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Weirich et al.

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[54] **DUST SUPPRESSION SPRAY VALVE CONTROL FOR LONGWALL MINING**

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[52] **U.S. Cl.** **299/43,** 251/50, 251/54, 299/17

[51] **Int. Cl.** **E21c 35/22**

[58] **Field of Search** 299/1, 17, 34, 43, 81; 251/54, 50

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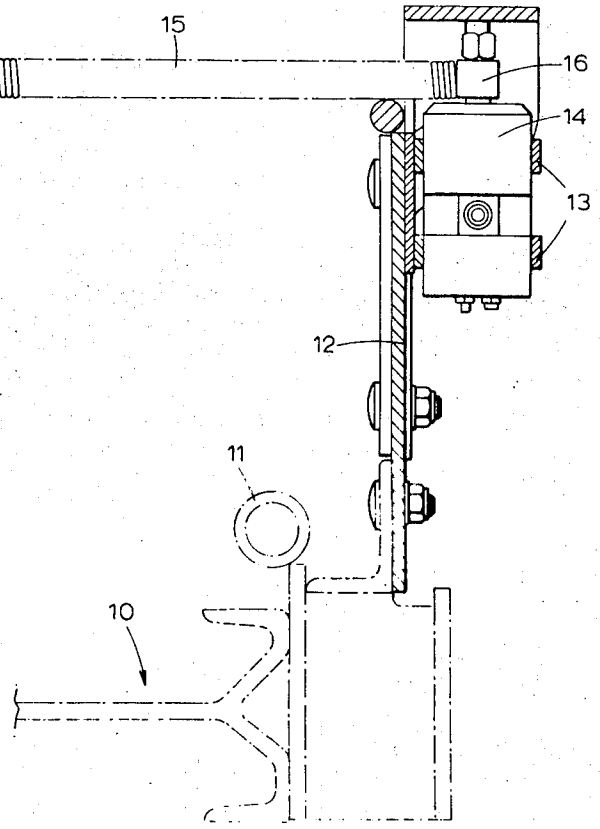
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Primary Examiner—Ernest R. Purser
Attorney, Agent, or Firm—Sughrue, Rothwell, Mion, Zinn & Macpeak

[57] **ABSTRACT**

Dust is suppressed in longwall mineral mining operations by means of water sprayed from spray heads disposed at intervals along the path travelled by a mining machine. The spray heads are arranged in groups and the machine is used to initiate the discharge of water from each group of heads in turn. Water is sprayed from each group of spray heads for a predetermined length of time which is preferably arranged to be equal to the time which elapses before discharge commences from the next group.

23 Claims, 11 Drawing Figures



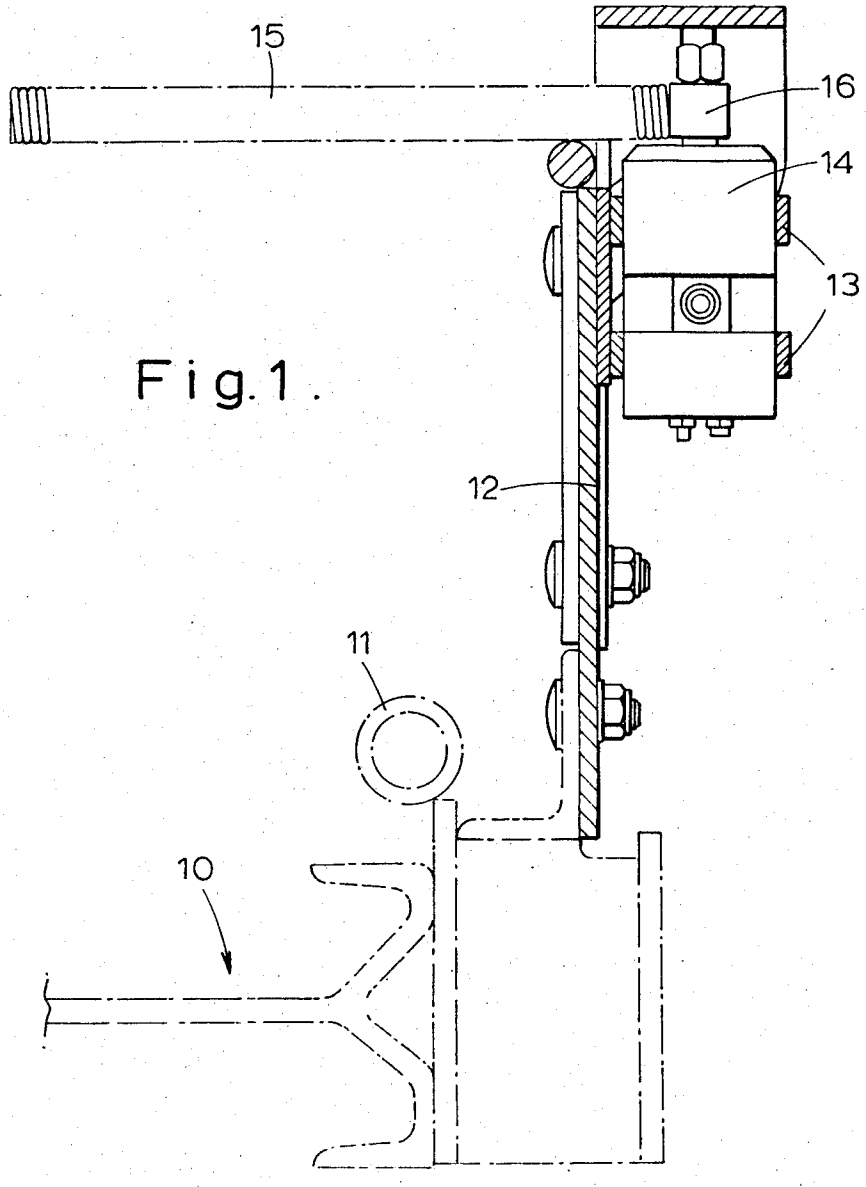


Fig.1.

