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(71) Applicant: **MARINI S.p.A.**
48011 Alfonsine (Ravenna) (IT)

(72) Inventor: **Cipriani, Antonio**
48011 Alfonsine (RA) (IT)

(74) Representative:
D'Agostini, Giovanni, Dr.
D'AGOSTINI ORGANIZZAZIONE
Via G. Giusti 17
33100 Udine (IT)

(54) Mobile mixer to be used in train for cold recycling asphalt conrete roadways

(57) Mobile mixer to be used in train for cold recycling asphalt concrete roadways, of the type comprising bitumen as binding base, where are provided:

- means to heat said binding material in fluid form at 150/200°C, preferably at about 170°C, and under pressure before the spraying (U2) in said mixing means (P1);
- means to convey hot and fluid bitumen (B, P2) in a controlled way (P3) with additives (AD) through a static turbo-mixer with opposite vanes (P4), to respective sprayers (P1) associated with: means to inject water, in a controlled way (U2), to said binding material immediately before the spraying, upstream of said sprayers (U3), under such a pressure to prevent the expansion of said added water, in order that at the exit from said spraying means (U3) a spraying of bituminous emulsion is formed with expansion by evaporation of the water particles forming a bituminous material foam that is sprayed into the aggregating material in the mixing/blending, thus mixing and binding with it (P1).

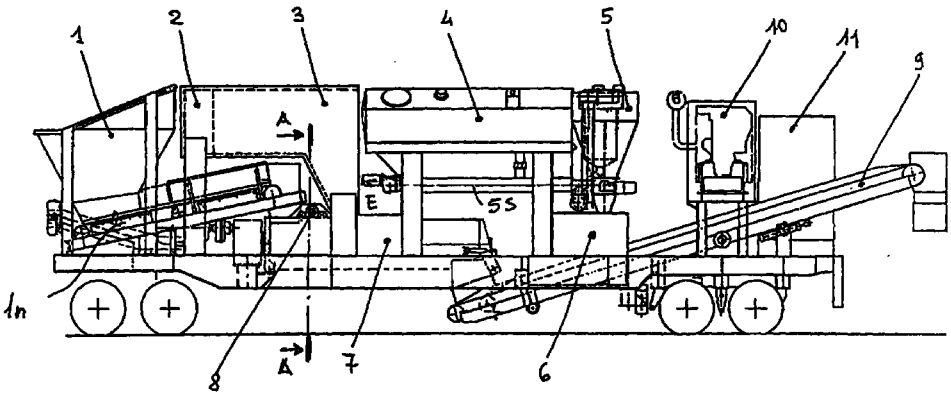

FIG. 1

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Description

[0001] The present patent has for object a mobile mixer to be used in train for cold recycling asphalt concrete roadways.

[0002] The innovation finds particular even if not exclusive application in a mobile train to operate in situ in the road paving/repaving by also using recyclable material obtained by road scarification of the pre-existing road paving (art commonly known as "stabilisation").

[0003] State of the art for in situ repaving: In prior art self-propelled systems for road repaving operating in situ are known, to see: IT-UD97A000143 / EP-A-9811183.1 (Marini); IT-4753489.A.89 /EP-A-0378973 (Todini); EP-A-0324491 (Wirtgen).

[0004] The in situ road (directly road), repaving known art provides the mixing and preparation of the components on the road itself after having carried out the milling (scarification) of the road paving for a certain depth (some centimetres), by means of a first front milling self-propelled machine, known as scarifier machine, which provides for milling the material upstream by a milling machine discharging it downstream on another towed machine, with eventual addition of new grit (for example by a grit spreader operating in front of the train), for the correction of the granulometric curves, and addition of binding materials with mixing action before the laying on road.

[0005] This second machine realises the so-called "Wood Train".

[0006] The "Wood Train "is substantially made up of:

- an inert materials spreader (grit spreader);
- a scarifier machine (road paving milling machine);
- a heap shaper-meter to form a continuous and constant in section grit line;
- a machine for the grit line picking up or loader machine;
- a machine for receiving and weighing the material from the first one and for a rotating drum continuous mixing associated with a spreader of binding material on the mixer, associated with a tank for the binding material, endowed with conveying means for making the necessary binder material flow within the mixer, through said spreader, and associated with means for spreading the material on the road.

[0007] By the " Wood Train " method the work is started from the scarifier machine which scarifies (mills) the road paving for a certain depth transforming the road pavement in granular form (broken asphalt) , discharging it in a downstream line (grit line or broken asphalt continuous cumulus or continuous heap) where the heap shaper-meter adjusts it.

[0008] Wanting granulometric curve correction, the corrective grit is spread by a grit spreader upstream of the scarifying machine, directly on the road pavement to be scarified, so that an even mixing virgin material or rejuvenant material with scarfied (milled material), by means of the same action of the milling cutters is obtained.

