

April 1, 1952

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2,591,529

COMPRESSED AIR COAL BREAKER

Filed March 30, 1951

2 SHEETS—SHEET 1

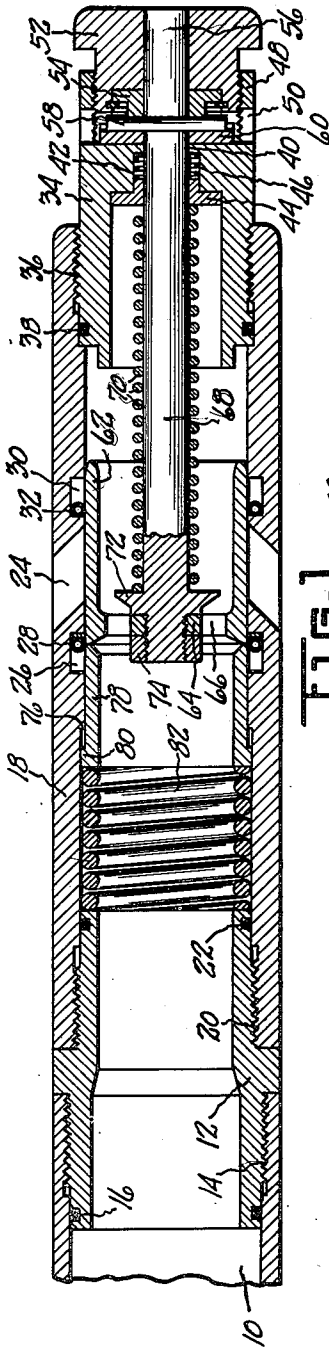


FIG. 1

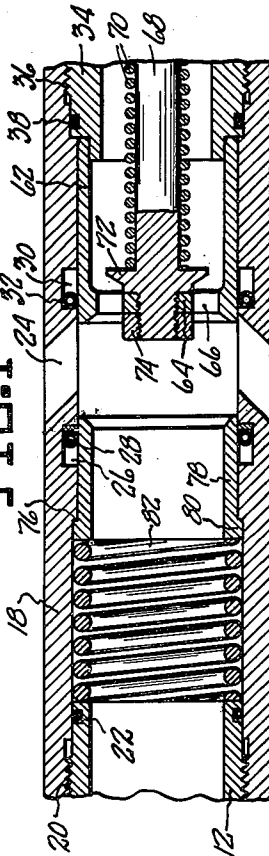


FIG. 2

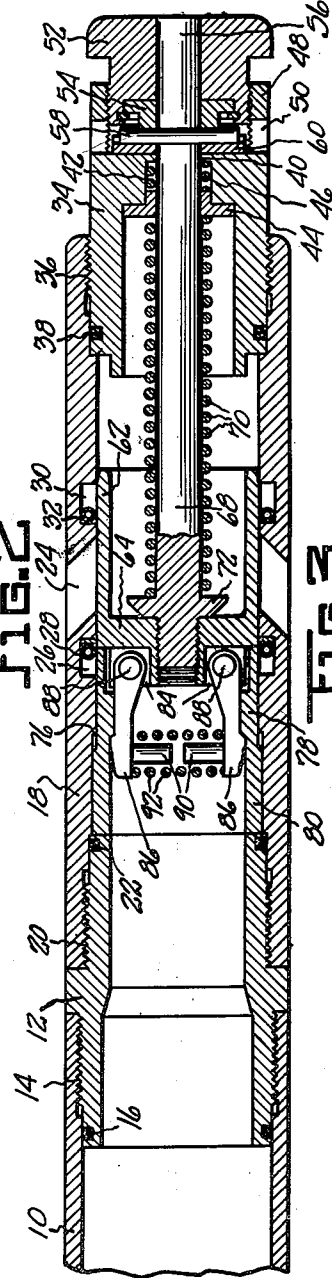


FIG. 3

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2 SHEETS—SHEET 2

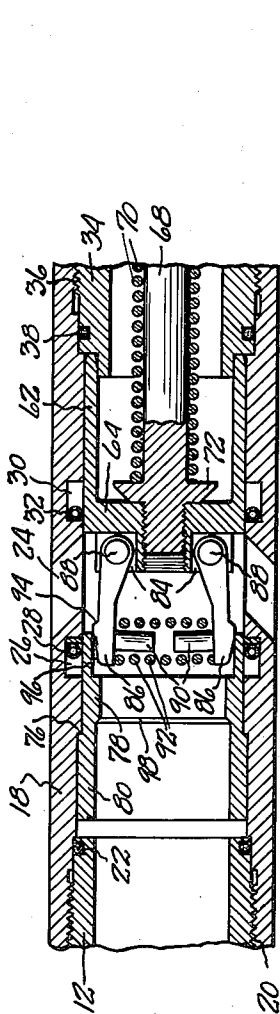


