Dec. 27, 1955 G. H. FUEHRER 2,728,328

AUTOMATIC WATER VALVE FOR ROCK DRILLS

Filed May 18, 1953

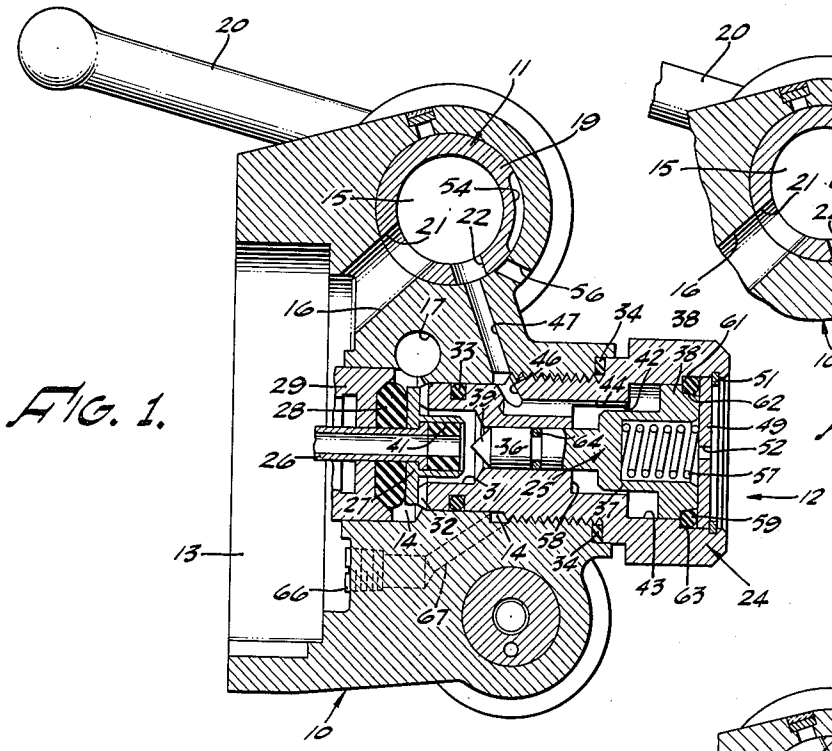


FIG. 1.

FIG. 4.

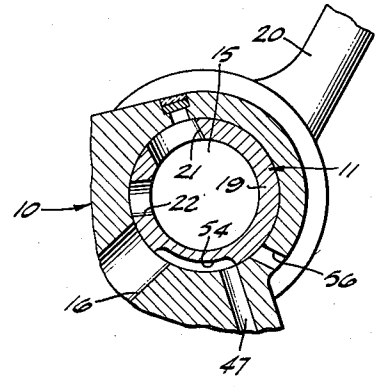


FIG. 3.

