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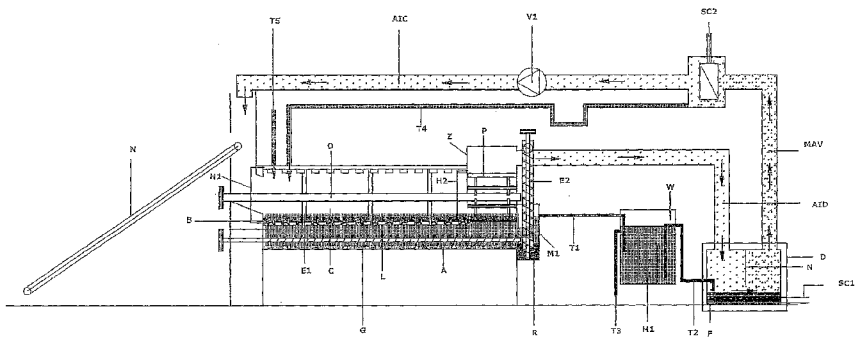
(54) **Title**: APPARATUS FOR RECOVERY AND RECYCLING OF BITUMINOUS AGGREGATES



(57) **Abstract**: An apparatus for recovery and recycling of bituminous aggregates, wherein the separation of aggregates from the bitumen is made, via a non-inflammable liquid organic solvent, in a closed environment to prevent harmful emissions into the atmosphere.

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APPARATUS FOR RECOVERY AND RECYCLING OF BITUMINOUS AGGREGATES

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The present invention relates to an apparatus that enables recovery of bituminous aggregates and recycling thereof.

Currently, there do not exist on the market apparatuses by means of which it is possible to recover said bituminous aggregates to enable recycling thereof.

As is known from the recent standards, blocks and fragments of road flooring made of bituminous conglomerate deriving from operations of scarification and removal of road surfaces, must be confined in special dumps, being classified as non-dangerous special waste.

There is, therefore, an extreme awareness of the need to recover as much as possible of the bituminous aggregates in order to reduce the costs of confinement of the dump, as well as to recover totally or partially said aggregates for subsequent use.

The purpose of the present invention is to overcome the above problems by providing an easy-to-use apparatus for recovery of bituminous aggregates of various size and recycling thereof at a cost lower than the market price of the re-usable recovered products.

According to the invention, this is obtained by providing an apparatus that comprises a purposely designed rotary drum or cylindrical chamber, with the bottom part partially immersed in an appropriate non-inflammable liquid solvent or any other chlorinated organic solvent designed to separate the aggregates

from the bitumen, having a specific weight greater than that of water.

Said drum separates the bituminous aggregates of larger size from those of smaller size so that they are expelled out of the drum independently of one another.

For said purpose, said drum is equipped with through holes that allow the aggregates of smaller size to exit from the drum itself, said aggregates dropping by gravity, being immersed in said liquid solvent where a screw conveyor pushes them towards a collection chamber, located in which is a second screw conveyor, designed to expel them outwards separated from the bitumen.

The aggregates of larger size, instead, are made to advance by the rotation of the drum until a plurality of expulsion blades are reached, which, being fixed with respect to said drum, are designed to expel them outwards separated from the bitumen.

The non-inflammable liquid solvent, as a result of the rotation of the drum and of the capacity of the solvent itself to bind with organic material, dissolves the bitumen and is bound thereto up to saturation.

A better understanding of the invention will be obtained with reference to the ensuing detailed description and to the attached drawings, which illustrate, purely by way of example, two preferred embodiments thereof.

In the drawings:

Figure 1 is a diagram of a first embodiment of the apparatus forming the subject of the invention;

Figures 2 and 3 are cross sections of the rotary

drum of the apparatus forming the subject of the invention;

Figures 4 and 5 are cross sections in the proximity of the vertical screw conveyor;

Figure 6A is a diagram of a second embodiment of the apparatus forming the subject of the invention, in which the pre-distillation section has been removed;

Figure 6B shows the pre-distillation section in detail;

Figure 7 is a perspective view of the rotary drum of the apparatus of Figure 6A;

Figure 8 is a partially sectioned side view of the apparatus of Figure 7;

Figure 9 is a partially sectioned front view of the apparatus of Figure 7;

Figure 10 is a cross-sectional view of the apparatus of Figure 7 in the plane of trace A-A;

Figure 11 is a top plan view of the plant in which the apparatus of Figure 6A and 6B is inserted; and

Figure 12 shows a detail of Figure 11.

With particular reference to Figure 1, in the preferred embodiment described, an apparatus is provided, designed for recovery of bituminous aggregates of various size and for recycling thereof, which comprises in combination:

- a purposely designed drum or cylindrical chamber C, which is able to turn about its own substantially horizontal axis O; said drum, as has already been mentioned, is partially immersed in an appropriate liquid solvent L contained in an underlying tank G, and is designed to receive, at a first open end H1, the

bituminous aggregates for separating the aggregates of smaller size A from those of larger size B; for this purpose, said drum C is equipped with a plurality of through holes made on its wall, which enable the aggregates of smaller size A to exit from the drum C falling by gravity into the tank G to be completely immersed in the liquid solvent L; said liquid solvent is non-inflammable and has a specific weight greater than that of water;

- a plurality of expulsion blades P, at a second open end H2, opposite to the first end H1, which, by turning fixedly with respect to said drum C, are designed to expel the bituminous aggregates of larger size B separated from the bituminous;

- a first screw conveyor E1 with substantially horizontal axis, which, by turning on itself in the lower part of the tank G underlying said drum C, is designed to displace the bituminous aggregates of smaller size A longitudinally, together with a solvent/bitumen mixture M1;

- a collection chamber or well R, which, adjacent to said second end H2 of the rotary drum C, is designed to receive the bituminous aggregates of smaller size A, which are made to advance by the screw conveyor E1, along with the solvent/bitumen mixture M1;

- a second screw conveyor E2 with substantially vertical axis, designed to draw from said well R and to expel the aggregates of smaller size A separated from the bitumen, which are present in the well R itself;

- a distiller D, designed to separate the bitumen from the solvent contained in the mixture M1;

- means of a known type for pumping the bitumen separated from the solvent outwards to be recovered;

- a water separator W, which, connected to the well R and to the distiller D, is designed to separate from the solvent/bitumen mixture M1 coming from said well R the water present in the mixture itself (due to the water absorbed by said bituminous aggregates when these are still in the form of bituminous conglomerate, for example for road flooring), so that the water will be made to exit outwards and the solvent/bitumen mixture M1 without water will be sent into the distiller D;

- means SC2 designed to cool down the vapours of the solvent contained inn a air/vapour mixture MAV of the solvent coming from the distiller D so that the re-condensed solvent will be recovered and re-introduced into the rotary drum C; and

- means V1 for drawing in the air AIC purified from the vapours of the solvent contained in the mixture MAV and introducing it into the rotary drum C.

According to a peculiar characteristic of the invention, the rotary drum C and the tank G are enclosed in a container that is open only at the first open end H1 of the drum itself.

The rotary drum C is equipped with a spiral interrupted in more than one point designed to favour the movement and advance of the bituminous aggregates that are introduced therein.

The liquid solvent L has a low boiling point and in the example that is described is trichloroethylene.

As a result of the rotation of the drum C and of

the capacity of the liquid solvent L for binding with organic material, said solvent dissolves the bitumen and binds thereto up to saturation.

The water separator W is connected, respectively, to the well R and to the distiller D by means of a first overflow pipe T1 and a second pipe T2. By means of the first pipe T1 the solvent/bitumen mixture M1 passes from the well R to the separator W, and by means of the second pipe T2 the solvent/bitumen mixture M1 without water passes from said separator W to the distiller D.

