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Patent Claims

1. Apparatus for the binding of dust comprising a binder reservoir, which provides liquid binder which is under pressure,
a binder line which is connected to the binder reservoir, wherein
there is connected to the binder line at least one spray nozzle (20, 21) which may be located in the vicinity of a dust source,
wherein the binder line (17) is suspended from a bearer cable (16) and the binder line (17) is made flexible, wherein the binder line (17) is arranged roughly parallel to the bearer cable (16), to which it is fastened at several points,
characterised in that
the binder line includes one or more flexible branch lines (19) which branch off from a main run (50) of the binder line which is fastened to the bearer cable (16), wherein in each case at least one spray nozzle (20, 21) is fitted to them.

2. Apparatus according to claim 1,
characterised in that

the binder line extends over a distance of at least 100 m or at least 300 m, and several spray nozzles (20, 21) are connected to the binder line along this length, wherein the apparatus is preferably so designed that no more than 6 l/m^2/h is discharged onto the ground during a spraying operation.

3. Apparatus according to claim 1 or 2,
characterized in that
an additional weight is provided on the flexible branch lines, so that the branch lines automatically aligns itself vertically.

4. Apparatus according to one of the claims 1 to 3,
characterized in that
the apparatus for the binding of dust is arranged at a height of at least 5 m above the ground.

5. Apparatus according to any of claims 1 to 4,
characterised in that
the spray nozzles (20, 21) for spraying out the binder are designed with a circular or circular-segment-shaped spray cone, with the maximum distance between two adjacent spray nozzles (20, 21) not exceeding 80% of the diameter of this circle.

6. Apparatus according to any of claims 1 to 3,
characterised in that

the apparatus is so designed that no more than 3 l/m^2h and preferably no more than 1.2 l/m^2h of binder are discharged during a spraying operation.

7. Apparatus according to any of claims 1 to 6,
characterised in that
the binder line (17) is fastened to the bearer cable (16) by means of pipeline hooks (18).

8. Apparatus according to any of claims 1 to 7,
characterised in that

the spray nozzles (20, 21) are arranged along the binder line at intervals of no more than 10 m, preferably no more than 8 m and in particular no more than 7 m.

9. Apparatus according to any of claims 1 to 8,
characterised in that
the binder reservoir provides the binder at a maximum pressure of 10 bar and preferably at a maximum pressure of 5 bar.

10. Apparatus according to any of claims 1 to 9,
characterised in that
the binder reservoir provides the binder at a maximum pressure of 2 bar and preferably at a maximum pressure of 4 bar.

11. Apparatus according to any of claims 1 to 10,
characterised in that
the spray nozzles (20, 21) are so arranged and aligned at a distance from the dust source that the binder is not sprayed directly on to the dust source.

12. Apparatus according to any of claims 1 to 11,
characterised in that
the spray nozzles (20, 21) are so designed that the binder is sprayed with a droplet size of 30 to 120 µm and preferably 50 to 150 µm and in particular with a droplet size of 60 to 90 µm with a droplet size of at least 100 µm, preferably at least 150 µm or at least 200 µm.

13. Apparatus according to any of claims 1 to 12,
characterised in that
at least one spray nozzle (20, 21) is a pressure nozzle, which opens automatically from a certain opening pressure of the fed binder upwards, or is combined with an automatically pressure control valve, and the apparatus has a pressure control, by which the pressure in the binder line may be controlled.

14. Apparatus according to any of claims 1 to 13,

characterised in that
the pressure control has a control valve which is fitted in the binder line in the area between the binder reservoir and the pressure nozzle or nozzles and may be activated by a control unit (38).

15. Apparatus according to any of claims 1 to 14,
characterised in that
the spray nozzle or nozzles (20, 21) is or are provided with a valve which may be activated directly by a control unit (38).

16. Apparatus according to any of claims 1 to 15,
characterised in that
the binder reservoir comprises at least one pressure vessel with gas cushion (41), which is divided into a gas pressure chamber and a binder chamber.