[0009] The train of machines which substantially concern the mixing, therefore downstream of the scarifier machine, which generally operates separately, subsequently provides in the front-end, a self-propelled loader that conveys the broken material previously prepared in grit heap-line to a towed mixer machine which substantially concerns this invention, through a proportioning hopper, from which through a suitable ponderal dosage, it is discharged into the mixer.

[0010] The towed mixing machine, mixes the materials introducing the hot or cold bituminous binder into a mixer, by a pump connected to the aggregates feeding system in order to add the binder necessary for the mixing by picking it up from a suitable binder material tank integrated with the train (asphalt recycling travelplant with cold planer).

[0011] The mixer or mixing machine or blending machine, is made up of a container having a double rotor with blades.

[0012] In prior art, one or more direct flame burners for the binder (bitumen) eventual heating are provided, and the mixed material is discharged while still hot, that is with the mixed bitumen not yet solidified, in the form of a heap line (grit line), from the rear mouth of the mixer,

[0013] The following machine in the train provides for spreading the material on the road by spreader.

[0014] At the end of the train a self-propelled finishing road straightening machine and vibrating-roller and/or gummed rollers is provided.

[0015] About the mixing unit, additional water tank to the binder tank may be provided for cement mixture.

[0016] Of course the same train can perform stabilisations with cement or with other binders (generally cold) such as for example bituminous mixtures in solution with solvents or in emulsion with water.

[0017] In IT-83469 A/88 Marini, it is proposed a solution of a train that concerns a plant to mix and produce in continuous conglomerates of different composition, in which it is provided:

- a mixing base unit, combined with:
- a demontable unit for the addition of solid binder in powder form, interchangeable with
- a demontable alternative unit for the addition of liquid or semi-liquid binder,
- or vice versa.

[0018] In this way preparing stabilised conglomerates with both cement and bitumen, by simply changing the binders feeding units from the whole mixing structure, is possible with the same mixing unit.

[0019] In said solution advantageously the mixing unit includes a mixer group or unit (equipped/able with a

water or volumetrically proportioned bituminous binders spraying device), of the "Trough" type with a pair of horizontal or lightly tilted shafts, longitudinally placed parallel to one another endowed with oppositely rotating mixing blades.

[0020] In this way it is possible to strongly compact the mixing unit size and it is possible to easily arrange the binder addition unit above the mixer device.

[0021] It is also provided the addition of an intermediate machine between the collecting machine and the mixer/blending machine which provides for a perfect cleaning of the road bed before the binder material spraying and mixed material laying is carried out by the mixing machine, but this addition of an intermediate cleaning-machine, besides lengthening the train, makes the transfer of the material collected by the collecting machine to the following mixing machine difficult.

[0022] With the IT-UD97A000143 / EP-A-9811183.1 (Marini); a road paving cold recycle train is provided, the train being for the collection in continuous of bulk material in a grit line along the feather-edge restoration runway, of the type frontally involving two arms with means for picking -up the bulk material in front of their path and means for the conveying on a downstream blending machine, which includes between the wheels or front tracks and wheels or rear tracks, suction means (SA) for sucking all that granulated material and dust which the front pick-up means have failed to collect from the underlying paving is provided.

[0023] Also the solutions IT-4753489.A.89 /EP-A-0378973 (Todini); EP-A-0324491 (Wirtgen), where in both solutions it is provided:

- scarifier means to collect the material to be mixed from the road and to discharge it into a heaping hopper which comprises weighing means;
- means to clean the road from the material left by using suction as in the former solution;
- means to transfer the collected material to sieving means;
- means for grinding the material discarded from the sieving for the recycle and
- at least one tank to mix the material in mixing means and
- means for spreading the mixed material on the road to form a paving new layer.

[0024] These latter solutions, and in particular even if the first one is more advantageous, have the drawback of using an art of mixing with bituminous emulsion, which involves autonomy problems (emulsion, on an average: 60% bitumen and 40% water).

[0025] While the cold solutions, previously mentioned, are complex, difficult and hardly reliable in consideration of the fact that:

- the use of sole cement is provided for sole ground layers;
- the use of cold bituminous emulsion did not allow to reach a suitable performance particularly due to technical mixing complexities and difficulties and also with spreading modified emulsions and problems of fast and effective use of the new paving.

[0026] Purpose of the present innovation is to realise a new train particularly suitable to the cold working and laying of the material, without the drawbacks, complexity, problems, of the prior cold arts and of the as much complex hot laying arts.

[0027] The problem is solved as claimed by means of a vehicle to mix in continuous aggregating material with binder material, to be associated in a road repaving train substantially operating with cold laying, of the type comprising bitumen as a binder base, wherein it si further provided in combination:

- means to heat said binder material in fluid form at 150/200°C, preferably at about 170°C, before the spraying in said mixing means;
- means to convey hot and fluid bitumen in a controlled way, pressure and flow rate, with additives, through a static turbo-mixer to respective sprayers above said mixer, associated with:
- means to inject water, in a controlled way, to said binder material immediately before the spraying, upstream of said sprayers, under such a pressure to prevent the vaporisation of said added water, in order that at the exit from said spraying means a bitumen foam is formed, caused by the expansion by evaporation of the particles of water that is sprayed in the cold aggregate material being mixed thus mixing and binding with it.