According to a further peculiar characteristic of the invention, the first pipe T1 is positioned at such a height as to guarantee that the level of the solvent/bitumen mixture M1 will remain constant. Alternatively, since when working on semitrailers it is not possible to position appropriately said pipe T1, a pump P4 is provided, preferably a magnetically driven one, for drawing said mixture and level switches designed to control said pump to guarantee the right level of the liquid. Said pump P4 is illustrated in the diagram of the second embodiment that will be described hereinafter.

The water that the separator W eliminates from the solvent/bitumen mixture is made to exit by means of a specially provided discharge pipe T3.

The distiller comprises a tank S equipped with a vertical separation wall N and with a tube-nest heat exchanger SC1, positioned on the bottom of the tank S, in which diathermic oil flows at a temperature of approximately 200°C. Said heat exchanger has the task

of separating the bitumen from the solvent/bitumen mixture M1 coming from the well R so that the bitumen separated from the solvent and designated in the figure by F comes to position itself on the bottom of the tank S and is rendered fluid by the heat coming from the tube nest.

There are then introduced into the tank S of the distiller D both the solvent/bitumen mixture M1 that comes from the well R and a flow of air AID coming from a conveyor Z located at the second end H2 of the drum C and containing solvent vapours, whilst the air/vapour mixture MAV of the solvent exits from the distiller D itself.

The bitumen F rendered fluid by the tube nest, once it has been recovered on the outside, is subjected to suitable treatments for being re-used, such as for example by mixing it with virgin bitumens or modifying it with polymers.

The means SC2 designed to cool down the vapours of the solvent coming from the distiller D comprise an air/water heat exchanger that functions as cold battery. In fact, the solvent is re-condensed and re-introduced into the rotary drum C by means of a purposely provided pipe for recovery of the solvent T4.

The water for cooling the cold battery SC2 enters at 5°C and exits at 10°C.

The means V1 for aspiration of the vapours of the solvent comprise a centrifugal suction fan.

Advantageously, said suction fan V1 is set downstream of the heat exchanger SC2 to prevent the solvent vapours from possibly damaging it, and provided

on the pipe T4 for recovery of the solvent is a siphon that functions as plug to prevent the negative pressure created by the fan V1 from stopping outflow thereof.

The air expelled by the fan V1 is re-introduced into the rotary drum C by means of a pipe positioned at the inlet of the drum itself.

The apparatus also comprises:

- a conveyor belt N designed to introduce bituminous aggregates into said drum C, normally coming from a feeder assembly U;
- means designed to detect saturation of the liquid solvent L and to send a saturation signal when the liquid solvent L reaches a pre-set level of saturation; and
- means designed to receive said saturation signal and to introduce clean solvent L into said rotary drum C.

The conveyor belt N also performs the role of dispenser, being equipped with a plurality of load cells that enable the amount of product to be processed to be kept constant, by regulating the rate thereof.

The means designed to detect saturation of the liquid solvent and send the rotation signal comprise an optical probe that is positioned in the well R and is connected to a PLC.

The means designed to receive the saturation signal and to introduce clean solvent L into the rotary drum C comprise a pump that is connected between a tank for storage of the solvent and a further pipe T5, by means of which the clean solvent L is introduced into the rotary drum C. Said pump is controlled by a level

switch to keep the level of solvent in the apparatus constant.

Advantageously, since the apparatus performs a closed cycle, emissions harmful for the atmosphere are not produced.

A further advantage is represented by the fact that the re-condensation of the liquid solvent, which is obtained by means of a cold battery, together with limited use of staff means that the recovery of bituminous aggregates, or special waste, will, as has already been mentioned, have a cost lower than the value of the re-usable recovered products.

With particular reference to Figures 6A and 6B, provided in a second embodiment of the invention is an apparatus capable of increasing the hourly processing output of bituminous conglomerate preferably up to approximately seventy tonnes.

According to this second embodiment of the invention, the non-inflammable liquid solvent L is a solvent with high boiling point, such as for example perchloroethylene (tetrachloroethylene), and the apparatus that is described comprises a pre-distillation section designed to be connected to the water separator W and to the distiller D, intercepting the pipe T2 in two points T2A and T2B, located, respectively, downstream of said water separator W and upstream of said distiller D, said pre-distillation section comprising:

- a heat exchanger S2, designed to heat the perchloroethylene/bitumen mixture (bringing it from a temperature of approximately 20°C to a temperature of

approximately 100°C), which is drawn from the water separator W by means of the pump P4 and introduced into said heat exchanger S2;

- a heat exchanger S3, supplied by a diathermic-oil boiler, designed to heat the perchloroethylene/bitumen mixture further (up to 155°C approximately), said mixture exiting from the heat exchanger S2, with the result that said mixture in part evaporates and in part is separated from the bitumen;

- a distillation tower D', which receives at inlet the vapour/perchloroethylene/bitumen mixture coming from the heat exchanger S3 and re-introduces said mixture (140°C approximately) into the heat exchanger S2 so that the mixture that traverses said heat exchanger S2 is heated by the vapour coming from said distillation tower D'; according to a peculiar characteristic of the invention, said distillation tower D', by working at a pressure lower than that of the heat exchanger S3, enables the mixture to continue to evaporate and the liquid part thereof to precipitate towards the bottom of said distillation tower D', where a tube-nest heat exchanger SC1' further separates the bitumen from said mixture, which settles on the bottom and is rendered fluid by the heat coming from the tube nest for being introduced by means of a pump P6 into the distiller D, where the bitumen is completely separated from the perchloroethylene;

- a water-storage tank SA, designed to receive the water that is drawn from the water separator W by means of a pump P13 and introduced into said tank via the pipe T3;

- an evaporative tower TE, designed to cool down the vapour/perchloroethylene mixture that traverses a water/perchloroethylene heat exchanger S1 by means of water that is drawn from said water-storage tank SA by means of a pump P15 and then introduced into the heat exchanger S1 itself (30°C approximately) by means of a pump P5; said evaporative tower TE re-condenses the perchloroethylene and brings it to a temperature of approximately 70°C; the water at outlet from said heat exchanger S1 is re-introduced from the heat exchanger S1 into said evaporative tower TE, whilst the re-condensed liquid perchloroethylene is introduced into the drum C via a pipe T6 that connects said heat exchanger S1 to the drum C.

According to the invention, it is preferable to provide an activated-carbon filter F1 at the inlet of the water tank SA in order to eliminate any possible residue of perchloroethylene bound to the water.

It is moreover preferable for the distillation tower D' to be equipped with a drop-separator SG, designed to cause the drops to drop back onto the tube-nest heat exchanger SC1' in the case of dribbling.

The heat exchanger SC1' of the distillation tower D', the heat exchanger S3, as likewise the heat exchanger SC1 of the distiller D are heated with means of a known type.

In other words, the heat exchanger S2 is traversed by the perchloroethylene/bitumen mixture at room temperature and, in countercurrent, by the perchloroethylene vapours coming from the distillation tower D', which are partially cooled, yielding heat to

the mixture at room temperature, thus raising the temperature thereof and hence recovering energy from the system.

Next, the mixture is introduced into the heat exchanger S3, where, thanks to the flow of diathermic oil at high temperature, it evaporates partially and is in part separated from the bitumen.

Then, the vapour/perchloroethylene/bitumen mixture at outlet from the heat exchanger S3 enters the distillation tower D' where, owing to the lower pressure, continues to evaporate whilst the liquid part precipitates into the bottom part of said distillation tower, where the tube nest of the heat exchanger SC1' that is traversed by diathermic oil heats the mixture, which, by evaporation from the perchloroethylene, separates off from the bitumen.

Said bitumen, which is still partially bound to the solvent, is introduced into the distiller D described previously.

