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- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
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(54) Title: METHOD FOR SCRUBBING GAS IN A CASCADE-TYPE WET SCRUBBER AND A CASCADE SCRUBBER

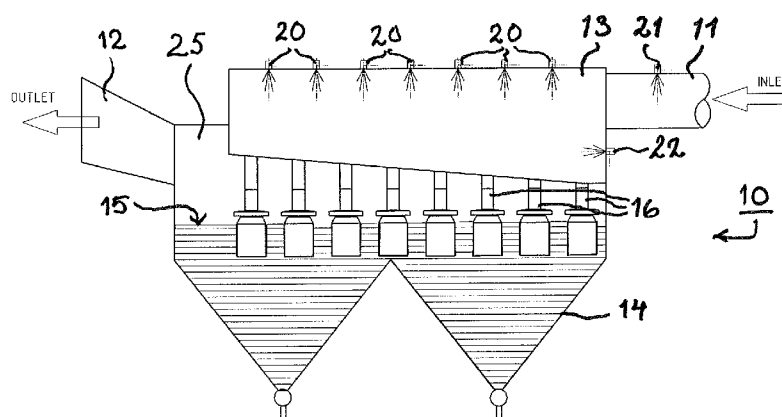


Fig. 1

(57) Abstract: The present invention relates to a method for scrubbing gas in a cascade-type wet scrubber. In the method gas to be cleaned and containing dust and fine impurities is led into a gas distribution chamber (13) of the cascade scrubber (10) through an inlet channel (11). From the gas distribution chamber (13) the gas is led downward through vertical cascade tubes (16) to a water tank (14) from which the purified gas is led to a droplet separator. According to the invention pressurized washing liquid is sprayed through spray nozzles (20, 21, 22) to the gas to be cleaned before and/or after said gas is discharged from the cascade tubes (16). The present invention relates also to a cascade scrubber (10).

Method for scrubbing gas in a cascade-type wet scrubber and a cascade scrubber

5 TECHNICAL FIELD OF THE INVENTION

The present invention relates to a method for scrubbing gas in a cascade-type wet scrubber.

10 Further, the invention relates to a cascade scrubber utilizing the method.

BACKGROUND ART

15 The operating principle of a cascade scrubber is known in prior art. Gas containing dust and fine impurities shall be cleaned and scrubbed and it is led into a gas distribution chamber in the upper section of the cascade scrubber. A tank or reservoir containing gas
20 scrubbing water is arranged below the gas distribution chamber in the lower section of the cascade scrubber. The gas scrubbing water is discharged from the bottom or lower part of the tank. Vertical cascade tubes are arranged in the cascade scrubber, and each of said
25 cascade tubes comprises an inner tube opening to the gas distribution chamber from below and extending downwards approximately onto the surface level of the water in the tank below the gas distribution chamber. An outer tube is arranged around the lower portion of
30 the inner tube, and said outer tube is immersed in the water so that the upper end of the outer tube extends a short distance above the water level. The outer tube

is open in both directions, i.e. upwards and downwards, and the upper end of the outer tube is bent inwards at a short distance. The outer tube is fixed to the inner tube and at a short distance above the outer
5 tube there is a cover fixed on the inner tube.

From the gas distribution chamber the gas can flow only into vertical cascade tubes connected to said gas distribution chamber. The gas is discharged at a high
10 velocity from the inner tube into the water in the tank and the gas pushes the water surface downwards in the outer tube in a pit. When the gas impacts onto the water surface at a high velocity, heavier particles contained by the gas will be mixed with water and they
15 will drop to the bottom of the tank. The gas which is supplied by high pressure will take along water from the inside of the outer tube, whereby water follows the gas flow upwards, impacts on the cover and when it flows off from below the cover edge an annular water
20 curtain is formed through which the gas is made to flow, so that water will further take along smaller particles from the gas. The gas which has gone under the cover and through the water curtain is scrubbed gas. Gas will be collected into a space for purified
25 gas and from there it is supplied to a duct and through a droplet separator to a fan.

