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Frey et al.

[11] **3,861,205**

[45] **Jan. 21, 1975**

[54] **MACHINE FOR TESTING TOE AND HEEL CLAMPS ON SKI BINDINGS**

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[73] Assignee: **Hydron Corporation**, Portland, Oreg.

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[52] **U.S. Cl.** ..... **73/133 A**

[51] **Int. Cl.** **G011 5/03**

[58] **Field of Search** ..... 73/133 A

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Primary Examiner—Charles A. Ruehl

Attorney, Agent, or Firm—Lee R. Schermerhorn

[57] **ABSTRACT**

A ski with a boot releasably secured thereon by toe and heel clamps is mounted on rests on the machine and secured by a pair of hydraulic clamps. Transverse toe check and heel check beams are slidably mounted for adjustment according to the position and size of the boot. The toe check beam is equipped with a pair of opposed hydraulically operated thrust arms for applying lateral forces to the sole of the boot alternately in opposite directions sufficient to effect release of the boot from its toe clamp on the ski. The heel check beam is equipped with a sling strap which may be raised under the heel of the boot by hydraulic actuators to effect release of the heel clamp on the ski. These hydraulic devices are actuated by a pump under pushbutton control. A maximum reading fluid pressure gauge registers the force necessary to release the boot from the toe clamp and heel clamp.

