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(54) Antenna device of a base station of a mobile telecommunication network.

(57) An antenna device for a base station of a mobile telecommunication network, comprising at least two linear phased-array antennas, with the longitudinal direction of each phased-array antenna being directed at least substantially vertically, the at least three phased-array antennas being jointly accommodated in a tubular housing, with the longitudinal direction of the housing being directed at least substantially vertically. Because the phased-array antennas are jointly accommodated in a single tubular housing, the visual appearance of the antenna is experienced as particularly attractive. The antenna has the appearance of a mast and is therefore hardly noticeable. The housing functions as a radome. An additional advantage of the housing is that the phased-array antennas are protected from weather influences.

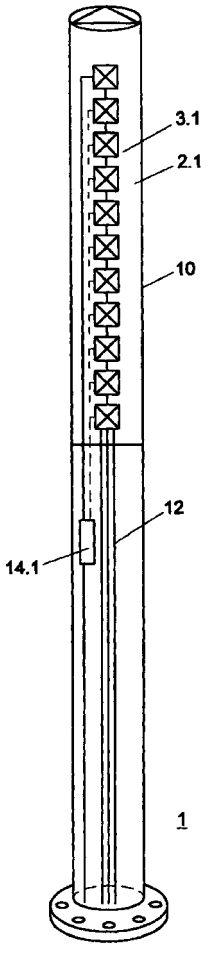

Fig. 2

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Description

[0001] This invention relates to an antenna device for a base station of a mobile telecommunication network, comprising at least two dual-polar phased-array antennas, the longitudinal direction of each phased-array antenna being directed at least substantially vertically.

[0002] Such an antenna device is known per se and is utilized inter alia in the GSM telecommunication network.

[0003] The known antenna device is often positioned on the roof of a building to enable coverage of the surroundings around the building. In particular, the antenna device comprises three phased-array antennas which are arranged at an angle of 120° relative to each other. Such a known, integrated high-gain cross-polarization antenna has, as such, good technical properties.

[0004] A disadvantage of the known antenna device, however, is that it is often experienced as visually unattractive. This makes it less and less easily acceptable that such an antenna device is positioned on top of a building. In particular when it is desired to direct the angle of elevation of the individual phased-array antennas over the horizon (zero degrees of elevation), the antenna device becomes visually unattractive in that the individual phased-array antennas must be directed upwards at an angle of about 6° with respect to the vertical. The angle which the longitudinal direction of a phased-array antenna makes with that vertical for a net zero degree elevation then corresponds to the angle which the antenna beam of the phased-array antenna makes with this antenna.

[0005] The object of the invention is to provide a solution to the problem outlined. The antenna device according to the invention is accordingly characterized in that the at least two phased-array antennas are jointly accommodated in a tubular housing, the longitudinal direction of the housing being directed at least substantially vertically.

[0006] Because the phased-array antennas are jointly accommodated in a single tubular housing, the visual appearance of the antenna is experienced as particularly attractive. The antenna has the appearance of a slender mast and is therefore hardly noticeable. The housing functions as a radome. An additional advantage of the housing is that the phased-array antennas are protected from weather influences.

[0007] Preferably, the antenna device is further characterized in that each phased-array antenna comprises a number of antenna elements arranged relative to each other in vertical direction.

[0008] More particularly, it further holds that the antenna device comprises at least one antenna beam forming unit which is electrically connected to the antenna elements of at least one of the phased-array antennas for processing in combination transmitted and/or received signals of the antenna elements, so that an antenna beam is formed when the phased-array antenna in question is used as a transmitting and/or receiving antenna, respectively.

[0009] In such a device, a very high gain for each phased-array antenna can be realized. According to a further aspect of the invention, the antenna beam forming unit includes means for electrically setting the elevation of the antenna beam. It is therefore not necessary, as in the known device, to mechanically set the longitudinal direction of the antenna array relative to the vertical for setting the elevation of the antenna beam. Instead, the vertical direction mentioned can be maintained unaltered. According to the invention, the elevation of the antenna beam is set in that, using the antenna beam forming unit, the phase relation of the above-mentioned transmitted and/or received signals relative to each other is regulated in a manner known per se.