Relating to prior art cascade scrubbers reference is made to publications WO 01/23071 A1 and WO 2009/153404
30 A1.

Cascade scrubbers are used e.g. to clean gases from a sintering furnace, a sintering plant or a pelletizing plant. Plant dust is collected from areas where dry materials, mainly sintered pellets are handled. On
5 some occasions it has been noted that the dust content in the plant gas is high and the particle size of the dust is very fine resulting in weaker separation efficiency of the cascade scrubber. Moving dust causes wear when coming into contact with structures and one
10 considerable problem has specifically related to the removal of general dusts. The particle size of general dusts is very fine and these dusts are not actual process dusts. These dusts are formed e.g. when pellets are ground on a conveyor. This fine dust must be re-
15 moved so that it does not get to the environment. Environmental requirements are all the time becoming tighter and tighter and the dust contents of gases must be kept within the set environmental limits.

20 SUMMARY OF THE INVENTION

The object of the present invention is to provide a method for improving the cleaning efficiency of a cascade scrubber. Further, an object of the invention is
25 to provide an efficient cascade scrubber using the method. The objects of the invention are achieved by the method and cascade scrubber characterized in the appended claims.

30 In the new method gas to be cleaned and containing dust and fine impurities is led into a gas distribution chamber of a cascade scrubber through an inlet

channel and from the gas distribution chamber downward through vertical cascade tubes to a water tank from which the purified gas is led through an outlet channel to a droplet separator. In the cascade scrubber
5 pressurized washing liquid is sprayed through spray nozzles to the gas to be cleaned before and/or after said gas is discharged from the cascade tubes.

The new cascade scrubber comprises a gas distribution
10 chamber into which gas containing dust and fine impurities is led through an inlet channel, a water tank arranged below the gas distribution chamber, vertical cascade tubes extending from the bottom of the gas distribution chamber and through which cascade tubes
15 the gas is led from the gas distribution chamber to the water tank, and an outlet channel through which the gas is led to a droplet separator. The cascade scrubber is equipped with spray nozzles through which pressurized washing liquid is sprayed to the gas to be
20 cleaned before and/or after said gas is discharged from the cascade tubes.

According to one aspect of the invention, spray nozzles are arranged in the cascade tubes for spraying
25 washing liquid downward in said cascade tubes.

According to another aspect of the invention, spray nozzles are arranged on the walls of the gas distribution chamber for spraying washing liquid into said gas
30 distribution chamber.

Additional spray nozzles can be arranged in the inlet channel for spraying washing liquid into the gas before said gas enters the gas distribution chamber.

5 Spray nozzles can also be arranged in the gas space of the water tank and/or in the outlet channel for spraying washing liquid into the gas before said gas is discharged from the scrubber.

10 Several advantages over prior art are attainable by the present invention. In the invention the dust separation efficiency has been improved by installing spray nozzles in the cascade scrubber, said spray nozzles spraying a pressurized washing liquid to the gas
15 to be cleaned. By this arrangement at least the following advantages are attainable. Additional scrubbing stage is performed by means of nozzles. Thereby, the performance of the scrubber is ensured. The nozzles are easy to replace if wearing or clogging of nozzles
20 is occurred and thus there is no need to open the scrubber for maintenance. This will reduce downtime for maintenance. Due to the enlarged gas distribution chamber a more uniform gas flow profile will be achieved, reducing wearing inside the scrubber itself.
25 Advantages include a simple design, no moving parts and a wide range of spray coverage.

Further advantages, characteristic features and embodiments of the invention will come out in more detail
30 in the following description of the invention, in which the invention is described by way of examples with reference to the accompanying drawing figures.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic view of the first embodiment of
5 the inventive method and cascade scrubber.

Fig. 2 is a schematic view of another embodiment of
the inventive method and cascade scrubber.