Fig.1A.

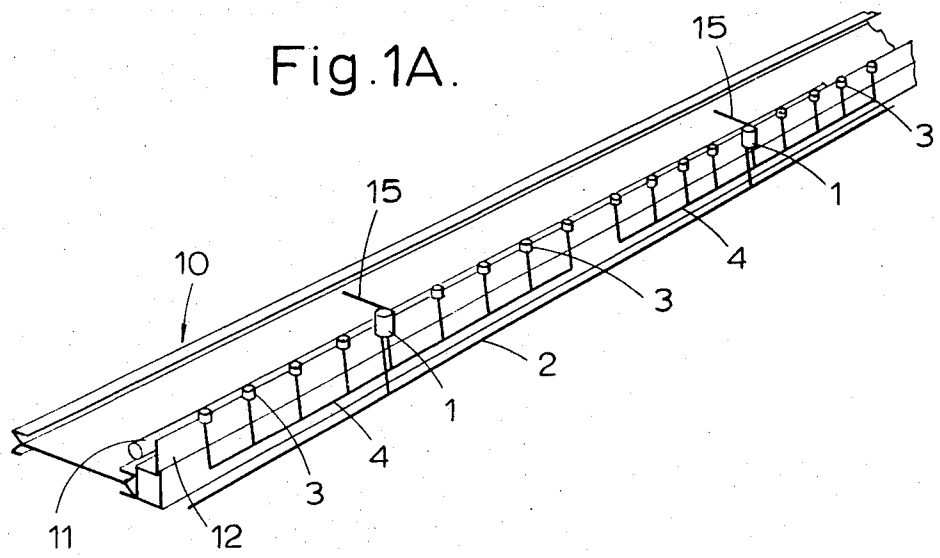
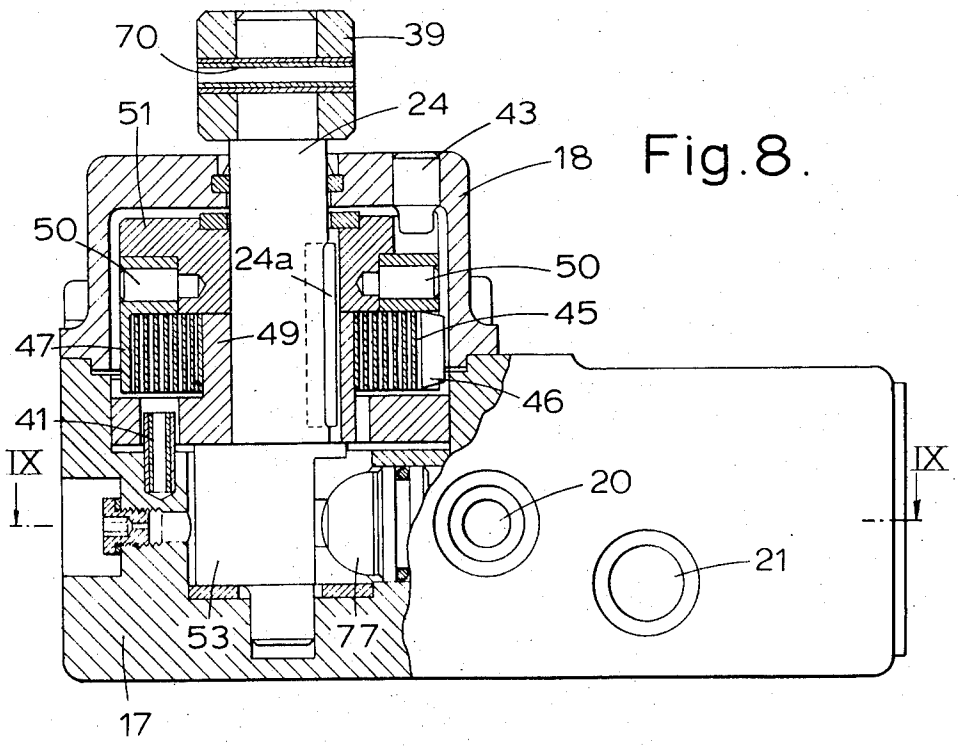

15
3
1
4
15
10
3
2
1
4
3
11
12

Fig.8.