The perchloroethylene vapours, after passing through the heat exchanger S2, are introduced into the heat exchanger S1 where, as a result of the cooling caused by traversal of water coming from the evaporative tower TE, the vapour will condense completely, and the liquid perchloroethylene will be re-introduced into the drum C.

Advantageously, according to the invention there are provided, both for the bituminous aggregates of smaller size A and for those of larger size B, respective means QA and QB for drying the perchloroethylene from said bituminous aggregates by

vibration, before the latter are collected separately at outlet from the apparatus. Said means are substantially vibrating grizzlies.

In both of the embodiments, it is preferable for the non-inflammable liquid solvent to have a low specific heat so that just a little heat is needed to bring it to boiling point.

The present invention has been described and illustrated according to two preferred embodiments, but it is understood that any person skilled in the branch may make equivalent modifications and/or replacements thereto, without thereby departing from the sphere of protection of the present industrial patent right.

CLAIMS:

1) An apparatus for recovery of bituminous aggregates of various size and for recycling thereof, characterized in that it comprises in combination:

- mechanical means for separation of the aggregates of larger size (B) from those of smaller size (A), as well as for washing thereof in an appropriate non-inflammable liquid solvent (L) with specific weight greater than that of water, said solvent being contained in a tank (G);
- first mechanical means for expulsion of the aggregates of larger size (B) already separated from the bitumen;
- mechanical means for transfer of the aggregates of smaller size (A) and of a solvent/bitumen mixture (M1) from the tank (G) into a collection chamber or well (R);
- second mechanical means for expulsion of the aggregates of smaller size (A) from said well (R);
- means for separation of the bitumen from the solvent and for pumping it out for recovery; and
- means for recovery of the solvent separated from the bitumen and recycling thereof in the tank (G).

2) The apparatus according to the preceding claim, characterized in that said mechanical means for separation of the aggregates of larger size (B) comprise a purposely designed rotary drum or cylindrical chamber (C) which turns about its own horizontal axis (O), said drum being partially immersed in an appropriate liquid solvent (L) and contained in a tank (G) underlying the drum itself and being designed

to receive at a first open end (H1) the bituminous aggregates for separating the aggregates of smaller size (A) from those of larger size (B); for said purpose said drum (C) being equipped with a plurality of through holes made on its wall that enable said aggregates of smaller size (A) to exit from the drum (C) falling by gravity into the tank (G) to be completely immersed in said liquid solvent (L).

3) The apparatus according to the preceding claim, characterized in that said first means for expulsion comprise a plurality of expulsion blades (P), located at a second open end (H2), opposite to the first end (H1), which, by turning fixedly with respect to said drum (C), are designed to expel the bituminous aggregates of larger size (B) separated from the bitumen.

4) The apparatus according to the preceding claim, characterized in that said mechanical means for transfer of the aggregates of smaller size (A) comprise a first screw conveyor (E1) with substantially horizontal axis, which, by turning on itself in the lower part of the tank (G), is designed to displace longitudinally the bituminous aggregates of smaller size (A), together with a solvent/bitumen mixture (M1).

5) The apparatus according to the preceding claim, characterized in that it further comprises a collection chamber or well (R), which, adjacent to said second end (H2) of the drum (C), is designed to receive the bituminous aggregates of smaller size (A), which are made to advance by the screw conveyor (E1) along with the solvent/bitumen mixture (M1).

6) The apparatus according to the preceding claim, characterized in that said second means for expulsion comprise a second screw conveyor (E2) with substantially vertical axis, designed to draw from said well (R) and to expel the aggregates of smaller size (A) separated from the bitumen that are present in the well (R) itself.

7) The apparatus according to the preceding claim, characterized in that said means for separation of the bitumen from the solvent comprise a distiller (D), designed to separate the bitumen from the solvent contained in the mixture (M1).

8) The apparatus according to the preceding claim, characterized in that it further comprises means of a known type for pumping the bitumen separated from the solvent outwards so as to be recovered.

9) The apparatus according to the preceding claim, characterized in that it comprises a water separator (W), which, being connected to the well R and to the distiller (D), is designed to separate from the solvent/bitumen mixture (M1) coming from said well (R) the water present in the mixture itself, so that the water will be made to exit outwards and the solvent/bitumen mixture (M1) without water will be sent into the distiller (D).

10) The apparatus according to the preceding claim, characterized in that said means for recovery of the solvent (L) comprise means (SC2), designed to cool down the vapours of the solvent of an air/vapour mixture (MAV) of the solvent coming from the distiller (D) so that the solvent will be re-condensed to be

recovered and re-introduced into the rotary drum (C).

11) The apparatus according to the preceding claim, characterized in that it comprises means (V1) for aspirating air (AIC) purified from the vapours of the solvent that are contained in the mixture (MAV) and introducing it into the rotary drum (C);

said rotary drum (C) and the tank (G) being enclosed in a container that is open at the first open end (H1) of the drum itself.

12. The apparatus according to the preceding claim, characterized in that said rotary drum (C) is equipped with a spiral interrupted in a number of points designed to favour the movement and advance of the bituminous aggregates that are introduced into the drum itself.

13. The apparatus according to Claim 9, characterized in that the water separator (W) is connected to the well (R) and to the distiller (D), respectively, by means of a first overflow pipe (T1) and a second pipe (T2); said first pipe (T1) being designed to enable passage of the solvent/bitumen mixture (M1) from the well (R) to the separator (W) and said second pipe (T2) being designed to enable passage of the solvent/bitumen mixture (M1) without water from said separator (W) to the distiller (D).

14. The apparatus according to the preceding claim, characterized in that the first pipe (T1) is positioned at such a height said as to guarantee that the level of the solvent/bitumen mixture (M1) will remain constant.

15. The apparatus according to Claim 13,

characterized in that the water that the separator (W) eliminates from the solvent/bitumen mixture (M1) is made to exit by means of a specially provided discharge pipe (T3).

16. The apparatus according to Claim 7, characterized in that the distiller (D) comprises a tank (S) equipped with a vertical separation wall (N) and a tube-nest heat exchanger (SC1), designed to separate the bitumen from the solvent/bitumen mixture (M1) coming from the well (R) so that the bitumen separated from the solvent comes to settle on the bottom of the tank (S) and will be rendered fluid by the heat coming from the tube nest; there being introduced into said tank (S) both the solvent/bitumen mixture (M1) that arrives from the well (R) and a flow of air (AID) coming from a conveyor (Z) set at the second end (H2) of the drum (C) and containing solvent vapours, whilst the air/vapour mixture (MAV) of the solvent comes out of the same distiller (D).

17. The apparatus according to the preceding claim, characterized in that in said tube-nest heat exchanger there flows diathermic oil at a temperature comprised between 140°C and 200°C, preferably approximately 200°C.

18. The apparatus according to Claim 10, characterized in that the means (SC2), designed to cool down the vapours of the solvent coming from the distiller (D) comprise an air/water heat exchanger, designed to function as cold battery; it thus being obtained that the solvent is re-condensed to be re-introduced into the rotary drum (C).

19. The apparatus according to the preceding claim, characterized in that the re-condensed solvent is re-introduced into the drum (C) by means of a purposely provided pipe for recovery of the solvent (T4).

20. The apparatus according to Claim 11, characterized in that the means (V1) for aspiration of the vapours of the solvent comprise a centrifugal suction fan, which is set downstream of the air/water heat exchanger to prevent the solvent vapours from possibly being damaged.

21. The apparatus according to Claims 19 and 20, characterized in that provided on said pipe (T4) for recovery of the solvent is a siphon designed to function as plug to prevent the negative pressure created by the centrifugal suction fan from preventing outflow thereof.