10 Fig. 3 shows a detail from Fig. 1 in a greater scale.

DESCRIPTION OF THE EMBODIMENT OF THE INVENTION

In Fig. 1 the inventive cascade scrubber is generally
15 denoted with reference numeral 10 and in the corresponding way in Fig. 2 with reference numeral 10a. The cascade scrubber 10, 10a comprises a gas distribution chamber 13 in the upper section of the cascade scrubber. Gas containing dust and fine impurities is led
20 into said gas distribution chamber 13 through an inlet channel 11. A water tank 14 is arranged below the gas distribution chamber 13 in the lower section of the cascade scrubber 10, 10a. Vertical cascade tubes 16 are arranged in the cascade scrubber 10, 10a, said
25 cascade tubes 16 extending from the bottom of the gas distribution chamber 13 into the tank 14. The structure of the cascade tubes 16 is shown in a more detailed manner in Fig. 3.

30 Each of said cascade tubes 16 comprises an inner tube 17 opening to the gas distribution chamber 13 from below and extending downwards approximately onto the wa-

ter level 15 in the tank 14 below the gas distribution chamber 13. An outer tube 18 is arranged around the lower portion of the inner tube 17, and said outer tube 18 is immersed in the water, so that the upper
5 end of the outer tube 18 extends a short distance above the water level 15. The outer tube 18 is open in both directions, i.e. upwards and downwards, and the upper end of the outer tube 18 is bent inwards at a short distance. The outer tube 18 is fixed to the in-
10 ner tube 17 and at a short distance above the outer tube 18 a cover 19 is fixed on the inner tube 17.

So gas flows from the gas distribution chamber 13 downwards into the vertical cascade tubes 16 and the
15 gas is discharged at a high velocity from the inner tube 17 into the water in the tank 14. The gas pushes the water surface downwards in the outer tube 18 in a pit. When the gas impacts onto the water surface at a high velocity, heavier particles contained by the gas
20 will be mixed with water and they will drop to the bottom of the tank 14. The gas which is supplied by high pressure will take along water from the inside of the outer tube 18, whereby water follows the gas flow upwards, impacts on the cover 19 and when it flows off
25 from below the edge of the cover 19 an annular water curtain is formed through which the gas is made to flow. Thereby the water will further take along smaller particles from the gas. The gas which has gone under the cover 19 and through the water curtain is
30 scrubbed gas. Gas will be collected into a space 25 for purified gas and from there it is supplied through an outlet channel 12 to a droplet separator.

In the present invention, in order to improve the dust separation efficiency spray nozzles 20, 21, 22, 23, 24 have been installed in the cascade scrubber 10, 10a.

5 Said spray nozzles 20, 21, 22, 23, 24 are used to spray a pressurized washing liquid to the gas to be cleaned. Nozzle pressure should preferably be in the area of 3 to 30 bars. Naturally, the nozzle pressure should be selected according to the circumstances. In

10 the embodiment according to Fig. 2, spray nozzles 23 are installed inside the cascade tubes 16. A pressurized washing liquid is sprayed vertically downward in the cascade tubes 16. Further spray nozzles 24 are installed in the gas space 25 of the water tank 14 and

15 in the outlet channel 12. In order to enhance the dust separation efficiency, further spray nozzles can be arranged also in the inlet channel 11 and at least on one wall of the gas distribution chamber 13.

20 In the embodiment according to Fig. 1, spray nozzles 20, 22 are installed on the walls of the gas distribution chamber 13. An advantage of this embodiment is that the enlarged gas distribution chamber 13 provides more retention time for drops to collide with dust

25 particles and gas distribution is also more uniform in the chamber 13, thereby reducing wearing inside the scrubber 10. In this embodiment the spray nozzles 20, 22 are easy to replace if wearing or clogging of nozzles is occurred, whereby there is no need to open the

30 scrubber 10 for maintenance. Also in this embodiment the inlet channel 11, the gas space 25 and the outlet channel 12 can be equipped with spray nozzles 21, 24.