12 Claims, 16 Drawing Figures

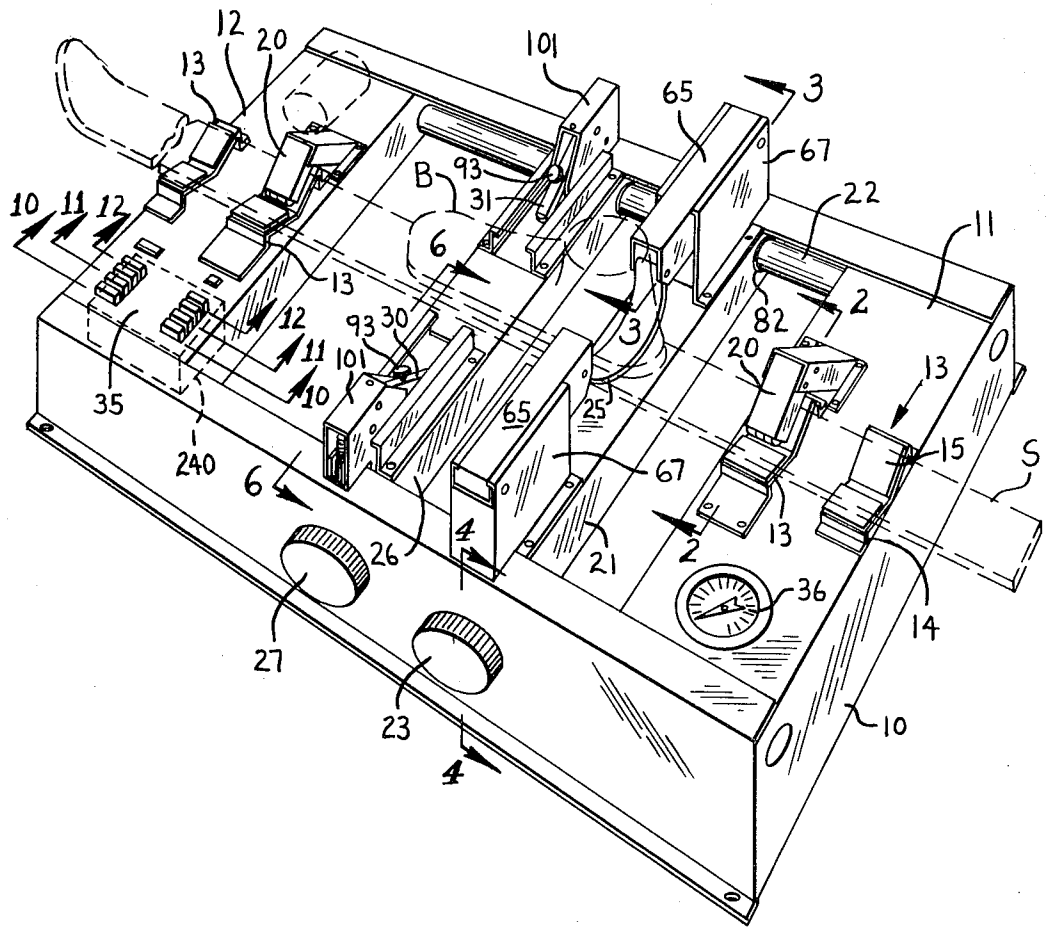


Fig 1

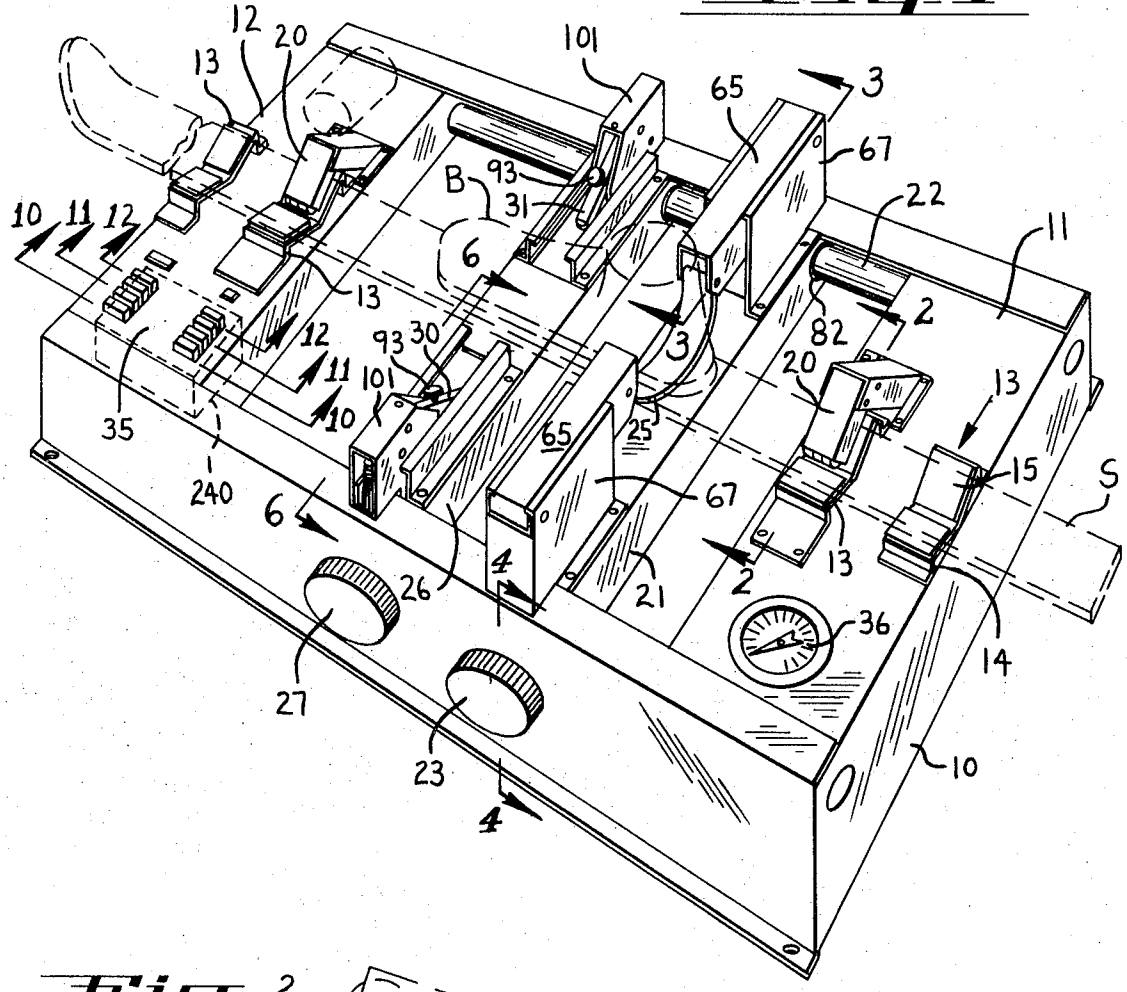

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Fig 2

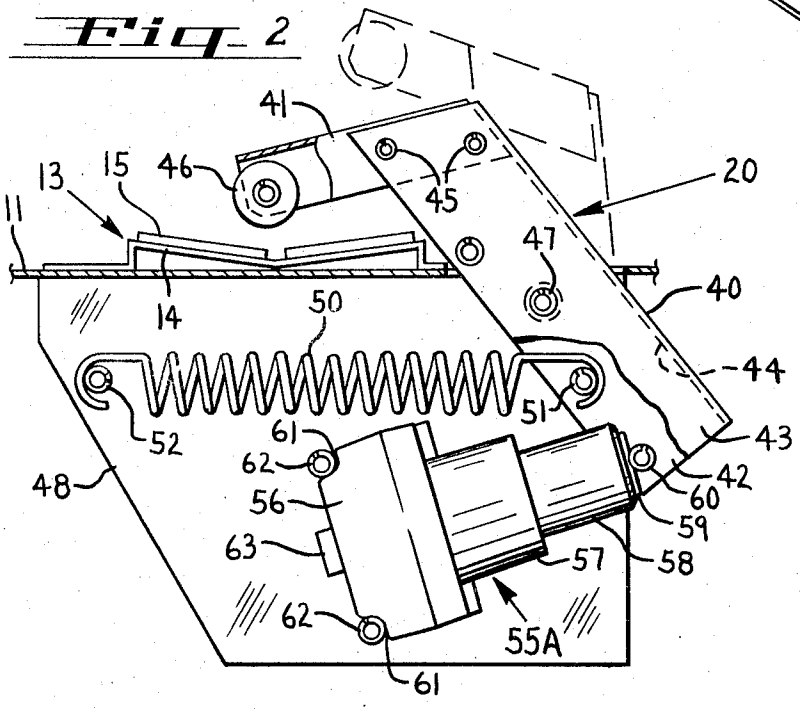
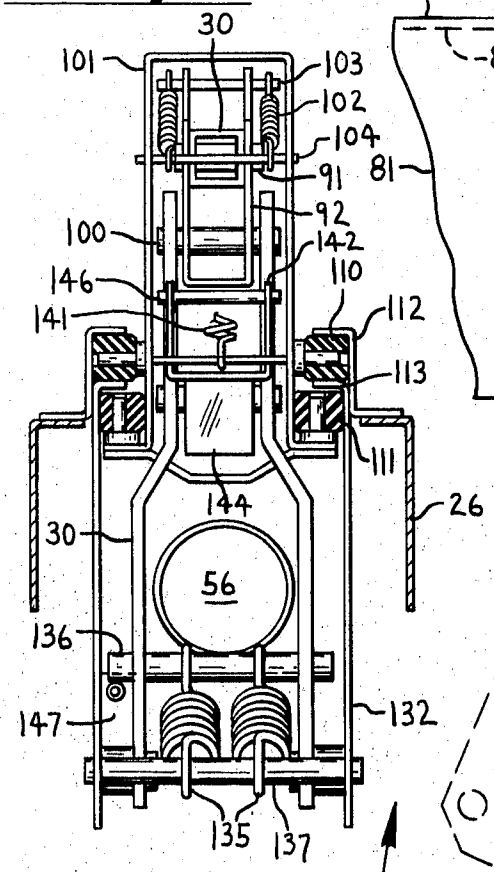

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Fig 8



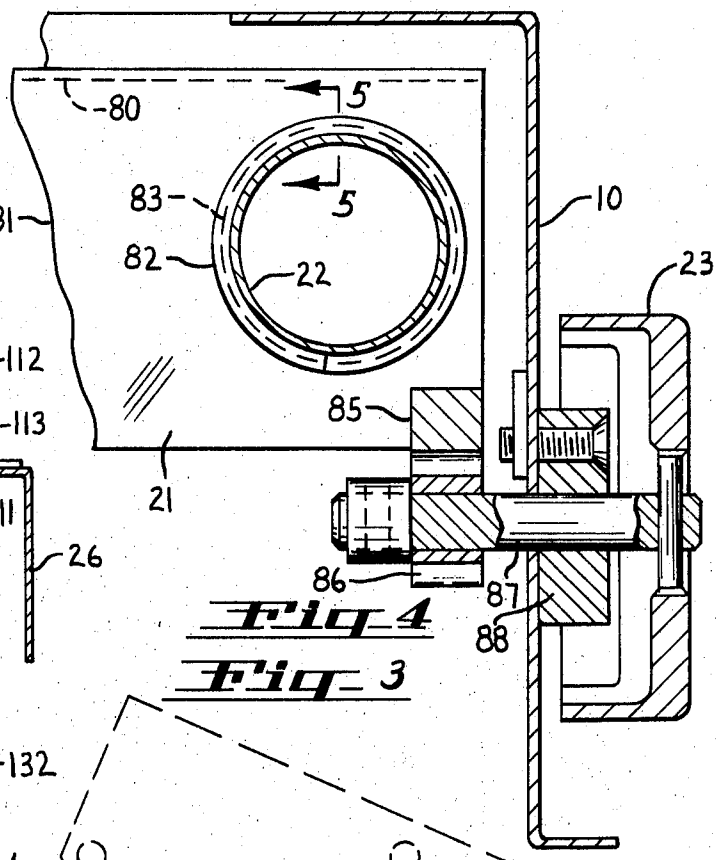
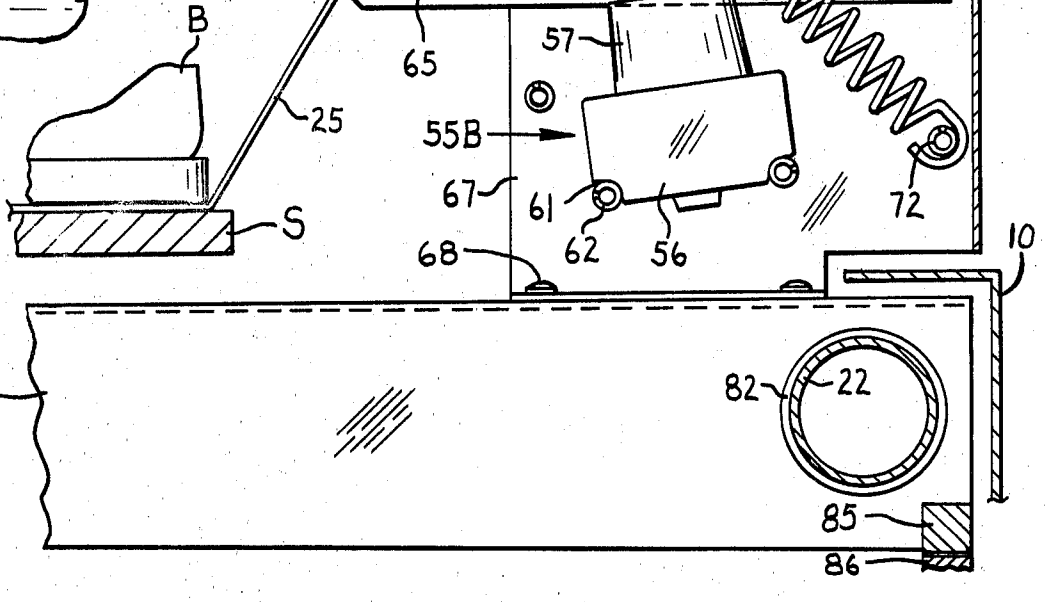