[0010] Preferably, the antenna beam forming unit is accommodated in the housing and can be remotely controlled for the purpose of setting the angle of elevation of the phased-array antennas in question.

[0011] The invention will now be further elucidated with reference to the drawing, wherein:

Fig. 1 shows an elevational view of a possible embodiment of an antenna device according to the invention;
Fig. 2 shows a transparent view of the antenna device according to Fig. 1;
Fig. 3 shows a transparent top plan view of the antenna device according to Fig. 1;
Fig. 4a shows a side view of an antenna beam of one of the phased-array antennas of the antenna device according to Fig. 1;
Fig. 4b shows a side view of an antenna beam of one of the phased-array antennas of the antenna device according to Fig. 1;
Fig. 4c is a top plan view of the antenna beams of the phased-array antenna of the antenna device according to Fig. 1; and
Fig. 5 shows an alternative embodiment of an antenna device according to the invention.

[0012] In Figs. 1-3, reference numeral 1 designates an antenna device for a base station of a mobile telecommunication network. The mobile telecommunication network can consist, for instance, of a GSM network, known per se.

[0013] The antenna device comprises at least two dual-polar, also known per se under the name of cross-polar, phased-array antennas 2.i (i = 1, 2, 3, ...). In this example, the antenna device comprises three phased-array antennas 2.1, 2.2, 2.3. In this example, each phased-array antenna comprises a rectangular platelike support 4. The longitudinal direction of the platelike support 4, in use, is directed vertically. Mounted on the platelike support 4 are a number of antenna elements 6 arranged relative to each other in vertical direction. The

antenna elements 6 are designed as dipole elements, known per se. Further, on opposite sides of the dipole elements, reflector plates 8 are arranged. In this example, therefore, each phased-array antenna is built up from a support 4, dipole elements 6 and reflector plates 8.

[0014] The three phased-array antennas 2.1, 2.2 and 2.3 are arranged at an angle α of 120° relative to each other in the horizontal plane. The three phased-array antennas are jointly accommodated in a tubular housing 10. The longitudinal direction of the housing 10, in use, is directed at least substantially vertically. The housing 10 constitutes a radome for the three phased-array antennas and to that end is manufactured from a material which is known to be usable for a radome. In this example, the tubular housing has a circular cross section, as can be seen in Fig. 3. Accordingly, the tubular housing is in the form of a cylinder.

[0015] As can be seen in Fig. 2, each of the phased-array antennas 2.1, 2.2, and 2.3 is positioned on a mast 12. In this example, the mast 12 is also accommodated in the housing 10. This provides the advantage that, as appears from Fig. 1, the antenna device as a whole has the form of a tube or mast. As a consequence, the visual impact of the antenna device when placed on a building is exceedingly slight.

[0016] As is known per se, a linear array antenna which is vertically arranged has the property that it has an antenna beam which is relatively narrow in vertical direction and relatively wide in horizontal direction. For obtaining such an antenna beam, the received signals of each of the antenna elements of a phased-array antenna 2.i are applied via lines 13 to an antenna beam forming unit 14.i.

[0017] The antenna beam forming unit 14.i is known per se and will therefore not be elucidated in detail here. It is noted, however, that the received signals of the antenna elements 6 are processed in combination for obtaining the antenna pattern when the phased-array antenna is used as receiving antenna. To that end, the antenna beam forming unit 14.i comprises delay lines to combine the received signals with appropriate delays. In this example, the antenna beam forming unit is also suited to supply transmitting signals to the various antenna elements of the phased-array antenna 2.i. The mutual phase differences of the various signals that are supplied to the antenna elements are such that the antenna pattern has a desired elevation. This aspect of the antenna beam forming unit is also known per se and can be realized using delay lines and will therefore not be further explained. The antenna beam forming unit further comprises means for electrically setting and varying the elevation of the antenna beam. This can be realized by setting and varying the delay lines accordingly.