[0028] In this way the advantage of a cold operating by starting from the base material that substantially remains the bitumen, which assures the better binding is obtained.

[0029] Advantageously also the addition to the mixer of fluid cement mortar substantially including at least water and cement, the whole being mixed in said mixer is provided.

[0030] In this way a paving material with high sticking quality, resistance to wear, breakage and detachment from the road bed is obtained.

[0031] Advantageously the mixer to form a cold recycle self-propelled train for the road paving rehash, of the type involving:

- a feeding-proportioning front hopper with weighing belt, to collect the material to be recycled from a front vehicle;
- at least a tank of additives and a tank of water to be added to the material to be recycled;
- at least one silo or tank of mixture cement to be added to the material to be recycled, with a respective cement proportioning unit or device;

- a water-cement blending group;
- a mixer group including:
- a mixer to mix said material to be recycled coming from said hopper with said additives, water and cement;
- a multiple ramp for spraying foam bitumen, additives, water and cement mortar;
- a belt for discharging in a line the mixed material along the road;
- a control electric board
- an electric generator.

[0032] In which it is provided that said mixing means and said binder material spreading means provide:

- means to heat and/or to maintain said binder material in fluid form at 150/200°C, preferably at about 170°C;
- means to convey under pressure in a controlled way said bituminous binder material to respective sprayers associated with:
- means to add additive substances;
- means to inject water, in a controlled way, to said binder material immediately before the spraying, upstream of said sprayers, under such a pressure to prevent the expansion by vaporisation of said added water;
- in order that at the exit from said spraying means the expansion by evaporation of the water particles occurs forming a bituminous material foam that is sprayed in the material being mixed thus mixing and binding with it.
- and means for the addition to said cement mortar mixer substantially made up of a previous liquid mixture of water and cement.

[0033] A towing vehicle provides to feed the fluid bitumen to said mixer in said spraying ramp.

[0034] In this way a maximum performance and functionality of the train self-propelled plant is obtained, and in particular a cold road paving stratification of maximum reliability and with all the qualitative features of the hot bituminous mixture may be carried out, but using a cold instead of an hot working and without the need of using a bituminous emulsion which proved to be little practical, as the very reduced volume of the water used in the bitumen foaming, after the spraying, forces its rapid evaporation, obliging the bitumen to coat and to stick strongly to the respective granules during mixing.

[0035] The addition of cement binder favours a fastest absorption in the mixture of the waste water after the new layer rolling, making the new paving more rapidly practicable.

[0036] Advantageously the additive materials to the bitumen are amines in the 1/3% percentage, which favour the realisation of the mixture.

[0037] The amount of bitumen is advantageously provided in about 2-4%, advantageously in about 3% of the material to be recycled (aggregates).

[0038] The amount of water for the bitumen foaming, advantageously ranges within a 2 to 5 % value.

Description

[0039] These and other advantages will appear from the following detailed description of preferred solutions of embodiments with the aid of the enclosed drawings whose details are not to be considered limiting but only illustrative.

Figure 1 shows a sideways schematic view in elevation of the mixing vehicle, according to this innovation.

Figure 2 shows a schematic view of the mixing apparatus with the mixer schematised in cross section.

Figure 3 shows an enlarged schematic view of the foamed material spraying system, in this specific case showing two of the series of spraying nozzles that extend above the mixer.

Figures 4,5 show schematic views in front longitudinal elevation and from the top, of the mixer, above which the binder material spraying ramp insists.

[0040] Referring to the figures it can be noticed that the mixing vehicle according to this invention includes:

- a front feeding-proportioning hopper with weighing continuous belt (1), to collect the material to be recycled or aggregate, from a preceding vehicle;
- at least one tank of additives (2) and a water tank (3) to be added to the material to be recycled;
- a silo of mixture cement (4) to be added to the material to be recycled, with a respective cement proportioning unit (5);
- a water-cement blending unit (6);
- a mixer blending unit (7) including:
- a mixer (P1) to mix said material to be recycled or aggregates, coming from said hopper (1) with cement+water (3-P6-P8; 3 - P6-P9);
- a multiple ramp for bitumen spraying (P2) with bypass control, liter-counter (P3) and static mixer (P4), toward compressed air pressure nozzles (P10) to obtain a bitumen foamed with pressurised water before the spraying (3-P7) in said spraying nozzles (P12) for the formation of foamed bitumen that will be mixed with the material being mixed in said mixer, being said additives (2-P5) added to the fluid bitumen and mixed with it by static mixer or turbo-mixer (P4), while the cement mortar is separately added (M-E);
- a belt for the discharge in a line (9) of the mixed material along the road;
- a control electric board (11) associated with a computer for controlling the dosages (PLC=Program-

mable Logic Computer) operating in function of the bitumen temperature (P13), of the aggregates weighing (P14), of the bitumen dosage set (P15), of the additives dosage set (P16), of the water and cement dosage set in form of fluid cement mortar (P 17) and of the water dosage set (P18);

- an electric generator (10) for the functioning of all the vehicle apparatuses.

