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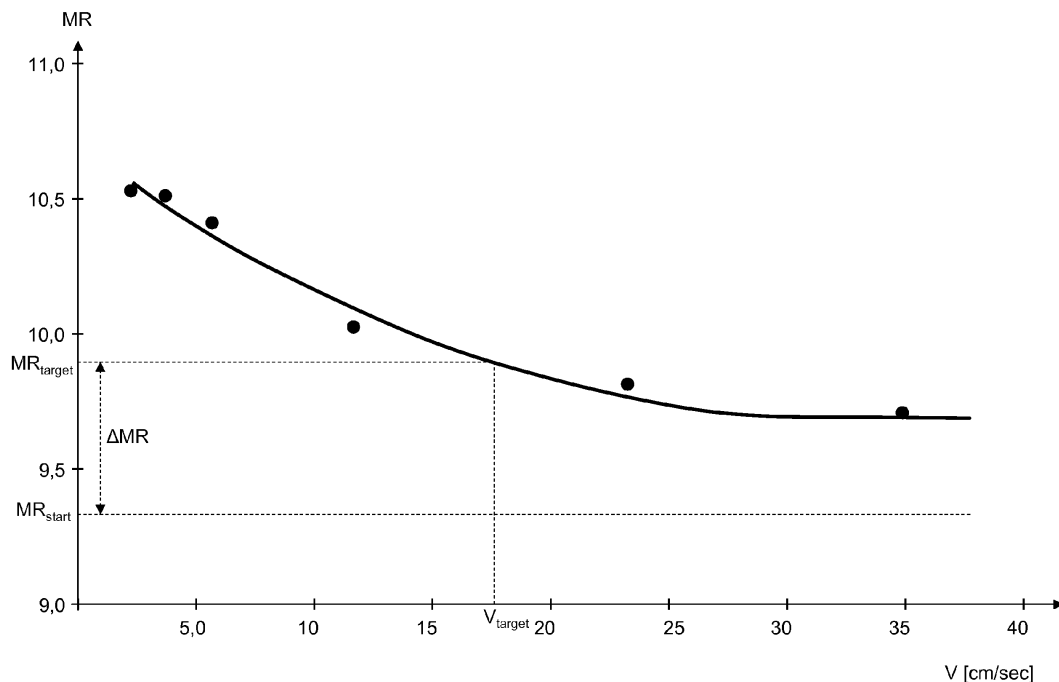
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(54) **Method of working a blacktop road surface to a target microroughness and a target macroroughness**

(57) A method of working a blacktop road surface (2) to a target microroughness (μR_{TARGET}) and a target macroroughness (MR_{TARGET}); the method including the steps of: measuring the initial macroroughness (MR_{START}) of the road surface (2); performing a number of treatments, differing from one another by at least one work parameter (V), on a limited calibration portion (9)

of the road surface (2); measuring the final macroroughness (MR_{END}) of the road surface (2) at the end of each treatment; extrapolating the best work parameter (V_{TARGET}), to achieve the target macroroughness (MR_{TARGET}), as a function of the final macroroughness (MR_{END}) measurements of the treatments; and performing the treatment, using the best work parameter (V_{TARGET}), over the whole road surface (2).

**Fig. 5****EP 2 586 915 A1**

Description

TECHNICAL FIELD

[0001] The present invention relates to a method of working a blacktop road surface to a target microroughness and target macroroughness.

BACKGROUND ART

[0002] Vehicle tyre performance depends largely on the characteristics (typically micro- and macroroughness) of the road surface on which the tyres roll, so, to accurately compare the findings of tyre tests conducted at different times and/or on different test tracks, the test road surfaces must have the same characteristics (i.e. same micro- and macroroughness).

[0003] Consequently, when asphaltting (i.e. blacktopping) a new test area, the micro- and macroroughness of the road surface required for correct tyre testing are established beforehand. Once the new asphalt is laid, it is allowed to mature, and the new test area allowed to rest, for at least 2-4 weeks. At the end of the maturation period, the road surface has a more or less thick surface layer of bitumen 'concealing' the aggregate underneath, and so normally has a very high microroughness and a very low macroroughness. At the end of the maturation period, the road surface must therefore be worked to the required micro- and macroroughness.