Fig 4

Fig 3

Fig 5





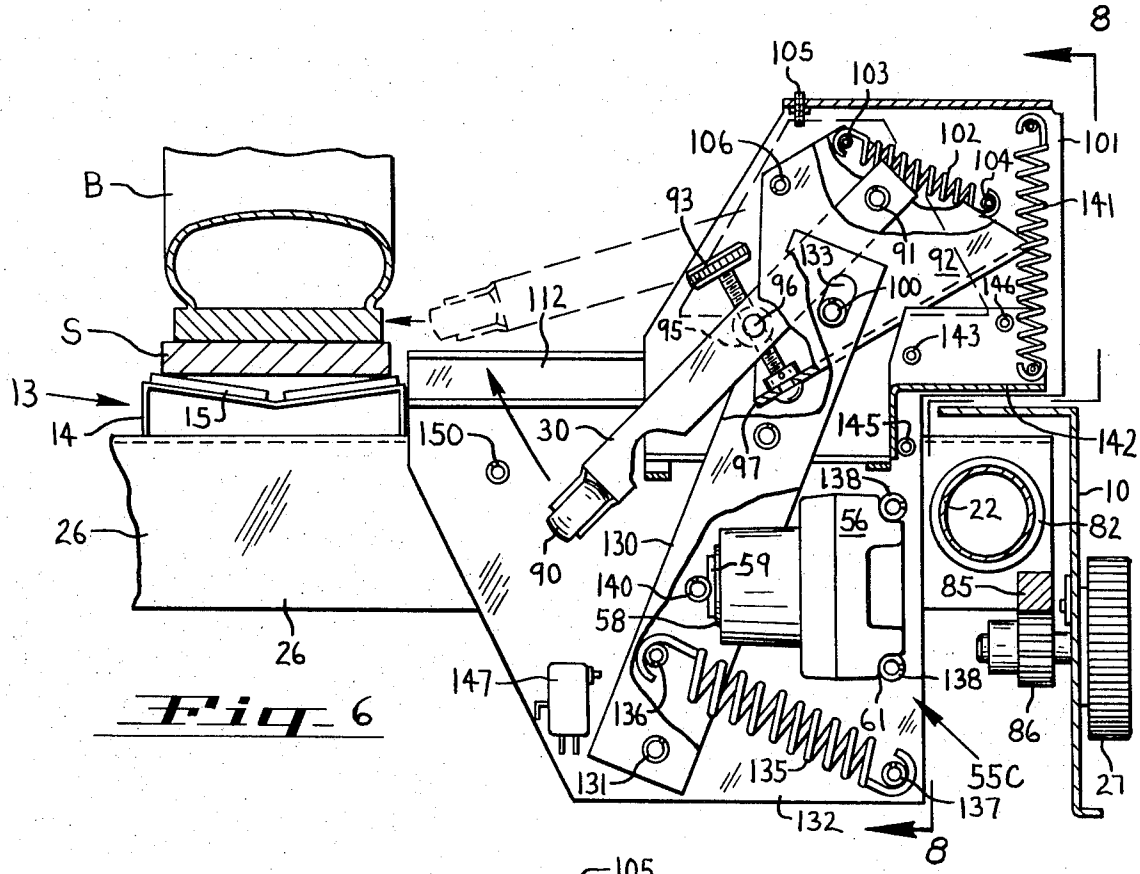

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Fig. 6

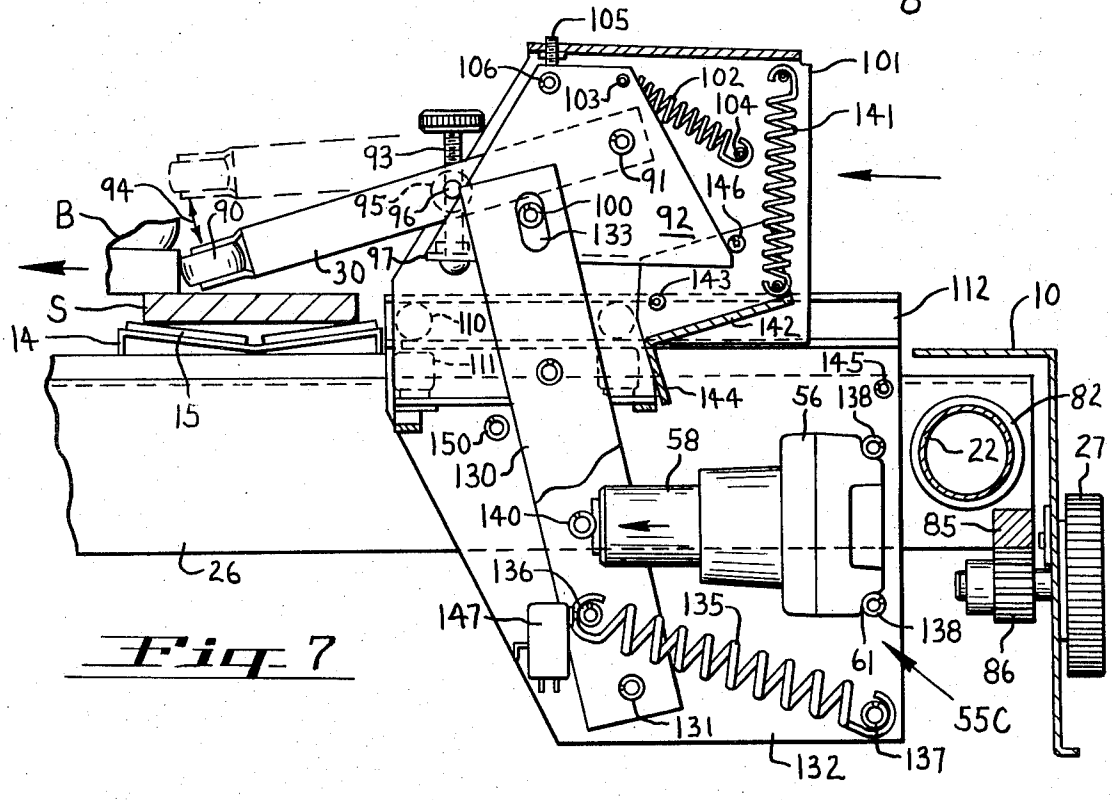

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Fig. 7

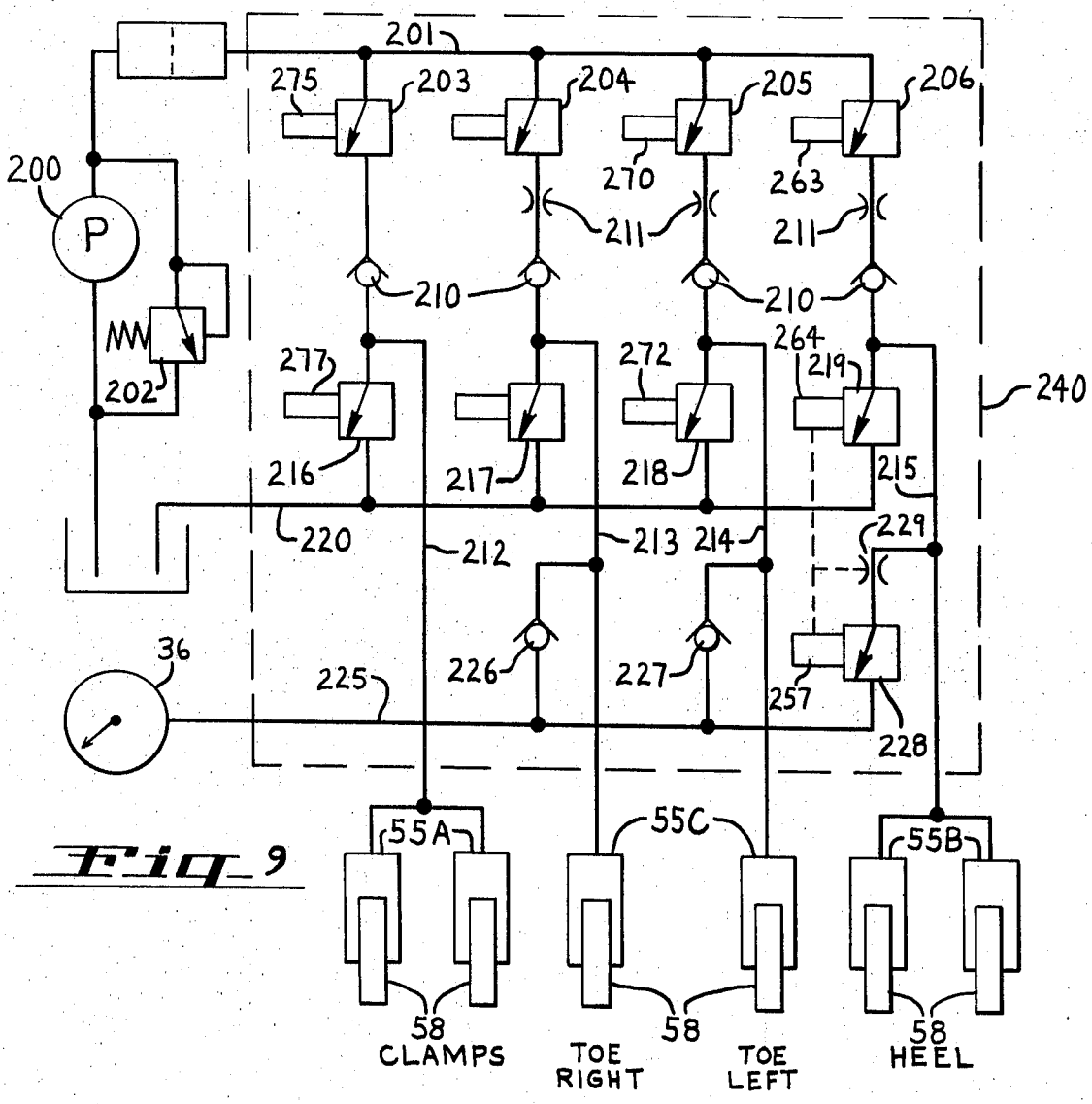