17. Apparatus according to claim 16,
characterised in that
the pressure vessel with gas cushion (41) has a feed line (42) for filling the pressure vessel with gas cushion (41) and a discharge line (43) for draining the pressure vessel with gas cushion (41), wherein the feed line (42) has a flow resistance compared to the discharge line (43), e.g. a cross-section constriction, so that filling of the pressure vessel with gas cushion (41) takes place with a lower volumetric flow than draining of the pressure vessel with gas cushion (41).

18. Apparatus according to claim 17,
characterised in that
the discharge line (43) has a non-return valve, so that binder can flow through the discharge line (43) only for draining a diaphragm vessel.

19. Apparatus according to any of claims 1 to 18,
characterised in that
the apparatus has a pump (24, 27) which pumps the binder and that there is connected to the binder line a pressure switch which switches on the pump (24, 27) if a predetermined switch-on pressure, the switch-on time, is undershot.

20. Apparatus according to claim 19,
characterised in that
the pressure switch is so designed that, if a predetermined switch-off pressure, the switch-off time, is exceeded, the pump (24, 27) switches off or an emergency release valve opens.

21. Apparatus according to claim 19 or 20,
characterised in that
a flow meter is so connected to the binder line that if the flow falls below a predetermined minimum flow rate, the switch-off time, the pump (24, 27) switches off or an emergency release valve opens.

22. Apparatus according to claim 20 or 21,
characterised in that
at least one switch-off delay device is provided, which allows the pump (24, 27) to be switched off only after a predetermined delay interval has elapsed, wherein the delay interval commences with the switch-on time or the switch-off time or a point in time between the switch-on time and the switch-off time.

23. Apparatus according any of claims 20 to 22,
characterised in that
an excess pressure switch is connected to the binder line and, if a predetermined excess pressure which is greater than the switch-off pressure is detected, switches off the pump (24, 27) and/or opens an emergency release valve.

24. Apparatus according any of claims 1 to 23,
characterised in that
a flow monitor is provided in the binder line and measures the flow in the binder line, and switches off the pump (24, 27) if, after the expiry of a predetermined delay interval after switching-on the pump (24, 27), the flow is less than a predetermined flow value.

25. Apparatus according to claim 24,
characterised in that

the binder line has a main run (50) and an auxiliary run (49) with smaller cross-section running parallel to the main run (50), wherein the flow monitor is located in the auxiliary run (49).

26. Apparatus according to claim 24 or 25,
characterised in that
the flow monitor is so designed that it detects the flow indirectly with the aid of the temperature of the binder in the pump (24, 27) or in the flow direction shortly after the pump (24, 27) and/or with the aid of the power consumption of the pump (24, 27) and/or with the aid of the power consumption of the pump (24, 27) and/or with the aid of the pressure difference before/after the pump (24, 27) and/or with the aid of the pressure after the pump (24, 27) nozzle with the aid of the noise of the pump (24, 27) and/or with the aid of the current energy consumption of the pump shaft.

27. Apparatus according to any of claims 1 to 26,
characterised in that
a venting device is provided in the binder line.

28. Apparatus according to claim 27,
characterised in that
the venting device is a passive vent valve which is permeable to gas and impermeable to fluids.

29. Apparatus according to claim 27 or 28,
characterised in that
the venting device is a switchable valve which is located in the binder line and which is opened by a control unit (38) if a gas bubble is present or after predetermined time intervals have elapsed or after the passage of a certain number of predetermined operating states.

30. Apparatus according to claim 29,
characterised in that
the presence of a gas bubble is detected by the control unit (38) with the aid of a predetermined operating state, and/or is detected by means of a sensor.

31. Apparatus according to any of claims 1 to 30,
characterised in that
the binder line has one or more pressure control valves which as pressure switching valves open from a predetermined switching pressure upwards and thereby release a binder feed to the spray nozzle(s) (20, 21) or as pressure regulating valves also open from a predetermined switching pressure upwards and at the same time regulate the pressure on the outflow side of the pressure regulating valve to a predetermined pressure range.