[0018] As shown in Fig. 4a, the longitudinal direction of a vertical cross section of the antenna beam can be directed horizontally. It is also possible that the antenna beam, using the beam forming unit, is set such that the longitudinal direction of the vertical cross section of the antenna pattern is directed slightly obliquely downwards, thereby including an angle β with the horizontal. The angle β can have a value of, for instance, about 6°. Of course, it is also possible that the antenna beam, instead of being directed downwards, as shown in Fig. 4b, is directed upwards. Preferably, the antenna beam forming unit includes means for remotely setting the elevation of the antenna beam. To that end, the antenna beam forming unit can be remotely controlled both via a wireless connection and via a wire connection. In this example, the antenna beam forming unit 14.i is accommodated in the housing 10.

[0019] Fig. 4c shows a horizontal cross section 18.i of the antenna beam 16.i of the phased-array antennas 2.i. As is quite apparent, each antenna pattern has a horizontal 3dB beam width greater than 65°. The consequence is that the entire surroundings are covered by the antenna device.

[0020] In this example, each phased-array antenna 2.i is electrically coupled to an associated beam forming unit 14.i. The elevations of the antenna beams of the various phased-array antennas can therefore be set independently of each other.

[0021] The invention is not in any way limited to the embodiments outlined hereinbefore. For instance, the mast 12 can also be formed by the housing 10 itself. In fact, the mast 12 in Fig. 2 can then be omitted. Also, it is possible for the antenna device not to have a mast at all. This situation is shown in Fig. 5. In this example, the antenna device is positioned on a construction 18. The construction 18 can, for instance, be a part of a building.

[0022] Such variants are understood to fall within the scope of the invention.

Claims

1. An antenna device for a base station of a mobile telecommunication network, comprising at least two dual-polar phased-array antennas, with the longitudinal direction of each phased-array antenna being directed at least substantially vertically, characterized in that the at least two phased-array antennas are jointly accommodated in a tubular housing, with the longitudinal direction of the housing being directed at least substantially vertically.

2. An antenna device according to claim 1, characterized in that each phased-array antenna comprises a number of antenna elements arranged relative to each other in vertical direction.

3. An antenna device according to claim 2, characterized in that the antenna device further comprises at least one antenna beam forming unit which is electrically connected to the antenna elements of at least one of the phased-array antennas for process-

ing in combination transmitting and/or received signals of the antenna elements, so that an antenna beam is formed when the at least one phased-array antenna in question is used as a transmitting and/or receiving antenna, respectively.

4. An antenna device according to claim 3, characterized in that the antenna beam forming unit comprises means for electrically setting the elevation of the antenna beam.

5. An antenna device according to claim 4, characterized in that the antenna beam forming unit comprises means for remotely setting the elevation of the antenna beam.

6. An antenna device according to any one of claims 3-5, characterized in that the antenna beam forming unit is accommodated in the housing.

7. An antenna device according to any one of claims 3-6, characterized in that each phased-array antenna is electrically connected to an antenna beam forming unit.

8. An antenna device according to any one of claims 3-7, characterized in that the beam width in horizontal direction is greater than the beam width in vertical direction.

9. An antenna device according to any one of the preceding claims, characterized in that the antenna device further comprises a mast on which the phased-array antennas are positioned.

10. An antenna device according to claim 9, characterized in that the mast is also accommodated in the housing.

11. An antenna device according to claim 9, characterized in that the mast is formed by the housing.

12. An antenna device according to any one of the preceding claims, characterized in that the antenna device comprises three phased-array antennas which are arranged at an angle of 120 degrees relative to each other in the horizontal plane.