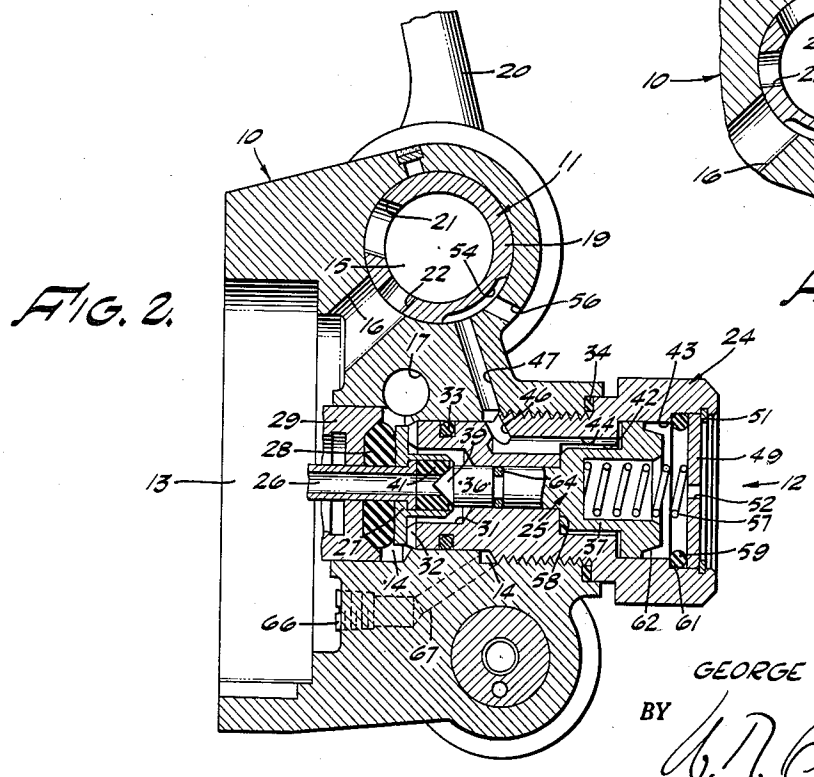


FIG. 2.

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2,728,328

Patented Dec. 27, 1955

2,728,328

AUTOMATIC WATER VALVE FOR ROCK DRILLS

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Application May 18, 1953, Serial No. 355,679

10 Claims. (Cl. 121—10)

This invention relates to automatic valves, and particularly to an air-operated valve for controlling the flow of water to the cutting head of a rock drill in accordance with the position of the drill throttle valve.

In rock drill structures of the type in which cleaning water is fed through the drill to the drill bit, it is conventional to provide a water tube plug in the backhead of the drill and adjacent the outer end of a removable water tube. Such a construction makes possible the replacement of the water tube upon mere removal of the water tube plug, so that the drill need not be lifted out of the mine when the water tube is broken. In my co-pending patent application Serial No. 325,005, filed December 9, 1952, for an Automatic Water Valve for Rock Drills, I have described and claimed an improved automatic water valve which is shaped as a water tube plug and may be substituted for it, and which is removable when it is desired to replace a broken water tube.

The present invention constitutes an improvement over the structure illustrated in my co-pending application, and is particularly directed to the solution of the following problems which may arise in the use of the described automatic valve, particularly where adequate maintenance and lubrication operations are not carried out. The first problem is that of sticking of the valve components after the initial lubrication has been lost. It is highly important in mining operations, where dirt and water are frequently present at the drill, that the water valve be designed to prevent sticking even in the absence of adequate lubrication or in the presence of foreign matter such as particles of dirt or dust. A second important problem is that of preventing the opening of the water valve, and consequent flow of water to the drill bit, when the throttle valve is in the "off" position and no drilling operation is in progress. It is inherent in a rock drill, particularly after a considerable amount of use and consequent wear on the drill components, that a certain amount of air pressure seeps from the inlet air line and into the drill. This air pressure may, after a substantial length of time, build up to a point where the automatic water valve is shifted to open position and the flow of water commenced at an undesired time. A third important problem is that of providing an automatic water valve and associated throttle valve which, in accordance with requirements of a particular customer, may or may not be adapted to effect water flow to the drill bit during the "collaring" or starting hole portion of the drilling operation.

These and other objects and advantages of the invention will be more fully set forth in the following specification and claims considered in connection with the attached drawing to which they relate.

In the drawing:

Figure 1 is a vertical sectional view of the backhead of a rock drill, the section being taken longitudinally of the drill and illustrating the components of the automatic valve of the invention;

Figure 2 is a view corresponding to Figure 1 but illustrating the water valve in closed position;

Figure 3 is a fragmentary view of the throttle valve portion of Figures 1 and 2, and showing the throttle valve in a third position at which the water valve is vented through the machine and permitted to asume a closed position; and

Figure 4 illustrates a throttle valve of a second embodiment of the invention adapted to effect flow of water during the collaring operation.

