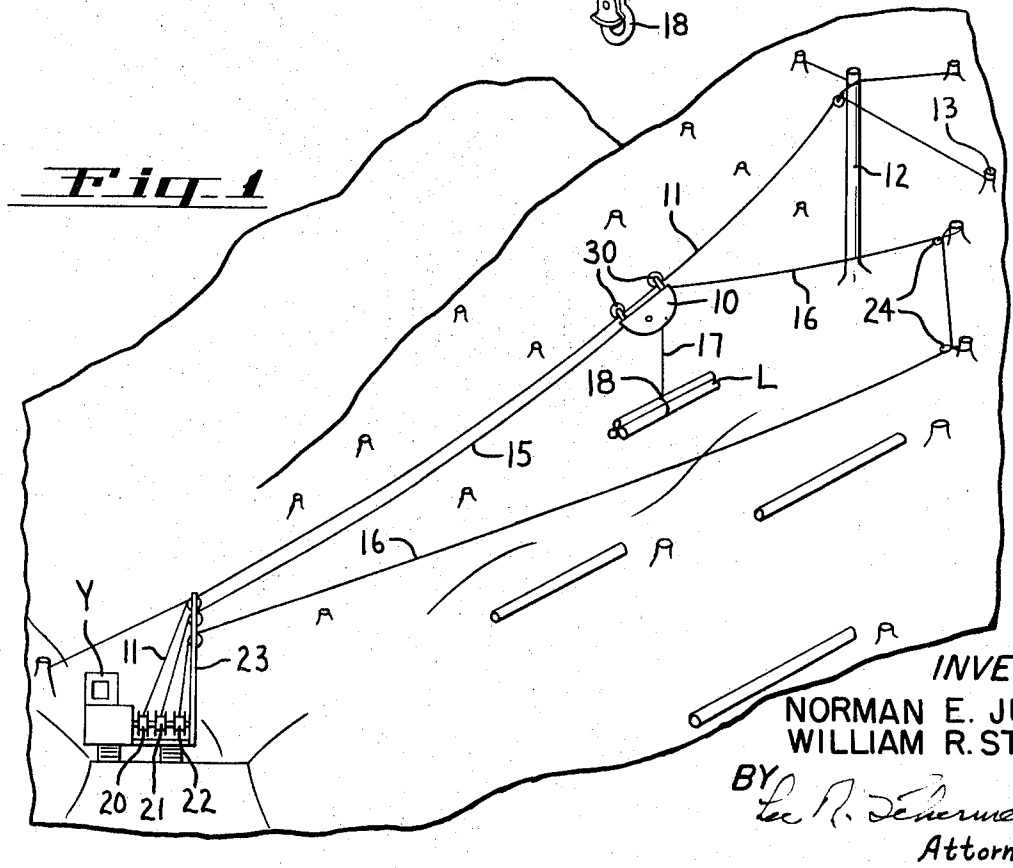


Fig 3

Fig 1



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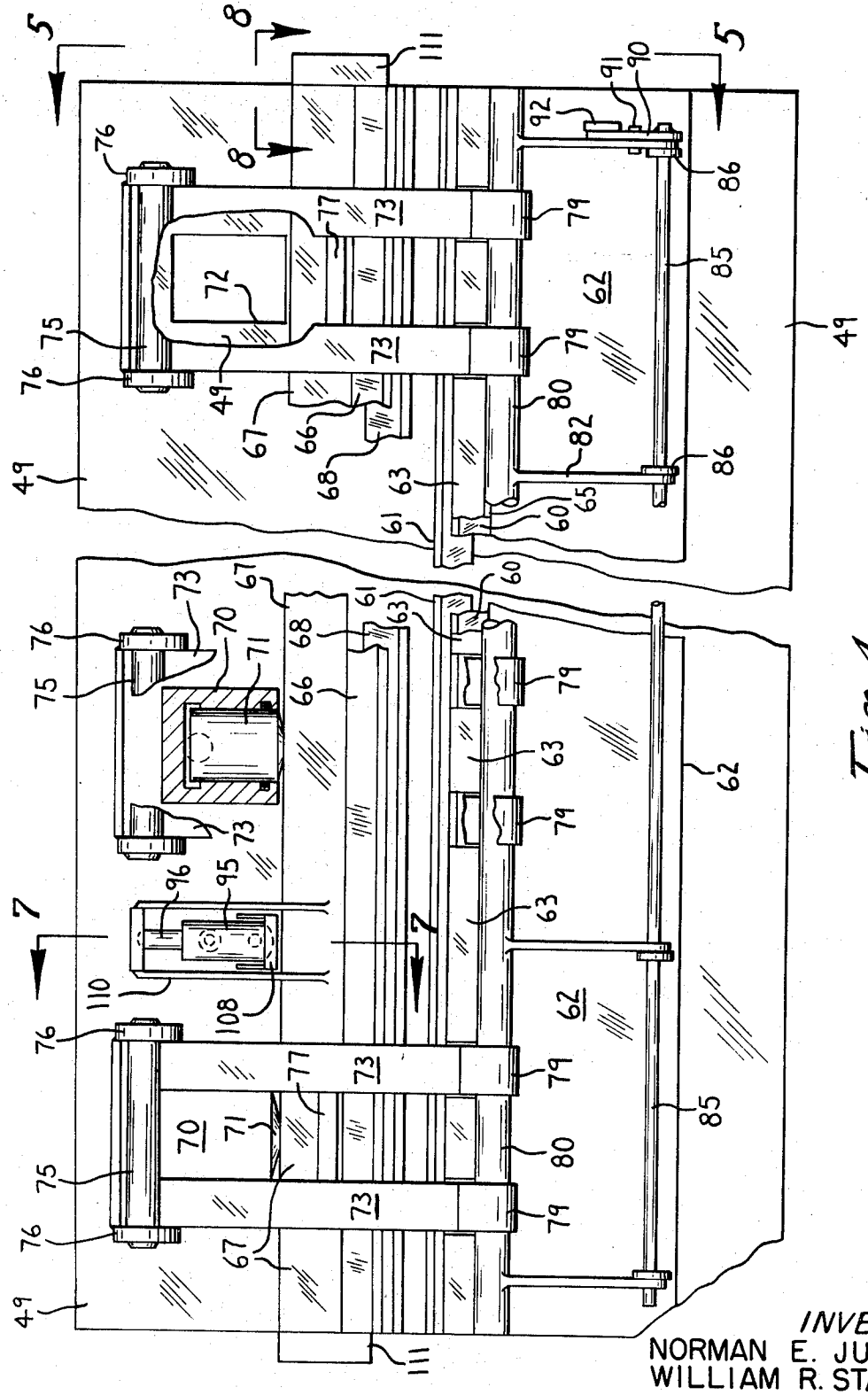