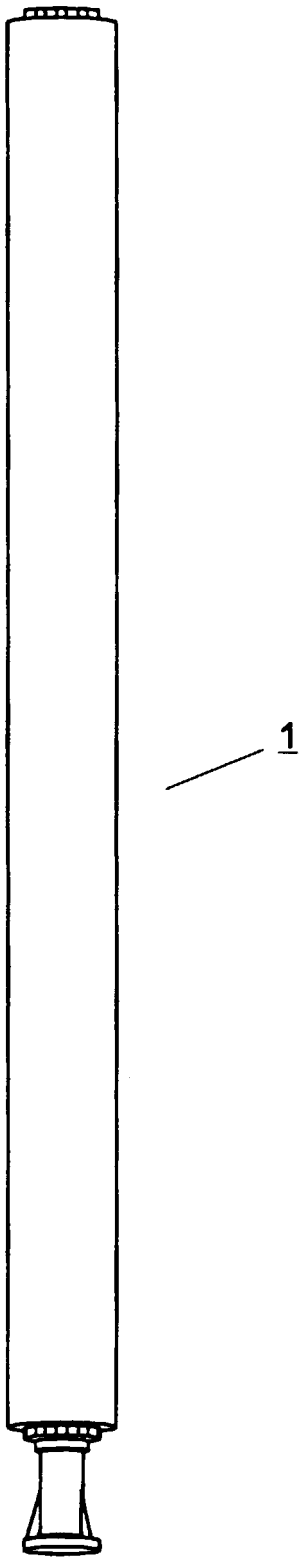


Fig. 1