FIG. 4

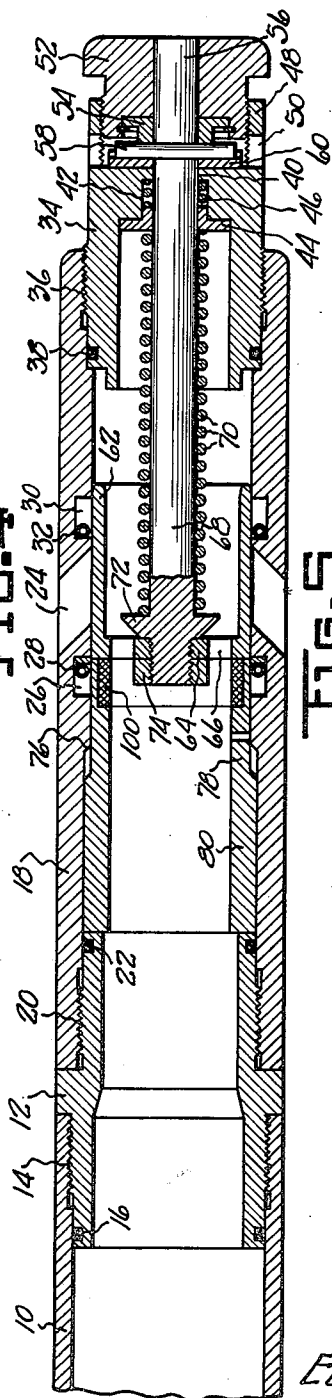


FIG. 5

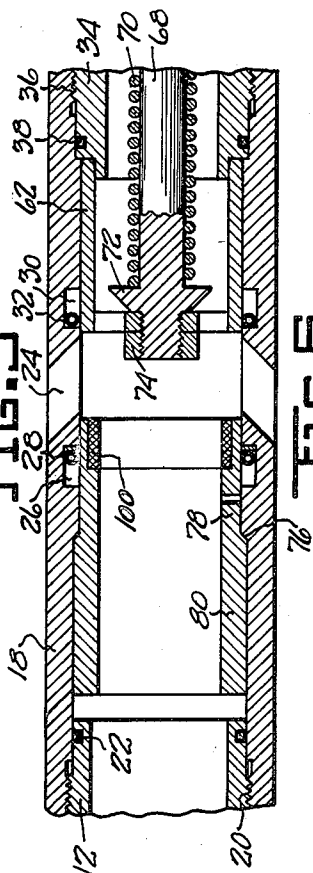


FIG. 6

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COMPRESSED AIR COAL BREAKER

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Application March 30, 1951, Serial No. 218,330

11 Claims. (Cl. 102—25)

1

This invention relates to improvements in compressed air coalbreakers.