70
39
51
24
43
18
50
24a
50
45
47
49
46
41
IX
IX
20
21
53
77
17

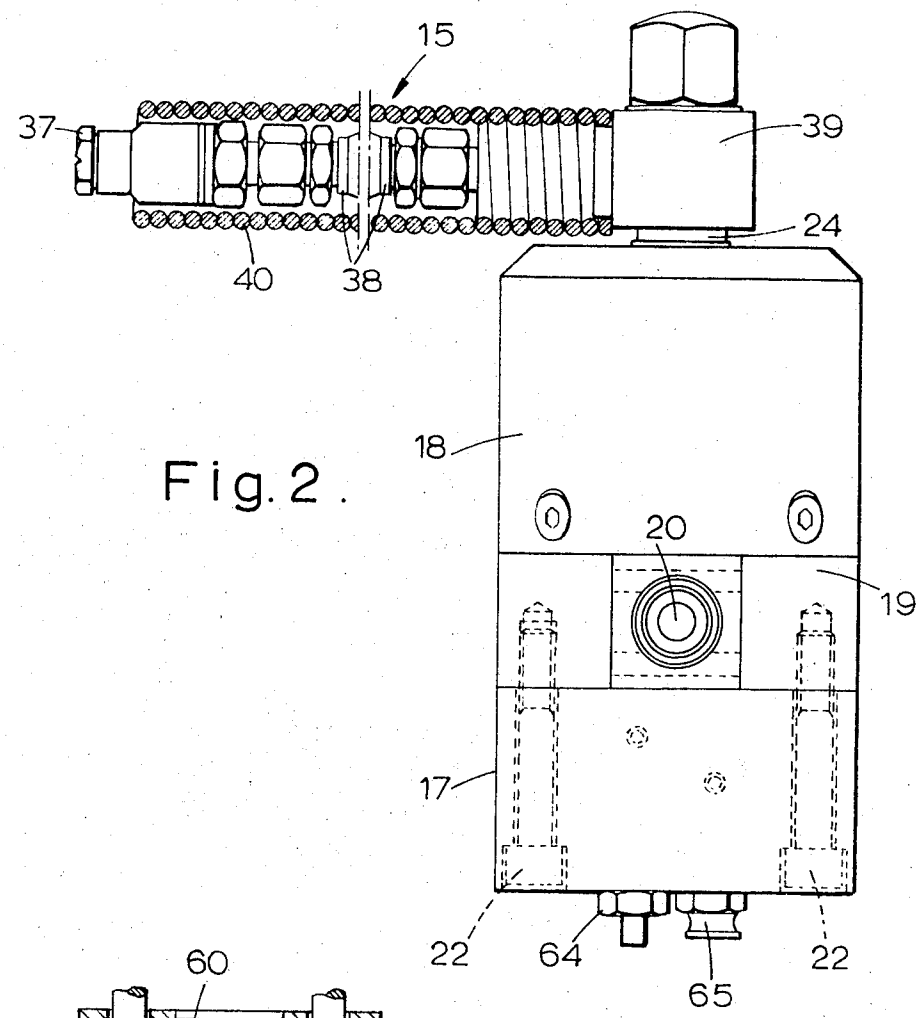


Fig. 2.

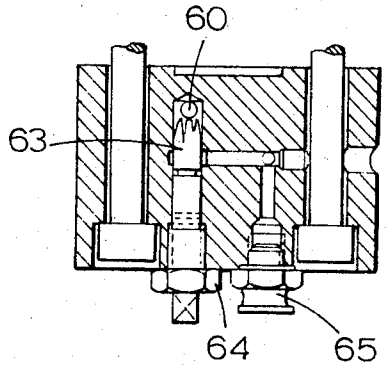


Fig. 7.

Fig.3.

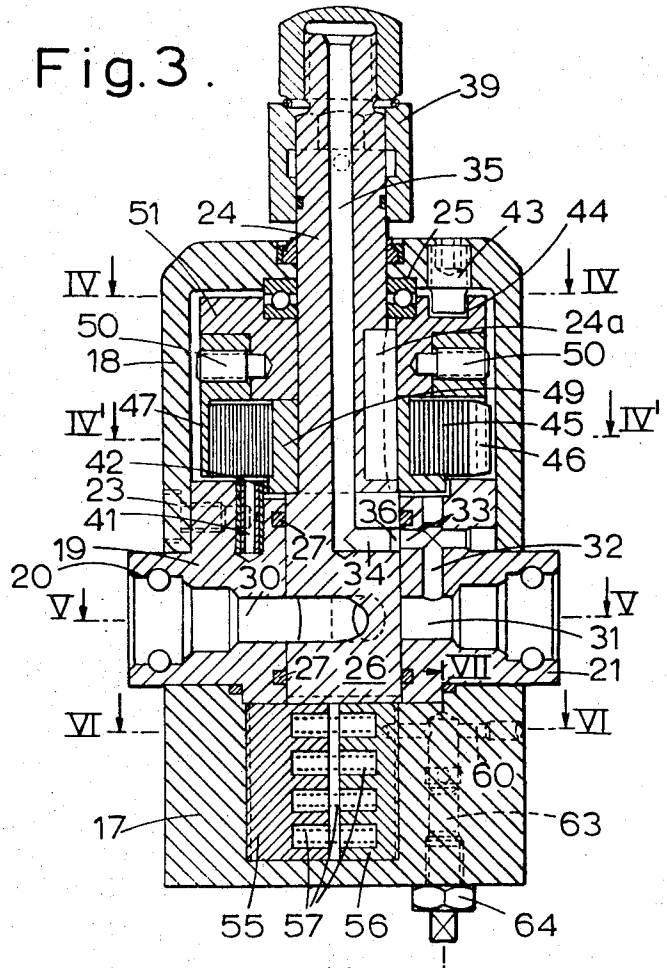

39
35
51
24
25
43
44
IV
IV
50
24a
18
50
49
47
IV'
45
IV'
42
46
23
41
36
33
19
27
32
20
30
34
V
V
31
27
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VII
21
VI
VI
60
17
63
55
57
56
64
VII

Fig.4.

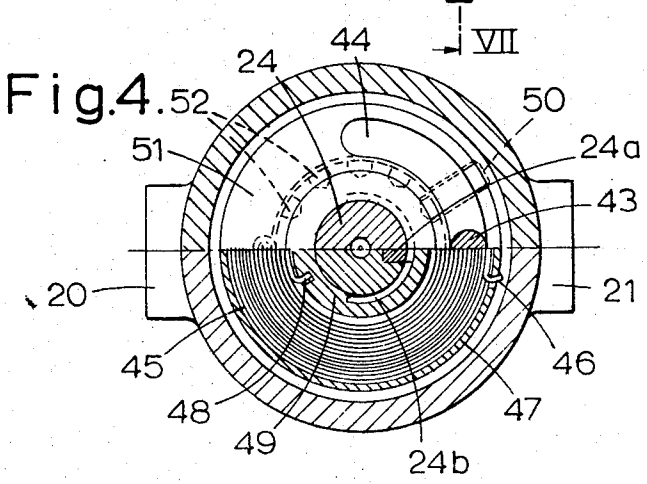

44
24
52
50
51
24a
43
20
21
45
46
48
47
49
24b

Fig.5.