Above, the invention has been described by way of examples with reference to the exemplifying embodiment illustrated in the accompanying drawing. The invention
5 is, however, not confined to the exemplifying embodiment shown in the drawing alone, but the invention may vary within the scope of the inventive idea defined in the accompanying claims.

CLAIMS

1. Method for scrubbing gas in a cascade-type wet
5 scrubber, in which method gas to be cleaned and containing dust and fine impurities is led into a gas distribution chamber (13) of the cascade scrubber (10, 10a) through an inlet channel (11) and from the gas distribution chamber (13) downward through vertical
10 cascade tubes (16) to a water tank (14) from which the purified gas is led through an outlet channel (12) to a droplet separator, characterized in that in the cascade scrubber (10, 10a) pressurized washing liquid is sprayed through spray nozzles (20, 21, 22, 23, 24)
15 to the gas to be cleaned before and/or after said gas is discharged from the cascade tubes (16).
2. Method as claimed in claim 1, characterized in that washing liquid is sprayed vertically downward in
20 the cascade tubes (16).
3. Method as claimed in claim 1, characterized in that washing liquid is sprayed to the gas inside the gas distribution chamber (13).
- 25 4. Method as claimed in any of the preceding claims, characterized in that washing liquid is additionally sprayed to the gas in the inlet channel (11) before the gas enters the gas distribution chamber (13).
- 30 5. Method as claimed in any of the preceding claims, characterized in that washing liquid is sprayed to

the gas in the gas space (25) of the water tank (14) and/or in the outlet channel (11).

6. Method as claimed in any of the preceding claims, characterized in that washing liquid is sprayed to the gas with a nozzle pressure of 3 to 30 bars.

7. Cascade scrubber for scrubbing gas, said cascade scrubber (10, 10a) comprising a gas distribution chamber (13) into which gas containing dust and fine impurities is led through an inlet channel (11), a water tank (14) arranged below the gas distribution chamber (13), vertical cascade tubes (16) extending from the bottom of the gas distribution chamber (13) and through which cascade tubes (16) the gas is led from the gas distribution chamber (13) to the water tank (14), and an outlet channel (12) through which the gas is led to a droplet separator, characterized in that the cascade scrubber (10, 10a) is equipped with spray nozzles (20, 21, 22, 23, 24) through which pressurized washing liquid is sprayed to the gas to be cleaned before and/or after said gas is discharged from the cascade tubes (16).

8. Cascade scrubber as claimed in claim 7, characterized in that spray nozzles (23) are arranged in the cascade tubes (16) for spraying washing liquid downward in said cascade tubes (16).

9. Cascade scrubber as claimed in claim 7, characterized in that spray nozzles (20, 22) are arranged on the walls of the gas distribution chamber (13) for

spraying washing liquid into said gas distribution chamber (13).

10. Cascade scrubber as claimed in any of claims 7-9,
5 characterized in that additional spray nozzles (21) are arranged in the inlet channel (11) for spraying washing liquid into the gas before said gas enters the gas distribution chamber (13).

10 11. Cascade scrubber as claimed in any of claims 7-10, characterized in that spray nozzles (24) are arranged in the in the gas space (25) of the water tank (14) and/or in the outlet channel (12) for spraying washing liquid into the gas before said gas is dis-
15 charged from the scrubber (10a).

12. Cascade scrubber as claimed in any of claims 7-11, characterized in that the nozzle pressure of the spray nozzles (20, 21, 22, 23, 24) is set to 3 to 30
20 bars.