Fig. 4

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Fig 5

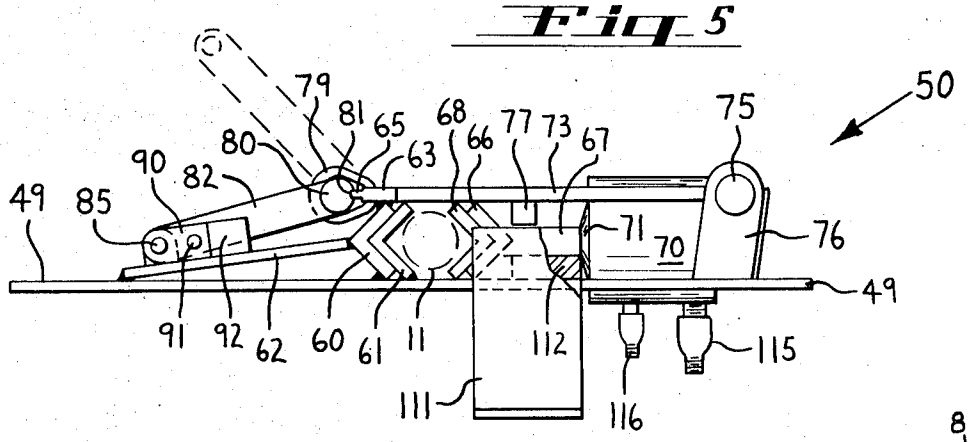


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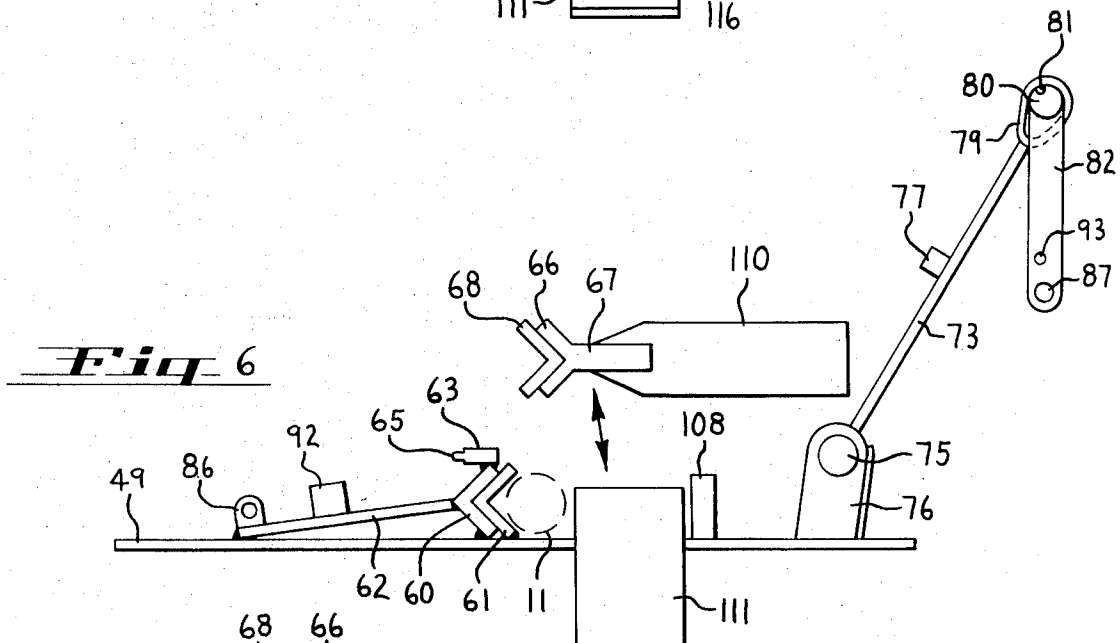


Fig 7

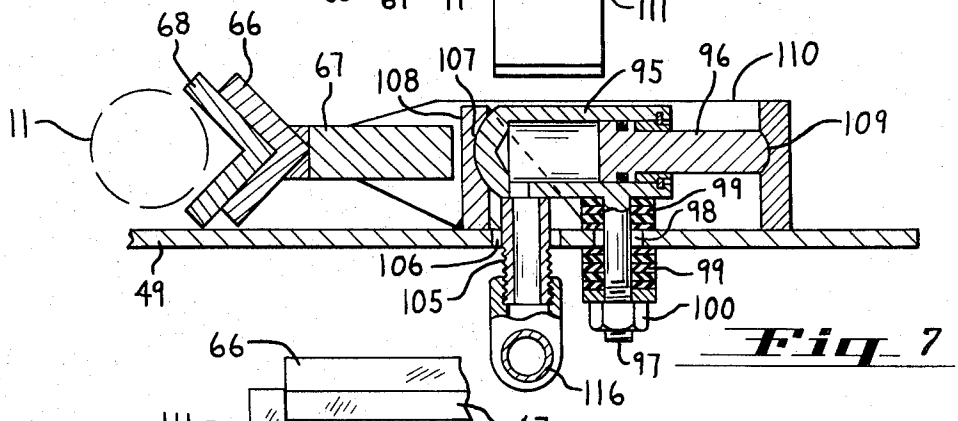
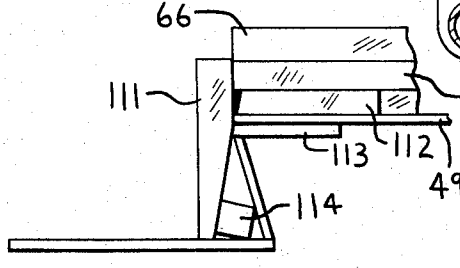


