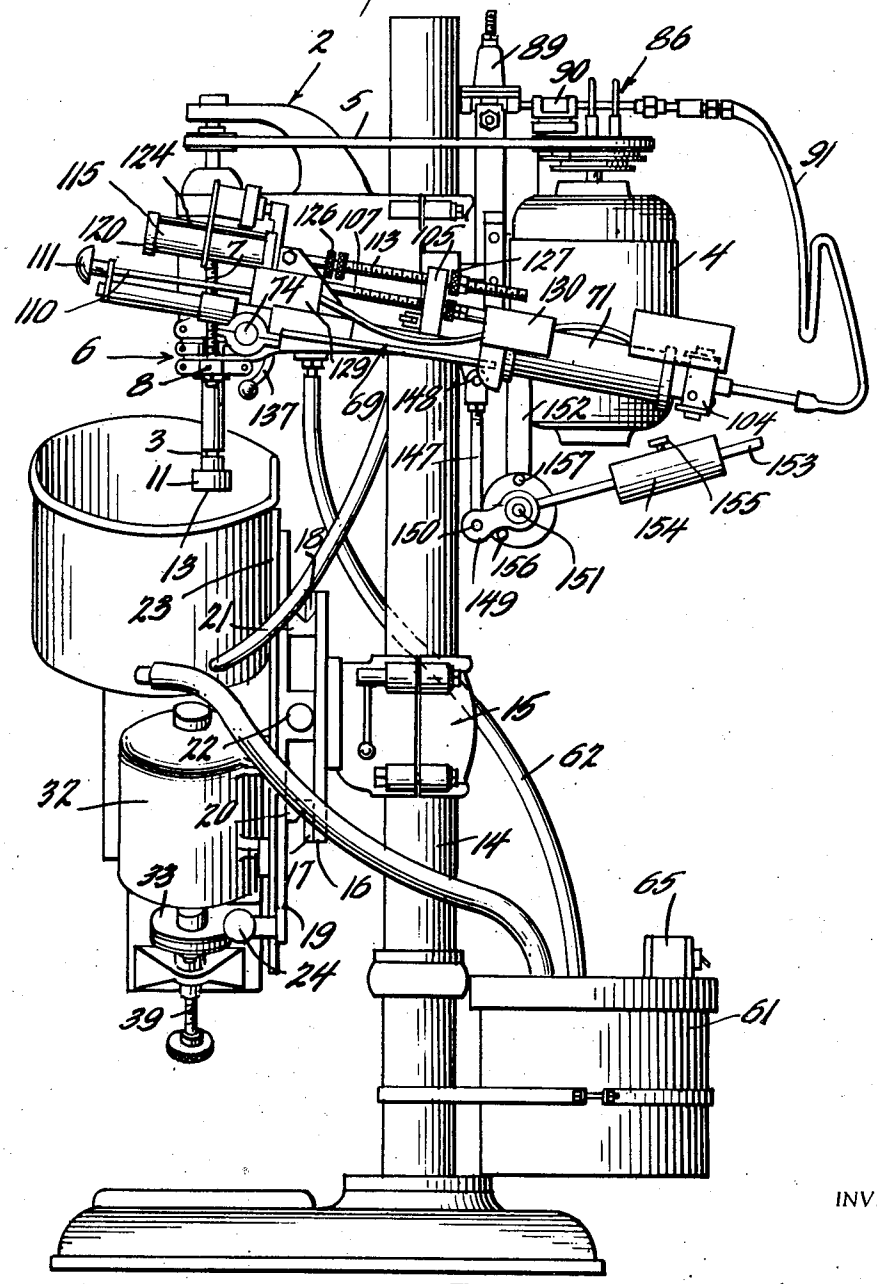
March 22, 1955 P. DE V. D'AVAUCOURT 2,704,424

APPARATUS FOR ABRADING

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FIG. 1.



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APPARATUS FOR ABRADING

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FIG. 2.

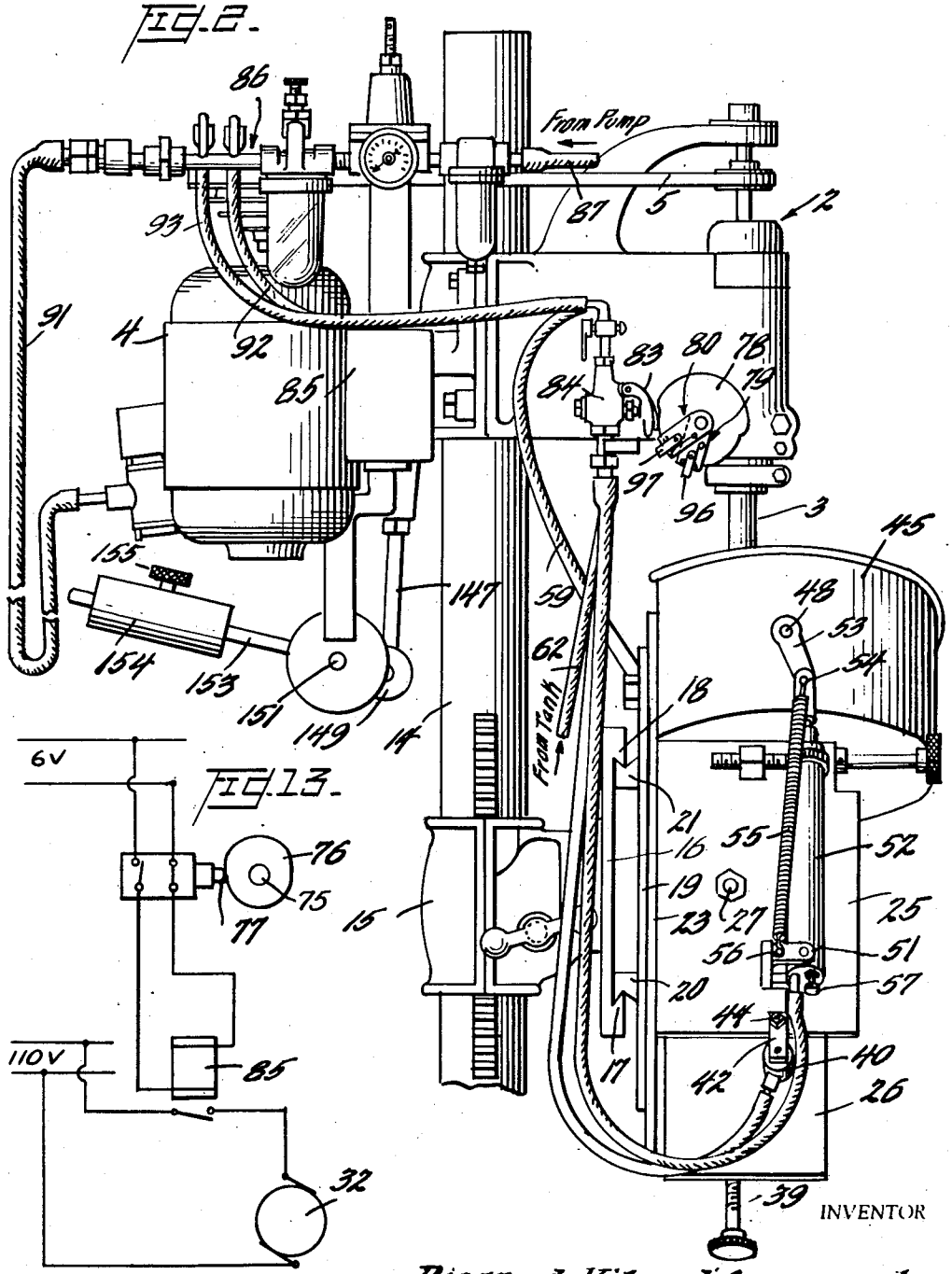


FIG. 13.