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Fig 9

Fig 13

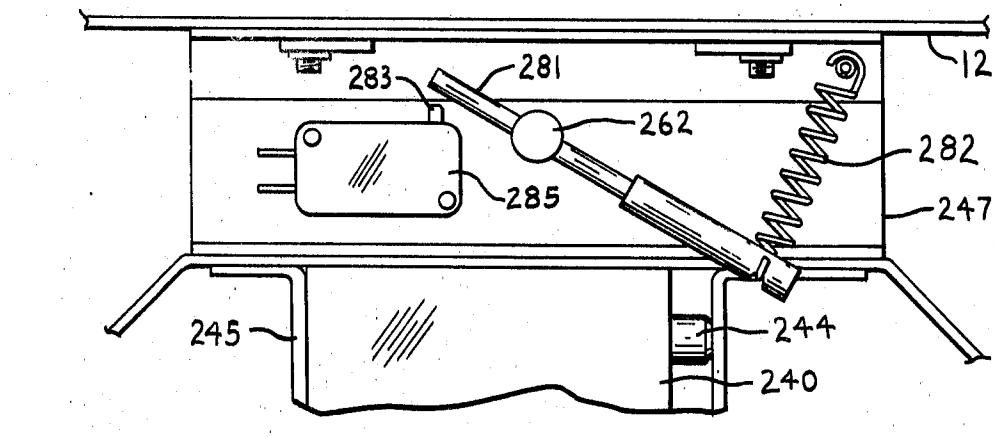
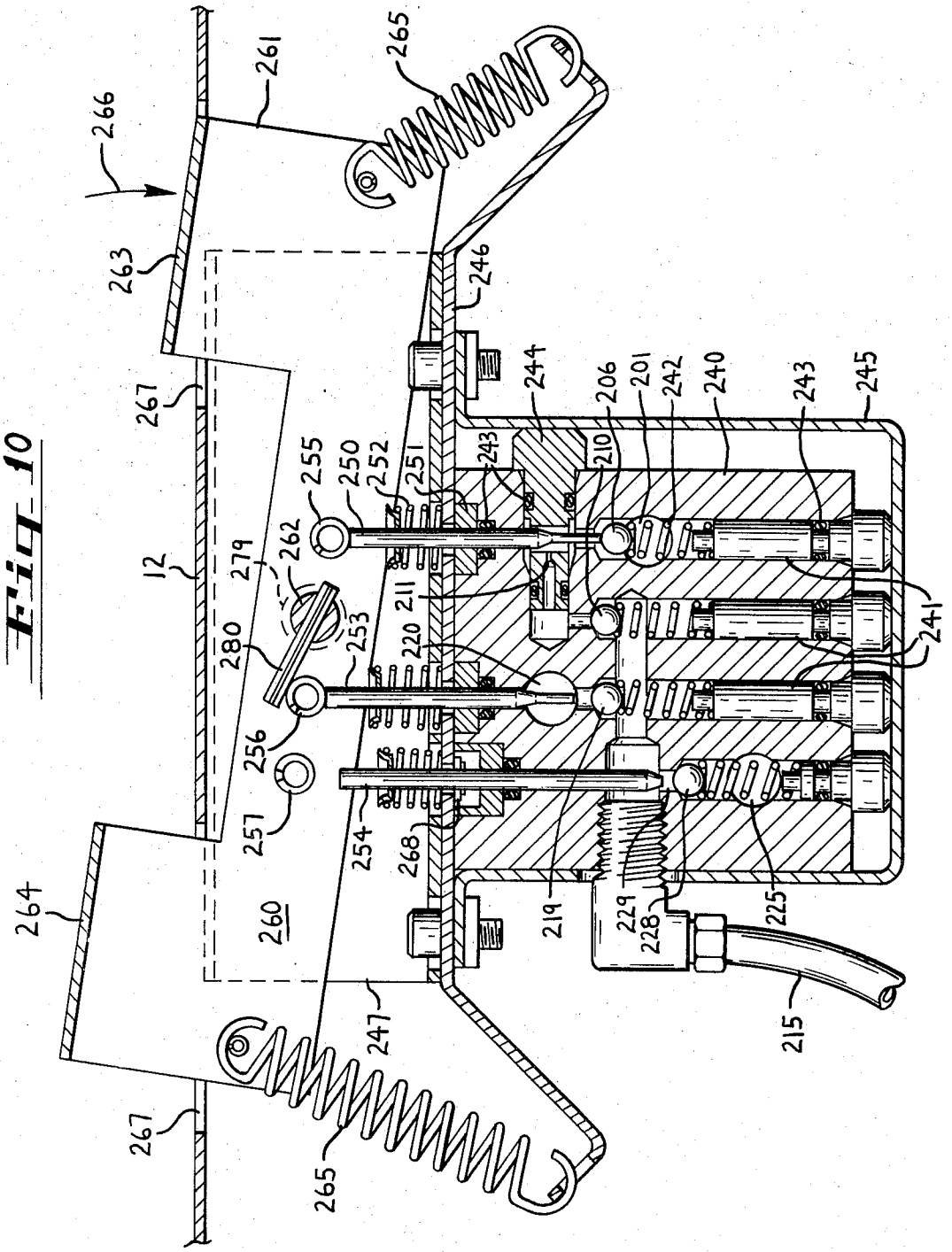

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Fig. 10


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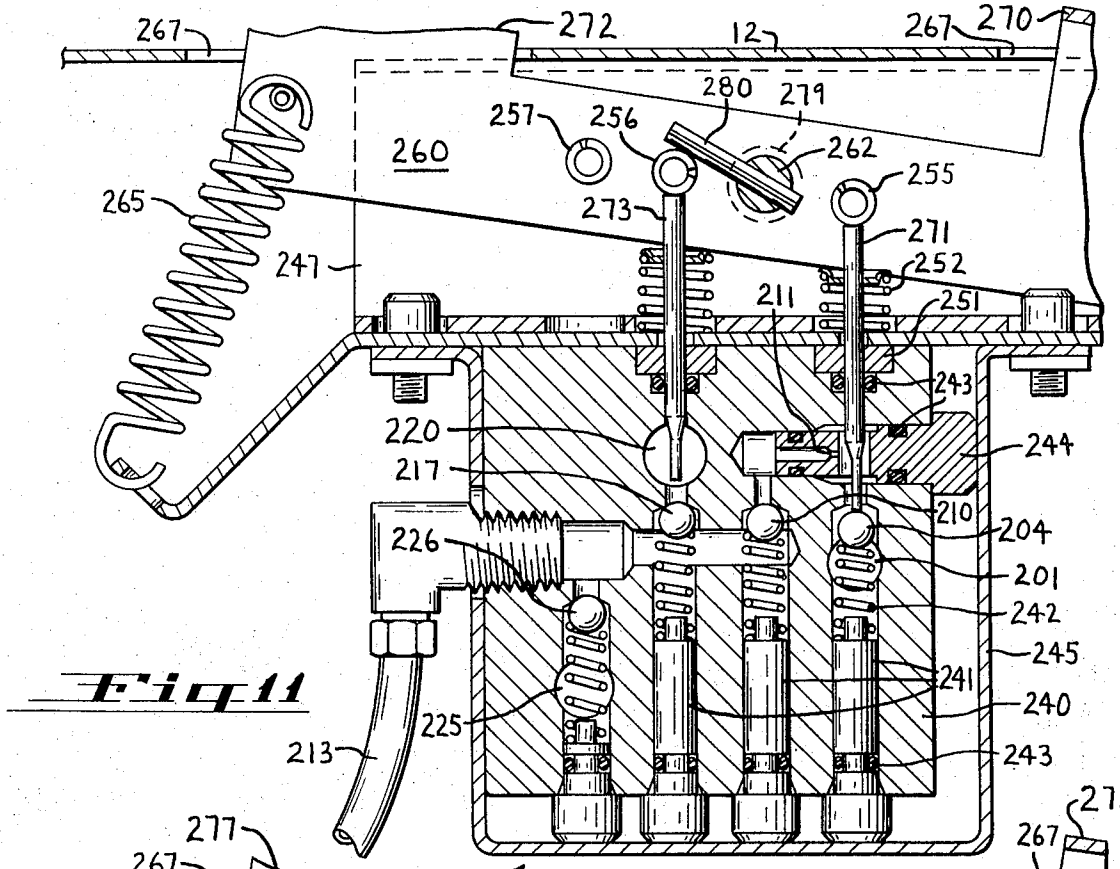