[0004] Correctly 'calibrating' the road surface micro- and macroroughness-altering work, however, is extremely complicated, on account of the effectiveness of the work depending significantly on numerous partly or totally uncontrollable factors. For example, the effectiveness of the work is strongly affected by sunlight and ambient temperature and humidity, not only when laying the asphalt but also during the maturation period. For example, asphalt laid in summer is normally harder and more compact than asphalt laid in winter, and is therefore normally less responsive to the road surface micro- or macroroughness-altering work.

[0005] Road surface micro- and macroroughness-altering work is currently 'calibrated' solely on the basis of experience, but is very often 'calibrated' wrongly, with the result that it has to be redone (best case scenario) or the asphalt has to be removed and re-laid (worst case scenario).

[0006] Patent US7850395B1 describes a road surface roughness analysis system, in which a wheel-mounted vehicle is run parallel to the road, and is equipped with an optical profilograph directed onto and for continuously measuring the roughness of the road surface. On the basis of the profilograph measurements, the road surface may be worked further, e.g. smoothed, to bring it up to specifications.

DESCRIPTION OF THE INVENTION

[0007] It is an object of the present invention to provide a method of working a blacktop road surface to a target microroughness and target macroroughness, designed to eliminate the above drawbacks, and which in particular is cheap and easy to implement.

[0008] According to the present invention, there is provided a method of working a blacktop road surface to a target microroughness and target macroroughness, as claimed in the accompanying Claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] A non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows a schematic of a blacktop road surface worked using the method according to the present invention;

Figure 2 shows a schematic front view of a device for measuring the micro- and macroroughness of the Figure 1 road surface;

Figures 3 and 4 show roughness test result graphs of the Figure 1 road surface;

Figure 5 shows a graph of macroroughness mathematical processing in accordance with the method of the present invention;

Figure 6 shows a schematic front view of a first processing device for processing the Figure 1 road surface and which substantially works on macroroughness;

Figure 7 shows a graph of microroughness mathematical processing in accordance with the method of the present invention;

Figure 8 shows a schematic plan view of a second processing device for processing the Figure 1 road surface and which substantially works on microroughness;

Figure 9 shows a schematic side view of the second processing device in Figure 8.

PREFERRED EMBODIMENTS OF THE INVENTION

[0010] Number 1 in Figure 1 indicates as a whole a tyre test area, which is in the form of a strip (roughly 1.5-3 metres wide and 20-50 metres long) and comprises an asphalted road surface 2, i.e. made of a bituminous conglomerate of aggregate (substantially pebbles), which forms the solid skeleton, and bitumen, which binds (i.e. 'glues') the aggregate together.

[0011] The main characteristics of road surface 2 are microroughness or microtexture, which relates to roughness with a horizontal wavelength λ of below 0.5 mm; and macroroughness or macrotexture, which relates to roughness with a horizontal wavelength λ of 0.5 to 50 mm.

[0012] As shown in Figure 2, the micro- and macroroughness of road surface 2 are measured using an optical measuring device 3, which comprises a gantry supporting frame 4 spanning road surface 2; and a laser distance meter 5, which is fitted to supporting frame 4, is positioned vertically a small distance from road surface 2, and is aimed vertically downwards to 'observe' road surface 2. An electric motor 6 moves laser distance meter 5 along supporting frame 4 and across road surface 2, and the position of laser distance meter 5 along supporting frame 4 is recorded by a position sensor 7 (more specifically, a high-resolution encoder). Finally, measuring device 3 comprises a processing unit 8 for processing the readings of laser distance meter 5 and position sensor 7.

[0013] In actual use, processing unit 8 (by controlling electric motor 6) moves laser distance meter 5 across road surface 2 on supporting frame 4, and, at the same time, records the readings of laser distance meter 5 and position sensor 7 at given (typically constant) measuring intervals. In other words, for each measuring point, processing unit 8 records the distance D recorded by laser distance meter 5, and the corresponding position X of laser distance meter 5 along supporting frame 4. Once recorded, the succession of distance D measurements as a function of positions X is processed mathematically (to ISO Standards) to give a synthetic indication of the roughness (divided into micro- and macroroughness) of road surface 2. Mathematical processing typically comprises a Fourier transform in the length domain to determine the spectrum of wavelengths λ in the recorded profile of road surface 2.