Fig 8



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Fig 9

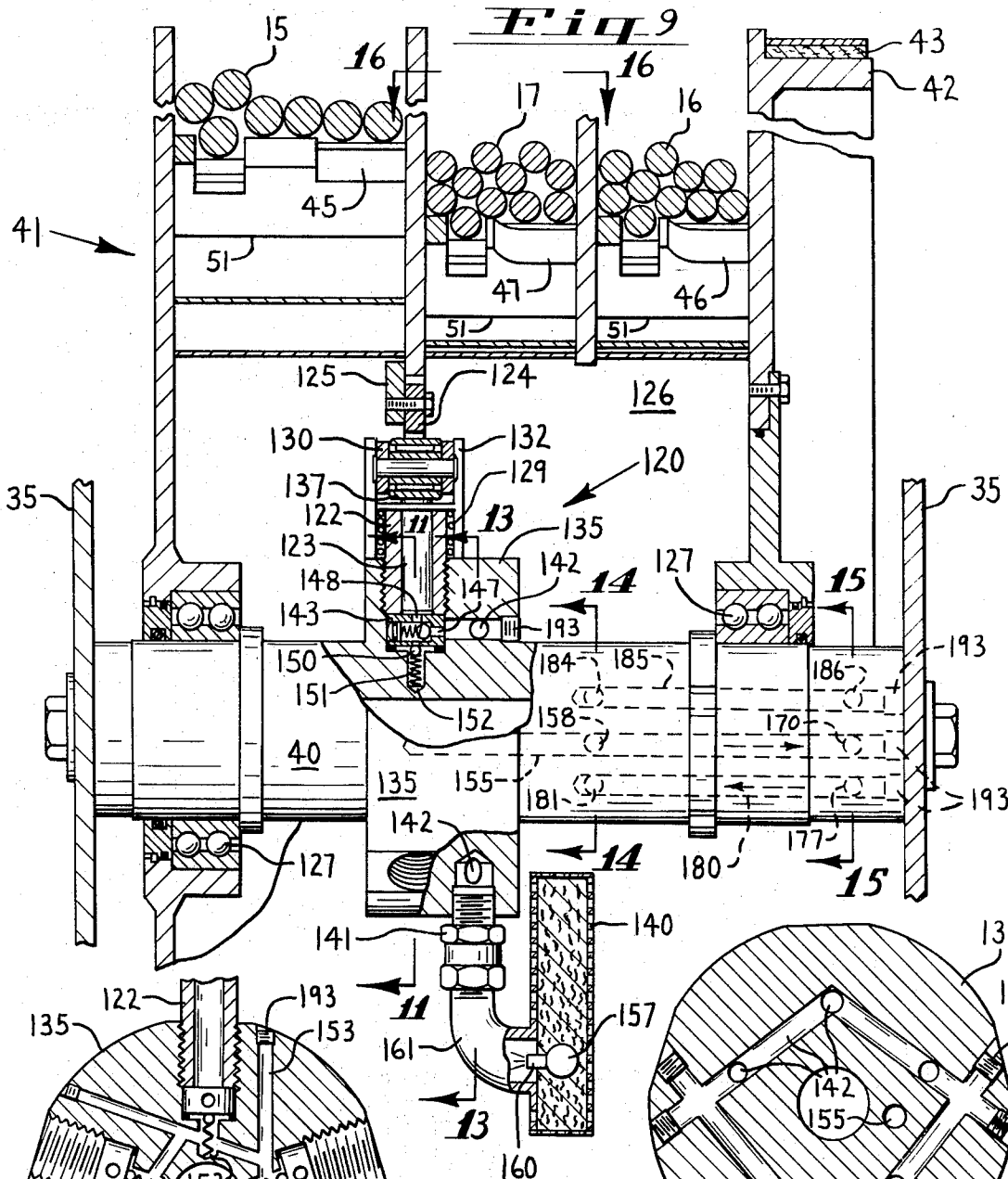