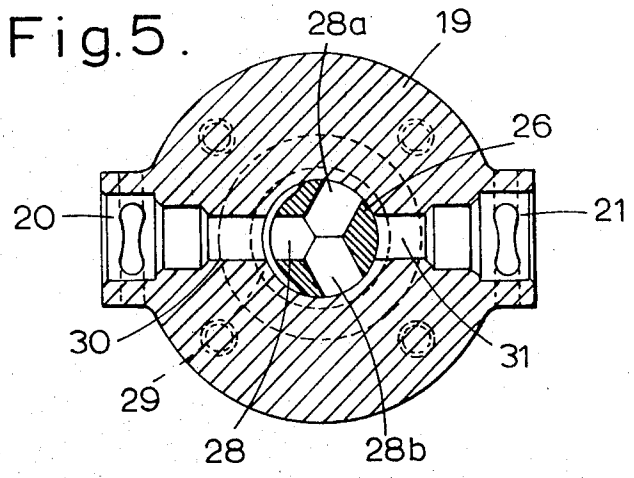
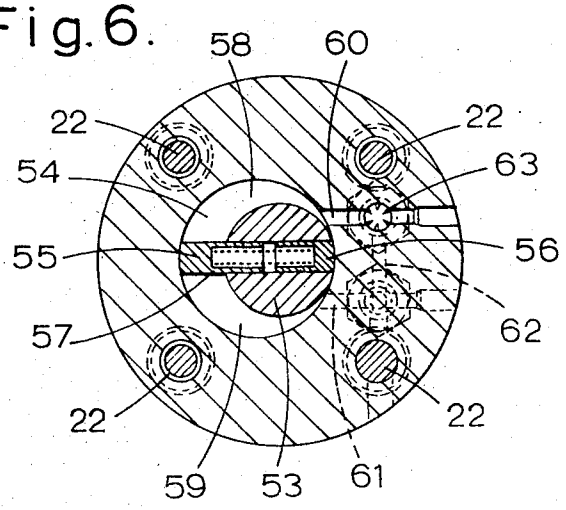

28a
19
26
20
21
30
31
29
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28b

Fig.6.


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22
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53
61

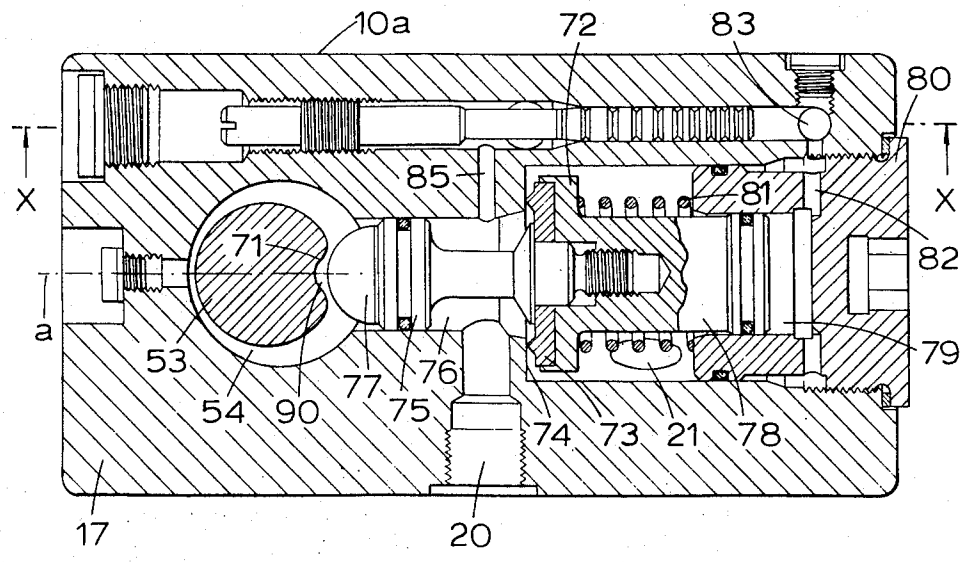

10a
72
83
80
X
X
85
81
71
82
a
79
53
54
90
77
76
75
74
73
21
78
17
20

Fig.9.

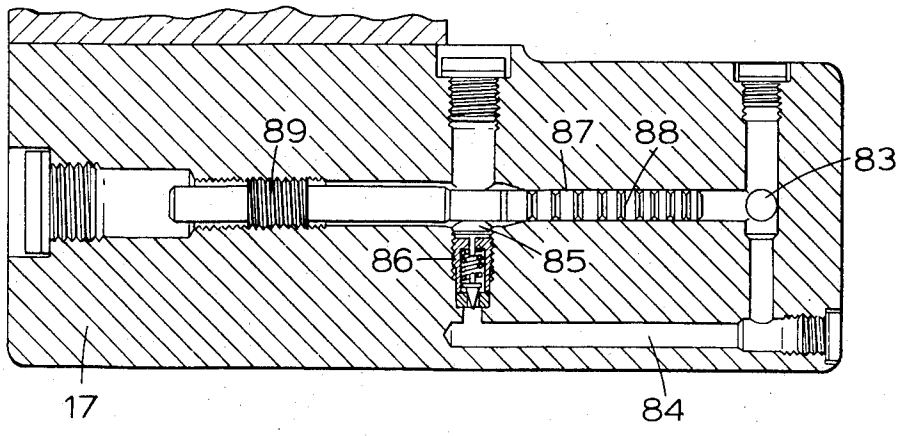

89
87
88
83
86
85
17
84

Fig.10.