Compressed air coalbreakers are commonly used for breaking down coal in a mine in place of the use of blasting powder. The laws of several States prohibit the use of blasting powder to break down or shoot coal on shift, that is, while the men are working in the mine. Several States do, however, permit the shooting of coal by the use of compressed air devices. The ability to shoot coal on shift is a substantial economic advantage to a mine operator. The principal advantage and safety factor of a compressed air coalbreaker, by reason of which it has use on shift, is that it obviates the hazard of explosion which occurs in connection with the use of blasting powder, or in connection with the use of compressed gas devices of the character which utilize a heating element to expand a gas to a blasting pressure.

The successful use of a compressed air coalbreaker is dependent upon the ability to charge a container with a large quantity of air at a very high pressure, for instance, to a pressure in the range of from 7,000 to 12,000 pounds per square inch, and the ability, when the desired pressure is reached, to release the same instantaneously from the container. The valve mechanism is of primary importance. The valve must be of a character which will effectively seal the container during the time that it is being charged and which will operate in a very short period of time to fully and completely exhaust the charge.

I have found that the use of a sleeve type of valve to close a circumferential series of ports until the force within the chamber is sufficient to cause shearing of a control member is very effective. Such sleeve valves, however, require the use of sealing members, such as annular resilient seals, mounted in circumferential grooves positioned at opposite sides of the circumferential series of discharge orifices. The valve normally spans the circumferential series of holes and the two annular resilient sealing means, and thus holds the desired pressure. In this connection the annular resilient sealing members employed are of the type commonly known in the art as "O-rings" and have the characteristic of deforming incident to the application of pressure so that the amount of pressure exerted is effective to create the seal, and the greater the pressure the greater the sealing action of the device.

To open such a valve, however, it is necessary that the sleeve valve disengage one of the an-

2

nular resilient sealing members as it passes to a position opening the discharge ports located between the two annular resilient sealing members. When this occurs the high gas pressure existing within the chamber causes the sealing member disengaged by the sleeve to "pop" out of its seating groove. It is necessary, therefore, in an operative device, if the repeated replacement of one annular resilient sealing member is to be avoided, that means be provided to protect the sealing member as the same is disengaged by the valve. This invention relates principally to novel mechanical means for protecting this resilient sealing member.

It has previously been proposed to employ a follower ring having a differential area at the two opposite ends thereof and so sealed that a predominating force responsive to the pressure in the chamber causes movement of the follower in the same direction as the sleeve moves toward open position. Devices of this character are somewhat complicated in construction, however, by reason of the fact that a number of annular resilient seals are required for the follower member as well as for the sleeve valve. Also, it is necessary to vent the follower sleeve to atmosphere. Such a construction entails substantial manufacturing cost.

It is the primary object of this invention to provide a device of this character with a protective follower operated mechanically so as to enable simplification of the construction, and at the same time secure an assured and positive operation of the device at all times.

A further object is to provide a coalbreaker having a sleeve valve cooperating with annular resilient sealing means to effectively seal an outlet port and characterized by a follower mechanically coupled to the sleeve valve to move with said valve as the opening movement of the sleeve occurs, said follower being uncoupled from said valve after it reaches the seal-protecting position and before it assumes a position which would interfere with opening of the valve.

Other objects will be apparent from the following specification.

In the drawings:

Fig. 1 is a fragmentary longitudinal axial sectional view of one embodiment of my invention.

Fig. 2 is a fragmentary axial longitudinal sectional view illustrating the same construction shown in Fig. 1 with the parts shown in open position.

Fig. 3 is a fragmentary longitudinal axial sec-

3

tional view illustrating another embodiment of my invention.

Fig. 4 is a fragmentary longitudinal axial sectional view illustrating the valve of Fig. 3 in open position.

Fig. 5 is a longitudinal axial sectional view of the head or discharge end of a coalbreaker of a third embodiment.

Fig. 6 is a fragmentary longitudinal axial sectional view illustrating the valve of the Fig. 5 embodiment in open position.