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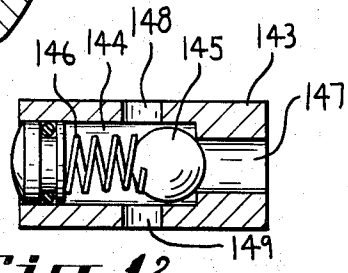
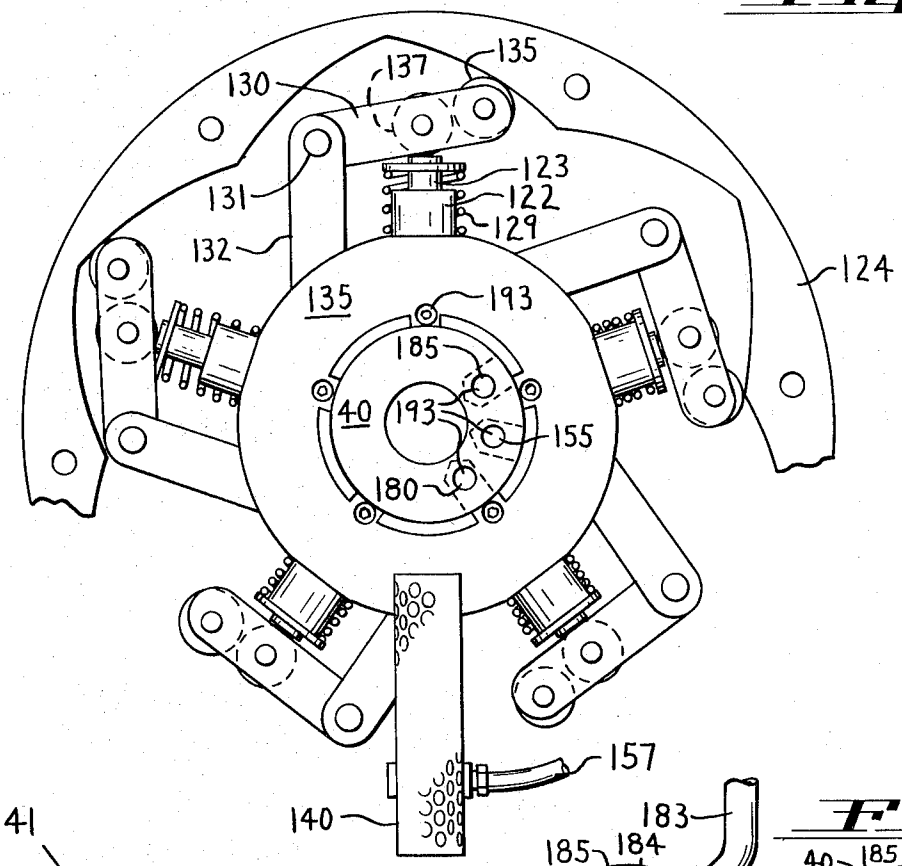