[0041] Substantially said mixing means and said binder material delivering means provide:

- means to heat said binder material in fluid form at 150/200°C, preferably at about 170°C, before of spraying (U2) in said mixing means (P1);
- means to convey by pressure and in a controlled way by a litre-counter (P3) said bituminous binder material (B-P2) with additives (AD-P5) through a static turbo-mixer with opposite vanes (P4), to respective sprayers (P1) associated to:
- means to inject water, in a controlled way (P7-U2), to said binder material immediately before the spraying, upstream of said sprayers (U3), with such a pressure to prevent the expansion of said added water;
- in order that at the exit from said spraying means (U3) the expansion by evaporation of the water particles is obtained forming a bituminous material foam that is sprayed into the material being mixed thus mixing and binding with it (P1).

[0042] As said, means for the transport of the bitumen (B) in the fluid state and its feeding in the train from a towing vehicle to said mixer in said spraying ramp (P12) are provided.

[0043] In this way a plant maximum performance and functionality is obtained.

[0044] More in particular a continuous mixer (P1) with double axis (Ax) with co-penetrating blades or crossing blades (PO) and discharge at one end (S) is used while on the top the spraying ramp extends (P12) with a plurality of sprayers comprising an additived bitumen duct (B+AD), that gets through an interchangeable gauger (U1) to flow in a turbulence pre-chamber where the water is injected under pressure (H2O), which is tightly mixed with the bitumen and additive (B+AD) and exits from the spraying nozzles with rapid expansion of the water particles that immediately evaporate foaming the material, which falling above the mixer (P1) is mixed with the aggregate together with the liquid cement mortar (M).

[0045] Each proportioning pump (P5, P2, P7, P8, P9) is controlled by a flow rate checking system (PLC=Programmable Logic Computer) by a variable motor (M) and by a tacho-dynamo (tachymetric dynamo or tachymeter-dynamo, P6).

[0046] A by-pass (BP) in the bitumen feeding for the recirculation in case of delivery stop to the mixer is provided.

[0047] The computer-controlled system determines and controls all the parameters for a regular continuous working.

[0048] More particularly the mixing vehicle is endowed with the following devices or units:

- in the front said aggregate feeding-proportioning hopper, with underlying continuous weighing belt (1n) connected to said aggregates control means (P14-PLC=Programmable Logic Computer), that carries the material, backwards, in a controlled amount for discharging it above said mixer (7) underlying said water tank (3), said additive materials tank being provided adjacent to this latter (2-AD) and above said mixer (7) and under said water tank (3) and additives tank (2), said spraying ramp being installed (8-P12);
- downstream of these, from beneath the discharge (S) of said mixer (P1), said discharge continuous conveyer belt (9) which tilts upwards and protrudes backwards from the vehicle, for the rearward mixed discharge material starts;
- above said discharge continuous conveyer belt (9) and immediately after and above said mixer group (P1, 8-7) the cement silo (4) from which the cement is taken by a conveyer system (55) up to the rear cement dosage unit (5) which discharges the cement in the blending unit with water (6) for the formation of a mortar that is sent by means of a volumetric/proportioning pump to the mixer (E) is installed;
- said electric generator that controls all the vehicle devices is placed above said discharge continuous belt (9) and behind this and always above said discharge continuous belt, also said control board into an electric box accessible from outside (11), which also includes the processor means (computer) for the control of all the system working or working process (PLC=Programmable Logic Computer) is placed.

Claims

1. An in-situ mixer vehicle to mix continuous aggregating material with binding material, to be associated in a road repaving train substantially operating with cold laying process, of the type comprising bitumen as binder base, and having a mixing means unit, characterised in that it is provided:

   - means to heat said binding material in fluid form at 150/200°C, before of the pressure spraying (U2), in said mixing means (P1);
   - means to convey hot and fluid bitumen (B, P2) in a controlled way (P3) with additives (AD) through a static turbo-mixer blender with opposite vanes (P4), to respective sprayers (P1)

associated with:

- means to inject water, in a controlled way (U2), to said binding material immediately before the spraying, upstream of said sprayers (U3), under such a pressure to prevent the expansion of said added water, in order that at the exit from said spraying means (U3) the expansion by evaporation of the water particles forming a foam of bituminous material which is sprayed into the in-mixing aggregating material, thus mixing and binding with it (P1) is obtained.

2. An in-situ mixer vehicle according to claim 1., characterised in that the temperature of the supply of said binding material in fluid form is about 170°.