32. Apparatus according to claim 31,
characterised in that
several pressure control valves are provided in the binder line and have different switching pressures, so as to create sections with different pressure levels in the binder line.

33. Apparatus according to claim 31 or 32,
characterised in that
one or more pressure control valves are provided in a main run (50) of the binder line, so that the main run (50) is divided into sections with predetermined pressure level.

34. Apparatus according to any of claims 31 to 33,
characterised in that
one or more pressure control valves are provided in a branch run of the binder line diverging from a main run (50) of the binder line, so that the respective branch run is closed if pressure falls below the switching pressure, wherein the pressure control valves are preferably in each case integrated with the spray nozzle (20, 21).

35. Apparatus according to any of claims 1 to 34,
characterised in that
the binder line has one or more pressure reducers which regulate the pressure on the outflow side of the pressure reducer to a predetermined pressure range, wherein the pressure reducer or reducers is or are preferably located adjacent to a spraying valve or integrated in a spraying valve.

36. Apparatus according to any of claims 1 to 17 or 19 to 35 in combination with claim 18,

characterised in that

the binder line is made with an elasticity for elastic buffering of binder of at least 1% and preferably at least 0.5% of the total volume of the binder line on the basis of pipe wall elasticity, at least one gas pocket and/or the diaphragm vessel.

37. Apparatus according to claim 16 or 17,
characterised in that
the binder line is made with an elasticity for elastic buffering of binder of a maximum 100% and preferably a maximum of 50% of the total volume of the binder line on the basis of pipe wall elasticity, at least one gas pocket and/or the pressure vessel with gas cushion (41).

38. Apparatus according to any of claims 1 to 34 or 36 or 37 in combination with claim 35, characterised in that
the binder line has a main run (50) in which the pressure reducer is provided and parallel to the main run (50) there is an auxiliary run (49) containing a non-return valve which opens against the direction of flow of the pressure reducer.

39. Apparatus according to any of claims 1 to 38,
characterised in that
the binder line has at least one filling rate control valve which, with the aid of the detected flow rate of the binder medium, opens a passage for the binder in roughly inverse proportion to the flow rate.

40. Apparatus according to claim 39,
characterised in that
the flow rate is determined with the aid of the pressure difference in the flow direction before and after the flow rate control valve, and/or that the flow rate control valve may additionally be activated by the control unit (38), wherein preferably the desired flow rate is adjustable.

41. Apparatus according to any of claims 1 to 40,
characterised in that
the binder line has at least one filling control valve which, with the aid of a detected filling state of the binder line, opens a passage roughly proportional to the filling state.

42. Apparatus according to claim 41,

characterised in that
the control valve is designed with at least two opening steps and/or is so designed that it may be open continuously.

43. Apparatus according to any of claims 1 to 42,
characterised in that
the binder line has at least one pressure retention valve which, with the aid of the pressure detected in the binder line in the flow direction before the pressure retention valve, opens roughly proportional to the pressure.

44. Apparatus according to any of claims 1 to 43,
characterised in that
the binder line has a main run (50) and at least one branch run diverging from the main run (50), wherein a control valve is provided in the branch run.

45. Apparatus according to claim 44,
characterised in that
the control valve is in the form of a pressure relief valve in the branch run, which opens roughly in proportion to the pressure in the main run (50).

46. Apparatus according to claim 45,
characterised in that
the pressure relief valve opens only after a predetermined minimum pressure has been reached in the main run (50).

47. Apparatus according to any of claims 44 to 46,
characterised in that
the control valve in the branch run is in the form of a quick drain valve which substantially opens completely after a predetermined minimum pressure has been reached in the main run (50).

48. Apparatus according to claim 47,
characterised in that

the quick drain valve closes more slowly than it opened after the pressure in the main run (50) has fallen below the minimum pressure.