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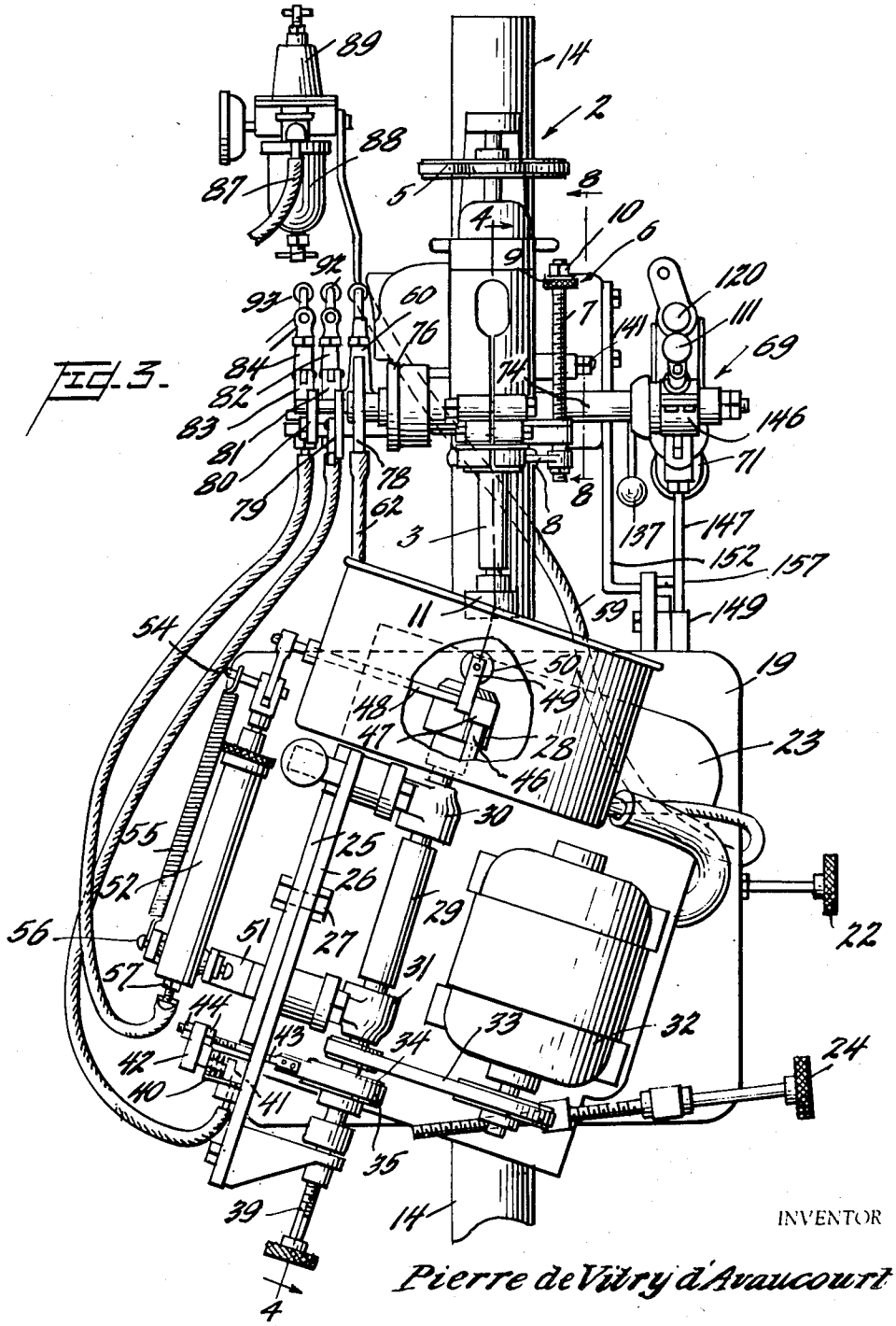
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APPARATUS FOR ABRADING

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FIG. 3.



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APPARATUS FOR ABRADING

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FIG. 4.

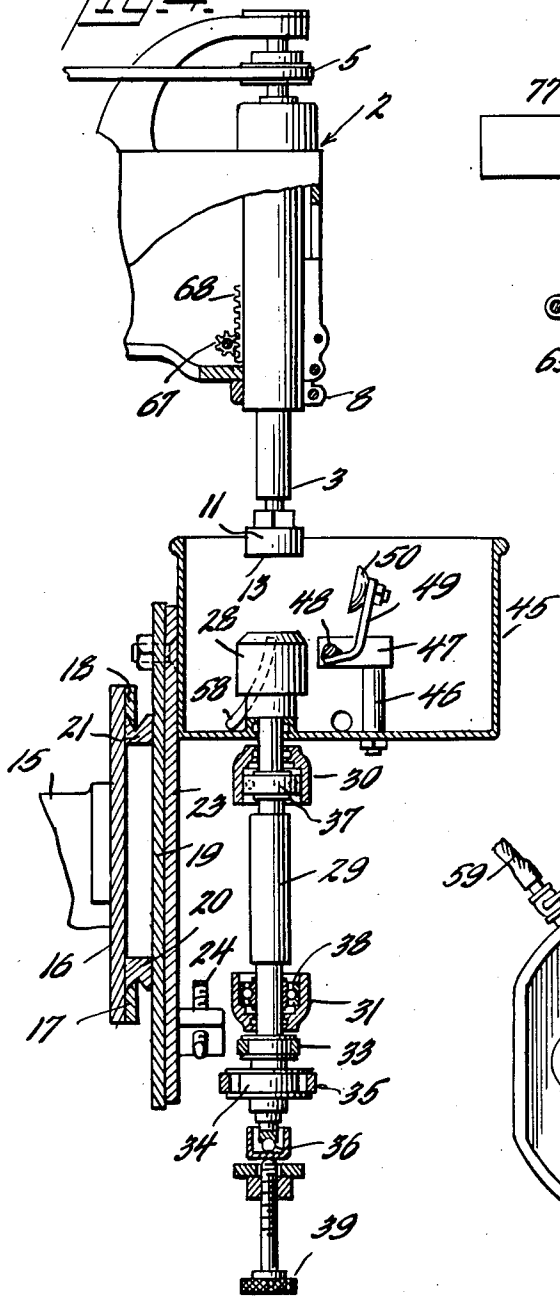


FIG. 14.