22. The apparatus according to Claim 20, characterized in that the air aspirated by the fan (V1) is re-introduced into the rotary drum (C) by means of a pipe positioned at the inlet of the drum itself.

23. The apparatus according to any one of the preceding claims, characterized in that it comprises:

- a conveyor belt (N), designed to introduce said bituminous aggregates of various size into said rotary drum (C);
- means designed to detect saturation of the liquid solvent (L) and to send a saturation signal when the liquid solvent (L) reaches a pre-set level of saturation; and
- means designed to receive said saturation signal

and to introduce clean liquid solvent (L) into said rotary drum (C).

24. The apparatus according to the preceding claim, characterized in that the clean liquid solvent (L) is introduced into the rotary drum (C) by means of a further purposely provided pipe (T5).

25. The apparatus according to the preceding claim, characterized in that the means designed to detect saturation of the liquid solvent and to send the rotation signal comprise an optical probe; said optical probe being designed to be positioned in the well (R) and connected to a PLC.

26. The apparatus according to the preceding claim, characterized in that the means designed to receive the saturation signal and to introduce clean liquid solvent (L) into the rotary drum (C) comprise a pump; said pump being designed to be connected between a tank for storage of the solvent and said further purposely provided pipe (T5) and being controlled by a level switch to keep the level of solvent constant in the apparatus.

27. The apparatus according to Claim 23, characterized in that said conveyor belt (N) is equipped with a plurality of load cells in order to perform the role of dispenser; said load cells keeping the amount of product to be processed constant, regulating the speed of the conveyor belt (N) itself.

28. The apparatus according to any one of the preceding claims, characterized in that said liquid solvent (L) is one having a low boiling point, such as trichloroethylene, or any other chlorinated organic

solvent.

29. The apparatus according to Claim 15, characterized in that it comprises a pre-distillation section, designed to be connected to the water separator (W) and to the distiller (D), intercepting the pipe (T2) in two points (T2A, T2B), respectively downstream of said water separator (W) and upstream of said distiller (D), said pre-distillation section comprising:

- a heat exchanger (S2), designed to heat the mixture of liquid solvent (L) and bitumen that is drawn from the water separator (W) by means of a pump (P4) and introduced into said heat exchanger (S2);

- a heat exchanger (S3), designed to heat further the liquid-solvent/bitumen mixture that exits from the heat exchanger (S2) with the result that said mixture in part evaporates and in part is separated from the bitumen;

- a distillation tower (D'), which receives at inlet the vapour/liquid-solvent/bitumen mixture coming from the heat exchanger (S3) and is designed to re-introduce said mixture into the heat exchanger (S2) so that the mixture that traverses said heat exchanger (S2) is heated by the vapour coming from said distillation tower (D'); said distillation tower (D'), by working at a pressure lower than that of the heat exchanger (S3), enabling the mixture to continue to evaporate and the liquid part to precipitate towards the bottom of said distillation tower (D'), where a tube-nest heat exchanger (SC1') further separates the bitumen from said mixture, which comes to settle on the

bottom and is rendered fluid by the heat coming from said tube nest to be introduced into the distiller (D), where the bitumen is separated completely from the perchloroethylene;

- a water-storage tank (SA), designed to receive the water that is drawn from the water separator (W) by means of a pump (P13) and introduced into said tank via the pipe (T3);

- an evaporative tower (TE), designed to cool down the vapour/liquid-solvent mixture that traverses a water/solvent heat exchanger (S1) by means of water that is drawn from a water-storage tank (SA) by means of a pump (P15) and then introduced into said heat exchanger (S1) itself by means of a pump (P5); said evaporative tower (TE) re-condensing the liquid solvent; the water at outlet from said heat exchanger (S1) being re-introduced into said evaporative tower (TE), whilst the re-condensed liquid solvent is introduced into the drum (C) via a pipe (T6), which connects said heat exchanger (S1) to the drum (C).

30. The apparatus according to the preceding claim, characterized in that an activated-carbon filter (F1) is provided at the inlet of the water tank (SA) in order to eliminate possible residue of liquid solvent bound to the water.

31. The apparatus according to Claim 29, characterized in that it moreover comprises means (QA, QB) for detaching by means of vibration the liquid solvent (L) respectively from the bituminous aggregates of smaller size (A) and from those of larger size (B).

32. The apparatus according to any one of Claims

29 onwards, characterized in that the liquid solvent (L) is one having a high boiling point, such as perchloroethylene or tetrachloroethylene.

33. The apparatus according to any one of the preceding claims, characterized in that the liquid solvent (L) has a low specific heat.

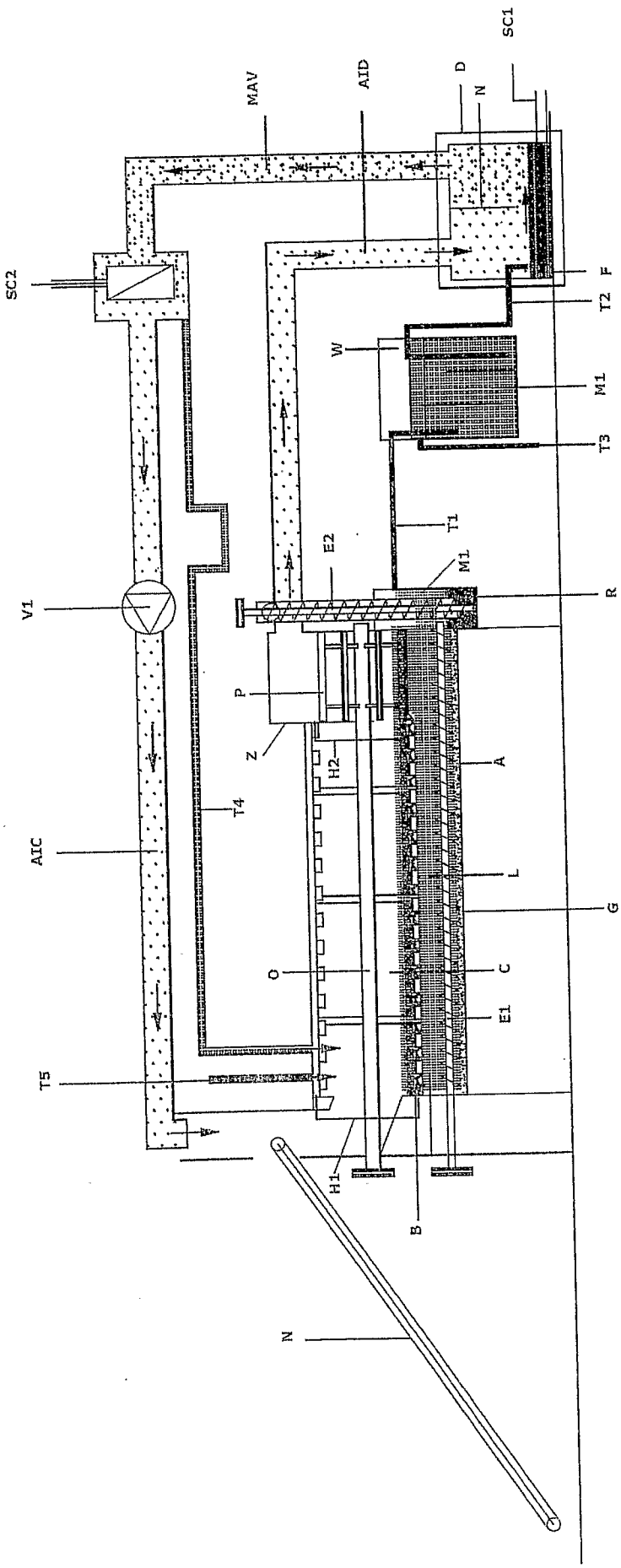
SC1
MAV
AID
D
N
SC2
F
T2
W
M1
T3
T1
E2
M1
V1
R
P
Z
H2
A
T4
AIC
L
G
O
C
E1
T5
H1
B
N