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Fig 11

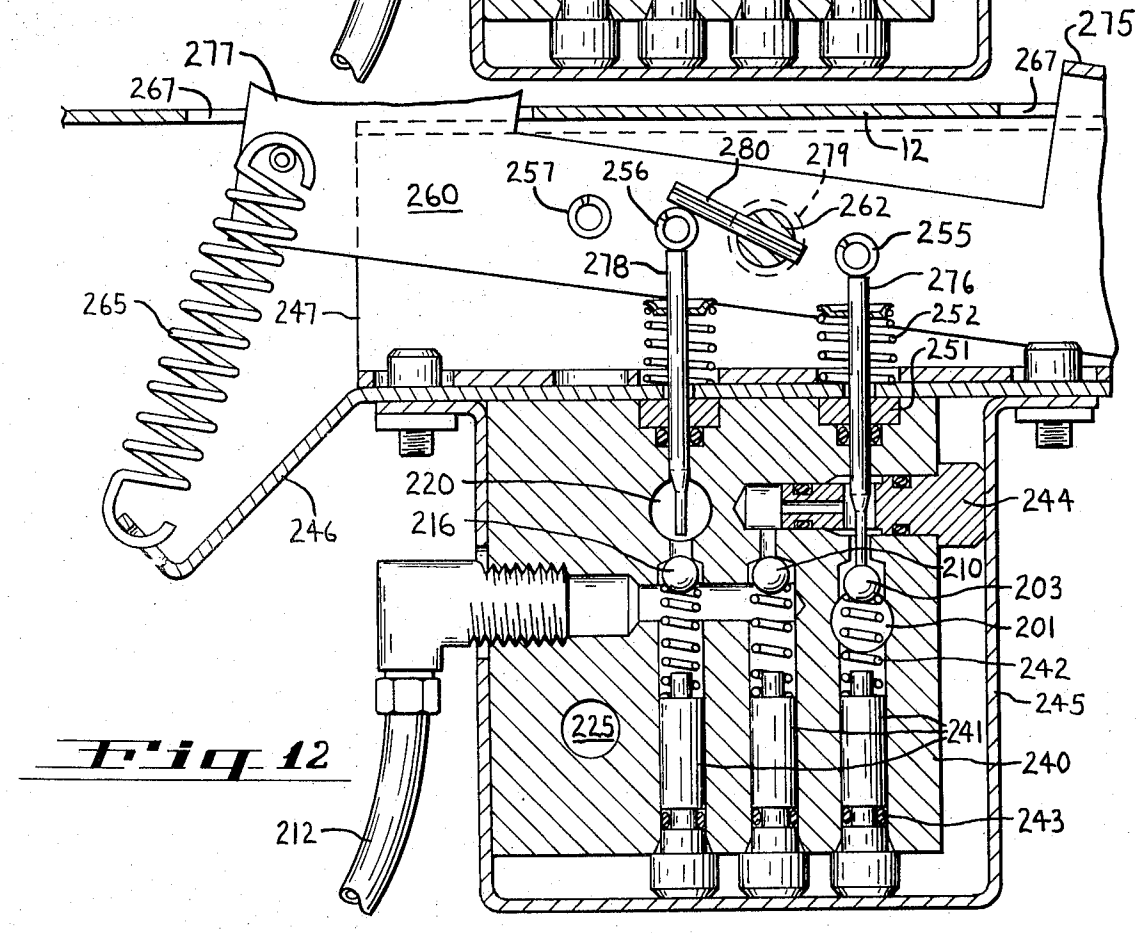
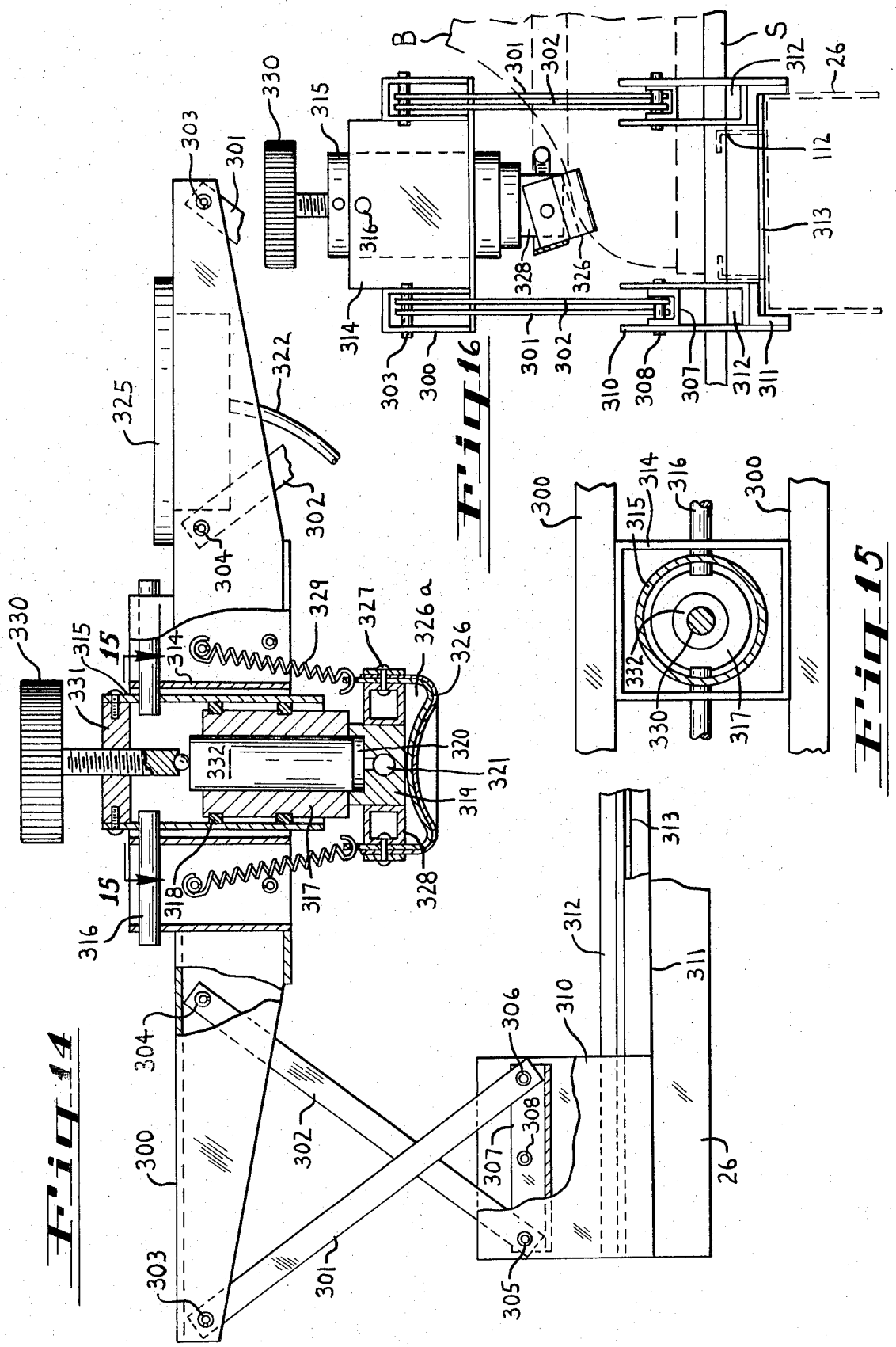

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Fig 12


Fig 14
Fig 15
Fig 16

MACHINE FOR TESTING TOE AND HEEL CLAMPS ON SKI BINDINGS

BACKGROUND OF THE INVENTION

This invention relates to a machine for testing and calibrating toe and heel clamps on ski bindings.

Heretofore these tests have usually been made by separate manually operated portable devices which are subject to human error and are not very accurate. Such devices are not well suited for testing or calibrating a large number of ski bindings quickly and with a high degree of uniformity and accuracy.

Objects of the invention are, therefore, to provide a single machine for testing and calibrating toe and heel clamps on skis, to provide a machine of the type described which is power operated and largely eliminates human error, to provide a machine which will perform all the necessary tests with the ski clamped in a fixed position in the machine, to provide a machine having improved features that make it economical to manufacture, to provide an improved hydraulic control valve unit, to provide an attachment for applying a downward force against the toe of the boot during the toe check tests, and to provide a machine of the type described which is suitable for use by ski or binding manufacturers having large numbers of ski bindings to test and calibrate in an efficient manner.

SUMMARY OF THE INVENTION

In the present machine, a ski carrying a ski boot is clamped in testing position by a pair of hydraulic clamps. Transverse toe check and heel check beams are adjustable to the position and size of the boot. The toe check beam carries a pair of opposed hydraulic thrust arms arranged to apply sufficient lateral force right and left to the sole of the boot to effect release of the toe clamp on the ski. The heel check beam carries a hydraulically actuated sling strap which is lifted under the heel of the boot to effect release of the heel clamp on the ski. All of these tests are performed with the ski clamped in fixed position.

An attachment is provided for applying a downward force on the toe of the boot during the toe check tests.

The hydraulic system is energized by a pump under pushbutton control. A maximum reading fluid pressure gauge registers the force required to release the boot from the toe and heel clamps on the ski. The various operations are performed mechanically to minimize operator error and insure consistently accurate readings in an efficient manner.

The foregoing and other objects and advantages will become apparent and the invention will be better understood from the following description of the preferred embodiment illustrated in the accompanying drawings. Various changes may be made, however, 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 machine embodying the invention;

FIG. 2 is a view on the line 2—2 in FIG. 1;

FIG. 3 is a view on the line 3—3 in FIG. 1;

FIG. 4 is a view on the line 4—4 in FIG. 1;

FIG. 5 is a view on the line 5—5 in FIG. 4;

FIG. 6 is a view on the line 6—6 in FIG. 1, showing one of the toe checks in retracted position;

FIG. 7 is a view similar to FIG. 6, showing the toe check in operative position;

FIG. 8 is a view on the line 8—8 in FIG. 6;

FIG. 9 is a schematic diagram of the hydraulic system;

FIG. 10 is a view on the line 10—10 in FIG. 1;

FIG. 11 is a view on the line 11—11 in FIG. 1;

FIG. 12 is a view on the line 12—12 in FIG. 1;

FIG. 13 is a view on the line 13—13 in FIG. 1;

FIG. 14 is an elevation view with parts broken away, showing an attachment for applying a downward force on the toe of the boot;

FIG. 15 is a view on the line 15—15 in FIG. 14; and

FIG. 16 is an elevation view of the attachment at right angles to FIG. 14.

DESCRIPTION OF THE PREFERRED EMBODIMENT

General Description

The general features of the machine will first be described with reference to FIG. 1. A frame 10 has a pair of horizontal end panels 11 and 12 equipped with ski rests 13 to support the bottom of a ski S. Each rest 13 comprises a V-shaped metal plate 14 carrying a pair of rubber pads 15. The V-shape of these rests provides lateral stability so that the ski is not dislodged under the lateral forces applied to the ski boot B during the testing or calibration of the bindings. The ski is firmly clamped on rests 13 by a pair of hydraulic clamps 20.

The ski bindings are omitted in the drawings for clarity of illustration. It is understood that the heel of boot B is secured to ski S by a conventional type of heel clamp on the ski which is releasable by a predetermined uplift force applied to the heel of the boot. The boot is also secured by a toe clamp on the ski which is releasable by the application of a predetermined horizontal or twisting force applied in either right or left directions to the toe of the boot. The purpose of the present machine is to test or calibrate the uplift force required to release the heel of the boot from its heel clamp and to test or calibrate the horizontal force required to release the toe of the boot from its toe clamp in either right or left directions. The heel and toe clamps on the ski must be accurately adjusted according to the strength and skill of the skier as is well understood in the art.

The present machine is designed to perform these tests or calibrations rapidly and efficiently for the manufacturers of skis and ski bindings and for the operators of skiing facilities where conventional equipment is too slow and uncertain for the purpose. The safety of the skier depends on having his bindings properly adjusted so that the heel and toe clamps will not release too easily or will not require too great a force for release.

A heel check beam 21 is mounted for sliding movement on a pair of longitudinal ways 22. A control knob 23 adjusts the position of beam 21 to place an uplift sling strap 25 under the heel of the boot, between the heel and the ski. Sling 25 is lifted by hydraulic actuators which apply gradually increasing force until the boot is released from its heel binding.

In a similar manner, a toe check beam 26 is also mounted for sliding movement on the longitudinal ways 22. The position of this beam is adjusted by control knob 27 to place a pair of opposed lateral thrust arms

30 and 31 in predetermined position adjacent the toe of the boot. Arm 30 may be hydraulically actuated toward the right and arm 31 may be hydraulically actuated toward the left to release the boot laterally from its toe binding on the ski. Adjusting knobs 23 and 27 thus permit accommodation to different sizes of ski boots and to the position of the boot on the machine so that the boot and ski do not have to be accurately positioned before the clamps 20 are actuated.