Fig 12

Fig 13

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Fig 10



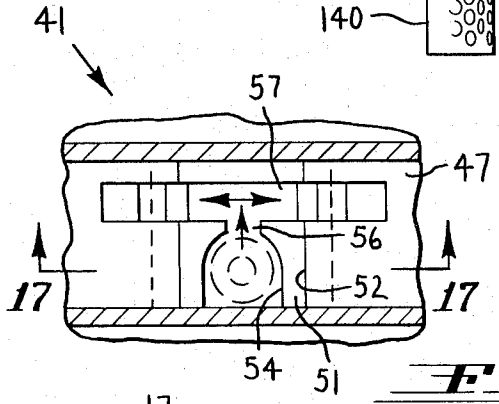


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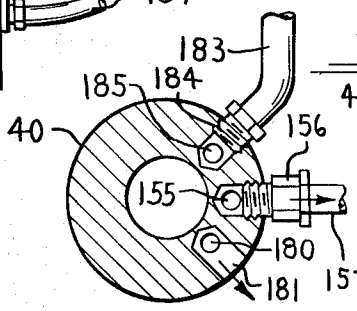


Fig 15

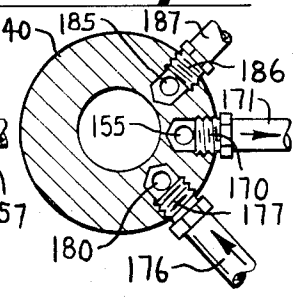
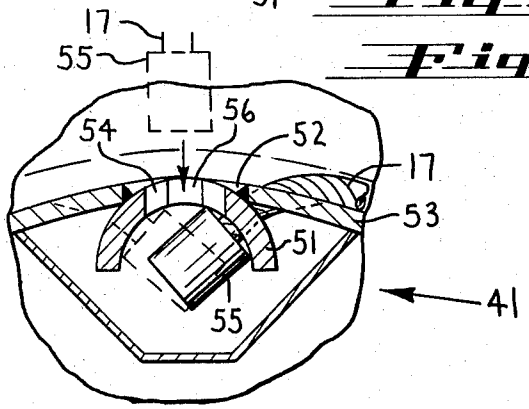