[0014] For example, Figure 3 shows a so-called 'height histogram', i.e. the distribution of wavelengths λ in the recorded profile: the x axis shows wavelength λ , and the y axis the presence percentage. Figure 4 shows a so-called 'PSD - Power Spectral Density' graph: the x axis shows (in logarithmic scale) the inverse of wavelength λ (i.e. the 'spatial frequency'), and the y axis shows PSD (in logarithmic scale). From the Figure 4 graph, it is possible to estimate the macroroughness MR corresponding to the highest PSD value (at a high wavelength λ , i.e. low 'spatial frequency'), and the microroughness μR corresponding to the lowest PSD value (at a low wavelength λ , i.e. high 'spatial frequency').

[0015] Once the asphalt of road surface 2 of test area 1 is laid, it is allowed to mature, and test area 1 to rest, for at least 2-4 weeks. At the end of the maturation period, the target microroughness μR_{TARGET} and target macroroughness MR_{TARGET} of road surface 2 required for correct tyre testing are established beforehand. At first (i.e. at the end of the maturation period), road surface 2 has a more or less thick surface layer of bitumen 'concealing' the aggregate underneath, so its actual microroughness is normally very high (i.e. much higher than target microroughness μR_{TARGET}), and its macroroughness is normally very low (i.e. much lower than target macroroughness MR_{TARGET}). At the end of the maturation period,

road surface 2 must therefore be worked to reduce its microroughness to target microroughness μR_{TARGET} , and increase its macroroughness to target macroroughness MR_{TARGET} .

[0016] Firstly, the initial macroroughness MR_{START} of road surface 2 is measured using measuring device 3 described above. A limited calibration portion 9 of road surface 2 (Figure 1) of test area 1 is then defined. Calibration portion 9 is roughly one metre long, and typically located at one end of test area 1. A number of first jobs, differing from one another by at least one work parameter V, are performed on different sections 10 of calibration portion 9. In other words, a first job, with a first work parameter V, is performed on a first section 10 of calibration portion 9 of road surface 2; a first job, with a second work parameter V different from first work parameter V, is performed on a second section 10 of calibration portion 9 of road surface 2; a first job, with a third work parameter V different from the first and second work parameters V, is performed on a third section 10 of calibration portion 9 of road surface 2, and so on (roughly four to eight first jobs, with respective different work parameters V, are performed on respective sections 10 of calibration portion 9).

[0017] The first jobs have a significant effect on the macroroughness of road surface 2, and only a limited (substantially negligible) effect on the microroughness of road surface 2.

[0018] The final macroroughness MR_{END} of road surface 2 is measured after each first job performed on calibration portion 9 of road surface 2 (i.e. on each section 10 of calibration portion 9). And the Figure 5 work parameter V/macroroughness MR graph can be constructed by plotting the test points corresponding to the first jobs performed on sections 10 of calibration portion 9. Using amply documented mathematical techniques, the best work parameter V_{TARGET} to achieve target macroroughness MR_{TARGET} can be extrapolated from the test points in the Figure 5 graph as a function of the final macroroughness MR_{END} measurements of the first jobs. For example, as shown in Figure 5, a curve is drawn approximating the test points (i.e. measurements) of the first jobs in the work parameter V/macroroughness MR plane, and is subsequently used to determine the best work parameter V_{TARGET} as a function of target macroroughness MR_{TARGET} .

[0019] Once the best work parameter V_{TARGET} is determined, the first job is performed over the whole of road surface 2 using the best work parameter V_{TARGET} . After the first job, the whole of road surface 2 (except for calibration portion 9, which is no longer used) therefore has a final macroroughness MR_{END} substantially equal to target macroroughness MR_{TARGET} .

[0020] As shown in Figure 6, each first job comprises dry blasting road surface 2 using a dry blasting device 11. Dry blasting device 11 comprises a gantry frame 12 resting on opposite sides of and spanning road surface 2; and a dry blasting head 13 facing road surface 2, fitted

movably to gantry frame 12, and moved across road surface 2 by an electric motor 14. Gantry frame 12 is preferably movable along road surface 2 on two rails 15 parallel to and on opposite sides of road surface 2. In actual use, dry blasting head 13 is moved along gantry frame 12, across road surface 2, to dry blast a strip of road surface 2 (of a longitudinal dimension of a few centimetres); and, once one 'sweep' of road surface 2 is completed, gantry frame 12 is moved longitudinally along rails 15 to 'sweep' another strip of road surface 2.