DUST SUPPRESSION SPRAY VALVE CONTROL FOR LONGWALL MINING

BACKGROUND OF THE INVENTION

It is already known to use water sprays to lay dust in underground mining operations but the known systems which are employed are wasteful of water of or a complex nature.

According to the present invention, dust is suppressed by discharging a spray of liquid into the air in the vicinity of a mineral face along which a mineral winning machine repeatedly passes, the discharge of the spray being initiated as the machine passes a sensor and terminated after a predetermined time. In connection with the preferred embodiments of apparatus for carrying out the invention, the sensor is constituted by a feeler which projects into the path of the machine and is deflected by the latter. The feeler is mechanically coupled with a control valve which opens upon deflection of the feeler to allow liquid to pass to one or more discharge nozzles.

Preferably a plurality of control units each equipped with a feeler is arranged along the length of the face, and each unit is actuated in turn by the machine. Each of the units may be equipped with a discharge nozzle, possibly provided at the end of the feeler, and in addition, or alternatively, may be associated with a series of ancillary spray heads positioned on one or both sides of the unit. Two embodiments of control unit will be described later in greater detail and it suffices to say for the present that the unit of each embodiment comprises a housing within which a shaft is supported for rotation about a vertical axis. The feeler is in the form of an arm mounted on an end of the shaft which projects from the housing and, when the unit is mounted in position, projects horizontally across a longwall conveyor into the path of the mineral winning machine. In each embodiment, a mechanism incorporating a spiral spring which surrounds the shaft serves to return the shaft into a neutral position regardless of the direction in which it has been deflected. Therefore, the unit is operated regardless of the direction in which the machine is travelling. This spring may be adjustable, as in the preferred embodiments, so as to vary the tension in the spring and hence the rapidity with which the feeler returns to its neutral position. In one of the preferred embodiments, the control shaft is provided or formed with a rotary control valve member and a brake rotor. The rotor is disposed within a non-circular chamber and has vanes which cooperate with the chamber wall. Fluid within the chamber resists rotation of the rotor and hence delays the re-closure of the valve. A passage extends between the high and low pressure sides of the rotor and the resistance to rotation of the rotor is variable by throttling this passage to a greater or lesser extent.

In the second preferred embodiment, the valve member is displaceable axially by means of a cam on the control shaft. The water which is sprayed from the unit and/or from the ancillary nozzles is used to feed the chamber of a piston which moves the control valve back into its closed position. The liquid is fed to the chamber through a passageway, which, once again, may be adjustably throttled to vary the time during which discharge takes place.

DESCRIPTION OF THE DRAWINGS

FIGS. **1** and **1A** are cross-sectional and perspective views respectively of a long wall face conveyor equipped to carry out a method of dust suppression in accordance with the invention,

FIG. **2** is a partly sectioned view to a larger scale than FIG. **1**, but looking in the same direction, showing a spray control unit,

FIG. **3** is a section taken on the axis of the housing of the control unit shown in FIG. **2**,

FIG. **4** is a cross-section of the control unit shown in FIGS. **2** and **3**, the upper half of the Figure being taken on the line IV—IV and the lower half on the line IV-'—IV' in FIG. **3**,

FIG. **5** is a cross-section of the device taken on the line V—V in FIG. **3**,

FIG. **6** is a cross section taken on the line VI—VI in FIG. **3**,

FIG. **7** is a cross-section taken on the line VII—VII in FIG. **3**,

FIG. **8** is a partly sectioned side elevation of a spray control unit in accordance with a second embodiment of the invention,

FIG. **9** is a section taken on the line IX—IX in FIG. **8**, and

FIG. **10** is a section taken on the line X—X in FIG. **9**.

DESCRIPTION OF SYSTEM GENERALLY

Referring to FIG. **1A**, which is a view of part of a mineral mining installation as it would appear looking towards the mineral face, a longwall conveyor **10** consisting of a series of interconnected line pans is provided on its goaf side with a guide bar **11** for a mineral winning machine, and an upwardly directed bar **12** for supporting the components of a dust suppression system. This system comprises a number of spaced spray control units **1** to which water is supplied through a pipe line **2** extending the length of the conveyor. Positioned at intervals on each side of each of the control units **1** are ancillary spray heads **3**, each of which is connected to the associated control unit by a delivery pipe line **4**. In FIG. **1**, only two control units with their associated spray heads are illustrated but in practice these items are distributed throughout the length of the conveyor.

Each of the control units, as shown in FIG. **1** in connection with the first embodiment, has a body **14** held in place by the brackets **13**, and a head generally designated at **16** from which projects towards the face a cantilevered feeler or control arm **15**. The head **39** together with the arm **15** can swing about an axis **16** so that in operation when the arm **15** is struck by the mineral winning machine as the latter passes along the face in one direction or the other, the arm **15** will be deflected. This deflection of the arm **15** is arranged to open a control valve within the control unit to supply water to the pipe line **4**. Jets of water spray out from the spray heads **3** and suppress the dust which has been raised. The arm **15** is automatically returned by spring action into the neutral position in which it is shown and the control valve re-closed. This re-closing of the control valve is arranged to take place after a time interval which is arranged to be at least equal to the time which elapses before the coal winning machine deflects the control arm **15** of the next control unit in its path. In

the first embodiment of control unit to be described in greater detail, the control units also act as spray heads, water being discharged from a nozzle at the end of the arm **15** of each unit. The other spray heads may also have their nozzles provided at the ends of arms deflectable by the machine. On the other hand, the second embodiment uses a control unit which has no in-built spraying facility.