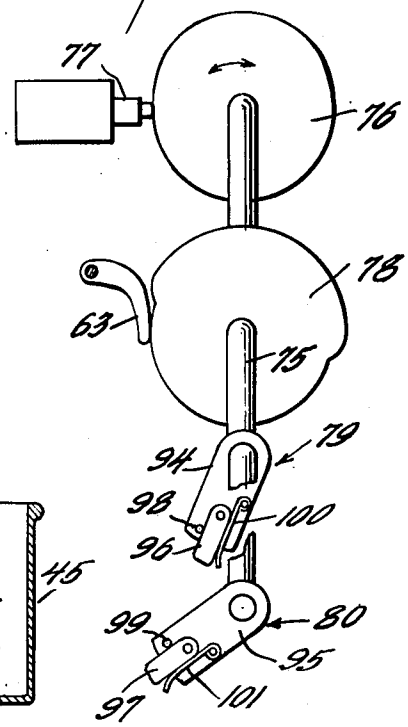
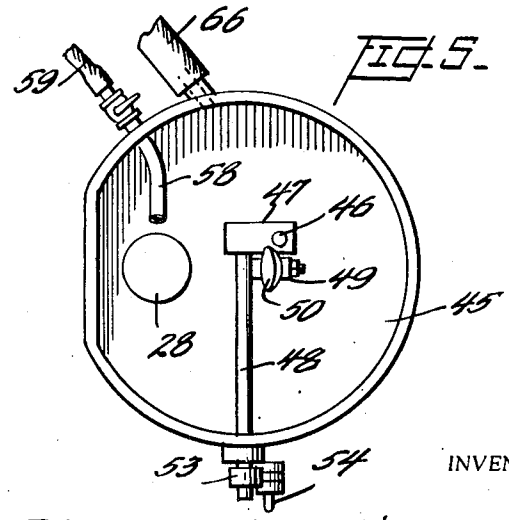


FIG. 5.



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FIG. 15.

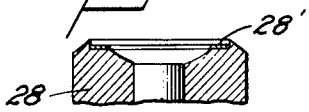


FIG. 6.

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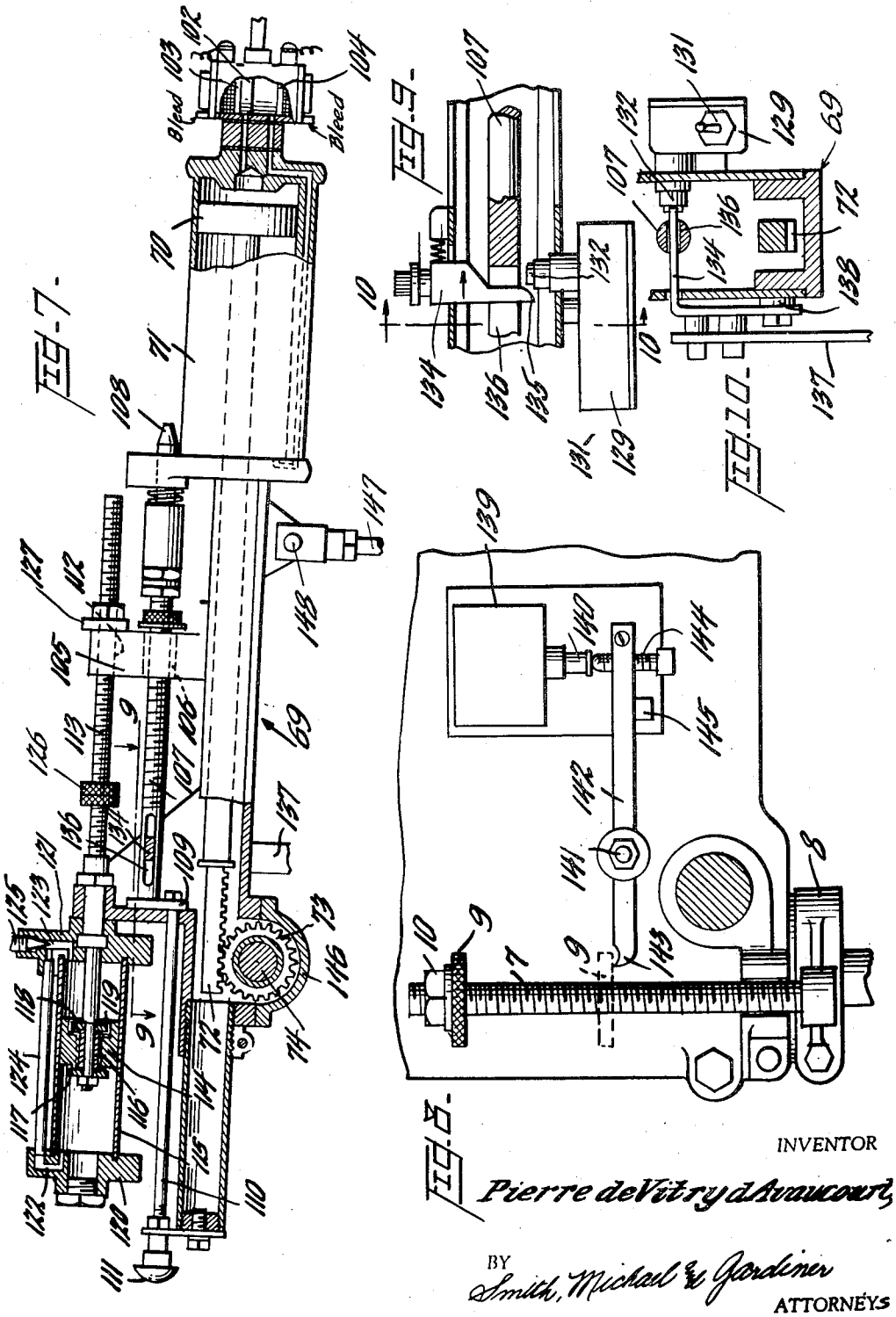
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APPARATUS FOR ABRADING

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APPARATUS FOR ABRADING

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FIG. 11.