3. An in-situ mixer vehicle according to claim 1., characterised in that it comprises:

- a feeding/proportioning front hopper with weighing continuous belt (1) connected to said aggregates control means (P14-PLC=Programmable Logic Computer), to collect the material to be recycled or aggregate, from a previous vehicle;
- at least one additives tank (2) and a water tank (3) to be added to the material to be recycled or aggregate;
- a silo of mixture cement (4) to be added to the material to be recycled or aggregate, with a respective cement dosage unit (5);
- a water-cement blending unit (6);
- a feeding and dosage group of the cement mortar to the mixer (E,P1-7)
- a mixer unit (7) including:
- a mixer device (P1) to mix said material to be recycled or aggregates, coming from said hopper (1) with cement+water (3-P6-P8; 3-P6-P9);
- a multiple ramp for bitumen spraying (B-P2) with by-pass control, litre-counter (P3) and static mixer (P4), toward compressed air pressure controlled nozzles (P10) to obtain a foamed bitumen by injecting pressurised water before of the spraying (3-P7) in said spraying nozzles (P12) for the formation of foamed bitumen that is mixed with the material being mixed in said mixer (P1), being said additives (2-P5) added to the fluid bitumen and mixed with it by static turbo-mixer (P4), while said water and cement in form of fluid cement mortar, is separately added (M-E);
- a belt for discharging in a line (9) the mixed material along the road;
- a control electric board (11) associated with a computer for controlling the quantity of the materials to add (PLC=Programmable Logic Computer), operating in function of said bitumen temperature (P13), of said aggregates weighing (P14), of the bitumen dosage set (P15), of the additives dosage set (P16), of said cement mortar dosage set (P17) and of the water dosage set (P 18);
- an electric generator (10) for the operation of all the vehicle apparatuses.

4. An in-situ mixer vehicle according to previous claim, characterised in that it comprises:

- in the front said aggregate feeding-proportioning hopper, with underlying continuous weighing belt (1n) connected to said aggregates control means (P14-PLC=Programmable Logic Computer), that carries the material, backwards, in a controlled amount for discharging it above said mixer (7) underlying said water tank (3), said additive materials tank being provided adjacent to this latter (2-AD) and above said mixer (7) and under said water tank (3) and additives tank (2), said spraying ramp being installed (8-P12);
- downstream of these, from beneath the discharge (S) of said mixer (P1), said discharge continuous conveyer belt (9) which tilts upwards and protrudes backwards from the vehicle, for the rearward mixed discharge material starts;
- above said discharge continuous conveyer belt (9) and immediately after and above said mixer group (P1, 8-7) said cement silo (4) from which the cement is taken by a respective conveyer (55) towards said rear cement dosage unit (5) which discharges the cement in the blending group with water for the formation of a mortar that is sent by means of a volumetric/proportioning pump to the mixer (E) is installed;
- said electric generator that controls all the vehicle devices being placed above said discharge continuous belt (9) and
- behind this and always above said discharge continuous belt, also said control board into an electric box accessible from outside (11), which also includes the processor control means for the control of all the system working (PLC=Programmable Logic Computer) being placed.