Fig 16

Fig 17



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Fig 18

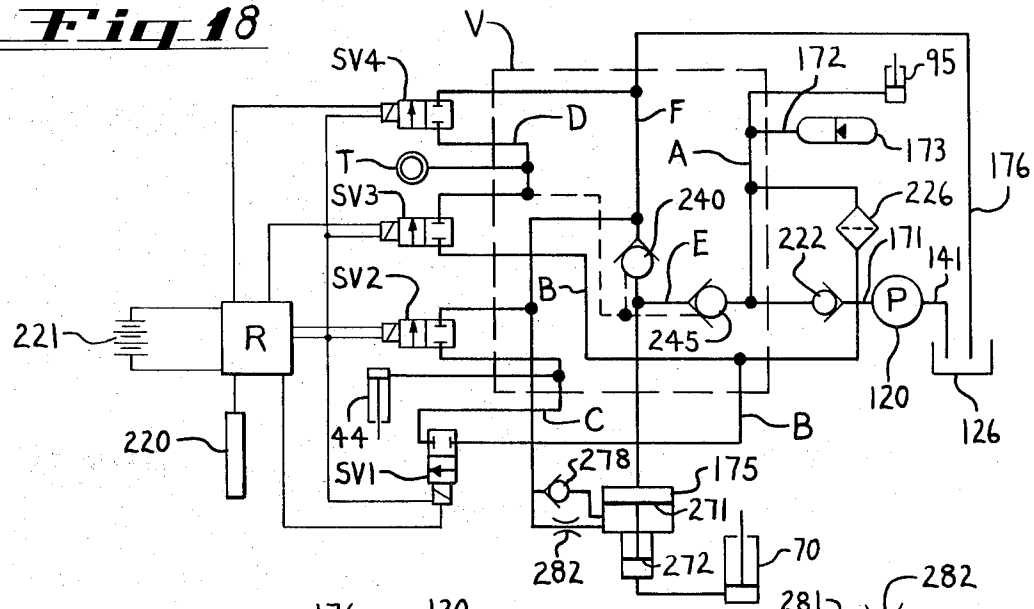


Fig 19

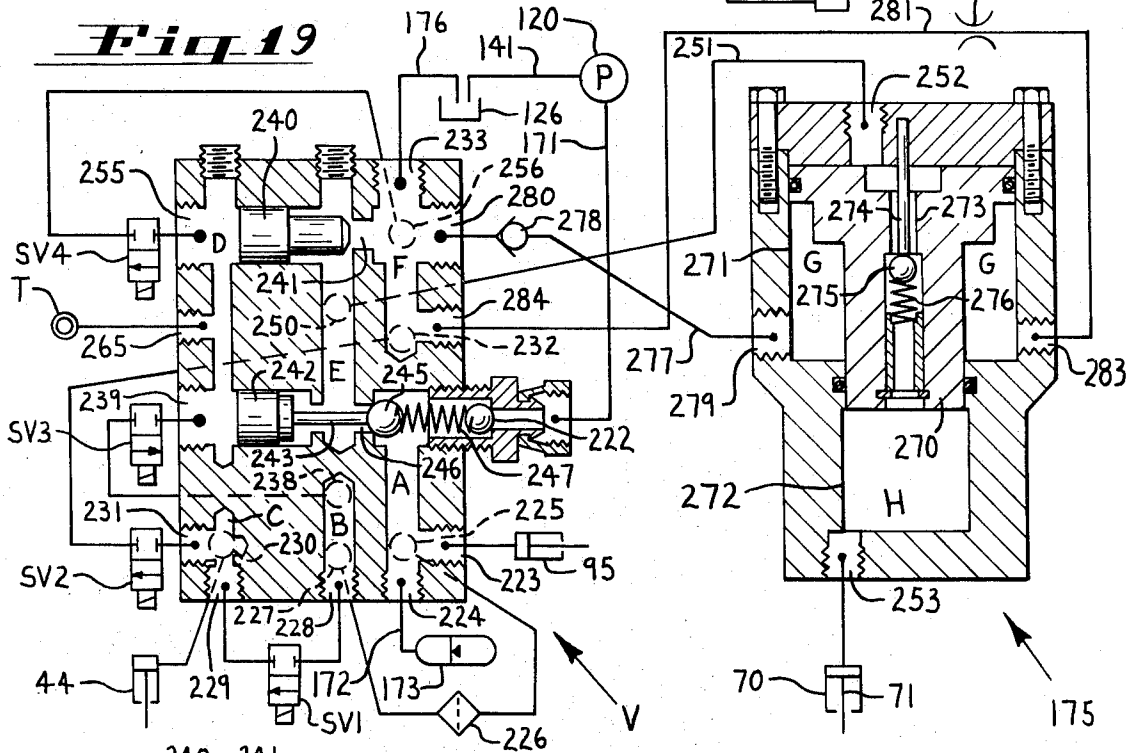
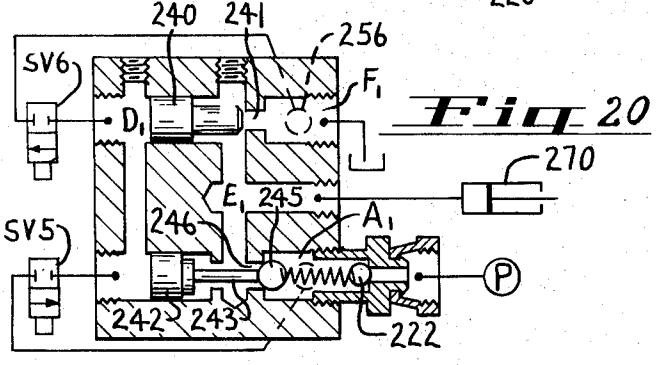