Referring to the drawing, the illustrated structure may be seen to comprise a backhead **10** provided at the outer end of a conventional rock drill, not shown, a throttle valve **11** mounted in backhead **10** and adapted to control the flow of air to the motor components of the drill, and an automatic water valve **12** associated with throttle valve **11** in controlling the flow of cleaning water to the drill bit. In addition to these elements specifically illustrated, the drill components at the backhead further comprise a handle and a suitable lubricating chamber, both not shown.

The backhead **10** is formed with a generally cylindrical chamber **13** adapted to receive the unshown motor valve components of the drilling apparatus, and with a communicating chamber or passage **14** extending axially of chamber **13** to the end of the drill for mounting of the automatic water valve **12** and associated elements. The upper portion of the backhead is provided with a relatively large transverse bore **15** adapted to receive the air throttle valve **11**, and which communicates through a passage **16** with the chamber **13**. Extending parallel to bore **15** is a second and smaller transverse bore **17**. This bore is connected at one end to a suitable water hose, not shown, and communiates at its other end with the passage or chamber **14**.

The air throttle valve **11** comprises a tubular body **19** which is mounted in bore **15** and adapted with a handle **20** for manual rotation to different controlling positions. The tubular body **19** connects to an air supply hose, not shown, and serves as an air conduit between the hose and passage **16** leading to the drill motor. For this purpose a relatively large "full speed" port **21** is provided in valve body **19** and disposed to register with the full diameter of passage **16** when the valve is in the full speed position shown in Figure 1. A second and smaller port **22**, known as the "collaring" port, is arcuately offset from the full speed port **21** and registers with passage **16** when the valve is in the collaring position shown in Figure 2. In the operation of the valve, the drill bit is first positioned at the desired location on the rock to be bored, and the throttle valve **11** is rotated to the Figure 2 position. A relatively small volume of air then flows through the small collaring port **22** and the passage **16** to the drill motor, so that the drill is operated at low speed and a starting or collaring hole formed in the absence of excessive drill movement. After the drill bit is firmly located in the collaring hole, the throttle valve **11** is rotated to the Figure 1 position at which a large volume of air flows through the relatively large full speed port **21** and passage **16** to effect full speed drill operation. The precise location of valve **11** at the various illustrated positions is insured through use of suitable detent means, not shown.

The automatic water valve **12** comprises a generally cylindrical casing **24** threaded into the passage **14**, and a piston or plunger **25** adapted to be air-actuated longitudinally of casing **24** to control the flow of water from inlet passage **17** to the drill bit. The water circuit thus controlled is through a water tube **26** which extends longitudinally of the full length of the drill and into passage **14**, there being a flange at the end of tube **26** for seating on the bottom of a suitable washer cup **27**. Cup **27**, in turn, is provided with an external flange for pressing connection with an annular packing member **28** which is nested in a cylinder **29** forming part of the internal

components of the drill itself. The flange of washer cup 27 is pressed against packing 28 by the inner end of water valve casing 24, the latter being suitably recessed at 31 to fit over the body of the washer cup. The inner end or rim of the casing 24 is suitably notched or ported, as shown at 32, to provide water passages between water bore 17 and recess 31. A water chamber is thus provided in passage 14, and is sealed by the packing 28 and by an O-ring 33 mounted between the unthreaded inner end of casing 24 and the cooperating passage wall. This water chamber is to be distinguished from an air chamber formed in passage 14 and sealed both by the O-ring 33 and by a gasket 34 mounted between a shoulder portion of casing 24 and a cooperating seat on the backhead.