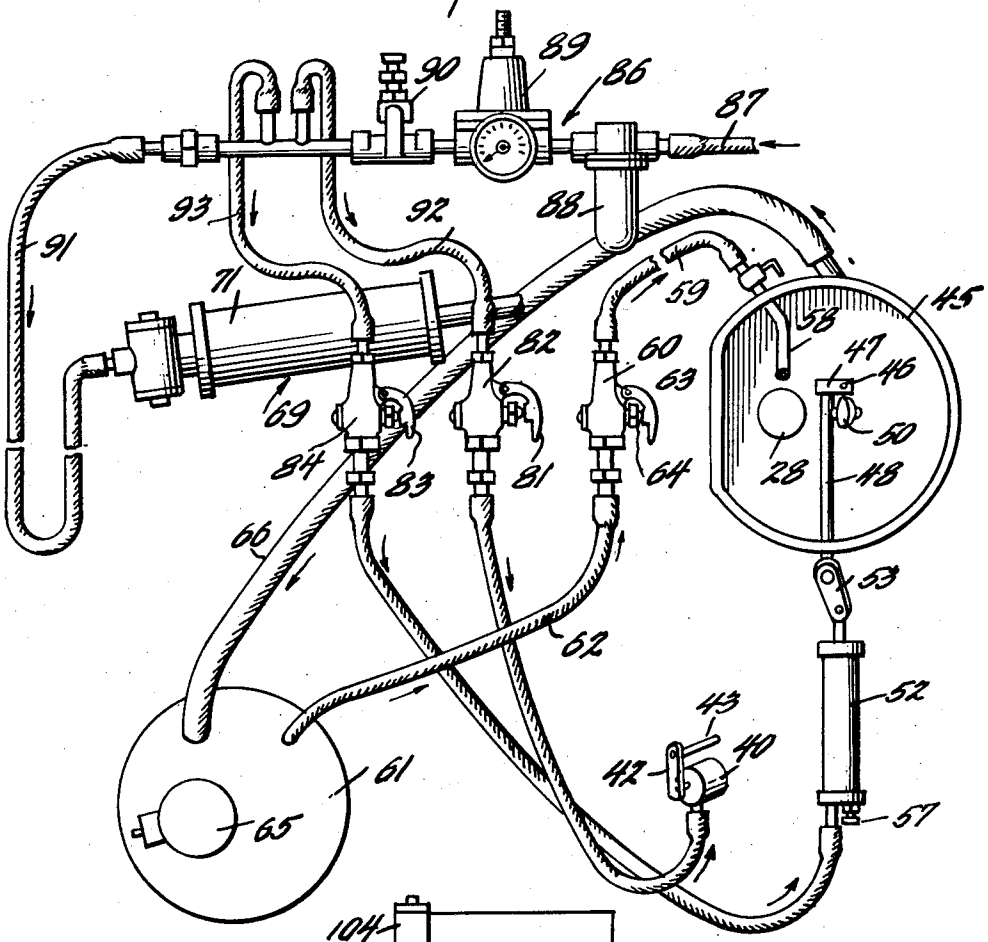
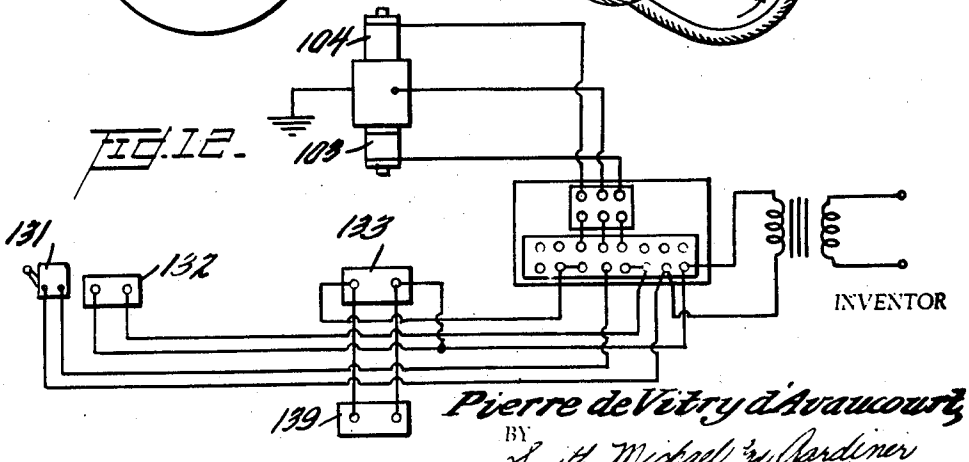


FIG. 12.



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United States Patent Office 2,704,424 Patented Mar. 22, 1955

2,704,424

APPARATUS FOR ABRADING

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Application July 28, 1952, Serial No. 301,334

11 Claims. (Cl. 51—131)

This invention relates to an apparatus for abrading, and more particularly to an apparatus for generating surfaces of lenses and other similar articles, including prisms and plane surfaces. It is particularly useful in the rough grinding of lens blanks.

The present application is a continuation-in-part of my application Serial Number 752,115, filed June 3, 1947, now Patent 2,616,226, dated November 4, 1952.

In the above-referred to application, a generating machine is disclosed which comprises a rotating chuck to receive the lens and a rotating lap which is brought into engagement with the lens by manually lowering the lap against the lens. At the completion of the grinding operation, a brake is brought into action manually to arrest the rotation of the chuck, and then a lens picker is manually operated to remove the lens from the chuck.

It is an object of the present invention to accomplish all of the foregoing results automatically upon initiating the operation of feeding the lap spindle toward the lens on the chuck.

In devices of the prior art, it has been common practice to adjust the position of the chuck vertically with reference to the grinding lap and such adjustments have universally been made from a position above the chuck, but in apparatus of the present kind, where the grinding lap is moved between two fixed limits, it is found that vertical adjustment of the chuck relative to the grinding position of the lap may be made from below the chuck so as to obtain the proper thickness of grind but without changing the grind plane.

In prior devices, and particularly those which employ a manual feed of the grinding lap into the lens blank, there is no means of regulating the pressure applied to the lens blank with the result that in many instances inaccurate grinding is effected or in many cases the lens blanks are broken.

A further object of the present invention is to eliminate this difficulty by adjustably regulating the pressure of the lap on the lens and to insure that such pressure will remain constant.

As in the machine of my prior application, the lens is applied to the chuck manually and must be removed from the chuck in the same manner. An object of the present application is to eliminate the tedious operation of removing the lens from the chuck by providing an automatically-operating lens picker which is swung into engagement with the lens when the chuck has ceased rotating and lifts the lens off the chuck.

A further object of the invention is to provide a novel form of combined air cylinder and dashpot arrangement which enables the lens picker to operate rapidly both in moving toward the lens and in moving the lens off the chuck.

Other objects and advantages will be evident as the description proceeds, and it is to be understood that changes may be made in the details of the construction and other features of the invention so long as they fall within the scope of the claims hereto appended.

Referring to the drawings, forming part hereof,

Fig. 1 is a side elevation of a machine embodying my invention;

Fig. 2 is a fragmentary side elevation looking from the other side of the machine;

Fig. 3 is a fragmentary front elevation;

Fig. 4 is a fragmentary, vertical, sectional view taken along the line 4—4 of Fig. 3;

Fig. 5 is a plan view of the coolant pan and lens picker;

Fig. 6 is a fragmentary plan view partially in section and showing the means for feeding the lap spindle;

Fig. 7 is a detailed view partially in section of the power unit;

Fig. 8 is a fragmentary, sectional view taken on the line 8—8 of Fig. 3;

Fig. 9 is a detailed, sectional view taken along the line 9—9 of Fig. 7;

Fig. 10 is a detailed, sectional view taken on the line 10—10 of Fig. 9;

Fig. 11 is a diagram of the pneumatic circuits employed;

Fig. 12 is a wiring diagram showing the circuits employed in the feeding and control of the lap spindle;

Fig. 13 is a wiring diagram of the circuits employed in initiating movement of the chuck-driving motor;

Fig. 14 is an expanded view of the cam shaft showing the angular displacement of the cams and dogs to bring about sequential operation; and

Figure 15 is a fragmentary sectional view of the lens chuck.