DESCRIPTION OF FIRST PREFERRED EMBODIMENT

The operation of the system having now been described, the construction of the first embodiment of control unit will be described in greater detail with reference to FIGS. **2** to **7**. The unit has a two part casing with a bottom part **17** and a cover part **18**, between which parts is an insert **19** provided with a socket **20** into which is insertable the water supply pipe of FIG. 1A, and a socket **21** into which is insertable the delivery pipe **4**. The insert **19** is secured to the bottom part **17** of the casing by cheese-head screws **22** (FIG. **6**) and to the cover part of the casing **18** by means of screws **23** (FIG. **3**). The casing parts are apertured to receive and support a rotatable control shaft **24** with which is formed integrally a rotary valve member **26** and a brake rotor **53**. Sealing rings **27** are provided to seal the valve member from the remainder of the shaft. The valve member **26** has three radial ports **28**, **28***a* and **28***b* (FIG. **5**) the axes of which ports are spaced equiangularly around the valve member at 120° intervals. The valve member is cut away throughout an angle of about 160° centered on the axis of the port **28** so as to form a recess which is continually in communication with the socket **20** when the shaft is rotated following contact of the arm **15** with the mineral winning machine. In the drawings, the parts of the unit are shown in the neutral positions that they occupy when inoperative, so that the inlet and outlet passages **30** and **31** respectively are blocked from each other by the valve member. Upon rotation of the latter out of the neutral position, water flows through one or other of the ports **28***a* and **28***b*, depending upon the direction of rotation, into the passage **31**. From here, water is fed through the pipe **4** fitted into the socket **21** to the spray heads **3** and through passages **32** and **33** to a groove **36** formed in the peripheral surface of the valve member and communicating with passages **34** and **35** leading through the shaft **24**. From the passage **35** water can pass through the head **39** to a high pressure hose **38** and a nozzle **37** which is preferably arranged to generate a planar jet. Thus, rotation of the valve member in either direction of rotation results in a discharge of water from the nozzle **37** until the valve member returns to its neutral closed position.

As described in general terms above, the valve member **26** is rotated by deflection of the arm **15** from its neutral position upon contact with the mineral winning machine. As shown in FIG. **2**, the arm **15** has an external sheath in the form of a tightly coiled helical spring **40** surrounding the high pressure hose **38** and the fittings of the latter, so as to protect them from damage. The arm **15** is therefore flexible and resiliently deformable in the directions normal to its axis but has considerable inherent stability. In order to restore the moving parts of the assembly to their neutral positions a spiral spring **45** surrounds the shaft and has at its radially inner end a lug **48** which fits into a slot in a bush **49** which closely surrounds the shaft. The bush has an arcuate groove **42** concentrically surrounding the shaft. The outer end of the spring also has a lug which in this case fits into a slot in a cylindrical member **47** housed within the casing and secured by threaded studs **50** to a sleeve **51** surrounding the shaft above the bush **49**. The upper side of the sleeve has an arcuate groove **44** which extends through about 180° around the shaft and receives a stop **43** screwed into the wall of the upper casing part. A thrust bearing **25** set into the upper wall of the upper casing part serves to retain the sleeve. A second stop **41** is in the form of a stud or clamping sleeve which is carried by the insert and extends into the arcuate groove **42** in the bush **49**. The arrangement of the stops and the grooves in which they are received is such that the return spring is tensioned regardless of the direction in which the arm **15** is deflected. Assuming that the shaft **24** is rotated in the clockwise direction (FIG. **4**), the sleeve **51** and hence the outer end of the spring **46** is locked against rotation by the stop **43** striking the end of the groove **44**, whereas the inner end of the spring **48** is entrained by the shaft and the spring is tensioned. This happens because the bush **49** is entrained with the shaft by a stop formed by a spring strip **24***a* which is fitted into a slot in the shaft and projects into a recess **24***b* extending through 180° in the parts **49** and **51**. Upon rotation of the shaft in the other direction, the inner end **48** of the spring is held stationary by the stop **41** which engages with the end of the groove **42** in the bush **49**, whereas the sleeve **51** is entrained by the stop **24***a* so that the outer end **46** of the spring follows the movement of the spindle.

As shown in FIG. **4**, blind holes **52** are provided at 15° intervals around the periphery of the sleeve **51** for reception of the ends of studs **50** which screw into the member **47**. This arrangement allows the tension in the spring to be adjusted since, with the upper casing part removed, the setting of part **47** can be adjusted relative to the sleeve **51** in 15° increments.

The return of the arm **15** and the parts which move with it into the neutral position shown in the Figures, in which the flow of water through the valve is terminated, is retarded by a brake system which comprises a rotor **53** which is integral with or connected to the shaft and is located below the rotary valve member, being best shown in FIG. **6**. The rotor **53** is located eccentrically in a chamber **54** and has radial slots receiving vanes **55** and **56** which are urged outwardly by helical springs **57** into contact with the wall of the chamber **54**. These blades thus divide the chamber into two spaces **58** and **59**, which are interconnected by a system of passages **60**, **61** and **62** in the lower casing part. Flow through these passages is constricted by an adjustable throttle valve **63** as best shown in FIG. **7**. The throttle valve has a valve member which is adjustable axially in a bore in the lower casing part, and can be locked in its adjusted position by a nut **64**. The cavity **54** contains a liquid such as glycerin, silicon fluid, or another viscous liquid, which resists rotation of the rotor **53**. Assuming that the shaft is rotated in the clockwise direction with regard to FIGS. **4**, **5** and **6**, this liquid is displaced from the space **58** into the space **59** by way of the system of passages obstructed by the throttle valve. Rotation in the opposite direction results in liquid flowing by the same route from the space **59** to the space **58**. A braking effect which is adjustable by resetting the throttle valve is thus applied to retard the

resetting by the spring **45** of the shaft following deflection of the arm from its neutral position. Water is therefore discharged for an adjustable period of time following the passage of mineral winning machine along the face past the control unit. In a practical installation, this period is adjusted so that it expires at the instant that the mineral winning machine encounters the arm of the next control unit.