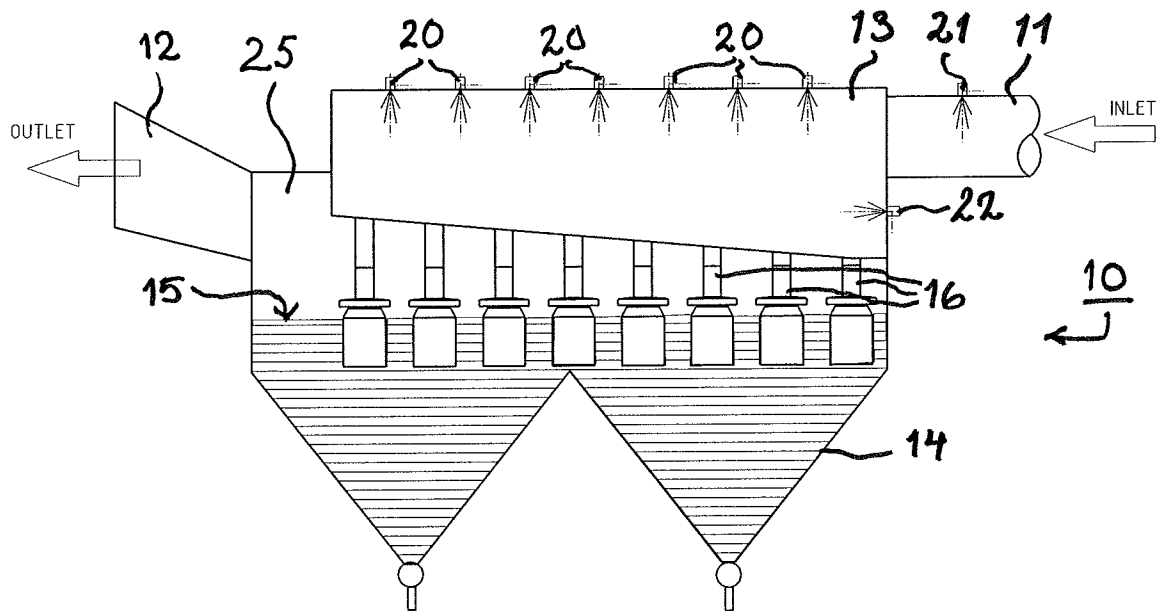


Fig. 1

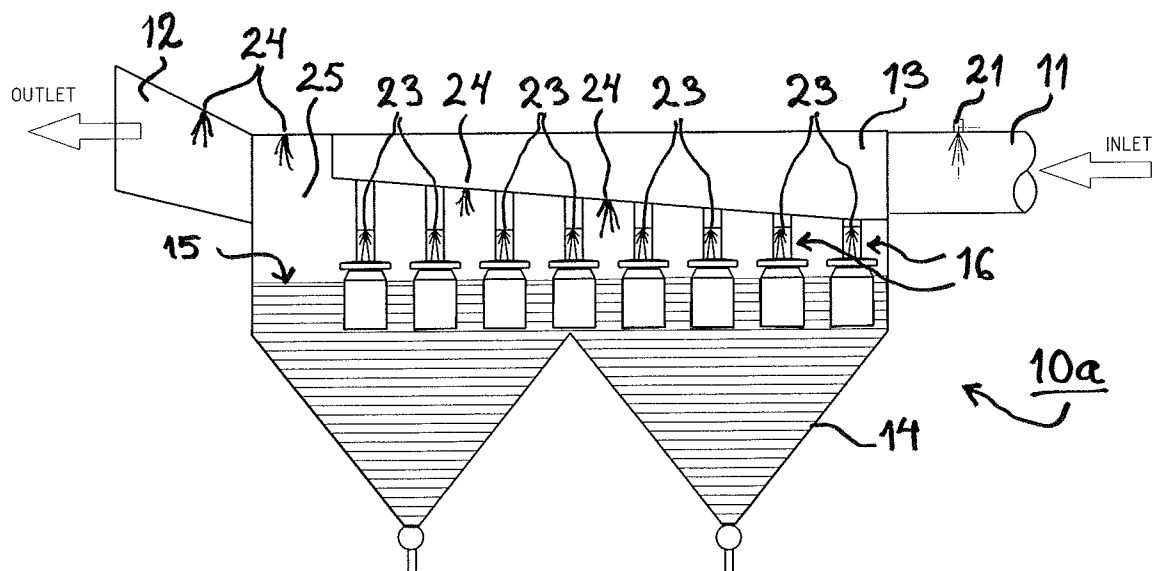


Fig. 2

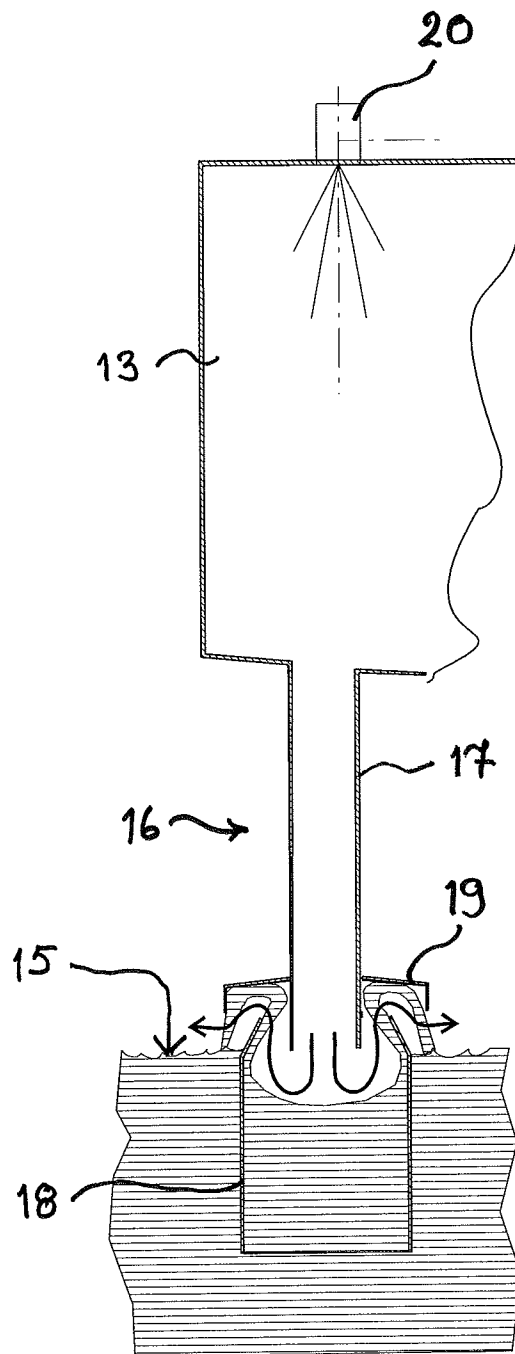


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI2013/051188

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
FI, SE, NO, DK

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3881898 A (DARBY KENNETH et al.) 06 May 1975 (06.05.1975) the whole document, especially column 2, line 10 – column 4, line 12; figure	1-12
X	WO 2009153404 A1 (OUTOTEC OYJ [FI]) 23 December 2009 (23.12.2009) the whole document, especially page 8, line 14 – page 12, line 11; page 13, lines 17-19; figures 1, 2A, 3A, 5A, 5B cited in the application	1, 7
X	EP 0509521 A1 (OUTOKUMPU RESEARCH OY [FI]) 21 October 1992 (21.10.1992) the whole document, especially column 4, line 14 – column 6, line 42; figures 1, 4a, 5a, 5c	1, 7



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

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INTERNATIONAL SEARCH REPORT
Information on patent family members

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PCT/FI2013/051188

Patent document cited in search report	Publication date	Patent family members(s)	Publication date
US 3881898 A	06/05/1975	None	
WO 2009153404 A1	23/12/2009	FI 20080409 A FI 121409 B	20/12/2009 15/11/2010
EP 0509521 A1	21/10/1992	AU 1380992 A AU 652617 B2 CA 2066090 A1 CA 2066090 C DE 69201587 D1 DE 69201587 T2 DK 0509521 T3 EP 0509521 B1 FI 87541 B FI 87541 C US 5178653 A	22/10/1992 01/09/1994 20/10/1992 22/06/1999 13/04/1995 13/07/1995 06/06/1995 08/03/1995 15/10/1992 25/01/1993 12/01/1993

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