Referring first to Fig. 1, the machine comprises a standard spindle rotating mechanism generally indicated by the numeral 2 which may be purchased from a manufacturer of machine tools. A standard drill press may be used for this purpose. The spindle is indicated at 3, and the motor 4 drives the spindle through the belt gearing 5. Mechanism is provided for raising and lowering the spindle 3 including the usual rack and pinion arrangement commonly used for this purpose. This is part of the standard drill press equipment. Encircling the spindle 3 and movable vertically therewith is a tripping arrangement indicated generally at 6 (Fig. 3) which includes a threaded member 7 attached to a bracket 8 movable with the spindle 3 in a vertical direction. An adjustable stop 9 in the form of a knurled nut is threaded on the member 7 and is secured in position by a lock nut 10. Adjustment of the knurled nut 9 controls the lens thickness as will be more fully described hereinafter.

Attached to the spindle 3 is a lap 11 which, in the embodiment shown, has an annular grinding surface 13 which may be formed of diamond particles embedded in a matrix. The lap 11 is secured to the spindle by any conventional means.

Mounted on an upright column 14 which constitutes the main connection of the machine to its base, is a bracket 15 which supports the lens holder and its associated mechanism including the mechanism for rotating the lens holder and the mechanism for adjusting the position of the lens holder with respect to the lap. Suitable means may be employed for raising and lowering the bracket 15 and for locking the same in place.

A plate 16 is attached to the bracket 15 and is fixed with respect thereto. The plate 16 is provided with ways 17 and 18 as shown in Fig. 1. A plate 19 is positioned for transverse movement along the ways 17 and 18 being guided by dovetail elements 20 and 21 which are secured to the plate 19 and interfit between the ways.

The plate 19 may be moved transversely with respect to the lap spindle 3 by means of the handle 22. By adjusting the plate 19 transversely with respect to the axis of rotation of the lap, it is possible to bring the lens blank and lap into proper transverse relationship. Attached to the plate 19 is a plate 23 as shown in Fig. 3, this plate being pivoted to the plate 19 so that the plate 23 which carries the lens blank chuck and its associated mechanism may be rotated about the pivot which joins the plates 19 and 23. This pivotal movement is produced by means of the adjusting screw 24 in order to adjust the angle of curvature to be formed on the lens blank without changing the transverse adjustment of the plate 19. Carried by the plate 23 and disposed at an angle normal to the plane thereof is another plate 25 to which is pivoted the plate 26 by means of the pivot 27, and the plate 26 has mounted thereon the bearings for the chuck spindle.

The foregoing mechanism for adjusting the lens chuck with reference to the lap is clearly shown and described in my application Serial Number 752,115 filed June 3, 1947, and reference may be made thereto for a full and complete understanding thereof.

The lens chuck is indicated at 28 and is carried on

spindle 29 mounted on the bearing supports 30 and 31 secured to the plate 26. The motor 32 is secured to the plate 23 and drives the chuck spindle 29 through the belt gearing 33, all as described in said prior application. Secured to the chuck spindle 29 is a brake wheel 34 for rotation therewith, and a friction brake engages the brake wheel 34 to arrest rotation of the spindle upon completion of the grinding operation, as will be described hereinafter.

The chuck spindle 29 is mounted in the same manner as disclosed in the prior application, so that the thrust is taken by the ball 36, but differs from said prior application in that the bearing supports 30 and 31 house bearings 37 and 38 to permit sliding movement thereof in the bearing supports 30 and 31 as the adjusting handle 39 is actuated. These bearings 37 and 38 comprise inner and outer ball races with the ball bearings interposed therebetween, and the outer race being slidably mounted in the bearing supports so that adjustment thereof may be effected from below the machine and thereby prevent any change in the plane of grind, as distinguished from machines of the prior art wherein adjustments have been made from above the chuck, and this is one of the important features of the present construction.

It will be seen from the foregoing that the mounting for the chuck spindle is in all respects substantially identical with that of my prior application, with the exception of the adjustable bearings and the fact that the brake 35 is power-operated through a cylinder and the piston arrangement carried by the plate 26.

As seen in Fig. 3, the brake cylinder is indicated at 40 and the piston is indicated at 41. The piston rod has secured thereto a cross head 42 to which is attached a threaded rod 43 adjustably positioned in the cross head 42 by the lock nuts 44 and having its end secured to one end of the brake strap 35, the other end of the brake strap 35 being secured to the plate 26. It is obvious, therefore, that upon the application of fluid behind the piston 41, the brake will be applied to the brake wheel 34 and thereby stop rotation of the chuck spindle. The brake piston 41 is spring-loaded to released position, so that when fluid pressure is bled from the cylinder 40, the brake will be released.

In prior devices, it has been customary to remove the lens from the lens chuck manually, but in the present application means are provided for automatically removing the lens from the chuck.

Referring now to Figs. 3 and 4, the lens picker is supported on the base of the housing 45, which surrounds the chuck 28, by a standard 46 carrying a bracket 47 closely adjacent the chuck 28, and an operating rod 48 is rotatably mounted in the bracket 47 and extends through the side wall of the housing 45. At one end of the rotary rod 48 is mounted a lens picking arm 49 to which is attached a vacuum cup 50, it being understood that the lens chuck is the same as that described in said prior application including a rubber seat 28' for the lens and necessitating only the use of a film of water between the chuck and lens in order to hold the lens on the chuck against rotation. It is apparent, therefore, that as the operating rod 48 is rotated in counterclockwise direction as seen in Fig. 4, the suction cup 50 engages the lens, and upon reverse movement of the rod 48, the lens is picked from the chuck.

Secured to the plate 25 by means of bracket 51 is a fluid cylinder 52 having a piston therein, the piston rod of which is connected to a link 53 as seen in Fig. 2, this link connecting the piston rod and the outer end of the operating rod 48. Attached to the pivot 54 between the piston rod and the link 53 is a coiled spring 55 having its other end secured to the bracket 51 at 56, it being understood that the spring 55 normally biases the lens picker arm 49 into elevated position as shown in Fig. 4.

Fluid pressure is admitted to the lower end of the cylinder 52 below the piston, moving the piston rod upwardly and consequently swinging the lens picking arm 49 and the suction cup 50 into engagement with the lens, and as soon as this engagement has been established, the fluid is bled from the cylinder 52 through the vent screw 57, whereupon the spring 55 returns the picker arm to its inoperative position. In the operations which will be subsequently described, a grinding operation is performed, and in proper sequence, the brake 35 is automatically applied to stop rotation of the lens chuck 28, after which the lens picker is operated to remove the lens from the chuck, and air is exhausted from the brake cylinder 40 and the lens picking cylinder 52, which are thereby restored to inoperative position, whereupon the cycle of operations may be repeated.