Very little maintenance of the control unit is required, the cavity **54** being topped-up with fluid using a suitable pressure gun applied to a nipple **65,** see FIG. **7.** Since only one control unit and the ancillary spray heads associated therewith are in operation at any one time, it is necessary to supply only a limited quantity of water to the equipment.

DESCRIPTION OF SECOND PREFERRED EMBODIMENT

In the second embodiment of the invention illustrated in FIGS. **8** to **10** there is no provision for discharging water from the control unit. The control unit of this embodiment has a housing with bottom and top parts **17** and **18.** The top of the housing has a central opening through which passes the control shaft **24** which is rotatable about its axis as in the first embodiment. A head **39** is carried on the upper end of the shaft and is equipped with clamping sleeves **70** for securing to the head an arm which extends into the path of the coal winning machine but is not shown in the drawings. As in the first embodiment, a spring **45** is provided to return the shaft **24** and the arm to their initial positions after deflection.

The spring and the parts associated therewith which ensure that the spring is tensioned in either direction of rotation of the shaft correspond to and have the same reference numerals as the parts shown in FIGS. **3** and **4.**

Unlike the first embodiment, the lower casing part of this embodiment has a lateral extension **10***a* which houses the control valve and time delay device. The shaft is profiled at its lower end to form a cam **53** located eccentrically within a chamber **54.** The cam has a recess **71** which is aligned with a hemispherical follower **77** when the shaft is in its neutral position. This follower is at the end of a control valve assembly **72** which is slidable axially within a bore **76** and is provided with a flexible valve member **73** which bears against a seat **74** when the valve is closed. The inlet socket **20** and the outlet socket **21** for the pipes **2** and **4** (FIG. **1**A) open into the bore **76** on opposite sides of the valve seat. At its end opposite the follower, the valve assembly terminates in a brake piston **78** which slides in a cylindrical brake chamber **79** within an insert **80** which screws into the end of the bore **76.** The valve assembly is biased into the closed position of valve member **73** by a helical compression spring which is interposed between the insert **80** and a shoulder backing the valve member.

Whereas in the first embodiment a viscous fluid is used to brake the motion of the control shaft, this embodiment uses the water in the spray system to bring about closure of the valve, the water being admitted to the piston chamber through a system of passages **82, 87** and **85** adjustably constricted by a throttle valve **88.** Escape of water from the piston during movement of the piston to the right chamber is permitted through a bypass passage **44** in which a non-return valve is located. The throttle valve **88** has at its end an adjusting screw **89** with which it is screwed into a tapped section of the bore. The extent to which the passage **87** is throttled depends upon the depth to which the valve member **88** is inserted there in.

When the winning machine contacts the control arm, the latter rotates the control shaft **12** towards one side or the other. The follower **77** of the valve assembly is pressed back by the cam during this movement and the control valve is opened. In this way, a connection is established between the inlet and outlet sockets. The water contained in the brake chamber **79** is expelled by the brake piston **78** through the by-pass passage into the chamber **76.** The control arm and the control shaft **12** swing back into the neutral position under the action of the spring after the coal winning machine has passed. The control valve **30** begins to return at the same time into its closed position but its movement takes place slowly under the force of the return spring **81** because the water entering the brake chamber must pass through the constriction provided by the throttle valve. Gradually, pressure builds up in the brake chamber and the valve moves into the closed position. The adjustment of the throttle valve thus determines the rate at which the piston **79** resets and thereby the length of time the control valve remains open. It will be understood that the areas of the brake piston and the valve and the force of the spring must be such that a resultant force acting in the sense of closing the valve is obtained. The recess **71** of the cam **53** is illustrated as being in front of the ball end **77** of the valve **35** so that a small clearance **90** exists between these parts. Therefore, small oscillations of the control shaft cannot be transmitted to the control valve. In this way, the control valve is re-closed without being affected by any residual movement of the control arm.

An advantage of this embodiment is that when sectional ploughing is carried out by reciprocating the plough over a short length of face, the valve does not have to pass through its closed position each time it is re-encountered by the plough. On the contrary, the valve is fully opened with each contact and discharge takes place without interruption.

What we claim is:

1. A spray control unit for use in connection with a mining machine travelling along a face, said control unit comprising a housing having inlet and outlet ports; a rotary valve mounted in said housing for angular movement about an axis from a neutral position into second positions disposed one on each side of the neutral position, said valve blocking fluid flow between said inlet and outlet ports when said valve is in its neutral position and permitting such flow when said valve is in either of its second positions; means biasing the valve towards its neutral position; means for delaying the movement of the valve under the action of the biasing means; and an elongate feeler operatively connected with the valve and being swingable about the valve axis, the feeler being adapted to project into the path of the mining machine for deflection thereby in one or other direction depending upon the direction of movement of the mining machine along the face, and to displace the valve during such deflection into one of said second positions.

2. A unit as claimed in claim **1,** wherein said feeler is provided with a spray nozzle, and a duct extends

through said feeler from the spray nozzle and is connected with the outlet port.