Referring to the drawings, and particularly to Figs. 1 and 2, which illustrate one embodiment of the invention, the numeral 10 designates a tubular body which may be of any desired size and usually has an external diameter in the range of from two to three inches and a length in the range of from four feet to ten feet or more. At one end the tube is connected with an inlet (not shown) associated with a compressor (not shown) or other source of compressed air, by means of which the device may be charged. At the end opposite the intake the device is provided with an adapter tube or sleeve 12, here illustrated as externally screw-threaded at 14 to the end of the tubular body 10. An annular resilient sealing member 16 serves to seal the joint between the tube 10 and the adapter 12. The adapter 12 serves as a means to connect a discharge tube 18 to the end of the tubular body 10, and for this purpose the adapter has a screw-threaded connection at 20 at its exterior with an internal screw-threaded bore portion of the outlet sleeve 18. A resilient annular sealing member 22 serves to effectively seal the joint between the adapter 12 and the tube 18.

Intermediate its length and spaced longitudinally from the adapter 12, the outlet tube 18 is provided with a circumferential series of spaced radial discharge outlets or ports 24. A circumferential groove 26 is formed in the interior of the outlet tube 18 between the outlet ports 24 and the adapter 12, and this groove 26 receives an annular resilient sealing member 28 which preferably will be in the nature of an O-ring. A second circumferential groove 30 is formed adjacent to the circumferential series of outlet ports 24 between said ports and the outer end of the outlet tube 18. This groove 30 mounts an annular sealing member 32.

A cup-shaped head 34 has an external screw thread which has a screw-threaded connection 36 at the outer end of the outlet tube 18. An annular resilient seal 38 seals the joint between the parts 18 and 34. The cup-shaped member 34 has a reduced central bore portion 40 adjacent its outer end and the interior of the part 34 is stepped at 42 inwardly of the part 40. An insert, plate or disk 44 having a bore substantially equal to the bore part 40 spans the open end of the bore portion 42, thus defining a circumferential groove within which are received annular resilient sealing members 46. The cup-shaped member 34 has a cylindrical projection 48 at its outer end which is apertured at 50 for purposes to be described, the portion 48 being internally screw-threaded. An end cap or plug 52 is screw-threaded in the part 48 and has a cylindrical insert 54 projecting from its inner end. The parts 52 and 54 have a bore 56 therein coaxial with and of substantially the same size as the bore 40 of the cup-shaped part 34. The part 54 defines a punch die carried by the plug 52 and is adapted to bear against a shear member, such as a pin 58, to lock the member 58 in place against

4

an aperture bearing disk 60 in the normal position of the parts as illustrated in Fig. 1.

A sleeve valve member 62 fits slidably within the bore of the outlet tube portion 18 and is of such length that it is adapted to span the discharge ports 24 and to engage the two annular resilient sealing members 28 and 32 in its normal operative sealing position illustrated in Fig. 1. The resilient sealing member has a spider 64 at one end thereof preferably provided with a plurality of apertures 66 and serving to mount an elongated plunger member 68 which extends through the bore of the disk 44, through the annular resilient sealing members 46 and through the reduced bore 40 to bear at its end against the shear pin 58. A coil spring 70 encircles the plunger 68, bearing at one end against the disk 44 and at its opposite end against a shoulder 72 formed on the stem adjacent to the apertured spider 64. A nut 74 may form the means for anchoring the plunger 68 to the sleeve valve 62.

The interior bore of the outlet tube 18 at the part adjacent to the adapter 12 is of a larger diameter than at the part within which the groove 26 receiving the annular sealing member 28 is formed, and a shoulder 76 is therefore provided within the outlet tube 18 between the two parts of different diameter. A follower sleeve 78 has a sliding fit in the small bore portion of the outlet tube 18 within which the circumferential groove 26 is formed. This sleeve 78 has an annular enlarged end portion 80 which is positioned in the large diameter portion of the outlet tube 18 to the left of the shoulder 76. The parts 78, 80 have a sliding fit within the outlet tube 18, which fit is not gas-tight so that compressed air may leak or pass around the follower sleeve 78 and through the clearance between the same and the outlet tube 18. Thus it will be apparent that while the follower tube 78 is stepped, the effective areas at both ends thereof are equal and the tube is balanced insofar as forces exerted by air pressure are concerned. The parts are so constructed and arranged that when the valve is sealed and the follower sleeve 78 bears thereagainst, the parts 76 and 80 will be spaced apart as seen in Fig. 1. A space is provided between the follower 78 and the adapter 12, and a coil spring 82 is positioned within that space, the same being compressed and tending normally to move the follower sleeve 78 to the right.