It is, of course, essential that coolant be applied to the lens and lap during the grinding operation, and provision is made for automatically applying this coolant during the grinding operation only. This mechanism consists of a coolant nozzle 58 projecting through the base of the housing 45 to a position adjacent the grinding chuck so that coolant may be applied to the lens and lap during the grinding operation. The coolant nozzle 58 is connected to a conduit 59 controlled by a trip valve generally indicated at 60, which valve is in turn connected to the coolant storage chamber 61 by means of a conduit 62. The trip valve 60 consists of a trigger finger 63 pressing on the valve stem 64, said valve being normally biased to closed position. The coolant storage receptacle is provided with a motor 65 driving a pump which feeds coolant to the trip valve 60 and is operated in proper sequence to supply the coolant to the lens only during the grinding operation, after which the trigger finger is released and the coolant supply shut off.

The coolant then drains by gravity from the housing 45 back to the storage tank through the conduit 66.

As mentioned heretofore, the lap spindle is moved to and from the work by means of a rack and pinion mechanism, and this is diagrammatically shown in Fig. 4, wherein the pinion 67 engages the rack 68 to feed the spindle 3 toward and from the work. This is shown more clearly in Fig. 6 on an enlarged scale. In my prior application, this feeding of the lap spindle was accomplished manually, but in the present application, the operation is automatic or power-operated by means of a power unit generally designated at 69 and which consists in part of a power-operated piston 70 housed within a cylinder 71 and having connected thereto a rack bar 72 meshing with a pinion 73 on a cross shaft 74, the cross shaft in turn carrying the pinion 67 meshing with the rack 68 on the spindle shaft.

As will be clearly described hereinafter, operation of the power piston 70 will feed the spindle toward and from the work on the chuck, and the rotating shaft 74 also brings into sequential operation the automatic application of the lens picker and brake, and at the same time initiates rotation of the lap spindle 3. This same shaft 74 also operates the coolant valve trigger finger to project the coolant at the proper moment.

In order that these operations may be more clearly understood, reference is made to Figs. 2 and 6. From these figures, it will be seen that the shaft 74 is provided with an extension 75 on which are mounted a cam 76 engageable with a switch member 77, a cam 78 engaging the trigger finger 63 of the coolant valve, and two one-way dog members, the dog member 79 engaging a trigger finger 81 on the valve 82 for admitting fluid to the brake cylinder 40, and the dog 80 engaging a trigger finger 83 controlling a valve 84 for supplying fluid to the lens picker fluid cylinder 52.

Upon operation of the power piston included in the unit 69, the cam 76 is so arranged on the shaft 75 that as the lap advances toward the lens, the switch 77 is closed and the circuit through relay 85 is closed, the relay being connected to the chuck-operating motor 32 so as to initiate rotation of the chuck 28. At the same time, the pump for the coolant supplies fluid through the conduit 62 to the valve controlled by the trigger finger 63. The cam 78 is angularly displaced on the shaft 75 so that at the proper moment of rotation, the trigger finger 63 is tripped, the valve 60 opens, and the coolant flows to the lens and lap at the time the grinding operation is taking place.

Immediately after the completion of the grinding operation, the dog 79 engages the trigger finger 81, opens the valve 82 in the fluid line to the brake cylinder 40, arresting movement of the chuck, and then releases the same by bleeding of the cylinder 40. As soon as the rotation of the chuck 28 has ceased, the dog 80 engages the trigger finger 83, opening the valve 84 and permitting fluid to flow to the bottom of the lens picker cylinder 52 to swing the vacuum cup 50 into engagement with the lens, where-

upon fluid is bled from the cylinder **52**, and the spring **55** returns the picker arm **49** and the lens to its elevated position.

The fluid pressure for the power-operated cylinder in the unit **69** and also for the brake and lens picker is supplied through a manifold **86** connected to any suitable source of fluid pressure by the conduit **87**. This manifold contains a lubricator **88**, a pressure gauge **89**, and a filter **90**. A fluid, in this instance air, passes through the manifold **86** which is connected to the power cylinder in the unit **69** by means of a flexible conduit **91**, and this manifold **86** is also connected to the brake-controlling valve **82** by means of flexible conduit **92** and to the valve **84** controlling the lens picker cylinder **52** by means of a conduit **93**.

In view of the fact that the shaft **74** does not make a complete revolution during its operation and since the valve trigger fingers **81** and **83** are operated only momentarily, the one-way dogs **79** and **80** are provided. These dogs consist of arms **94** and **95** secured to the shaft extension **75** and having pivoted thereon yielding fingers **96** and **97**, it being clear from Figs. 2 and 14 that these fingers are yieldingly held against stops **98** and **99** by means of springs **100** and **101**, so that when the arms **94** and **95** are rotated in counterclockwise direction, the fingers **96** and **97** are against the stops and therefore held in rigid position, but on the return stroke the springs **94** and **95** yield, allowing the dogs to pass over the trigger levers for the valves without depressing the same.

As previously mentioned, the lap spindle **3** is fed toward and away from the chuck by a power unit **69**, and upon reference to Fig. 7, the details of construction of this power unit will be clear.

At the rear end of the cylinder **71** is a valve **102** which may be actuated by means of an advancing solenoid **103** or a retracting solenoid **104** to permit air to be directed to either end of the cylinder for the purpose of causing reciprocation of the piston **70**. A hydraulic check is provided so as to retard movement of the lap spindle during the grinding operation so that the spindle moves into the work at the proper speed, it being evident that the speed of movement of the rack bar **72** will move the lap spindle rapidly toward the work, after which the speed of progress is slowed down in order that the lap may engage the work gently and thereby avoid breakage of the lens blanks.

Secured to the rack bar **72** is an upstanding bracket **105** provided with an aperture **106** therein through which passes a threaded plunger **107** carrying at its end a beveled nose **108**. This plunger is connected to a cross head **109** to which is secured an operating rod **110** having a button **111** at its forward end.

The bracket **105** is also provided with a U-shaped groove **112** which straddles the screw threaded piston rod **113**, this rod being connected to the piston **114** reciprocably mounted in the cylinder **115**.

The piston **114** is secured to the piston rod **113** by means of a sleeve **116** passing through the piston and being of a diameter slightly less than the diameter of the opening through the piston **114**. At each end of the sleeve **116** are collars **117** and **118**. A passageway **119** is provided around the collar **118**, this passageway communicating with the opening through the piston **114**, and the collars **117** and **118** are spaced apart such a distance as to permit relative movement between the piston rod **113** and the piston **114**.

With this construction, it is evident that with the cylinder **115** full of oil, movement of the piston **114** in one direction will force the collar **117** away from the piston **114**, thereby permitting passage of fluid around the collar **117**, through the bore of the piston and through the passageway **119** to the opposite side of the piston, thereby retarding movement of the rack bar **72**.

Movement of the piston **114** in the opposite direction will, of course, pull the collar **117** against the piston, thereby preventing passage of fluid through the port in the cylinder.