Pushbuttons in a control panel 35 start a pump to pressure the hydraulic system, actuate hydraulic clamps 20, energize the hydraulic actuators for sling 25 and thrust arms 30 and 31, and release the fluid pressure from the hydraulic actuators and pressure gauge 36.

Ski Clamps

The two clamps 20 are of identical construction as shown in FIG. 2. Each clamp 20 comprises an L-shaped clamp arm having an upright portion 40 and a transverse portion 41, each formed of sheet metal in channel shape. Thus, upright portion 40 has two parallel flanges 42 and 43 bent from opposite sides of an interconnecting web portion 44. The two channel members 40 and 41 are connected together by a pair of roll pins 45 having a press fit in holes in the flanges. The outer end of channel member 41 is equipped with a plastic shoe 46 to bear against the top of the ski.

Clamp arm 20 is pivotally mounted on a roll pin 47, the opposite ends of which have a press fit in holes in a pair of spaced parallel vertical plates 48 depending from top panel 11. The clamp arm is biased toward its retracted position, shown in broken lines, by a tension spring 50, one end of which is connected to a roll pin 51 in the clamp arm and the other end of which is connected to a roll pin 52 spanning the two vertical plates 48. The clamp arm is moved to clamping position, shown in solid lines in FIG. 2, by a hydraulic actuator 55A.

Hydraulic actuator 55A comprises a diaphragm chamber 56, a guide cylinder 57 and a piston 58 which is slidable in cylinder 57 and extended hy hydraulic pressure beind a diaphragm in diaphragm chamber 56. The outer end of piston 58 is equipped with a Teflon wafer 59 which bears against a roll pin 60 mounted in the flanges 42, 43 of channel arm portion 40.

Diaphragm chamber 56 is formed with two parallel shoulders 61 which seat on a pair of roll pins 62 spanning the two vertical plates 48. The end of the diaphragm chamber has an external connection 63 for a hydraulic line. The axis of piston 58 is tangential to the arcuate path of movement of pin 60 at the mid point of its normal travel. This makes it unnecessary to provide a pivotal mounting for diaphragm chamber 56. The slight shift of position of pin 60 on wafer 59 is accommodated by the resilience of the plastic.

Piston 58 is retained in its guide cylinder 57 by retracting spring 50 and in the same manner the diaphragm chamber is held seated on pins 62 without any positive fastening or connection. If clamp arm 20 is held in its clamped position shown in solid lines, the hydraulic actuator 55A may be removed by merely forcing the piston 58 into cylinder 57 and then lifting the unit 55A bodily away from pins 62. Pins 62 provide an abutment type of support which is effective as long as pin 60 bears against the end of the piston. This mounting of the hydraulic actuator is employed throughout the machine, greatly simplifying assembly in manufacture and disassembly for service or inspection.

Heel Check

FIG. 3 shows the right side of the heel check device on transverse beam 21. A channel-shaped arm 65 is pivotally mounted on a roll pin 66 which is supported at its ends in holes in a pair of spaced apart vertical plates 67 which are attached to the top of beam 21 by screw 68. Arm 65 is biased downward by a tension spring 70 connected at its upper end to a roll pin 71 spanning the flanges of channel arm 65 and anchored at its lower end to a roll pin 72 mounted in the pair of plates 67. Arm 65 may be lifted by a hydraulic actuator 55B which is mounted as described in connection with hydraulic actuator 55A in FIG. 2. Shoulders 61 on diaphragm chamber 56 seat on a pair of roll pins 62 spanning the upstanding plate 67 and plastic wafer 59 on piston 58 bears against a roll pin 73 bridging the flanges of channel arm 65.

One end of sling strap 25 is anchored on a roll pin 75 in the end of arm 65 and the opposite end of the sling strap is similarly anchored to an opposed corresponding arm 65 on the left side of the machine as shown in FIG. 1. One end of the sling strap may be detachable from its lifting pin 75 for convenience in passing the strap under the boot heel. The uplift device on the left side is the same as that shown on the right side in FIG. 3.

When hydraulic pressure is introduced into diaphragm chambers 56 on the left and right sides of the machine, the two pistons 58 raise the arms 65 toward broken line position gradually lifting the heel of boot B until the boot is released from its heel clamp on the ski. The maximum hydraulic pressure developed in diaphragm chambers 56 at the instant of release measures the uplift force applied to the heel of the boot. This pressure is registered on gauge 36 in FIG. 1.

Upon release of the boot from its heel clamp, a pin 76 on arm 65 opens a normally closed switch 77 to stop the motor for the hydraulic pump which energizes diaphragm chamber 56. The upward movement of arm 65 is limited by the engagement of the ends of pin 73 with top flanges 78 on plates 67.

The geometry of the movement in FIG. 3 is arranged to provide a substantially constant mechanical advantage in applying an uplift force to the heel of the boot. The decrease in mechanical advantage as arm 65 changes its angular position in rising is approximately compensated by the increasing mechanical advantage of sling strap 25 as it moves closer to a vertical position. Thus, an essentially linear relationship exists between the uplift force applied to the heel and the hydraulic pressure to which pressure gauge 36 responds whereby the gauge scale may be marked in pounds of applied force.

The uplift force applied by sling strap 25 tends to lift the center of the ski and deflect its ends downward. This distortion is resisted by the additional rests 13 in FIG. 1 beyond the clamps 20.

As described in connection with FIG. 2, retracting spring 70 retains piston 58 in guide cylinder 57 and holds the entire actuator unit 55B seated on roll pins 62 without any positive fastening connection. In assembling the machine, hydraulic actuator 55B is installed by raising the arm 65 and merely placing the hydraulic actuator is installed by raising the arm 65 and merely

placing the hydraulic actuator in position on its supporting pins **62.** Removal of hydraulic actuator **55B** for service or inspection is accomplished by merely raising arm **65** and lifting the hydraulic actuator off pins **62.** The axis of piston **58** is tangential to the arcuate path of movement of pin **73** at the mid point in the movement as explained in connection with FIG. **2.**

The mounting and adjustment of beam **21** are shown in FIGS. **4** and **5.** Beam **21** is of channel shape having a top web **80** with depending side flanges **81.** Grooved Teflon rings **82** are mounted in holes **83** in the side flanges **81** at opposite ends of the beam. Rings **82** serve as bearings to support the beam for sliding movement on the ways **22** which comprise a pair of stationary metal tubes supported at their opposite ends in the frame **10** of the machine.

The left end of beam **21** is provided with a rack **85** which is engaged by a pinion **86** on a shaft **87.** Shaft **87** is mounted in a bearing **88** on frame **10** and is equipped with the knob **23** for moving the beam to position sling strap **25** under the heel of the boot after the ski has been clamped by clamps **20.**

Toe Check

FIGS. **6, 7** and **8** illustrate one of the toe check mechanisms. These mechanisms are mounted on a beam **26** which is slidable on the ways **22** and adjustable longitudinally of the machine by knob **27** as described in connection with FIG. **4** with respect to the knob **23** and beam **21.** Each thrust arm **30** and **31** carries a plastic shoe **90** on its free end to bear against the side of the boot sole adjacent the toe clamp. Adjusting knob **27** accomplishes this relationship after the ski has been secured by clamps **20.**

The inner end of arm **30** is pivotally mounted on a roll pin **91** in a rocker frame **92.** The elevation of shoe **90** is adjustable by a screw **93** to accommodate different thicknesses of skis and boot soles, this range of adjustment being represented by the arrow **94** in FIG. **7.** This adjustment is accomplished by a nut **95** on screw **93** which has a trunnion pin **96** journaled in holes in the arm **30.** Screw **93** is journaled for rotation in a hole in a bottom plate **97** in rocker frame **92.**

Rocker frame **92** is pivoted for rotative movement on pin **91** which is supported in a slide **101.** Rocker frame **92** is biased clockwise on its supporting pin **91** by a pair of tension springs **102** connected at one end to a pin **103** in the rocker frame and anchored at its other end on a pin **104** in slide **101.** The clockwise rotation of rocker frame **92** is limited by a stop screw **105** in slide **101** which engages a roll pin **106** in the rocker frame. Slide **101** is supported for a sliding movement by four horizontal rollers **110** and four vertical rollers **111** which travel in guide tracks **112, 113** on the beam **26.**

Rocker frame **92** and slide **101** are shifted by an arm **130** which is pivotally mounted at its lower end on a roll pin **131** which is supported at its opposite ends in two spaced apart vertical plates **132** within the beam **26.** A pin **100** in rocker frame **92** extends through a slot **133** in the upper end of arm **130.** Arm **130** is biased clockwise by a pair of retracting springs **135** which are connected to a roll pin **136** in the arm **130** and to a roll pin **137** in the plates **132.**

Arm **130** is actuated counterclockwise to operative position by a hydraulic actuator **55C** which has shoulders **61** seated on a pair of roll pins **138** in the plates **132** similar to the mounting arrangement described in connection with FIG. **2.** Piston **58** is faced with a Teflon disc **59** to bear against a roll pin **140** in the arm **130.** Piston **58** moves in a straight line tangent to the arc of travel of pin **140** at the mid point of the arc, the resilience of the plastic accommodating the slight relative movement between the pin and the piston. Springs **135** retain piston **58** in its guide cylinder **57** and hold diaphragm chamber **56** seated against pins **138** without any positive connection, as described in connection with FIG. **2.**

In FIG. **6** the toe check mechanism is in retracted position with springs **135** holding arm **130** to the right. The upper end of arm **130** bears against pin **100** in rocker frame **92,** causing the back side of the rocker frame to bear against pin **104** as a stop with thrust arm **30** depressed to its retracted position in solid lines. With the counterclockwise rotation of rocker frame **92** stopped by pin **104,** the clockwise bias of springs **135** on the upper end of arm **130** also holds slide **101** fully retracted to the right.