[0021] In a preferred embodiment, work parameter V is the travelling speed (crosswise) of dry blasting head 13. As shown clearly in Figure 5, the higher work parameter V is (i.e. the faster dry blasting head 13 travels), the lower macroroughness MR is. In other words, increasing the travelling speed of dry blasting head 13 reduces the amount of bitumen it removes, thus producing a 'smoother' road surface 2 (i.e. with a lower macroroughness MR). In a preferred embodiment, the first jobs only differ by work parameter V, i.e. only work parameter V differs from one first job to another, and all the other parameters (e.g. dry blasting pressure, dry blasting material type and size, and distance between dry blasting head 13 and road surface 2 ...) remain unchanged, thus making the calibration process much simpler and more effective (i.e. in obtaining a more accurate, more repeatable target macroroughness MR_{TARGET}).

[0022] In a different embodiment not shown, the first job, as opposed to dry blasting, comprises directing a high-pressure water jet onto road surface 2. By way of a further alternative, the first job, as opposed to dry blasting, may comprise applying road surface 2 with chemical solvents (e.g. petrol or diesel fuel), the action of which, however, is much more difficult to control.

[0023] After the first job is completed over the whole of road surface 2, the initial microroughness μR_{START} of road surface 2 is measured using device 3. A limited calibration portion 16 of road surface 2 (Figure 1) of test area 1 is then defined. Calibration portion 16 is roughly one metre long, is typically located at one end of test area 1, and differs from and is located alongside calibration portion 9 (which at this stage is ignored). A number of second jobs, differing from one another by at least one work parameter P, are performed on calibration portion 16. In other words, a second job with different work parameters P is performed on calibration portion 16 of road surface 2 (roughly four to eight second jobs with respective different work parameters P are performed).

[0024] The second jobs have a significant effect on the microroughness of road surface 2, and only a limited (substantially negligible) effect on the macroroughness of road surface 2.

[0025] The final microroughness μR_{END} of road surface 2 is measured after each second job performed on calibration portion 16 of road surface 2. And the Figure 7 work parameter P/microroughness μR graph can be constructed by plotting the test points corresponding to the second jobs performed on calibration portion 16. Us-

ing amply documented mathematical techniques, the best work parameter P_{TARGET} to achieve target microroughness μR_{TARGET} can be extrapolated from the test points in the Figure 7 graph as a function of the final microroughness μR_{END} measurements of the second jobs. For example, as shown in Figure 7, a curve is drawn approximating the test points (i.e. measurements) of the second jobs in the work parameter P/microroughness μR plane, and is subsequently used to determine the best work parameter P_{TARGET} as a function of target microroughness μR_{TARGET} .

[0026] Once the best work parameter P_{TARGET} is determined, the second job is performed over the whole of road surface 2 using the best work parameter P_{TARGET} . After the second job, the whole of road surface 2 (except for calibration portions 9 and 16, which are no longer used) therefore has a final microroughness μR_{END} substantially equal to target microroughness μR_{TARGET} (as well as a final macroroughness MR_{END} substantially equal to target macroroughness MR_{TARGET}).

[0027] As shown in Figures 8 and 9, each second job comprises drawing along road surface 2 (at a speed of roughly 1-15 cm/sec) a truck 17 mounted on rubber-tyred wheels 18, which are locked to slide along road surface 2. Truck 17 preferably comprises at least two separate axles 19, each of which supports a respective number of wheels 18, and is locked by a releasable lock to prevent wheels 18 from rotating. Wheels 18 on the two axles 19 are staggered, so that the footprint of each wheel 18 is complementary to and does not overlap those of the other wheels 18. In a preferred embodiment, each second job comprises wetting road surface 2 with water prior to passage of truck 17, to prevent the tyres of wheels 18 from leaving large amounts of rubber on road surface 2 (i.e. to prevent 'rubber coating' road surface 2).

[0028] In a preferred embodiment, work parameter P is the number of passes of truck 17 along road surface 2. For example, truck 17 is drawn 30 times along the whole of calibration portion 16 with wheels 18 locked, and final microroughness μR_{END} after 30 passes is measured; truck 17 is then drawn another 30 times along the whole of calibration portion 16 with wheels 18 locked, and final microroughness μR_{END} after 60 passes is measured; truck 17 is then drawn another 30 times along the whole of calibration portion 16 with wheels 18 locked, and final microroughness μR_{END} after 90 passes is measured, and so on.