In the operation of the device, as air pressure is built up in the tube 10, the same is resisted by the shear member 58. This pressure acts upon the area of the plunger, that is, the effective area of the port or opening 40, and, when the value of the force as determined by the product of the area of the plunger times the air pressure within the chamber, plus or minus the forces of springs 70 and 82, is sufficient to shear the pin 58, the sleeve valve 62 will be moved toward the right to the position illustrated in Fig. 2 clearing the ports 24 and permitting the charge of air therein to be exhausted. As movement of the plunger 68 occurs, the spring 82 expands, forcing the protective follower 78 toward the right and maintaining the forward or right-hand end of the follower in contact with the left-hand end of the sleeve valve 62. When the enlargement 80 of the follower engages the shoulder 76 of the outlet tube 18, the movement of the follower is stopped and this will occur when the follower 78 has entered the protective sealing ring 28 so as to close or span its seating groove 26 and thus confine the ring 28 during the application of the air pressure thereto.

The point at which the parts 76 and 80 engage is so positioned that the forward or right-hand end of the follower sleeve will be positioned clear of or spaced from the outlet ports 24 so that it will not interfere with opening of the valve.

After the charge of high pressure air has been exhausted through the outlet ports 24 and the air pressure within the coalbreaker cartridge has been reduced to a value which can be overcome by the mechanical force exerted by the spring 70, the spring 70 will expand to return the sleeve valve 62 to its position illustrated in Fig. 1. For this purpose it is preferred that the force exerted by the spring 70 shall be greater than the force exerted by the spring 82 so that the expansion of the spring 70 will again place the spring 82 in compression. This arrangement is not necessary, however, as it will be apparent that the opening 50 within which the shear member 58 is positioned may be elongated and the play of the follower sleeve 78 may be so limited that the member 58 can be inserted in place even though the spring 70 has been unable to restore the sleeve valve 62 to its fully closed position. In such case it will be apparent that the insertion of a new shear member 58 in place of the one which had been used for the last shot, followed by the screw-threading of the plug 52 to cause the member 58 to be brought against the seating plate 60, will cause bodily movement of the plunger 68, the sleeve valve 62 and the follower 78 toward the left to the position illustrated in Fig. 1 with the result that the spring 82 is compressed. It will be apparent, therefore, that the only operation that is required to condition the coal-breaking device after each operation thereof is the insertion of a shear member 58 and the seating of that shear pin to insure the closing of the valve 62. It will also be apparent that the spring 82 effects a mechanical coupling between the follower 78 and the sleeve valve 62 through the permitted stroke of the follower to a position engaging and protecting the sealing ring 28.

The embodiment of the invention illustrated in Figs. 3 and 4 utilizes a mechanical latch as the coupling means between the sleeve valve and the follower member. Except for this mechanical latch, the parts are the same as those illustrated in Figs. 1 and 2, and parts in Figs. 3 and 4 which are similar to parts in Figs. 1 and 2 bear the same numerals used in Figs. 1 and 2.