When piston **58** is extended, arm **130** starts to swing to the left, rotating rocker frame **92** clockwise on its pivot **91** until the top of the rocker frame engages stop **105,** this movement placing thrust arm **30** in its broken line position in FIG. **6** on the level of the boot sole.

Further movement of arm **130** to the left starts to move slide **101** leftward, allowing spring **141** to lift latch member **142** on its pivot pin **143** in the slide as latch tongue **144** draws away from stop pin **145** in stationary plates **132.** The lifting of latch member **142** raises a stop pin **146** in the latch member up behind the lower corner of rocker frame **92** to latch the rocker frame and thrust arm **30** in FIG. **7** position. Further extension of piston **58** continues to move arm **130** and slide **101** to the left until the movement is stopped by engagement of shoe **90** on thrust arm **30** with the sole of the boot. In testing a toe clamp, the hydraulic pressure continues to increase in diaphragm chamber **56** until the toe of the boot is dislodged laterally by thrust arm **30,** the maximum pressure developed in diaphragm chamber **56** being utilized in pressure gauge **36** to measure the maximum thrust exerted by the thrust arm **30** in dislodging the boot.

As the boot is dislodged from its toe clamp, pin **136** on arm **130** opens a normally closed switch **147** to shut off the pump which supplies hydraulic pressure to diaphragm chamber **56.** Leftward movement of arm **130** is limited by a stop pin **150** in plates **132.**

When the valves in the multiple valve unit are shifted to retract positions, hydraulic pressure is relieved from diaphragm chamber **56** and springs **135** retract piston **58,** displacing hydraulic fluid from the diaphragm chamber. With rocker frame **92** locked against rotation by stop pin **46,** the movement of arm **130** to the right retracts slide **101** to the right until latch tongue **144** engages stop pin **145,** this engagement pulling stop pin **146** down and away from engagement with the back side of rocker frame **92.** This brings the parts back to FIG. **6** position with pin **145** serving as a stop for the retracting movement of slide **101.** Then, as arm **130** continues to move to the right, it rotates rocker frame **92** counterclockwise until the back side of the rocker frame engages pin **104** placing thrust arm **30** in the depressed position shown in solid lines. With the thrust arm thus retracted and depressed, it does not interfere with the dislodgement of the boot by thrust arm **31** on the opposite side in the next test operation.

The toe check mechanism associated with thrust arm **31** corresponds to that shown in FIGS. **6** and **8**.

Hydraulic System

In the hydraulic integrated circuit shown in FIG. **9**, a pump **200** supplies a pressure line **201**. Excess flow beyond the demands of the system is bypassed around the pump by a bypass relief valve **202**. A series of manual valves **203, 204, 205** and **206** supply hydraulic fluid under pressure to the hydraulic actuators **55A**, in the clamps **55C** in the right and left toe checks, and **55B** in the heel check, respectively. The pressure fluid is transmitted through check valves **210**, and also through restricted orifices **211** in the case of the toe and heel checks, to lines **212, 213, 214** and **215** connected with the respective hydraulic actuators.

A series of manual valves **216, 217, 218** and **219** is connected to the respective lines **212, 213, 214** and **215** to discharge fluid from the hydraulic actuators **55A, 55C** and **55A** into a relief line **220**. The clamps **20** are released by manual valve **216**, the spring **50** in FIG. **2** causing fluid in the diaphragm chamber **56** of each hydraulic actuator **55A** to discharge through line **212**, valve **216** and relief line **220**.

Heel check sling strap **25** is released by manual valve **219**, the springs **70**, one of which appears in FIG. **3**, causing fluid in hydraulic actuators **55B** to discharge through line **215**, valve **219** and relief line **220**.

Toe check thrust arms **30** and **31** are retracted by valves **218** and **217**, the springs **135**, one of which appears in FIG. **6**, causing fluid in hydraulic actuators **55C** to discharge through lines **214** and **213**, valves **218** and **217** and relief line **220**.

A pressure gauge line **225** is connected through check valves **226** and **227** to the toe check lines **213** and **214**, respectively. Pressure gauge line **225** is also connected through a manual valve **228** and restricted orifice **229** to the heel check line **215**. After the toe check and heel check operations, valves **226, 227** and **228** hold the maximum pressure in gauge **36** until the pressure is relieved by manual valve **228**. Valves **219** and **228** have a common operator as indicated in FIG. **9**.

Multiple Valve Unit

The valves in the hydraulic integrated circuit in FIG. **9** are contained in a valve unit which comprises a single block of metal **240** having groups of intersecting vertical and horizontal bores as shown in FIGS. **10, 11** and **12**. One group of such bores contains the valves for the heel check as shown in FIG. **10**, another group of bores contains the valves for the right toe check as shown in FIG. **11**, another identical group of bores (not shown) contains the valves for the left toe check, and another group of bores contains the valves for the clamps **20** as shown in FIG. **12**.

The lower ends of the vertical bores are closed by slidable plugs **241** which provide spring seats for valve springs **242**. These plugs are sealed in the bores by rubber O-rings **243**. Some of the horizontal bores provide fluid passageways as shown and others receive special plugs such as the slidable plugs **244**. The plugs **241** and **244** have protruding heads and are retained in their bores by a casing **245** which supports the unit on the underside of a cover plate **246**. Cover plate **246** is suspended from panel **12** by a bracket **247**. Cover plate **246** is bolted to casing **245** and bracket **247**. This arrangement greatly facilitates manufacture and assembly by avoiding the threading of most of the numerous bores and plugs.

The upper ends of the vertical bores in metal block **240** receive slidable valve stems for opening the manual valves described in FIG. **9**. Thus, in FIG. **10** ball valve **206** is opened and closed by a valve stem **250**. This and other similar bores are sealed by a washer **251** and rubber O-ring **243** receive in counterbores in the top of the block **240**. The valve stem is biased upward by a spring **252**. In a similar manner, the ball valve **219** may be unseated downward by a valve stem **253** and the ball valve **228** may be unseated by a valve stem **254**.

The valve stems **250, 253, 254** are depressed selectively by horizontal roll pins **255, 256** and **257** in a three-position pushbutton rocking lever **260**. Lever **260** is of channel-shape having a pair of apertured vertical flanges **261** journaled on a horizontal shaft **262** mounted in the bracket **247**. The web of the channel is cut away in its mid portion, leaving one end portion **263** which forms a pushbutton for actuating the heel check device and an opposite end portion **264** which forms a pushbutton for retracting the heel check device.

Pushbutton lever **260** is normally held in horizontal position by a pair of tension springs **265** connected to opposite ends thereof. In FIG. **10**, pushbutton **263** is indicated as being held depressed by finger pressure represented by the arrow **266**. This opens the valve **206** to actuate the heel check device. When finger pressure at **266** is released, the springs **265** return pushbutton arm **260** to horizontal position, closing valve **206**.

When pushbutton **264** is depressed, valve **219** is first opened to permit spring retraction of the heel check device and then valve **228** is opened to relieve fluid pressure from gauge **36**. Valve stem **254** forms a restricted orifice at **229** to prevent sudden return of the gauge needle to its zero position. Stem **254** is equipped with a stop **268**. Pushbuttons **263** and **264** protrude through openings **267** in panel **12**.

In a similar manner, pressing pushbutton **270** in FIG. **11** depresses valve stem **271** to open valve **204** and actuate the right toe check. Releasing pushbutton **270** closes valve **204** and pressing pushbutton **272** depresses valve stem **273** to open valve **217**. This relieves the pressure in hydraulic actuator **55C** in the right toe check device, allowing its thrust arm to be spring retracted. The valve and pushbutton arrangement for the left toe check is the same. As previously mentioned, the gauge **36** is returned to zero pressure after a toe check by pressing heel check release pushbutton **264** in FIG. **10**.

In FIG. **12**, pushing pushbutton **275** depresses valve stem **276** to open valve **203** and actuate the clamps **20**. Pushing pushbutton **277** depresses valve stem **278** to open valve **216** to relief line **220** and permit spring retraction of the clamps.

As shown in FIGS. **10, 11** and **12**, each of the pushbutton arms **260** is mounted for relative rotation in shaft **262**. The arms **260** are maintained in properly spaced relation to the shaft by spacer sleeves **279** between the arms. A radial pin **280** in shaft **262** between the side flanges **261** of each pushbutton arm **260** bears against pin **256** in the arm. Thus, any one of pushbuttons **263, 270** and **275** in FIGS. **10, 11** and **12** produces clockwise rotation of shaft **262**.

Shaft 262 extends out of the front end of casing 245 where it is equipped with another radial pin 281 as shown in FIG. 13. The left end of pin 281 is biased downward by a spring 282 to engage the actuating button 283 of a normally closed limit switch 285 and hold the switch open.