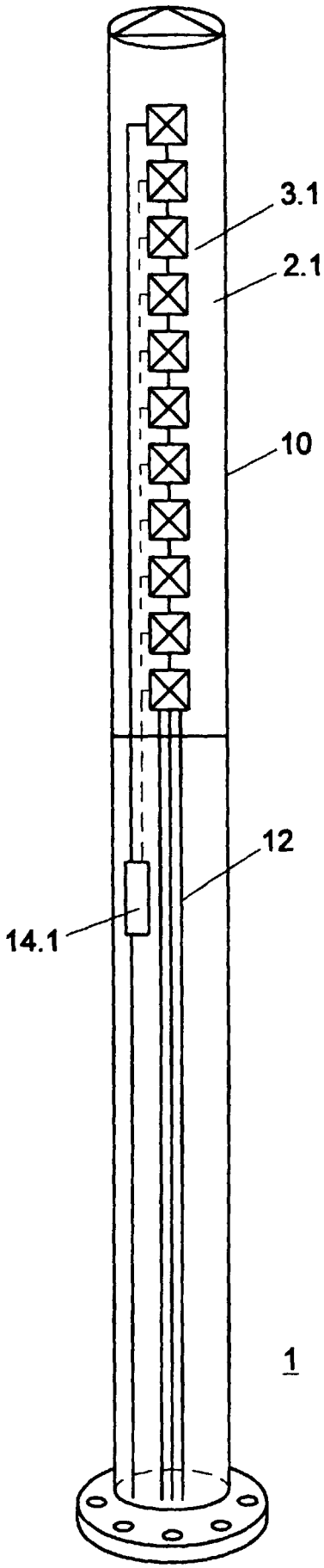
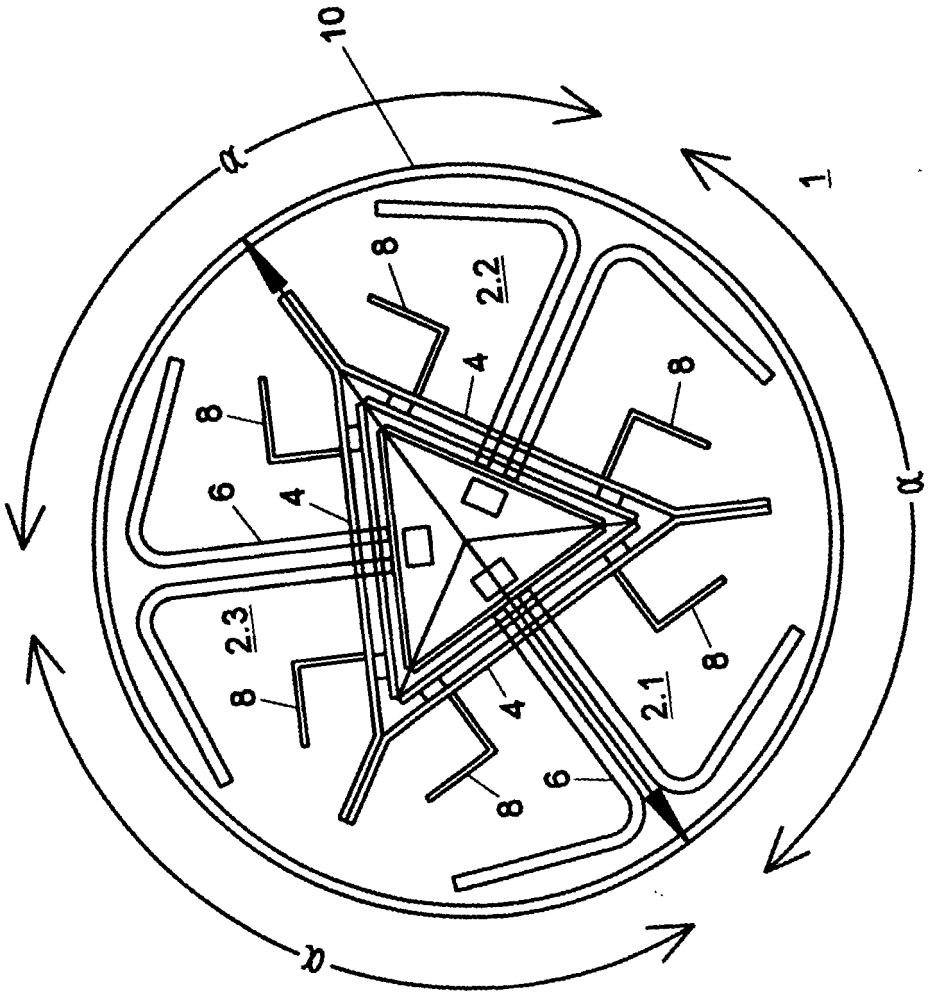