Fig 20



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Fig 21

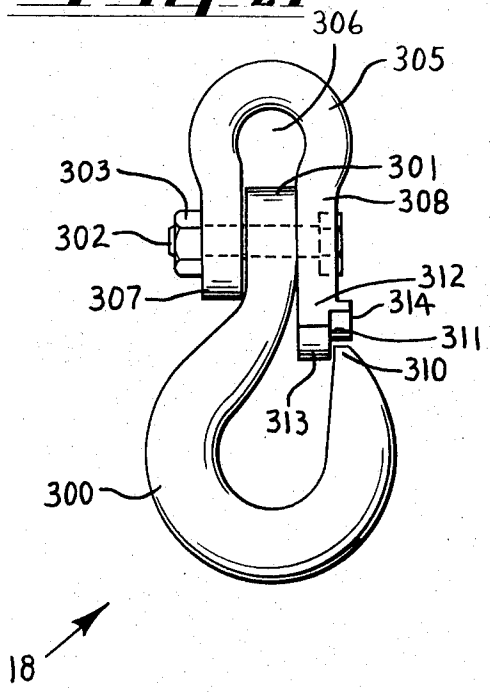
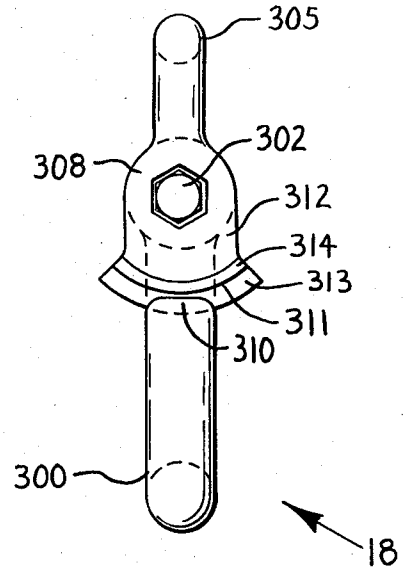


Fig 22



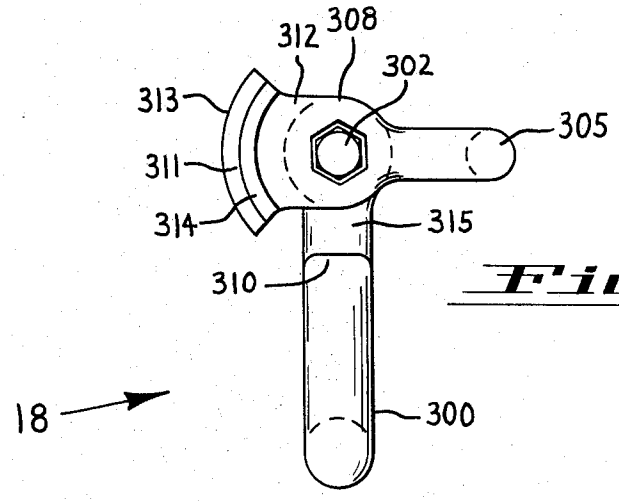


Fig 23

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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 upended 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 leakproof multiple valve unit, to provide an improved skyline clamp, to provide an improved hydrostatic transformer, to provide an improved bi-rotational pump, and to provide an improved choker hook.

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 mutiple valve unit and hydrostatic transformer including other parts of the hydraulic system in FIG. **18**;

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

FIG. **21** is a side elevation view of the choker hook in FIG. **2**;

FIG. **22** is an elevation view at right angles to FIG. **21**, showing the hook in closed position; and

FIG. **23** is a view similar to FIG. **22**, showing the hook in open position.

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,** and 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 end 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 kicking 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 shown 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 entirely 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 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 arm **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 birotational 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 thirty 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 cylinders **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 **150** 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 **3000** 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 **227** 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 three and one-half 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 thorough 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 pro-

vides 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 prssure 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 V_1 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 A_1, D_1, E_1 and F_1 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 D_1, very large volumes of oil can be controlled in working fluid manifold chamber E_1 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 V_1, if desired. Valve unit V_1 is of general application to hydraulic systems for various purposes where the major features of valve unit V are of advantage.

Choker Hook

The choker hook **18** in FIG. **2** is illustrated in FIGS. **21, 22** and **23.** The hook **300** has an eye **301** at right angles to the hook pivotally mounted on a bolt **302** which is equipped with a nut **303.**

A shackle **305** is of U-shaped configuration to provide a lifting eye **306** for a hoisting cable intermediate two eyes **307** and **308** which are disposed on opposite sides of the hook eye **301** on the bolt **302.** This allows the hook **300** and shackle **305** to pivot relative to each other on the bolt as shown in FIG. **23.**

The point **310** of the hook is disposed in a groove **311** in an extension **312** of the shackle eye **308.** Groove **311** is formed by an arcuate tongue **313** on the end of extension **312** in the plane of eye **308,** and an arcuate guard flange **314** projecting perpendicular to the extension **312** and overhanging the point **310** of the hook. Both the arcuate tongue **313** and the arcuate flange **314** are concentric with the axis of bolt **302** and have an arcuate extent of approximately 90°.