The plunger 25 of water valve 12 is formed with a small diameter inner or stem portion 36, a medium diameter stop portion 37 outwardly adjacent stem 36, and a relatively large diameter flange or piston disc portion 38 outwardly of stop portion 37. The stem portion 36 is freely slidable within a corresponding axial bore in casing 24 and is provided with a conical inner end 39 for sealing engagement with a rubber washer 41, the latter being mounted in washer cup 27 adjacent the flanged end of the water tube. The stop portion 37 of plunger 25 is mounted in a casing chamber of substantially larger diameter, so that an annulus 42 is provided between the plunger and its casing for passage of air as will be described. The piston disc 38 is mounted in a corresponding cylindrical piston chamber 43 formed axially of casing 24 at its outer end.

Air passage means for connecting throttle valve 11 and piston chamber 43 are provided in the form of a longitudinal passage 44 formed in casing 24 and communicating both with piston chamber 43 and annulus 42, and a communicating radial passage 46 extending from the inner end of passage 44 to the air chamber portion of passage 14. The air chamber portion adjacent casing passage 46 takes the form of an annular groove between a shoulder of the backhead 10 and the inner thread member of the valve casing 24. This groove communicates through an upwardly extending passage 47 with the air bore 15.

As shown in Figure 1, the location of collaring port 22 is such that it registers with passage 47 when the valve is in the full speed position, so that air is then admitted from air bore 15 and through collaring port 22, passages 47, 46, and 44 to the inner end of piston chamber 43. The piston disc 38 is thus air pressed outwardly to shift the plunger 25 to its open position permitting the flow of water through water tube 26. When the piston disc 38 is at the outer position, its outer edge is seated against a stop disc 49 which is maintained at the outer end of chamber 43 by a snap ring 51. The stop disc 49 is provided with an axial port 52 to effect venting of the air behind piston disc 38 when it shifts to open the valve.

For the majority of applications of the automatic water valve structure, it is not desired that water flow to the drill bit during the collaring operation. Accordingly, an arcuate venting groove 54 is provided on the external surface of throttle valve body 19 and disposed to connect passage 47 and a venting port 56 when the valve is rotated to the collaring position illustrated in Figure 2. At this time the supply of pressure air to the piston disc 38 is blocked, and the air at the inner end of piston chamber 43 is vented through passages 44, 46 and 47, and through arcuate groove 54, to the port 56 which leads to the atmosphere. A helical compression spring 57, seated between disc 49 and the bottom of a spring chamber at the outer end of plunger 25, is then effective to shift the plunger to its water blocking position at which the stop portion 37 of the plunger is seated on a shoulder 58 formed in casing 24 at the outer end of the bore for stem 36. The conical end 39 of the plunger then being spring pressed against sealing washer 41, the flow of water from water bore 17 and through the water chamber to water tube 26 is effectively blocked.

Referring to Figure 3, the spring return movement of the plunger 25 is also effected when the throttle valve 11 is rotated to off position, at which neither the collaring port 22 nor the full speed port 21 registers with passage 16 leading to the drill motor. Venting in this instance is effected through the drill body, with the arcuate groove 54 connecting the passage 47 and passage 16.

According to the invention, the described air actuation of plunger 25 between closed and open positions is effected even in the absence of adequate lubrication and after a substantial number of opening and closing operations under adverse conditions. To accomplish this result, the diameter of piston disc 38 is made substantially smaller than that of piston chamber 43, and no seal is provided on the periphery of the piston disc. Instead, an O-ring 59, formed of rubber or other suitable elastomer, is fixedly mounted in an annular groove 61 at the outer end of piston chamber 43. The side walls of groove 61 are defined by a shoulder in casing 24 and by the stop disc 49, while the bottom wall of groove 61 is defined by an axially extending cylindrical casing surface. It will be noted that the depth of groove 61 is only about half the diameter of the O-ring 59, which is cylindrical in section when in its undeformed state. To provide for the sealing engagement between O-ring 59 and the plunger 25, the outer edge of piston disc 38 is beveled to form a frusto-conical surface 62 adapted to engage the inner portion of O-ring 59, and a surface 63 which extends radially from the inner edge of surface 62. The surface 63 is spaced, relative to the outer end of plunger 25, so that it forms a continuation of the inner wall of O-ring groove 61 when the valve is in its open position as shown in Figure 1, the plunger end then being seated on stop disc 49 as previously stated.