3. A unit as claimed in claim **1,** wherein the feeler is resiliently deformable.

4. A unit as claimed in claim **3,** wherein the feeler has an outer sleeve consisting of a tightly coiled helical spring.

5. A unit as claimed in claim **1,** wherein the biasing means comprises a spring means and the delay means comprises a brake.

6. A unit as claimed in claim **5,** wherein the spring means is a spiral spring means and means is provided for adjusting the tension in the said spiral spring means.

7. A unit as claimed in claim **1,** wherein the valve is operatively connected to a rotor which is disposed eccentrically with respect to a chamber filled with brake fluid and in which said rotor is housed, the rotor being provided with sliding vanes which divide the cavity remaining in the chamber into two spaces, the housing including a passage interconnecting the two spaces, fluid flow through said passage being constricted.

8. A unit as claimed in claim **1,** wherein the valve is operatively connected to a rotor disposed within a chamber containing a brake fluid, the rotor dividing the brake chamber into two spaces, the housing including a passage which interconnects the two spaces, the passage being constricted by an adjustable throttle member.

9. A unit as claimed in claim **8,** wherein the brake fluid is a fluid such as glycerin, a highly viscous silicon fluid, and the like.

10. A unit as claimed in claim **8,** including a common housing for the valve, the spring and the rotor; the valve, rotor and feeler being directly interconnected.

11. A unit as claimed in claim **10,** wherein the valve and rotor are integral with a shaft on which the feeler is mounted.

12. A spray control unit for use in connection with a mining machine travelling along a mineral face, said control unit comprising:

a. a housing within which is defined a bore forming a valve chamber and a piston chamber, and inlet and outlet ports opening into said valve chamber on opposite sides of a valve seat;

b. a valve assembly slidable within said bore, said assembly comprising a valve member for cooperation with said valve seat, a piston chamber, and a follower portion, said valve member being biased towards said seat by pressure of fluid in said piston chamber;

c. a shaft mounted for rotation in said housing about an axis substantially perpendicular to the axis of the said bore, said shaft being provided with a cam surface for contact with said follower;

d. a feeler carried by said shaft, said feeler being adapted to extend in the direction normal of said shaft axis into the path of the mining machine, and means biasing the feeler to that position; and

e. said housing having a constricted passage way leading from said piston chamber to a point upstream of said valve seat.

13. A unit as claimed in claim **12,** wherein the follower has a rounded head and the cam has a recess in which the head is disposed when the valve member is on its seat.

14. A unit as claimed in claim **13,** wherein the recess in the cam is in line with the axis of the valve assembly.

15. A unit as claimed in claim **13,** wherein a clearance exists between the head and cam when the valve member is on its seat.

16. In a spray control unit for use in mining, said control unit having a housing formed with inlet and outlet ports, and a valve member slidable axially between a first position in which the valve member blocks flow of a fluid between said ports and a second position in which such flow is permitted, the improvement comprising a follower carried by the valve member, a control cam having a recess in which said follower is normally received, a piston slidable in a piston chamber and operative on being displaced by pressure of fluid therein to move said valve member to the said first position, a passage extending through the housing from a position upstream of the valve member to the piston chamber, and adjustable means throttling said passage.

17. In a spray control unit for use in mining, said control unit having a housing formed with a valve chamber and inlet and outlet ports controlled by a valve in the chamber, the improvement comprising a control shaft supported in the housing for angular displacement about an axis, movement of said shaft controlling the position of the valve, a feeler carried on the shaft and adapted to project into the path of the mining machine for deflection thereby about said axis, means biasing the control shaft towards a neutral position, said means comprising a bush closely surrounding the shaft, a sleeve surrounding the bush, a spiral spring interposed between the bush and sleeve and having one end connected to the sleeve and the other end connected to the bush, means for connecting the bush to the shaft for rotation therewith during rotation of the shaft in a first direction, means for connecting the sleeve to the shaft for rotation therewith during rotation of the shaft in a second direction, means for restraining the bush against movement in the second direction and means for restraining movement of the sleeve in the first direction.

18. A spray control unit for use in connection with a mining machine travelling along a face, said control unit comprising a housing having inlet and outlet ports, a valve movable to connect and disconnect the ports, a feeler for contact with the machine and operatively connected to the valve, a spring biasing the valve to its neutral position in which the valve disconnects the ports, and a brake means for delaying the return of the valve under the action of the spring means.

19. A unit as claimed in claim **18,** wherein the braking effect of said brake is adjustable.

20. A unit as claimed in claim **19,** wherein means for adjusting the effect of said brake comprises a throttle member throttling a passage through which fluid is displaced during operation of the brake.

21. A unit as claimed in claim **18,** wherein said brake comprises a brake member movable in a chamber containing a fluid, and a constricted passageway through which fluid is displaced by said brake member, said fluid resisting return of the brake member.

22. A spray control unit for use in connection with a mining machine travelling along a mineral face, said control unit comprising:

a. a housing within which is defined a bore forming a valve chamber, and inlet and outlet ports opening into said valve chamber on opposite sides of a valve seat;

b. a valve assembly slidable within said bore, said assembly comprising a valve member for cooperation with said valve seat, a follower and means biasing said valve assembly to return said valve towards the valve seat, and means delaying the return of the valve member;

c. a shaft mounted for rotation in said housing about an axis substantially perpendicular to the axis of said bore, said shaft being provided with a cam surface for contact with the follower; and

d. a feeler carried by said shaft, said feeler being adapted to extend in the direction normal of said shaft axis into the path of the mining machine, and means biasing the feeler to that position.

23. A unit as claimed in claim **22,** wherein the means for biasing the valve member towards its valve seat comprises a piston slidable in a piston chamber and a duct for supplying fluid throttling the said duct.

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