In the construction illustrated in Figs. 3 and 4 the spider portion 64 of the valve sleeve 62 may be apertured, if desired, and is provided with rearward projections 84 having longitudinal slots therein and receiving latching dogs 86 pivoted thereto at 88. Two diametrically opposed sets of slotted projections 84 are preferably provided so that two dogs 86 are provided positioned in diametrically opposed relation and swinging about their pivots 88 in a radial direction. The dogs 86 project rearwardly from the valve sleeve 62, that is, toward the left as viewed in Figs. 3 and 4, and at their free ends mount inwardly projecting stop pins 90 normally spaced apart as illustrated in Fig. 3. A coil spring 92 bears at its opposite ends against the inner faces of the dogs 86, and its end portions encircle the pins 90. The coil spring 92 serves normally to press the dogs 86 radially outwardly. Each dog 86 has a latching shoulder 94 formed in its outer surface intermediate its ends and is also provided with a camming surface 96. The follower 78 is provided with a circumferential shoulder 98 intermediate its ends, so positioned that when the forward or

right-hand edge of the follower bears against the left-hand edge of the valve sleeve 62, the latching shoulders 94 upon the latch members 86 will engage the follower shoulder 98. In this way, as best seen in Fig. 3, a mechanical interlock is provided between the valve sleeve 62 and the follower 78, the same being normally maintained by the pressure of the spring 92 acting against the latch members 86.

In the operation of this device, when the pressure within the coal-breaking cartridge reaches a value which enables the plunger 68 to shear the shear member 58 and thereby bodily move the sleeve valve 62 toward the right to the open position illustrated in Fig. 4, the initial movement of the pressure responsive sleeve 62 will carry with it the follower 78. The follower 78 is of pressure balanced construction, that is, it has clearance within the tube 18 permitting equal gas pressure to act against all surfaces thereof and avoiding any tendency of the contained gas pressure to urge the sleeve in any direction. In other words, the sleeve 78 is balanced and the pressure in the device has no tendency to move it. The latching shoulders 94, 98 upon the latch elements 86 and the follower 78, respectively, are somewhat beveled or angularly displaced with relation to the axis of the sleeve 18 and are thus capable of providing a camming action. This camming action results in the release of the latch when the enlarged end 80 of the follower 78 engages the shoulder 76 of the outlet tube portion 18 of the coal-breaking cartridge. In other words, the camming action serves to swing the latching members 86 inwardly against the action of the spring 92, thus disengaging the latch members from the follower 78 and permitting continued movement of the valve sleeve toward the right to the fully open position illustrated in Fig. 4.

After the charge of gas has been discharged from the coal-break cartridge by the movement of the parts to the position illustrated in Fig. 4 with the resultant reduction in pressure in the cartridge to a value which exerts a force less than the force exerted toward the left by the spring 70, the spring 70 comes into play to move the sleeve valve 62 toward the left to resume a closed or sealing position. The spring is of sufficient force and strength to move the follower 78 to the position illustrated in Fig. 2 along with the sleeve valve 62, and also causes the latching dogs 86 to re-assume a latching position. The cam surfaces 96 upon the latching dogs facilitate the return of the parts toward latching position and in particular cams the latch dogs 86 inwardly to ride over the shoulders formed in the interior of the follower sleeve as the parts are moved by the spring 70 to the left from the position illustrated in Fig. 4 to the position illustrated in Fig. 3.

It will be understood that the construction of the device illustrated in Figs. 3 and 4 constitutes one embodiment of a device which is operative to mechanically latch the follower to the valve until the follower reaches a position protecting the annular resilient sealing member 28 and then is mechanically disconnected to permit continuing movement of the sleeve valve after the follower stops. It will be understood, however, that the precise mechanical construction of this mechanical latch is not essential and that other forms of mechanical latches which will serve the same function are contemplated to fall within the scope of this invention.

Another embodiment of the invention is illus-

trated in Figs. 5 and 6. In this embodiment of the invention, parts similar to the parts shown in the embodiments of Figs. 1 to 4, inclusive, bear the same numbers. The device illustrated in Figs. 5 and 6 is primarily characterized by a magnetic coupling between the follower and the valve sleeve. Thus as illustrated, the follower sleeve 78 at its forward end carries an annular strong permanent magnet 100 whose force or strength is normally sufficient to cause it to follow movement of the valve sleeve 62 from Fig. 5 position toward Fig. 6 position through the full scope of movement permitted by the longitudinal clearance between the shoulder defined by the part 80 of the sleeve 78 and the shoulder 76 formed in the interior of the outlet tube portion 18 of the coal-breaker cartridge. This device operates similarly to the devices previously mentioned. More particularly, this device is characterized by normal magnetic coupling between the follower 78 and the sleeve valve 62 such that the follower 78 will assume a protective position within the annular resilient sealing member 28 as the pressure responsive movement of the sleeve 62 toward open position commences. The movement of the follower continues until it strikes the shoulder 76 and thereupon the pressure responsive movement of the valve sleeve continues, thus permitting the sleeve valve to separate from the follower and to expose the outlet ports 24.