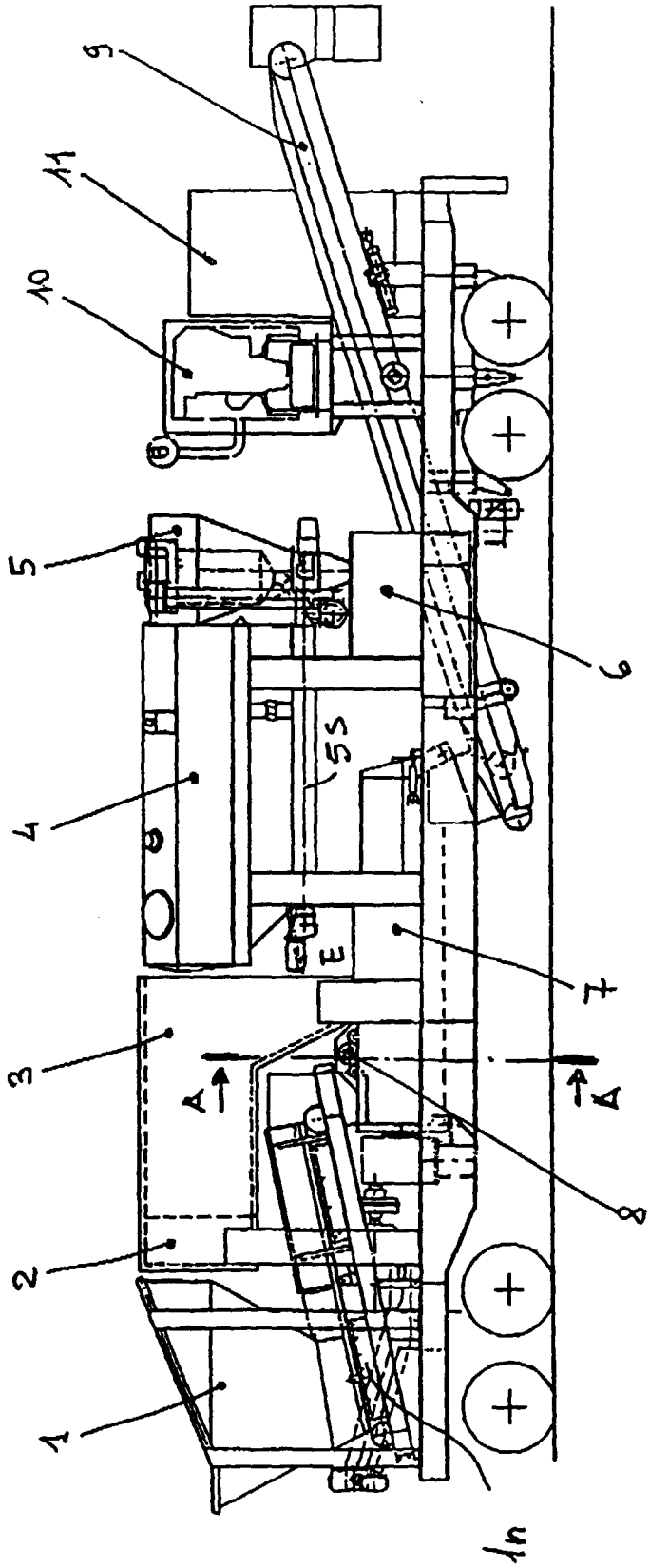

FIG. 1

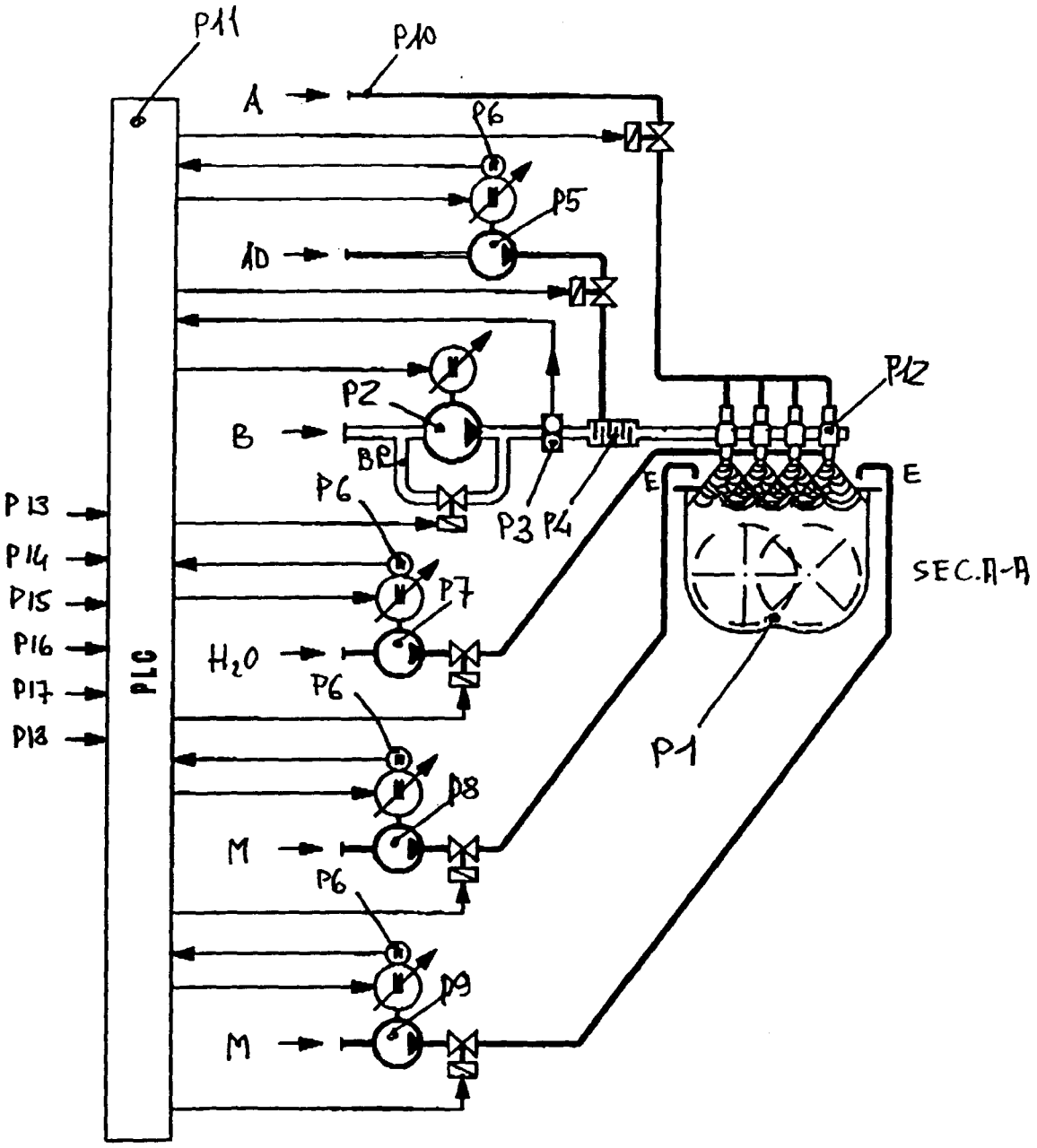
P11
P10
A
P6
P5
AD
P12
P2
B
BP
P6
P3
P4
E
E
P13
P14
P15
P16
P17
P18
PLC
P7
H2O
P6
P8
M
P6
P9
M
SEC.A-A
P1