Rotation of shackle **305** approximately 90° out of the plane of hook **300** swings the tongue **313** and flange **314** clear of the hook point **310** to provide an open space at **315** for receiving the eyes of a choker cable, sling or other load carrying cable into the hook **300** behind its point **310.** Then merely rotating shackle **305** back to its normal position in the plane of hook **300** as shown in FIG. **22** causes the shackle extension **312** and tongue **313** to close the space **315** and retain the cable eyes or cables which were inserted through the space **315.** Such cable eyes or cables cannot disengage accidentally from the hook to drop a load because when the hoisting cable is tensioned in shackle eye **306,** the weight of the hook and the load will maintain the hook and shackle in alignment in the position in FIG. **22.** As soon as tension is relaxed on the hoisting line, it is easy to release the load by merely turning the shackle back to its position in FIG. **23** to open the gap at **315.**

The present form of construction is extremely simple and inexpensive to manufacture and is readily manipulated by an operator wearing heavy gloves. There are no small parts to complicate the construction or the manipulation and no parts likely to get out of order or malfunction in rough usage. The shackle may be manipulated with facility by one hand and its operation is not critically affected by mud, snow or ice. The simplicity of construction makes it virtually impossible to manipulate improperly because as soon as the hook is lifted by its hoisting line, the opening **315** is immediately closed regardless of operator carelessness.

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. A skyline logging carriage comprising a carriage frame; a pair of yokes mounted on transverse pivots at opposite ends of said frame and having skyline rider sheaves for flexible suspension of said carriage on a skyline cable; a removable lid plate on said carriage, a skyline clamp having stationary and movable clamp jaws mounted on said lid plate and extending approximately the length of said carriage, a series of clamp cylinders operable on said movable clamp jaw at intervals along the length thereof to apply said clamp, a plurality of retractor cylinders operable on said movable clamp jaw to release said clamp; a three section cable drum in said carriage receiving a main line, a haulback line and a hoisting line, a pair of end plates on said drum supporting the drum for rotation on a stationary shaft in said carriage, said drum having a central chamber between said end plates defining an oil reservoir; a bi-rotational pump having radial cylinders mounted on said shaft in said oil reservoir, a cam ring connected with said drum arranged to reciprocate pistons in said cylinders; a hydraulic brake operable on said drum, said drum being rotated to raise and lower said hoisting line by yarder winch drums at one end of said skyline connected with said main and haulback lines; a hydraulic system in said carriage outside of said drum having radio controlled solenoid valves arranged to apply and release said brake and clamp, axial oil passageways in said shaft connecting said pump with said hydraulic system, and a pressure accumulator in said hydraulic system maintaining fluid pressure in said retractor cylinders at all times.

2. A logging carriage as defined in claim **1** including a combined inlet and outlet check valve unit mounted at and communicating with the inner end of each of said pump cylinders.

3. A logging carriage as defined in claim **1** including an oil bypass line having an injector nozzle in the intake of said pump, and a pressure relief valve connected between the pump discharge and said bypass line.

4. A logging carriage as defined in claim **1** including a target ring on said carriage, and a hydraulic line adapted to be ruptured by a rifle shot into the target area to release hydraulic clamping pressure from said skyline clamp in an emergency.

5. A logging carriage as defined in claim **1** including means in each of said drum sections for anchoring a cable end without damage to the cable in the event that drum rotation overruns the length of cable on the drum, said means comprising an arcuate plate of short radius curvature in the drum section extending parallel with the drum axis, an axial keyhole slot in said plate having a wide portion to receive an end ferrule on the cable and a narrow portion only wide enough to pass the cable, and a narrow circumferential slot in said plate intersected at mid length by the narrow end of said keyhole slot.

6. In a skyline logging carriage as defined in claim **1,** means holding said plurality of hydraulic clamp cylinders loosely in position at said 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.

7. A skyline logging carriage as defined in claim **6,** 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.

8. A skyline logging carriage as defined in claim **7,** said lid plate 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.

9. A skyline logging carriage as defined in claim 1 including a hydrostatic transformer connected with said hydraulic 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.

10. A logging carriage as defined in claim 9, said hydrostatic transformer comprising a piston having a large diameter end and a small diameter end, a large diameter cylinder containing said large end of said piston and a small diameter cylinder integral with said large diameter cylinder containing said small end of said piston, external port connections in the opposite ends of said large cylinder and in the end of said small cylinder which is remote from said large cylinder, an axial fluid passageway through said piston, a check valve in said passageway normally preventing fluid flow through said passageway from said small cylinder to said large cylinder, and a rod mounted in the end of said large cylinder which is remote from said small cylinder, said rod projecting into said passageway and arranged to open said check valve as said piston approaches said end of said large cylinder.

11. A skyline logging carriage as defined in claim 9, said retractor cylinders being effective to retract said movable jaw when said clamp cylinders are not energized.

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