It will be understood that changes in the construction of the device may be made within the scope of the appended claims without departing from the spirit of the invention.

I claim:

1. A coalbreaker comprising a hollow body adapted to contain gas at high pressure and having a lateral discharge opening intermediate its ends, a sleeve valve axially slidable in said body between open and closed positions, relative to said opening, a pair of annular resilient sealing members circumferentially carried by said body at opposite sides of said discharge opening and engaged by opposite ends of said sleeve valve when in closed position, a sleeve follower axially slidable in said body, means mechanically coupling said valve and follower whereby said follower moves to protective engagement with one of said sealing members as said valve shifts axially from closed position toward open position clear of said sealing member, and a stop limiting axial movement of said follower in a position clear of said discharge opening.

2. A coalbreaker comprising a hollow body adapted to contain gas at high pressure and having a lateral discharge opening spaced from one end, a pair of spaced circumferential seals, said discharge opening being positioned between said seals, a pressure actuated sleeve valve shiftable axially between a closed position spanning said opening and engaging said seals and an open position clear of one seal and said opening, a pressure-balanced sleeve follower slidable axially in said body between a position engaging said valve when closed and a position clear of said opening and engaging said one seal, and a mechanical coupling between said valve and follower releasable when said follower reaches said last named position.

3. A coalbreaker comprising a hollow body adapted to contain gas at high pressure and having a lateral discharge opening spaced from one end, a pair of spaced circumferential seals, said discharge opening being positioned between said seals, a pressure actuated sleeve valve shift-

able axially between a closed position spanning said opening and engaging said seals and an open position clear of one seal and said opening, a pressure-balanced sleeve follower slidable axially in said body between a position engaging said valve when closed and a position clear of said opening and engaging said one seal, means releasably connecting said valve and follower, said valve pulling said follower therewith as it moves toward open position, and a stop limiting movement of said follower at said last named position.

4. A coalbreaker comprising a hollow body adapted to contain gas at high pressure and having a lateral discharge opening intermediate its ends, a sleeve valve axially slidable in said body between open and closed positions relative to said opening, a pair of annular resilient sealing members circumferentially carried by said body at opposite sides of said discharge opening and engaged by opposite ends of said sleeve valve when in closed position, a sleeve follower axially slidable in said body, means mechanically coupling said valve and follower whereby said follower moves to protective engagement with one of said sealing members as said valve shifts axially from closed position toward open position clear of said sealing member, and a stop limiting axial movement of said follower in a position clear of said discharge opening, said mechanical coupling means constituting a spring pressing said follower against said valve.

5. A coalbreaker comprising a hollow body adapted to contain gas at high pressure and having a lateral discharge opening intermediate its ends, a sleeve valve axially slidable in said body between open and closed positions relative to said opening, a pair of annular resilient sealing members circumferentially carried by said body at opposite sides of said discharge opening and engaged by opposite ends of said sleeve valve when in closed position, a sleeve follower axially slidable in said body, means mechanically coupling said valve and follower whereby said follower moves to protective engagement with one of said sealing members as said valve shifts axially from closed position toward open position clear of said sealing member, and a stop limiting axial movement of said follower in a position clear of said discharge opening, said mechanical coupling means constituting a magnet carried by one of said sleeve members at the end thereof adjacent the other sleeve member.