The above construction is to be distinguished from previous constructions in which an O-ring is provided on the piston disc 38 for movement with it. Such an O-ring, because of its relatively large size, has a distinct tendency to stick in the presence of particles of foreign matter and in the absence of proper lubrication. Although an O-ring 64 is provided on stem portion 36 of plunger 25, to prevent seepage of water into the air components of the water valve, this O-ring is of extremely small cross-section and diameter and does not impede the valve-shifting operations even in the absence of lubrication.

When the drill is in its "off" position (Figure 3), any seepage of air from the throttle valve 11 and into the drill and the piston disc chamber 43 will not be effective to shift the water valve to its open position since, as above indicated, a clearance is provided between the piston disc and cooperating chamber wall. The seepage air thus merely leaks through the clearance annulus and out vent 52, without shifting the piston disc. Preferably, this clearance is on the order of .001 to .002 inch difference between the diameters of piston disc 38 and piston chamber 43. Upon rotation of throttle valve 11 to the "full speed" position (Figure 1), the plunger 25 shifts to open position due to the large volume of air suddenly acting against the piston disc. The frusto-conical surface 62 then seats on O-ring 59 and provides a tight sealing engagement preventing any further air seepage through the clearance annulus. The plunger will then be effectively maintained in open position as desired, and without wastage of air. When the throttle valve is again rotated to the "off" position of Figure 3, the intentional supply of pressure air to the water valve is blocked and a venting path created through passage 44 and into the drill. The spring 57 then shifts plunger 25 in the return direction to again close the water valve.

As previously indicated, for some applications of the drilling apparatus it is desirable that water be applied to the drill bit even during the collaring operation. The present apparatus may be adapted to accomplish this result by merely removing a plug 66 from the end of a passage 67 in backhead 10, and substituting the valve

body 68 illustrated in Figure 4 for the body 19 shown in Figures 1 through 3. The passage 67 interconnects the drill chamber 13 with the annular groove in passage 14, which communicates through passages 46 and 44 with the piston chamber 43. The tubular body 68 of throttle valve 11 is constructed the same as body 19 except that the arcuate venting groove 54 is not provided.

Referring to Figure 2, it will be noted that when the throttle valve 11 is in its collaring position, an air path is created from air bore 15 and through collaring port 22, passage 16, and chamber 13 to passage 67, the plug 66 being removed. From passage 67 the air flows through the annular groove to radial passage 46 and longitudinal passage 44 leading to the inner end of piston chamber 43. The resulting pressure in chamber 43 effects shifting of plunger 25 to open the water valve and permit the flow of water. It will be noted that this pressure actuation of the plunger 25 during the collaring operation would not be possible if the valve body 19 of Figures 1 through 3 were employed since the pressure from passage 67 would vent through port 56 to the atmosphere instead of shifting the plunger. When the embodiment of Figure 4 is employed, and the valve is in the full speed position shown in Figure 4, parallel air paths are formed to the chamber 43. One path is through the passages 47, 46 and 44, and another path is through passage 16, chamber 13, passage 67, and passages 46 and 44. When the throttle valve of Figure 4 is in the off position, venting is through passage 67 to the body of the drill.