FIG. 1

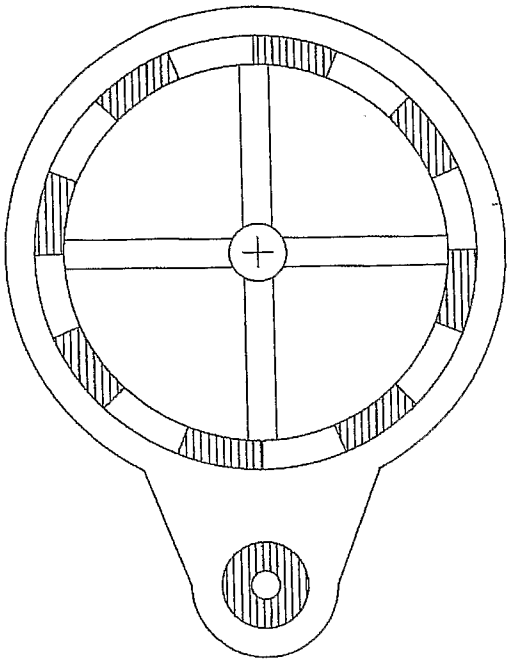

FIG. 2

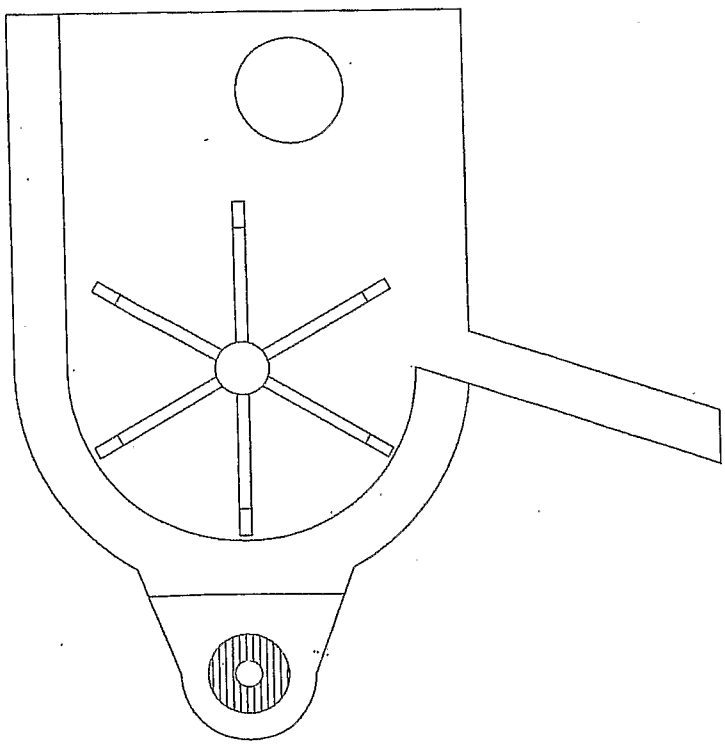

FIG. 3

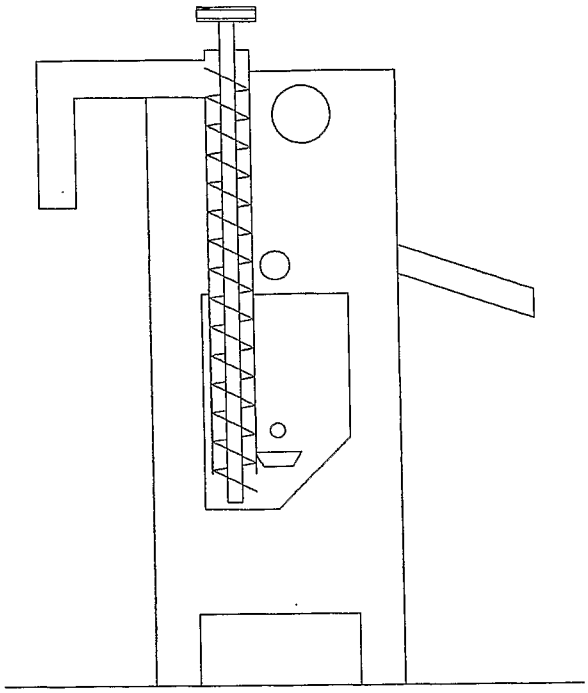

FIG. 4

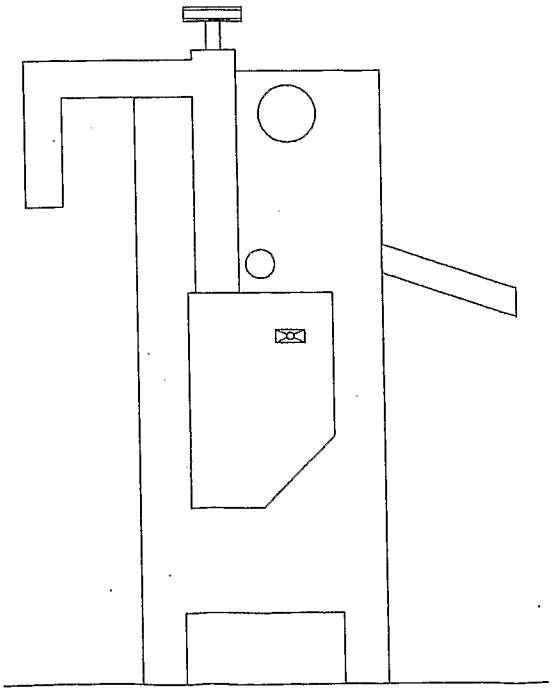

FIG. 5

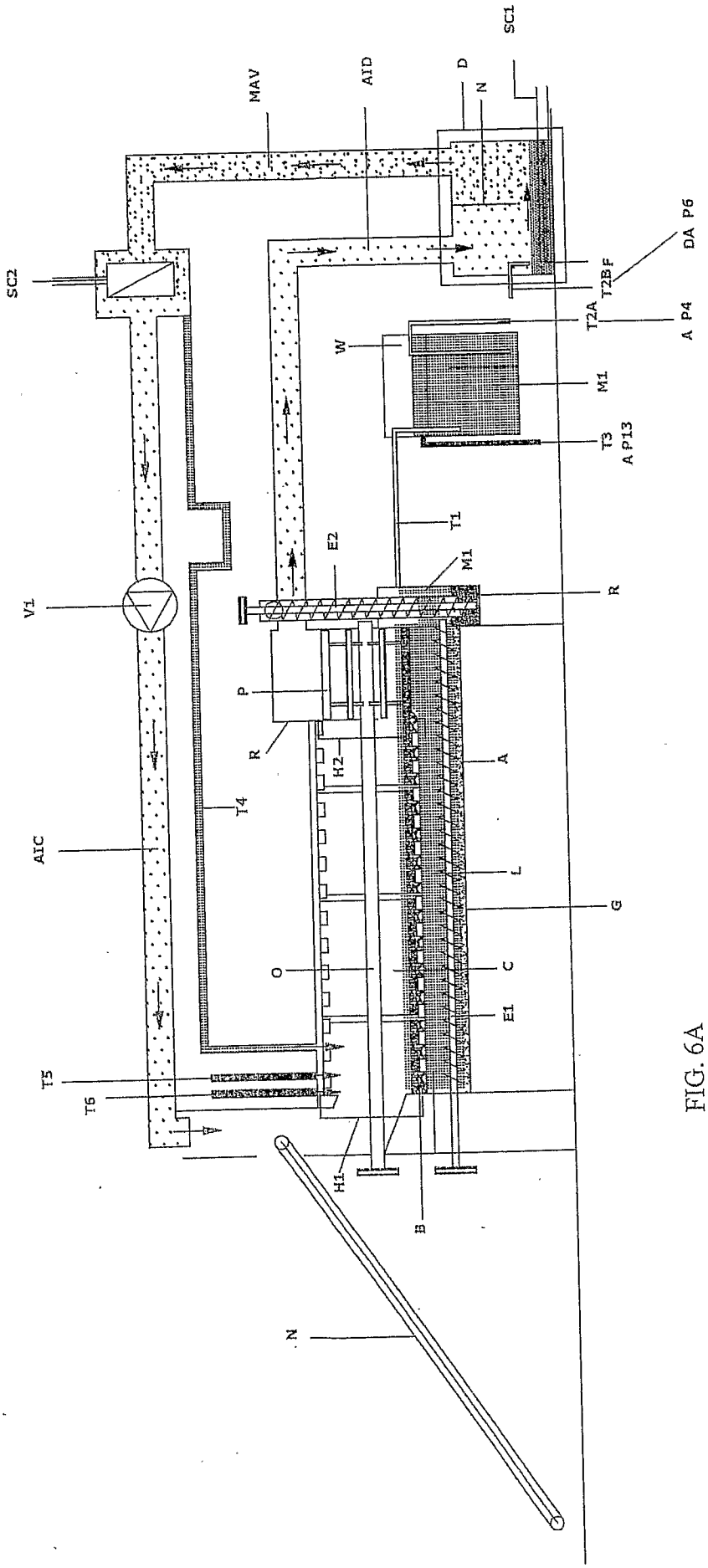
SC1
MAV
AID
D
N
DA P6
SC2
T2BF
T2A
A P4
W
M1
T3
A P13
T1
E2
M1
V1
R
P
R
H2
A
T4
AIC
L
G
O
C
E1
T5
T6
H1
B
N