Fig. 2

Fig. 3



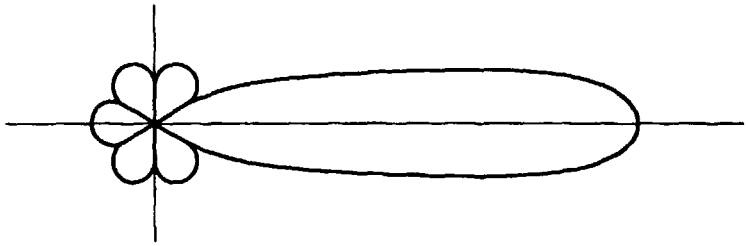


Fig. 4a

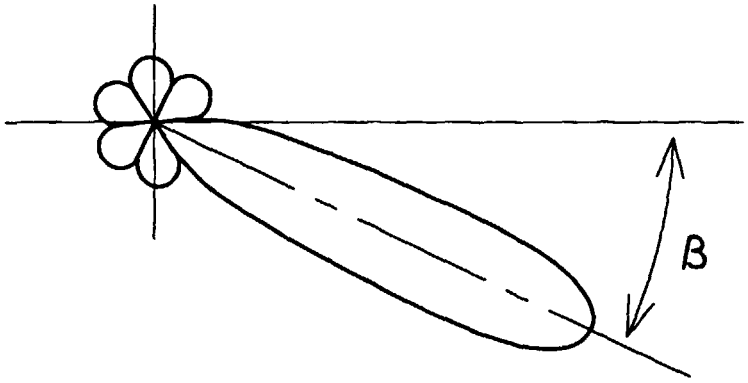


Fig. 4b

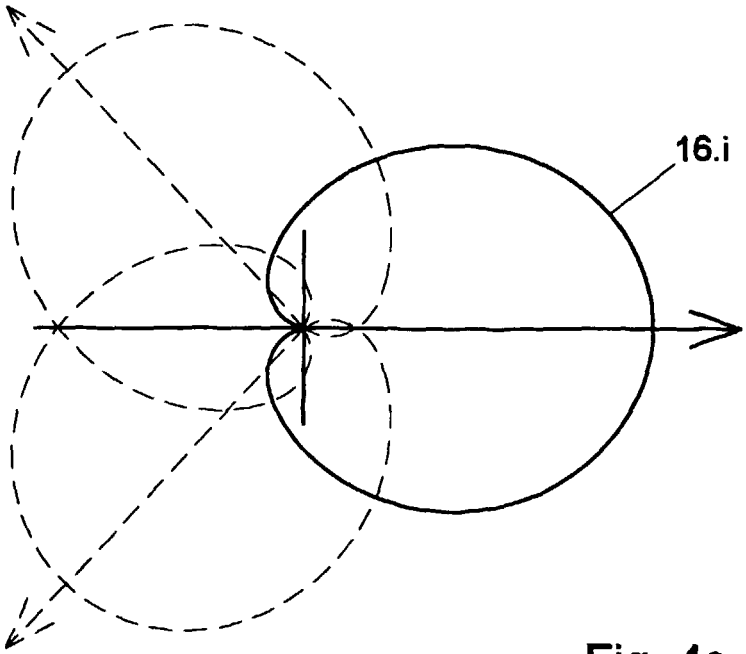


Fig. 4c

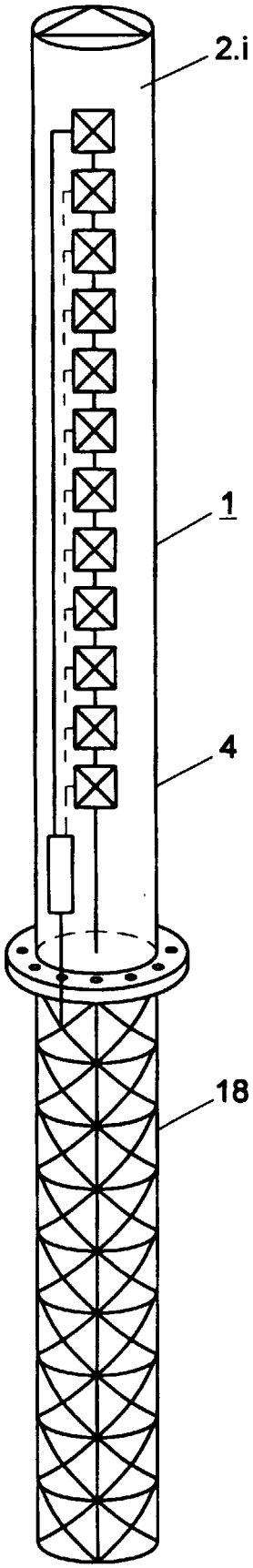


Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 98 20 1691

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	WO 97 06576 A (E SYSTEMS INC) 20 February 1997 * page 3, line 4-11 * * page 5, line 9 - page 6, line 18 * * page 8, line 10 - page 10, line 13; claims 1-5; figures 2-5 *	1-3,6-12	H01Q1/32
Y		4,5	
X	EP 0 688 040 A (NIPPON TELEGRAPH & TELEPHONE) 20 December 1995 * column 15, line 34 - column 16, line 20 * * column 17, line 10 - column 18, line 37 * * column 19, line 51 - column 21, line 21; figures 9,11-14 *	1-3,6-8	
Y	WO 96 14670 A (DELTEC NEW ZEALAND ;HEINZ WILLIAM EMIL (NZ); EHLEN MATHIAS MARTIN) 17 May 1996 * page 6, line 28 - page 7, line 5; claims 1,14-21 *	4,5	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
A	EP 0 575 808 A (ALLEN TELECOM GROUP INC) 29 December 1993 * column 5, line 29 - column 6, line 31; figures 1-3 *	1,4,5	H01Q
A	PATENT ABSTRACTS OF JAPAN vol. 097, no. 001, 31 January 1997 & JP 08 250929 A (MITSUBISHI ELECTRIC CORP), 27 September 1996 * abstract *	1	
A	US 5 548 813 A (CHARAS PHILIPPE M ET AL) 20 August 1996	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	30 September 1998	Van Dooren, G

CATEGORY OF CITED DOCUMENTS

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