To summarize the operation of the drilling apparatus, let it first be assumed that the plug 66 is positioned, as indicated in Figures 1 through 3, to block passage 67, and that the tubular valve body 19 is employed. With the throttle valve 11 in the off position (Figure 3) the drill bit is engaged with the rock face and at the desired location, the water valve 12 then being closed since the pressure connection to passage 47 is blocked. The throttle valve 11 is then rotated to the collaring position shown in Figure 2, and air is admitted through collaring port 22 and passage 16 to the drill motor to effect its low speed operation until a collar hole is bored. At this time the plunger 25 of water valve 12 is in its left or inner position, with the conical end 39 of the plunger serving to block the end of water tube 26 and prevent flow of water to the drill bit. The collar hole having been bored, the throttle valve 11 is rotated to the full speed position of Figure 1, and air is admitted through port 21 and passage 16 for full speed operation of the drill motor. At this time, the collaring port 22 registers with passage 47 to admit air through passages 46 and 44 to the inner end of piston chamber 43, the air pressure pressing the plunger 25 to its outer or open position against the bias of spring 57. Water then flows from water bore 17, through the notched or ported end 32 of valve casing 24, and around the end of washer cup 27 to the water tube 26 and the drill bit. At the completion of the drilling operation, the throttle valve is rotated to the position of Figure 3, operating to block the pressure connection to passage 47 and complete a venting path from piston chamber 43 through passages 44, 46 and 47 and venting groove 54 to backhead passage 16 and the drill body. The spring 57 then returns plunger 25 to its fluid-blocking position. If it is desired to switch from full speed to collaring position instead of to the off position of Figure 3, the operation of the water valve is the same except that the venting path is through groove 54 and out port 56 to the atmosphere.

In applications where it is desired to supply water to the drill bit during collaring, the plug 66 is removed and the valve body 68 of Figure 4 is substituted for that previously described. The operation of the drill is then the same except that parallel paths are created to piston chamber 43 when the throttle valve 11 is in the full speed position of Figure 1, the second path being through the chamber 13 and passage 67 to passages 46 and 44 leading to the piston chamber. When the throttle valve is in the collaring position, the plunger 25 is air actuated to its open position since a pressure path is then created through collaring port 22, passage 16, chamber 13, passage 67, and passages 46 and 44 to the inner end of piston chamber 43. When the valve is rotated to the off position of Figure 3, the spring 57 becomes operative to return the plunger 25 to water-blocking position, the venting path then being through passage 67.

Because of the substantial clearances provided, and the use of the stationary O-ring 59 instead of an O-ring on the movable piston disc 38, the plunger 25 is free for either air or spring actuation even in the absence of a lubricating substance. For the same reasons the return spring 57 may be made relatively weak, so that only a minimum opposition is created to the shifting of the plunger to open position by the air pressure from the throttle valve.

While the particular apparatus herein shown and described in detail is fully capable of attaining the objects and providing the advantages hereinbefore stated, it is to be understood that it is merely illustrative of the presently preferred embodiments of the invention and that no limitations are intended to the details of construction or design herein shown other than as defined in the appended claims.

I claim:

1. In an air-operated automatic water valve for a rock drill, a valve casing defining a cylindrical piston chamber, a piston disc reciprocably mounted in said piston chamber and adapted to control the flow of water to the cutting bit of said rock drill, said piston disc having clearance between its peripheral surface and the interior piston chamber-defining surface of said valve casing to provide substantially frictionless sliding of said piston disc in said piston chamber and permitting seepage of air through sail clearance space, passage means to conduct pressurized air from a source of supply to one side of said piston disc to shift the same to one extreme position, and a sealing element fixedly mounted in said casing on the other side of said piston disc thereof from said air supply, said sealing element being disposed to sealingly engage both said interior casing surface and said piston disc to prevent seepage of air through said clearance space when said piston disc is in said one extreme position.

2. An automatic water valve for use in the backhead of an air-operated drill controlled by a throttle valve, said drill having a water tube adapted to conduct water to the drill bit from a chamber formed in the backhead adjacent the end of said water tube and conventionally containing a water tube; which comprises a valve casing mounted in said chamber in alignment with said water tube, a plunger mounted in said casing and slidable between outer and inner positions, said plunger being formed with a stem portion adapted when said plunger is in one of said positions to block the flow of water to said water tube and with a piston portion disposed in a piston chamber in said casing for substantially frictionless sliding movement therein, passage means formed in said casing to conduct air pressure to one end of said piston chamber for shifting said plunger in one direction between said outer and inner positions, vent means for venting the opposite side of said piston to the atmosphere, means to return said plunger in an opposite direction to its initial position after release of said air pressure, and a resilient sealing member fixedly mounted in said casing on the vented side of said piston, said sealing member being disposed to be sealingly engaged by said piston portion when the same is in the position assumed immediately after said air pressure shifting thereof.