FIG. 6A

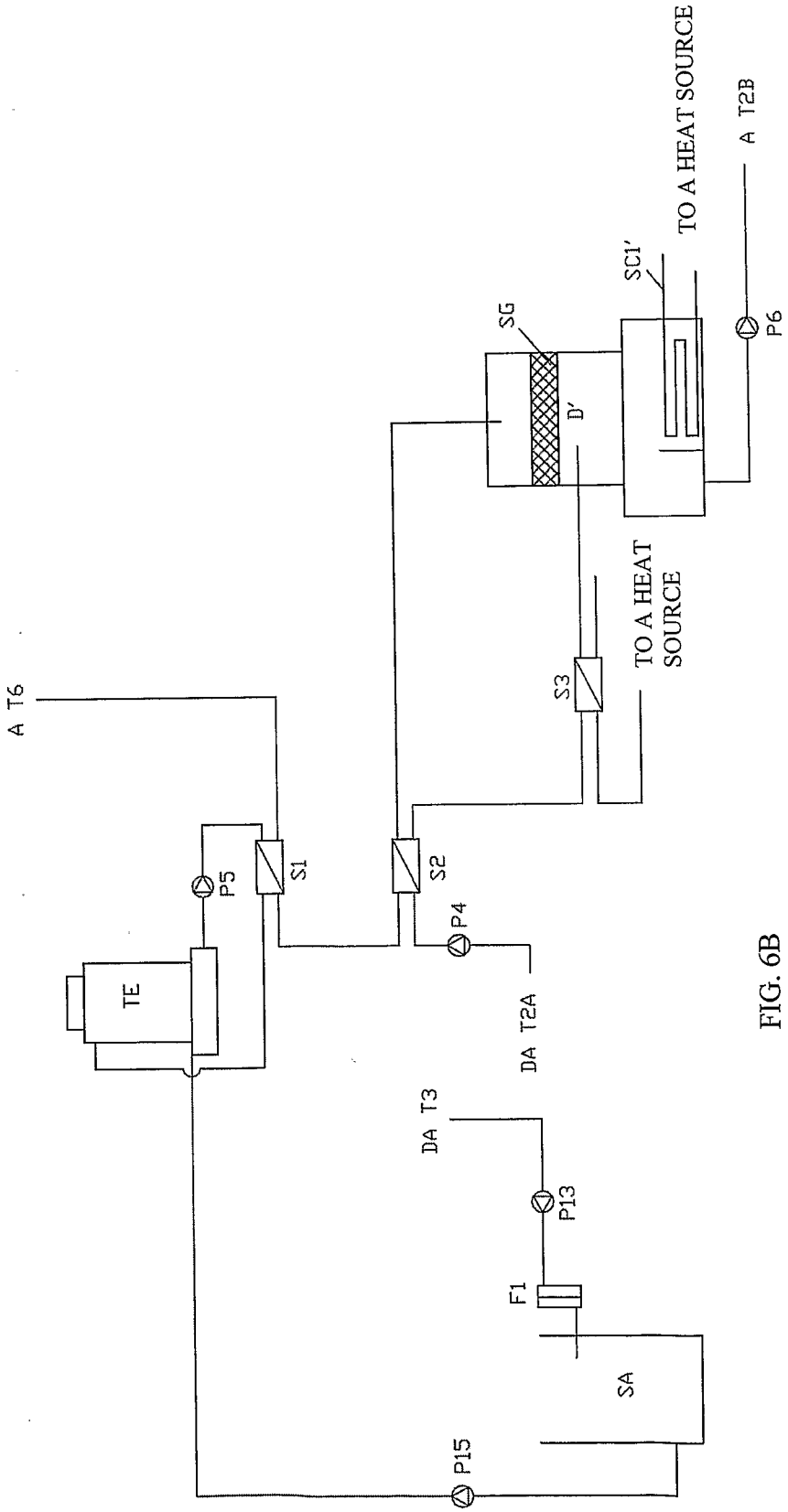
A T6
S1
P5
TE
S2
P4
DA T2A
DA T3
P13
F1
SA
P15
S3
TO A HEAT SOURCE
SG
D'
SC1'
TO A HEAT SOURCE
A T2B
P6