When any one of the pushbuttons 263, 270 or 275 in FIGS. 10 to 12 is depressed to actuate the heel check, toe check or clamps, the pin 256 associated with the depressed pushbutton rotates shaft 262 and pin 281 to the position shown in FIG. 13, allowing switch 285 to close and start the hydraulic pump 200. This occurs just prior to the opening of the valve 206, 204 or 203 which is associated with the depressed pushbutton so that the pump motor is started before the valve is opened.

When the depressed pushbutton is released, the springs 265 return the pushbutton arm 260 to horizontal position, allowing shaft 262 to rotate counterclockwise under the bias of spring 282 and cause pin 281 to engage switch button 283 and open the pump motor switch 285 to stop the pump. Thus, the pump operates only as long as one of the pushbuttons 263, 270 or 275 is depressed.

The limit switches 77 in FIG. 3, 147 in FIGS. 6 and 7 and 285 in FIG. 13 are all wired in series with the pump motor whereby all of these switches must be closed to start the pump 200 and whereby the opening of any one switch will stop the pump.

Toe Pressure Attachment

FIGS. 14 to 16 illustrate an attachment for applying a downward force on the toe of the boot to simulate the weight of the wearer when he is using the skis. A factor to be considered in adjusting the ski toe clamps is the sliding friction between the sole of the boot and the top of the ski. This frictional restraint against the lateral movement of the toe of the boot affects the lateral force necessary to slide the boot on the ski and release the toe from the toe clamp in skiing. The use of the attachment on the present machine more closely approximates the condition existing in actual skiing.

A transverse beam 300 is supported at each end by two pairs of crossed arms 301 and 302 which are pivotally connected at their upper ends to pins 303 and 304 in the beam. The lower ends of each pair of arms are pivotally connected to pins 305 and 306 in the opposite ends of a rocker arm 307. Each rocker arm 307 is pivotally mounted at its center on a pin 308 in a support frame 310. The underside of each support frame 310 contains an angle iron 311 which rests on top of beam 26 between the slides 101. Support frame 310 are open through their centers to admit the toe check thrust arms 30 and 31. Bars 312 and angle irons 311 underlie ski S and interconnect the right and left support frames 310. Tie plate 313 interconnects the two angle irons 311.

A square housing 314 in the center of beam 300 supports a vertical cylinder 315 on pins 316. An inner cylinder 317 has guide rings 318 slidable in cylinder 315. Mounted on the lower end of cylinder 317 is a recessed cylinder head 319 having a chamber 320 containing hydraulic fluid. A bore 321 communicating with chamber 320 has an external connection at one end for a hydraulic tube 322 leading to a fluid pressure gauge 325 on the beam 300.

A flexible pressure shoe 326 is pivotally mounted on pins 327 in a bracket 328 connected with cylinder head 319. Pressure shoe 326 contains a chamber 326a filled with liquid so that the pressure shoe 326 can conform to the shape of the top of the toe of the boot B as well as pivot on pins 327 as shown in FIG. 16. Pressure shoe 326 and cylinder 317 are biased upward by springs 329.

An adjusting screw 330 has threaded engagement with an end member 331 in the cylinder 315. Screw 330 provides means for applying a downward force against a piston 332 in cylinder 317 which transmits this force to hydraulic fluid in chamber 320, cylinder head 319 and pressure shoe 326. The amount of the applied force is indicated in pounds on the pressure gauge 325. The upward reaction from this downward force is assumed by angle irons 311 and bars 312 under the ski. Thus, the attachment merely rests on beam 26 and does not have to have positive connection therewith.

Linkage arms 301, 302, 307 allow lengthwise movement of beam 300 when one of the thrust arms 30 and 31 pushes the toe of the boot laterally out of the toe clamp on the ski. For example, if beam 300 moves to the right with a boot in FIG. 14, the arms 301, 302 rock the arm 307 clockwise to follow this movement without significantly raising or lowering the pivot points 303 and 304. Within a limited range of movement right or left, the beam 300 shifts in a rectilinear path of travel at uniform elevation.

The downward force applied against the toe of the boot produces a frictional restraint against lateral movement of the boot sole on the top of the ski equivalent to that produced by the weight of the skier whereby the ski toe clamp may be adjusted so that the lateral force applied by thrust arm 30 or 31 to release the toe clamp may be significantly related to the actual conditions in skiing.

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. machine for testing ski bindings comprising an elongated frame, means for clamping a ski with a ski boot in said frame, a heel clamp testing device, means for adjusting said heel clamp testing device longitudinally in said frame, a toe clamp testing device operable on the right side of said boot, a toe clamp testing device operable on the left side of said boot, means for adjusting said toe clamp testing devices longitudinally in said frame, said heel and toe clamp testing devices all being operable with the ski clamped in a single fixed position by said clamping means, and means for applying a downward force on the toe of the boot during operation of said toe clamp testing devices.

2. A machine for testing ski bindings comprising an elongated frame, means for clamping a ski with a ski boot in said frame, a heel clamp testing device, means for adjusting said heel clamp testing device longitudinally in said frame, a toe clamp testing device operable on the right side of said boot, a toe clamp testing device operable on the left side of said boot, and means for adjusting said toe clamp testing devices longitudinally in said frame, said heel and toe clamp testing devices all being operable with the ski clamped in a single fixed position by said clamping means, said means for adjusting said heel clamp testing device comprising a first transverse beam slidably supported on ways extending along opposite sides of said frame, and said means for adjusting said right and left toe clamp testing devices

comprising a second transverse beam slidably supported on said ways.

3. A machine as defined in claim **2** including an attachment for mounting on said second beam to apply a downward force on the toe of the boot.

4. A machine as defined in claim **3,** said attachment comprising an upper transverse beam, a linkage supporting said upper beam for lengthwise movement on said second beam at constant elevation, a vertical cylinder slidably mounted in said upper beam and having a cylinder head and pressure shoe on its lower end, hydraulic fluid in said cylinder head communicating with a fluid pressure gauge on said upper beam, and a screw in said upper beam bearing against the upper end of a piston in said cylinder to press said pressure shoe against the top of the toe of the boot.

5. A machine as defined in claim **2** including V-shaped rests for the ski on opposite ends of said frame, pivotal clamp arms movable into engagement with the top of the ski above said rests, and hydraulic actuators for said clamp arms.

6. A machine as defined in claim **2,** said heel clamp testing device comprising a heel sling strap, a pair of pivotal arms on said first beam connected with opposite ends of said sling strap, and hydraulic actuators on said first beam for raising said arms.

7. A machine as defined in claim **2,** said toe clamp testing device comprising a pair of slides on opposite ends of said second beam, a rocker frame in each of said slides, thrust arms on said rocker frames arranged to bear against opposite sides of the boot sole selectively, a pair of actuating arms pivotally mounted on opposite ends of said second beam and having swinging ends pivotally connected with said rocker frames, retracting springs connected with said actuating arms to depress said thrust arms and retract said slides toward the ends of said second beam, and hydraulic actuators operable on said actuating arms to raise said thrust arms and move said slides toward the center of said second beam causing said thrust arms to engage said boot sole.

8. A machine as defined in claim **7** including adjusting means to raise and lower said thrust arms relative to said rocker frames in accordance with the thickness of the ski and the thickness of the boot sole.

9. A machine for testing ski bindings comprising an elongated frame, means for clamping a ski with a ski boot in said frame, a heel clamp testing device, means for adjusting said heel clamp testing device longitudinally in said frame, a toe clamp testing device operable on the right side of the said boot, a toe clamp testing device operable on the left side of said boot, means for adjusting said toe clamp testing devices longitudinally in said frame, said heel and toe clamp testing devices all being operable with the ski clamped in a single fixed position by said clamping means, hydraulic actuators for said ski clamping means, said heel clamp testing device and said toe clamp testing devices, a hydraulic pressure system for operating said actuators, manual valves in said system for transmitting hydraulic pressure to said actuators, manual valves for relieving hydraulic pressure from said actuators, a hydraulic pressure gauge, hydraulic lines connecting said pressure gauge with said actuators for said heel and toe clamp testing devices, check valves in said lines to hold maximum pressures in said gauge occurring during operation of said heel and toe clamp testing devices, and a manual valve for relieving said pressures in said gauge.

10. A machine as defined in claim **9,** said hydraulic pressure system including a hydraulic integrated circuit in which said manual valves comprise spring actuated ball valves seated in bores in a block of metal, slidable valve stems arranged to unseat said ball valves, and push buttons arranged to move said valve stems.

11. A machine for testing ski bindings comprising a frame, a pair of pivotal arms for clamping said ski on said frame at a point in front of said bindings and at a point behind said bindings, a heel clamp testing device comprising a heel sling strap, a pair of pivotal arms on said frame connected with opposite ends of said sling strap to lift said sling strap, a toe clamp testing device comprising right and left side lateral thrust arms, a pivotal arm for actuating each of said thrust arms; a hydraulic actuator for actuating each of said pivotal arms, each of said actuators comprising a shouldered pressure chamber having a cylinder and a piston in said cylinder, said pressure chamber in each actuator bearing against a pair of pins in said frame and the end of said piston in each actuator bearing against a pin in one of said pivotal arms, and retracting springs acting on said pivotal arms to hold said actuators in operative positions bearing against said pins.

12. A machine as defined in claim **11,** said cylinders being in fixed positions with their axes tangent to the arcuate paths of travel of said pins in said pivotal arms at the mid points of said paths of travel.

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