The cylinder heads **120** and **121** are provided with passageways **122** and **123** connected by a by-pass tube **124** and the passageway **123** is controlled by a needle valve **125** which regulates the speed of flow of the fluid through the by-pass tube **124** as the piston **114** reciprocates back and forth in the cylinder **115**.

The piston rod **113** is provided with spaced nuts **126** and **127** which are threaded onto the rod **113** and which may be adjusted to be engaged by the bracket **105** at any point along the piston rod. From the foregoing, it is clear that as the rack bar **72** moves to the left as in Fig. 7, the bracket **105** will strike the nut **126** thereby forcing the piston **114** to the left and retarding the speed of travel of the rack bar **72** and consequently the grinding lap. Upon the return stroke of the rack bar **72**, the bracket **105** engages the nut **127** and returns the piston **114** to a position for retarding action during the next cycle of operations.

Referring to Fig. 6, the power unit has attached to one side thereof an electrical conduit **128** including spaced switch boxes **129** and **130**. The box **129** contains a master switch **131** and a push button microswitch **132**, whereas the box **130** contains a single push button microswitch **133** lying in the path of the beveled nose **108** carried by the plunger **107** so that upon actuation of the safety button **111**, the plunger **107** is moved to actuate the microswitch **133** which is in circuit with the retracting solenoid **104** which actuates the valve **102** and thereby causes reverse movement of the power piston **70**.

By the provision of this safety feature, it is evident that by operating the safety button **111**, the power piston **70** can be reversed at any point in its movement, and the grinding lap returned to its inoperative position when desired.

The push button switch **132** is in circuit with the advancing solenoid **103**, and this switch **132** is actuated by a switch arm **134** provided with a beveled toe **135** and extending through a slot **136** in the plunger **107**, so as to contact the microswitch **132** upon operation of the hand lever **137** pivoted at **138** to a suitable portion of the frame of the power unit **69**, as will be clearly seen from Figs. 9 and 10.

As previously described, the lap spindle carries a tripping arrangement comprising the threaded member **7** movable with the lap spindle and having the adjustable stop **9** thereon. Attached to the frame of the machine adjacent the threaded member **7** is a microswitch **139** having a push button operator **140**. Pivoted to the frame at **141** is a trip lever **142** having a nose **143** lying in the path of travel of the adjustable stop **9**, and having at its other end a threaded finger **144** which engages the push button operator **140** to actuate the switch **139**. This switch is in parallel with the switch **132** and is connected to the retracting solenoid **104**.

By adjusting the knurled nut **9** along the threaded member **7**, it will be apparent that it is possible to control the thickness of the lens to be ground, because during the descent of the grinding lap, the nut **9** engages the nose **143** of the lever **142** and actuates the push button operator **140** for the purpose of reversing the movement of the power piston **70** and thereby elevating the grinding lap from the lens.

The lever **142** normally rests on a stop **145**, and by adjusting the threaded finger **144**, the time of operation of the switch **139** can be controlled.

In prior devices, it has been difficult if not impossible accurately to control the pressure of the grinding lap on the work, but this is of extreme importance in order that accurate grinding may be produced and breakage or chipping of the lenses eliminated.

The present invention embodies means for controlling the pressure so that it will remain constant under all conditions.

The power unit **69** carries a yoke **146** which surrounds the cross shaft **74**, and this cross shaft is the sole means of support for the entire power unit **69**. It is evident from an inspection of Fig. 1 that the center of gravity of the power unit **69** is to one side of the cross shaft **74**, and that this power unit is free to turn about the shaft **74** as a fulcrum point.

In normal operation, the power unit **69** is maintained in horizontal position by a counter-weight, but in Fig. 1 it is shown at the opposite extreme of its rocking movement. When pressure is applied to the power piston **70**, the lap is fed into engagement with the work. If the lens being ground is unusually thick, it is evident that the downward pressure of the lap on the lens will be excessive. Under these conditions, there is an upward thrust on the lap spindle **3** which tends to rotate the gear **73** and force the rack bar **72** to the right as shown

in Fig. 7. However, since at that time there is pressure behind the piston 70, the rack bar 72 can not move to the right, and consequently the upward thrust on the lap spindle 3 causes rotation of the power unit 69 bodily about the cross shaft 74.

In order to regulate the pressure of the lap on the lens, there is provided a counter-weight consisting of a connecting rod 147 pivoted to the power unit at 148 and to a counter-weight arm 149 at 150. The counter-weight arm 149 is pivoted on a stud 151 carried by bracket 152 which is secured to the frame of the machine. The counter-weight arm 149 terminates in a rod 153 on which is mounted a slidable counter-weight 154, which may be held in adjusted position by a lock screw 155. Suitable stops 156 and 157 are provided on the bracket 152 to limit the swinging movement of the counter-weight arm 149.

From the foregoing, it will be seen that by adjusting the counter-weight 154 along the rod 153, the pressure of the lap on the work is controlled and that when this pressure exceeds the force of the counter-weight, the rear end of the power unit 69 will move downwardly against the counter-weight and due to the thrust of the rack bar 72 on the teeth of the pinion 73, this rocking movement of the power unit 69 will cause the lap to be elevated to the proper degree, thereby relieving the pressure on the lens. By this means, constant pressure can be maintained accurately, and all danger of injury to either the lap or the lens eliminated.

The operation of the machine is as follows: With the motor 4 for rotating the lap spindle 3 in operation and with the coolant pump 65 functioning, the operator actuates the hand lever 137 to close the advancing switch 132, thereby actuating the advancing solenoid 103 and causing air to pass into the cylinder 71 of the power unit 69 and thereby move the power piston 70 to the left, as seen in Fig. 7, and thus advance the grinding lap toward the work rapidly.

Just prior to engagement between the lap and the lens, the hydraulic check comes into action and slows down the advancing movement of the lap so that it engages the lens gently and then moves slowly into the lens to a distance determined by the setting of the stop nut 9.

During the downward movement of the lap spindle, the stop nut 9 engages the trip lever 142 and actuates the switch 139 to cause reverse movement of the power piston 70, since the switch 139 energizes the retracting solenoid and permits air to flow to the opposite side of the power piston 70. It will be seen from the foregoing that the thickness of grind can be nicely and automatically controlled, and that extreme accuracy may be obtained.

The advance motion of the grinding spindle 3 is caused by rotation of the cross shaft 74, and during the rotation of this shaft, the cam 76 engages the switch 77 just prior to the engagement of the lap with the lens, and the closing of this switch energizes the relay 85 to energize the chuck-driving motor 32. At the same time, the cam 78 engages the trigger finger 63 of the coolant valve, thereby permitting the coolant to be supplied to the lap and lens during the actual grinding operation.

When the lap has advanced into the lens the required distance, and the trip lever has been actuated to reverse the power piston, the lap will be elevated and the grinding operation completed. Immediately after the lap has been returned to its retracted position, the dog 79 engages the trigger finger 81 and air is supplied to the brake cylinder 40 to apply the brake 35, and thereby stop rotation of the chuck spindle. With the chuck spindle stationary, the dog 80 engages the trigger finger 83 on the lens picker valve, and air is supplied to the lens picker cylinder 52, thereby rotating the rod 48 and causing engagement of the suction cup 50 with the lens. It will be apparent that this engagement between the dog 80 and the trip finger 83 is only momentary and that upon release of the valve 83, the spring 55 returns the lens picker piston to its lowered position and elevates the suction cup together with the lens away from the chuck.