3. The invention as claimed in claim 2, wherein a seal-free clearance is provided between the periphery of said piston portion and the corresponding wall of said piston chamber, the size of said clearance being sufficient

to permit seepage of air around said piston portion prior to its engagement with said sealing member.

4. The invention as claimed in claim 2, wherein said clearance is on the order of .001 to .002 inch difference in the diameter of said piston portion and piston chamber.

5. The invention as claimed in claim 2, wherein said return means is a compression spring seated between said plunger and a stop surface at the outer end of said piston chamber.

6. The invention as claimed in claim 2, wherein said sealing member is an O-ring, and said piston portion is formed with a frusto-conical end surface adapted to be inserted through said O-ring for sealing engagement with its interior surface.

7. The invention as claimed in claim 2, wherein said O-ring is seated in an annular groove one side wall of which is formed by a stop disc at the outer end of said piston chamber, the depth of said groove being approximately half the cross-sectional diameter of said O-ring.

8. A combination water valve and throttle valve mechanism for use in the backhead of an air-operated rock drill, said rock drill having a water tube adapted to conduct water to the drill bit from a chamber formed in the backhead adjacent the end of said water tube and conventionally containing a water tube; which comprises a valve casing inserted in said chamber in alignment with said water tube, a flanged valve element mounted in said casing and movable between an open position and a closed position blocking the flow of water through said water tube, the clearance between the flange of said valve element and cooperating wall of said casing being sufficient to permit seepage of air therebetween when said valve element is in closed position, resilient sealing means mounted at the outer end of said casing opposite the open position of said flanged valve element for sealing engagement with said valve element when the latter is in open position, a hollow throttle valve cylinder connected to a pressurized air supply means and rotatable to different drill-controlling positions, an air passage in said backhead and said valve casing and extending from said throttle valve cylinder to one end of the chamber enclosing said flanged valve element, a port in said throttle valve cylinder disposed to register with said air

passage when the throttle valve is in a first controlling position, and a venting groove in the outer surface of said throttle valve cylinder, said venting groove being disposed to communicate with said air passage and with a vent to the atmosphere when said throttle valve is in a second controlling position blocking the flow of pressurized air to said flanged valve element.

9. The invention as claimed in claim 8, wherein said sealing means comprises an O-ring, and said flange of said valve element is formed with a frusto-conical surface adapted to be inserted into sealing engagement with said O-ring when said valve element is shifted to open position.

10. A combination water valve and throttle valve mechanism for use in the backhead of an air-operated rock drill, said rock drill having a water tube adapted to conduct water to the drill bit from a chamber formed in the backhead adjacent the end of said water and conventionally containing a water tube; which comprises a valve casing inserted in said chamber in alignment with the water tube, a cylindrical valve element freely movable in said casing between an outer open position and an inner closed position blocking the flow of water through said water tube, resilient sealing means fixedly mounted in said casing positioned to engage and seal the slight clearance between said casing and the periphery of said valve element when the latter is in its open position, a hollow throttle valve cylinder connected to a pressurized air supply means and rotatable to different drill-controlling positions, a first air passage extending from said throttle valve cylinder to the drill motor chamber of said rock drill, a second air passage extending from said drill motor chamber to adjacent said flange on said movable valve element, and port means in said throttle valve cylinder disposed to register with said first air passage when said throttle valve is in an operating position, whereby air pressure is conducted through said first and second passages to shift said valve element to open position.

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