FIG.2

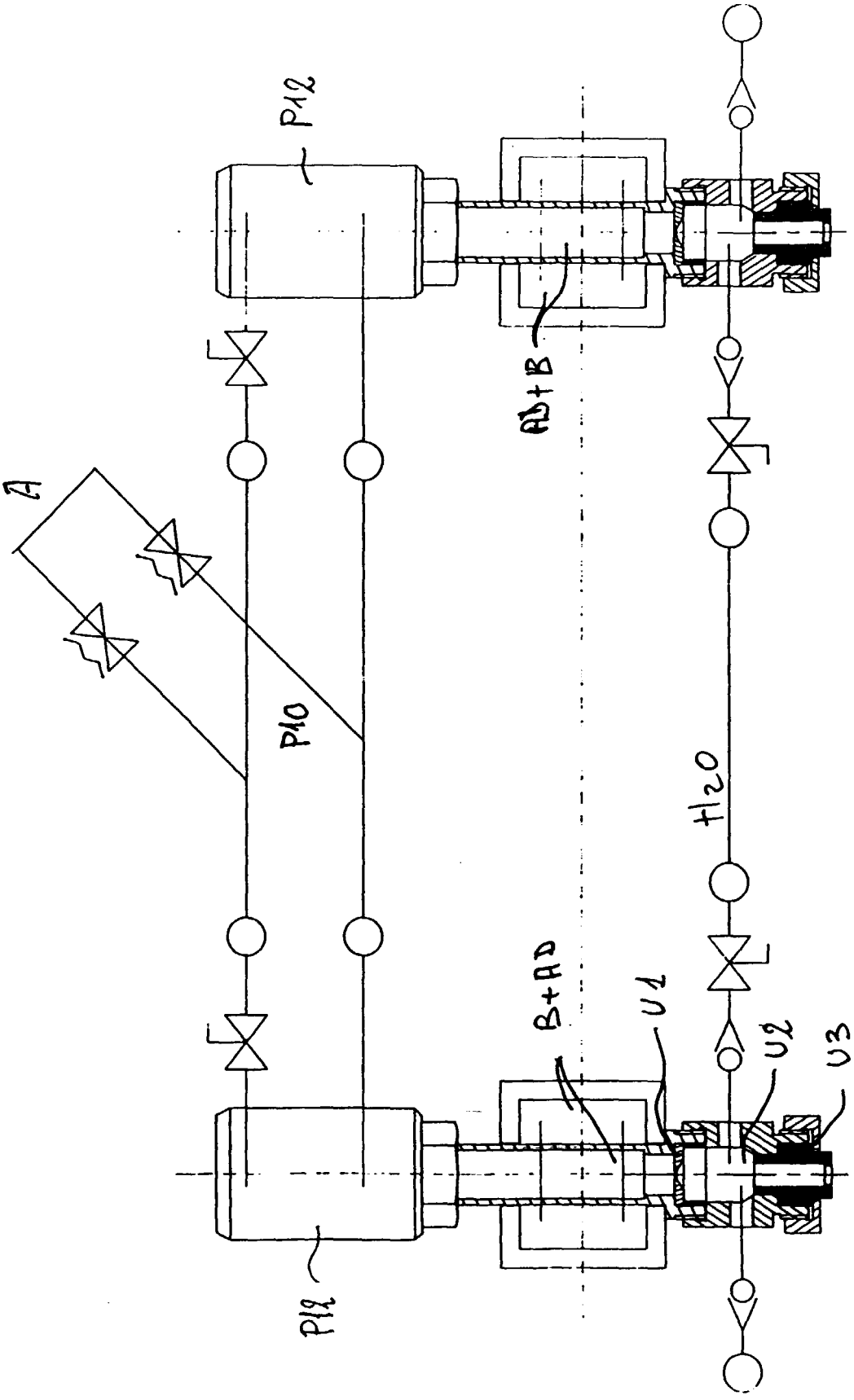

FIG.3