It should be noted in connection with the lens picker cylinder that provision is made for rapidly bleeding air from behind the piston during its return stroke. As previously described, this bleeding is controlled by the vent screw 57 passing into an aperture at the lower end of the cylinder 52. The aperture is open at all times, but the screw 57 controls the area of the aperture and is so adjusted that in the advance movement of the piston which swings the suction cup into engagement with the lens, the volume of air flowing into the cylinder is so great that an insufficient amount will escape through the vent to prevent proper operation of the piston. When the piston has reached the end of its advancing stroke, the flow of air is immediately cut off by release of the trigger finger 83 and the spring 55 returns the piston, thereby forcing the air rapidly through the opening 57 and permitting the lens picker to return to inoperative position.

From the foregoing it will be seen that an efficient, accurate, and rapid lens grinding apparatus has been disclosed requiring only the placing of the lens on the chuck and the operation of the hand lever 137 to initiate a complete cycle of operation in which the lens is ground to the proper thickness, coolant is supplied during the grinding, the chuck spindle quickly braked, and the lens removed from the chuck.

I claim:

1. In an abrading machine, a rotatable work-carrying chuck and a rotating abrading element, means for feeding the abrading element to and retracting the same from the work including a reciprocable spindle, adjustable trip means carried by said spindle and engaging a switch-actuating arm on the machine to cause retracting movement of the spindle, and thereby regulate the grinding thickness, a switch operable upon feeding movement of the spindle toward the work to initiate rotation of the chuck, a coolant conduit for directing coolant onto the work and having a valve therein, a cam operable by the feeding means to actuate said valve and permit flow of coolant to the work, a fluid-actuated brake for arresting rotation of the chuck, a conduit for directing fluid to said brake and having a valve therein, a dog carried by said feeding means engageable with the valve in the brake conduit to open the same, and a fluid-operated lens picker, said lens picker including a fluid conduit having a valve therein, and another dog on the feeding means engageable with the lens picker valve to open the same and actuate the picker to remove the work from the chuck.

2. The combination with a rotatable lens chuck having a rubber lens seat therein and a film of water on said seat between said seat and a lens mounted in the chuck to hold the lens against relative rotation in said chuck, of a lens picker comprising a swinging arm, a suction cup on one end of said arm, and means at the other end thereof for swinging said arm, said suction cup being positioned to engage the lens when swung in one direction and to lift the lens from the chuck when swung in the opposite direction.

3. The combination with a rotatable lens chuck having a rubber lens seat therein and a film of water on said seat between said seat and a lens mounted in the chuck to hold the lens against relative rotation in said chuck, of a lens picker comprising a swinging arm, a suction cup on one end of said arm, and means at the other end thereof for swinging said arm, said means including a rotary rod secured to said swinging arm at one end, a link secured to the opposite end of the rod, and a piston rod secured to said link, means for supplying fluid pressure behind the piston to swing the suction cup into engagement with the lens, and spring means for moving the piston in the opposite direction to swing the suction cup and lens away from the chuck.

4. A lens picker comprising a fluid cylinder and a piston therein, a swinging arm operable by said piston and having a suction cup on the end thereof to engage a lens, means for supplying fluid pressure to said piston to move the same in one direction, and a spring for moving the piston in the opposite direction, and means for bleeding air from said cylinder upon said last-mentioned movement comprising a constantly open vent aperture and an adjustable screw for regulating the flow of fluid therethrough, the area of said aperture being at all times insufficient to permit escape of fluid as fast as it is supplied to the cylinder, but of an area rapidly to vent the cylinder when the supply ceases.

5. In an abrading machine, a rotatable lens-carrying chuck and a rotating abrading lap carried by a reciprocable spindle, a rotary cross shaft having a gear thereon meshing with a rack on said spindle to feed the lap to and away from the work, a second gear on said cross

shaft, a power unit supported solely by said shaft and rockable thereabout including a piston and cylinder for rotating said second gear, said piston carrying a reciprocating rack bar engaging said second gear, and a counter-weight secured to the machine and power unit to permit the unit to rock about said shaft against the action of the counter-weight when pressure on the abrading lap overcomes the counter-weight thereby to relieve the pressure of the lap on the lens.

6. An abrading machine as claimed in claim 9 in which the counter-weight comprises a connecting rod secured to the power unit rearwardly of the cross shaft, a counter-weight arm pivoted intermediate its ends to a bracket on the machine and having one end pivoted to said connecting rod, said counter-weight arm terminating at its other end in a rod, and a counter-weight slidable along said rod to adjust the pressure on the grinding lap.

7. An abrading machine comprising a lens-carrying chuck and a rotating grinding lap spindle, a power-operated shaft lying behind said spindle and connected to said lap spindle for feeding the same to and from the lens, and including a gear, a power unit mounted on said shaft and rockable thereabout, said power unit including a rack bar engageable with said gear, and an adjustable counter-weight for maintaining the desired pressure of the lap on the lens secured to said power unit on the opposite side of said shaft from said lap spindle, whereby upward thrust on the lap spindle causes rocking of the power unit about said shaft against the action of the counter-weight to maintain desired pressure of the lap on the spindle.

8. An abrading machine comprising a rotatable lens-carrying chuck and a rotating grinding lap, a fluid cylinder having a piston therein operatively connected to the lap to feed the lap to and from the work, a manifold through which fluid is supplied to said cylinder to operate the piston, a fluid brake for arresting movement of the rotatable lens chuck and a fluid-operated lens picker for removing a lens from said chuck, said brake and lens picker being supplied through conduits communicating with said manifold, and valve means in said conduits automatically operable to pass fluid therethrough during operation of the feeding means.

9. An abrading machine comprising a lens-holding chuck, a lens picker for removing the lens from the chuck, said picker comprising a swinging arm, a suction cup secured to one end of the arm and movable into engagement with the lens when the arm is swung in one direction and to lift the lens from the chuck when rotated in the opposite direction, and means for swinging said arm.

10. An abrading machine comprising a lens-holding chuck, a lens picker for removing the lens from the chuck, said picker comprising a swinging arm, a suction cup secured to one end of the arm and movable into engagement with the lens when the arm is swung in one direction and to lift the lens from the chuck when rotated in the opposite direction, and fluid means for swinging said arm.

11. In combination, a rotatable lens-carrying chuck and a rotating abrading element, fluid means for feeding the abrading element to and retracting the same from the lens, and a fluid-operated lens picker comprising a swinging arm having a suction cup mounted on one end thereof and engaging the lens when the arm is swung in one direction, a rotary rod connected to the other end of said arm, a fluid cylinder having a piston therein secured to said rod to rotate the same, and means controlled by the spindle-feeding means for actuating the piston to swing the arm in the opposite direction to remove the lens from the chuck.

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