49. Apparatus according to any of claims 44 to 48 in combination with claim 19, characterised in that
the binder line is connected to a well pipe which leads downwards from the binder line into an underground well, wherein the pump (24, 27) is located in the well pipe and the control valve in the branch run is so activated that, when the pump (24, 27) is switched on, the control valve is closed gradually over a predetermined interval of time and/or when the pump (24, 27) is switched off, it is opened gradually over a further predetermined interval of time.

50. Apparatus according to any of claims 44 to 49,
characterised in that
the binder line is connected to a well pipe which leads downwards from the binder line into an underground well, wherein the pump (24, 27) is located in the well pipe and the control valve in the branch run is so activated that the control valve is opened if there is a sudden stoppage of the pump (24, 27).

51. Apparatus according to any of claims 1 to 13 or 15 to 50 in combination with claim 14, characterised in that
the binder line has the control valve which is so activated by a control unit (38) that, when the pump (24, 27) is switched on, it opens slowly over a predetermined interval of time, and/or is closed when the pump (24, 27) is switched off.

52. Apparatus according to claim 51,
characterised in that
the control valve is in the form of a non-return valve which prevents any backflow into the pump (24, 27).

53. Apparatus according to claim 51 or 52,
characterised in that
the control unit (38) is designed to drive the pump (24, 27)

54. Apparatus according to any of claims 16, 17 or 37,

characterised in that
a control unit (38) is provided which, depending on the filling state of the binder line, the filling state of the pressure vessel with gas cushion (41) and/or the flow rate in the binder line, controls the feed of binder from the pressure vessel with gas cushion (41) into the binder line.

55. Apparatus according to any of claims 1 to 54,
characterised in that
there is provided in the binder line a cyclone filter which has a flush inflow line and a flush outflow line with a flush outflow valve so that it is possible to flush the cyclone filter without having to drain the other sections of the binder line.

56. Apparatus according to claim 55 in combination with any of the claims 16, 17, 37, or 54, characterised in that
the pressure vessel with gas cushion (41) and/or an external water pressure port may be connected to the flush inflow line, in order to provide flushing water.

57. Apparatus according to any of claims 1 to 56,
characterised in that
the binder line (17) is suspended from a bearer cable (16).

58. Apparatus according to claim 57,
characterised in that
the binder line (17) is made to be elastic, and/or the binder line (17) is attached to the bearer cable (16) by means of pipeline hooks (18), and/or the binder line includes one or more flexible branch lines (19), on which at least one spray nozzle (20, 21) is provided in each case.

59. Method of binding dust with a binder, wherein an apparatus according to any of claims 1 to 58 is used, and the binder is discharged at intervals with spraying phases and pause phases.

60. Method according to claim 59,
characterised in that

for wetting the ground, the spraying phases and the pause phases are at least 2 minutes and preferably at least 5 minutes and in particular at least 10 minutes.

61. Method according to claim 59,
characterised in that
for creating an artificial fog, the spraying phases and the pause phases lie in the range of 1 second to 120 seconds and preferably in the range of 1 second to 30 seconds.

62. Method according to claim 61,
characterised in that
the spraying phase lasts longer than the pause phase and in particular is at least twice as long as the pause phase.

63. Method for the binding of dust using a binder according to any of claims 59 to 62, wherein an apparatus according to any of claims 1 to 58 is used wherein, during spraying of binder, the latter is discharged at a rate of no more than 6 l/m^2h and preferably no more than 4 l/m^2h and in particular no more than 1.5 l/m^2h and in particular no more than 1.2 l/m^2h.

64. Method for the binding of dust using a binder according to any of claims 59 to 63, wherein an apparatus according to any of claims 1 to 58 is used, wherein binder is sprayed to create an artificial fog, and the binder is sprayed in an area which is so far from a dust source that an airflow in this area does not exceed 1 m/s.