6. A coalbreaker comprising a hollow body adapted to contain gas at high pressure and having a lateral discharge opening intermediate its ends, a sleeve valve axially slidable in said body between open and closed positions relative to said opening, a pair of annular resilient sealing members circumferentially carried by said body at opposite sides of said discharge opening and engaged by opposite ends of said sleeve valve when in closed position, a sleeve follower axially slidable in said body, means mechanically coupling said valve and follower whereby said follower moves to protective engagement with one of said sealing members as said valve shifts axially from closed position toward open position clear of said follower in a position clear of said discharge opening, said mechanical coupling means constituting a latch having interengaging parts carried by said sleeve members and normally spring pressed to locking relation.

7. A coalbreaker comprising a hollow body

adapted to contain gas at high pressure and having a lateral discharge opening intermediate its ends, a sleeve valve axially slidable in said body between open and closed positions relative to said opening, a pair of annular resilient sealing members circumferentially carried by said body at opposite sides of said discharge opening and engaged by opposite ends of said sleeve valve when in closed position, a sleeve follower axially slidable in said body, means mechanically coupling said valve and follower whereby said follower moves to protective engagement with one of said sealing members as said valve shifts axially from closed position toward open position clear of said sealing member, and a stop limiting axial movement of said follower in a position clear of said discharge opening, said mechanical coupling means constituting a latch carried by one sleeve member, a shoulder on the other sleeve member, and spring pressing said latch to interlocking engagement with said shoulder.

8. A coalbreaker comprising an elongated cartridge adapted to contain a charge of gas at high pressure and having a lateral discharge port adjacent to one end, a pressure actuated sleeve valve shiftable longitudinally in said cartridge and adapted to span said port, a shear member carried by said cartridge and normally resisting movement of said valve to open position, a seal carried by said body adjacent to said discharge opening, said sleeve valve engaging said seal in its closed position and shifting clear of said seal upon movement to open position, a pressure-balanced follower shiftable in said cartridge, a stop limiting movement of said follower toward said port, and a releasable mechanical coupling between said sleeve valve and follower whereby said follower moves with said valve upon failure of said shear member and until said sleeve follower engages said stop.

9. A coalbreaker comprising an elongated cartridge adapted to contain a charge of gas at high pressure and having a lateral discharge port adjacent to one end, a pressure actuated sleeve valve shiftable longitudinally in said cartridge and adapted to span said port, a shear member carried by said cartridge and normally resisting movement of said valve to open position, a seal

carried by said body adjacent to said discharge opening, said sleeve valve engaging said seal in its closed position and shifting clear of said seal upon movement to open position, a pressure-balanced follower shiftable in said cartridge, a stop limiting movement of said follower toward said port, and a spring pressing said follower against said sleeve valve and toward said port and said stop.

10. A coalbreaker comprising an elongated cartridge adapted to contain a charge of gas at high pressure and having a lateral discharge port adjacent to one end, a pressure actuated sleeve valve shiftable longitudinally in said cartridge and adapted to span said port, a shear member carried by said cartridge and normally resisting movement of said valve to open position, a seal carried by said body adjacent to said discharge opening, said sleeve valve engaging said seal in its closed position and shifting clear of said seal upon movement to open position, a pressure balanced follower shiftable in said cartridge, a stop limiting movement of said follower toward said port, and a permanent magnet carried on one of said valve and follower members, the other of said valve and follower members being formed of magnetic material.

11. A coalbreaker comprising an elongated cartridge adapted to contain a charge of gas at high pressure and having a lateral discharge port adjacent to one end, a pressure actuated sleeve valve shiftable longitudinally in said cartridge and adapted to span said port, a shear member carried by said cartridge and normally resisting movement of said valve to open position, a seal carried by said body adjacent to said discharge opening, said sleeve valve engaging said seal in its closed position and shifting clear of said seal upon movement to open position, a pressure balanced follower shiftable in said cartridge, a stop limiting movement of said follower toward said port, one of said valve and follower members carrying a latch and the other having a part releasably interlocked with said latch, and a spring pressing said latch toward interlocking position.

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No references cited.