FIG. 6B

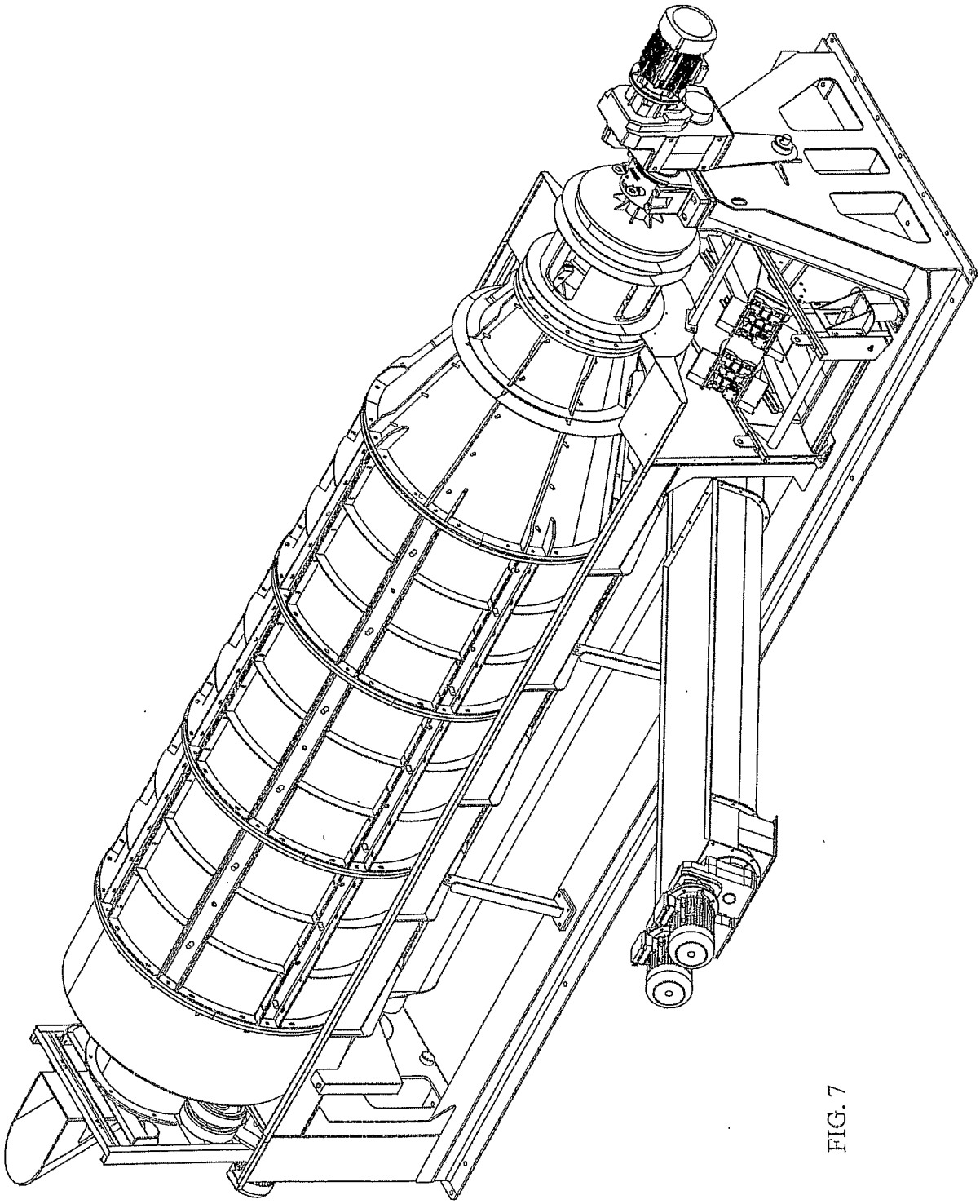

FIG. 7

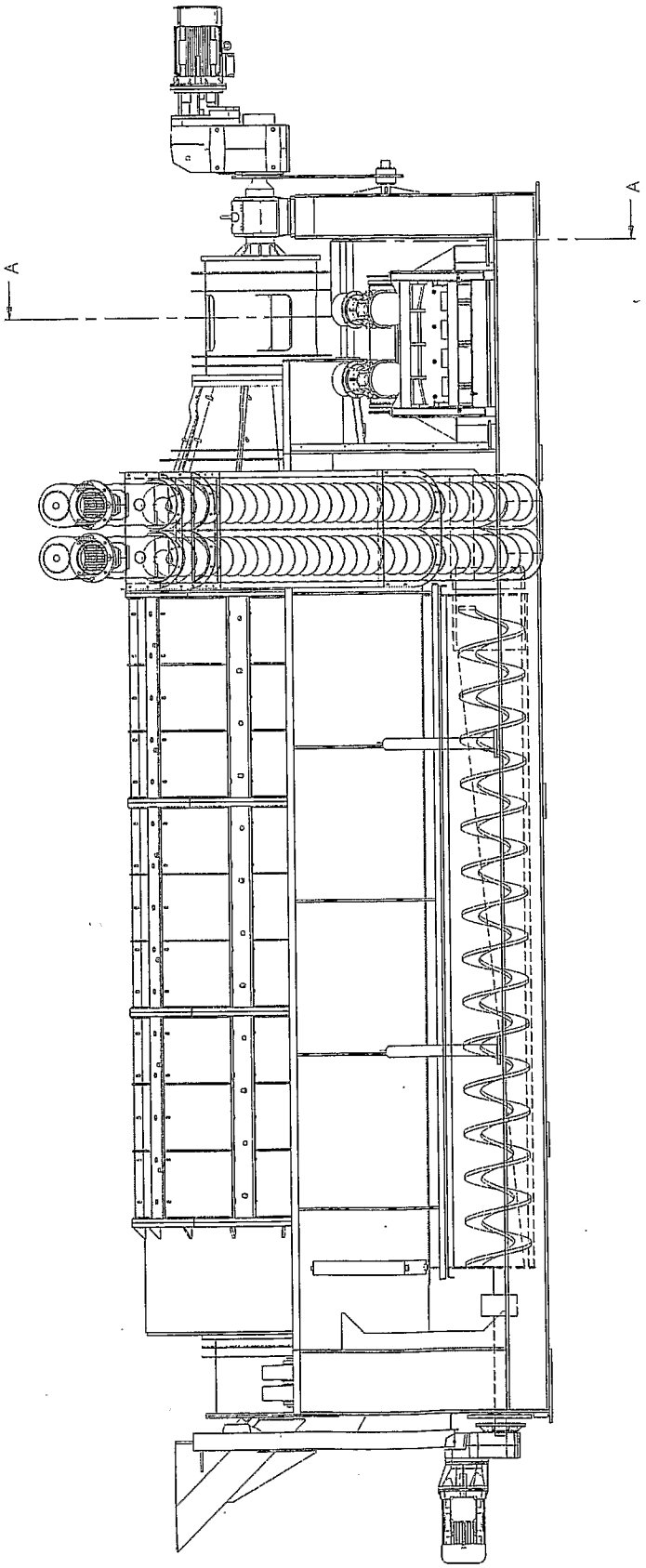

FIG. 8

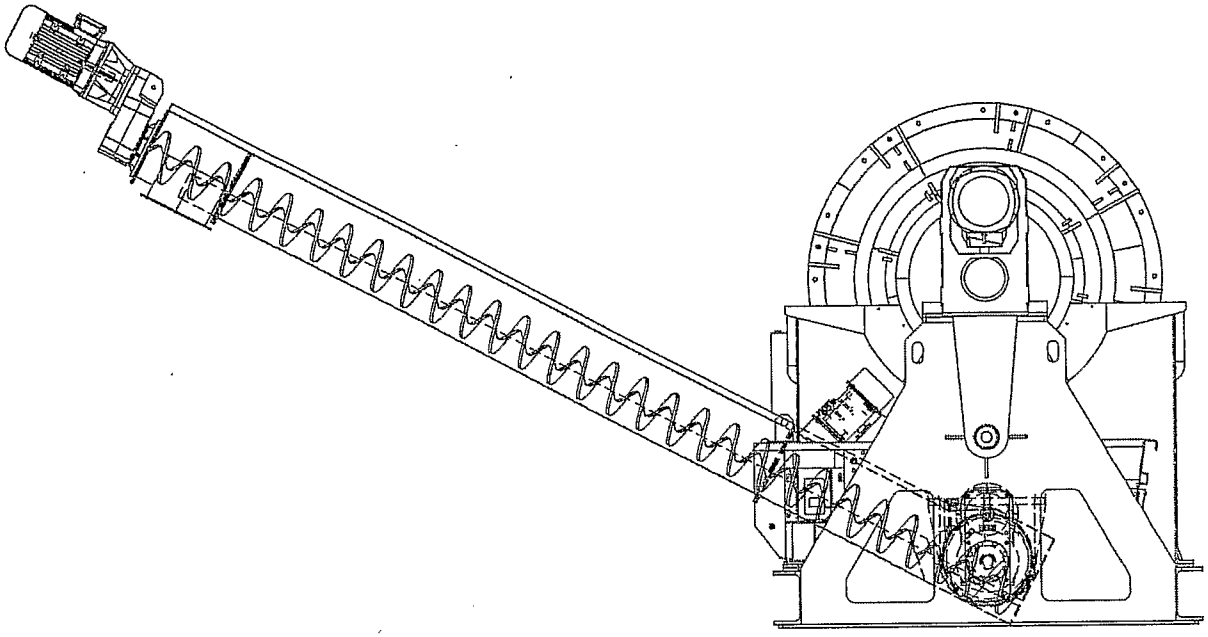