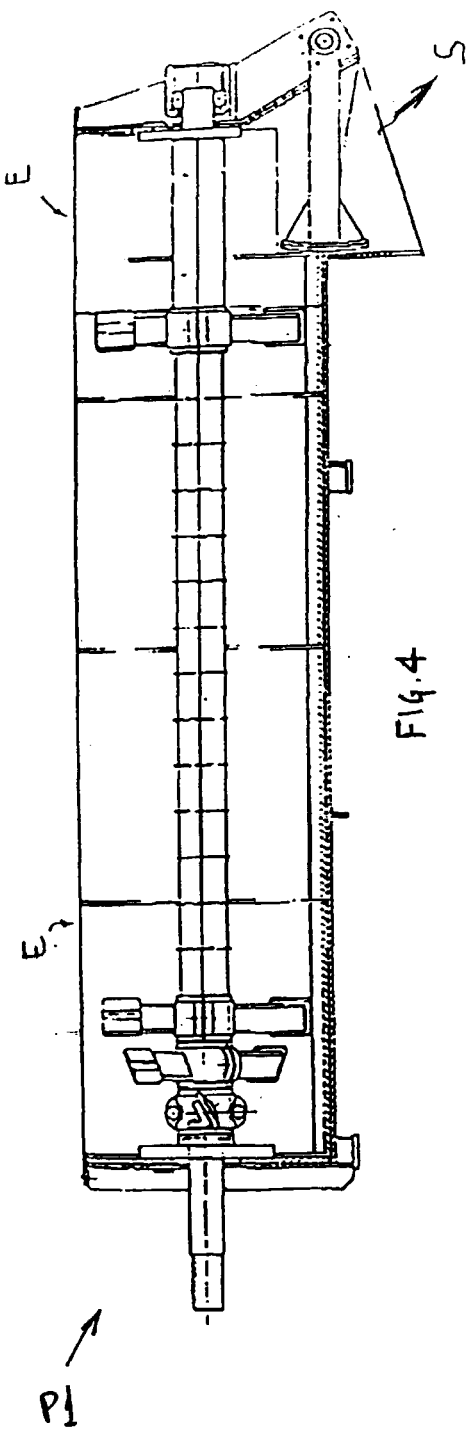

FIG.4

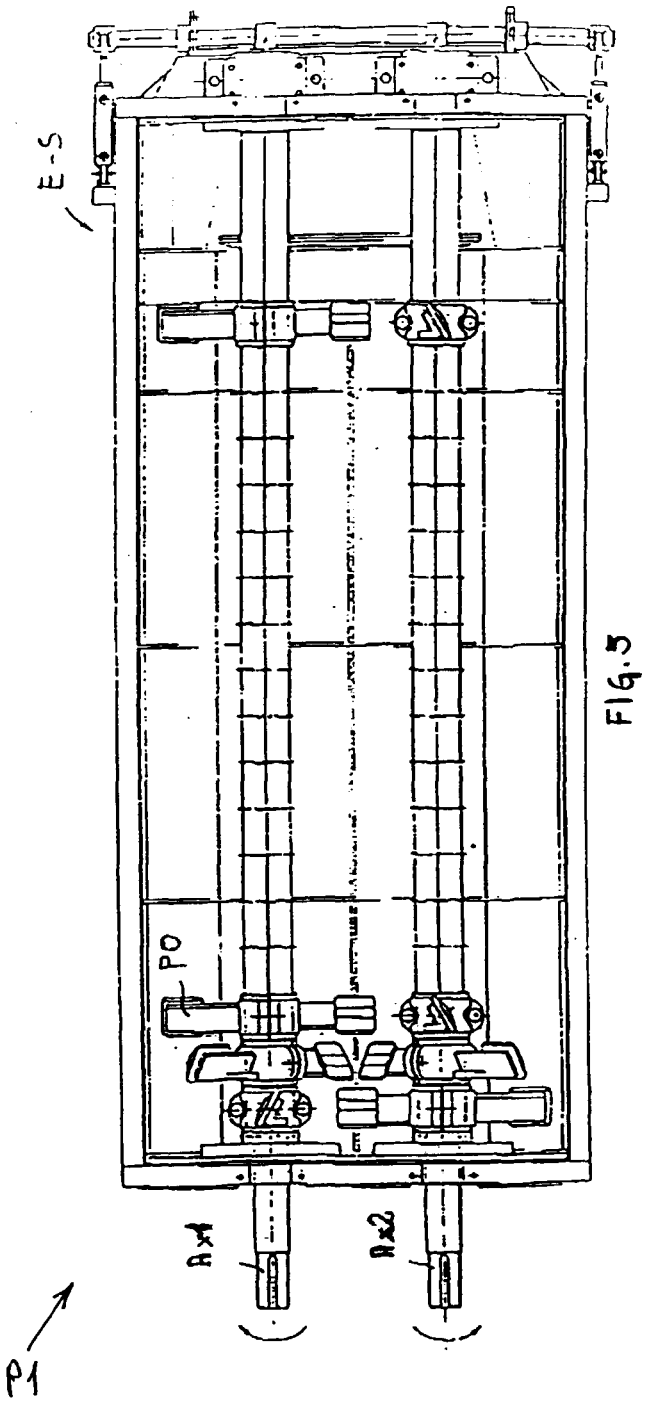

FIG.3