FIG. 9

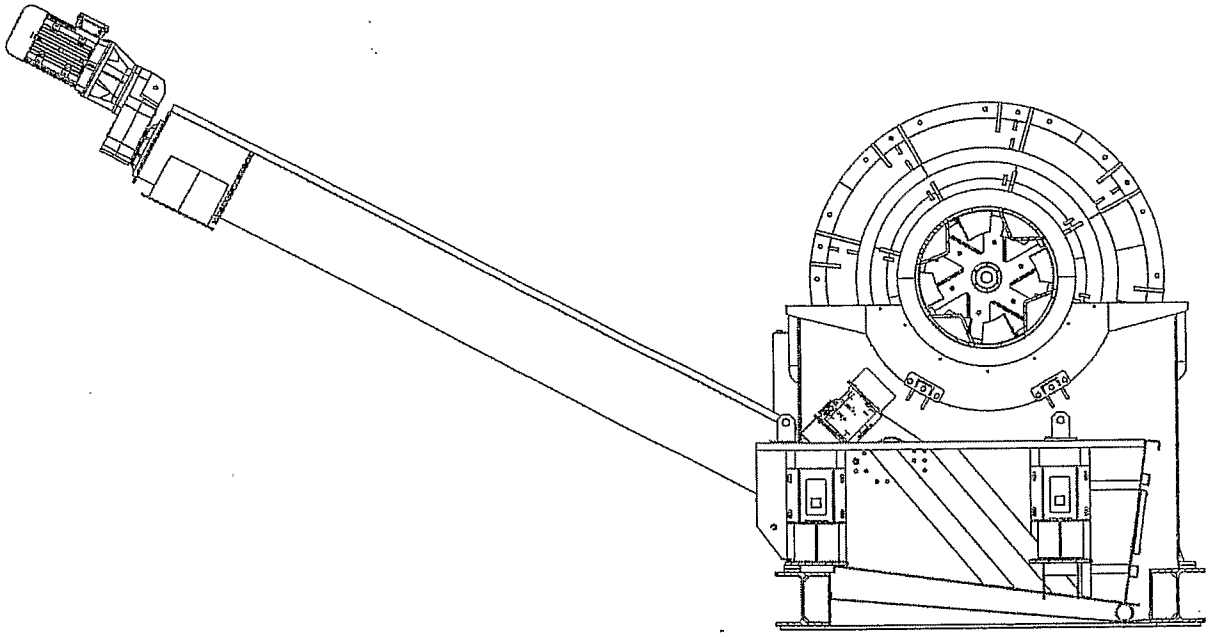

FIG. 10

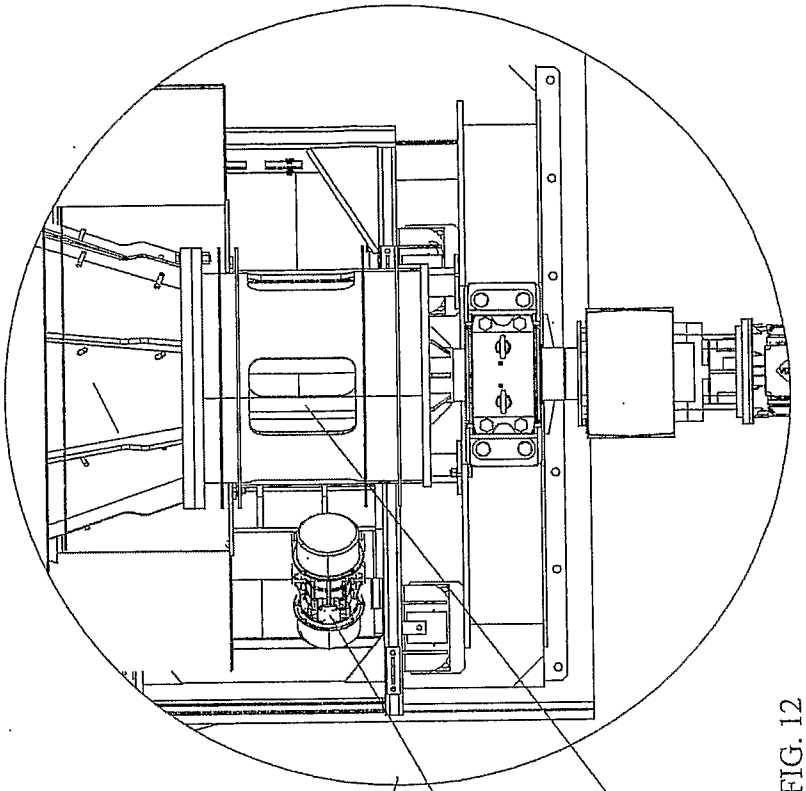

FIG. 12

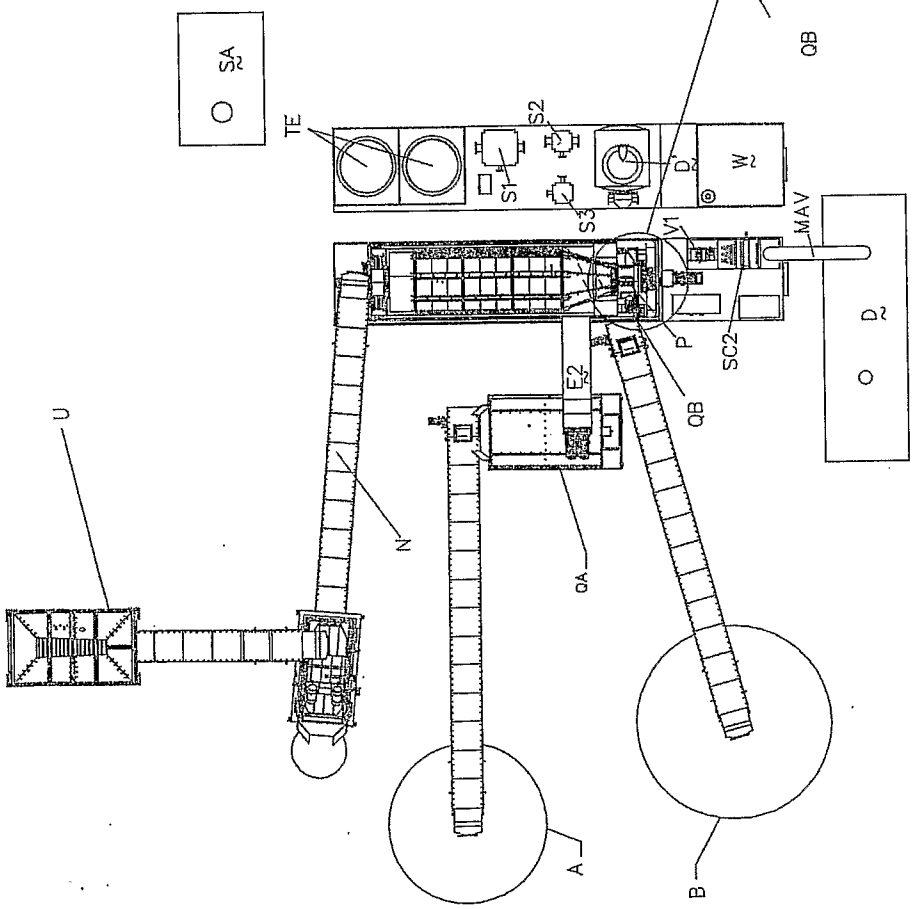

FIG. 11