[0029] As shown clearly in Figure 7, the higher work parameter P is (i.e. the greater the number of passes of truck 17), the lower microroughness μR is. In other words, increasing the number of passes of truck 17 increases the 'smoothing' effect, thus producing a 'smoother' road surface 2 (i.e. with a lower microroughness μR). In a preferred embodiment, the second jobs only differ from one another by work parameter P, i.e. only work parameter P differs from one second job to another, and all the other parameters (i.e. tyre inflation pressure, the total mass of truck 17, the

draw speed of truck 17 ...) remain unchanged, thus making the calibration process much simpler and more effective (i.e. in obtaining a more accurate, more repeatable target microroughness μR_{TARGET}).

[0030] In a different embodiment not shown, as opposed to a truck 17 with locked wheels 18, the second job comprises smoothing or abrading road surface 2 mechanically with a smoothing tool.

[0031] In one possible embodiment, target macroroughness MR_{TARGET} is increased slightly (by roughly 5-10%) to allow for the effect of the second job on the macroroughness of road surface 2 when extrapolating the best work parameter V_{TARGET} . In other words, albeit limited, the second job performed over the whole of road surface 2 to achieve target microroughness μR_{TARGET} of road surface 2 still has some effect on (i.e. slightly reduces) the macroroughness of the road surface. The effect of the second job on the macroroughness of the road surface may either be ignored, or taken into account by slightly increasing target macroroughness MR_{TARGET} when extrapolating the best work parameter V_{TARGET} (i.e. after the first job, macroroughness is slightly higher than target macroroughness MR_{TARGET} , and, after the second job, substantially equals target macroroughness MR_{TARGET}).

[0032] The method described of working road surface 2 has numerous advantages.

[0033] Firstly, it provides for accurately achieving both the target macroroughness MR_{TARGET} and target microroughness μR_{TARGET} of road surface 2 of test area 1. This is made possible by the preliminary calibration work carried out on calibration portions 9 and 16, which provides for accurately determining the best work parameters V_T and P_T , taking into account all the possible variables more or less affecting the characteristics of road surface 2.

[0034] Secondly, the method described is fast and easy to implement, by simply involving, with respect to known methods, a few additional jobs (identical to those carried out over the whole of road surface 2) and a few additional roughness measurements (also identical to those performed on road surface 2) on very limited calibration portions 9 and 16.

Claims

1. A method of working a blacktop road surface (2) to a target microroughness (μR_{TARGET}) and a target macroroughness (MR_{TARGET}); the method comprising the steps of:

measuring the initial macroroughness (MR_{START}) of the road surface (2);
performing a number of first jobs, differing from one another by at least one first work parameter (V), on a limited first calibration portion (9) of the road surface (2);

measuring the final macroroughness (MR_{END}) of the road surface (2) at the end of each first job; extrapolating the best first work parameter (V_{TARGET}), to achieve the target macroroughness (MR_{TARGET}), as a function of the final macroroughness (MR_{END}) measurements of the first jobs; and

performing the first job, using the best first work parameter (V_{TARGET}), over the whole road surface (2).

2. A method as claimed in Claim 1, wherein each first job comprises dry blasting the road surface (2) with a dry blasting device (11).

3. A method as claimed in Claim 2, wherein the dry blasting device (11) comprises :

a gantry frame (12) resting on opposite sides of and extending across the road surface (2); and a dry blasting head (13) directed onto the road surface (2) and fitted to the gantry frame (12) to move across the road surface (2).

4. A method as claimed in Claim 3, wherein the gantry frame (12) is mounted to move along the road surface (2) on two rails (15) parallel to and on opposite sides of the road surface (2).

5. A method as claimed in Claim 2, 3 or 4, wherein the first work parameter (V) is the travelling speed of the dry blasting head (13).

6. A method as claimed in Claim 1, wherein each first job comprises directing a high-pressure water jet on to the road surface (2).

7. A method as claimed in one of Claims 1 to 6, wherein the first jobs differ from one another solely by a first work parameter (V).

8. A method as claimed in one of Claims 1 to 7, and comprising, after performing the first job over the whole road surface (2), the further steps of :

measuring the initial microroughness (μR_{START}) of the road surface (2);

performing a number of second jobs, differing from one another by at least one second work parameter (P), on a limited second calibration portion (16) of the road surface (2); measuring the final microroughness (μR_{END}) of the road surface (2) at the end of each second job;

extrapolating the best second work parameter (P_{TARGET}), to achieve the target microroughness (μR_{TARGET}), as a function of the final microroughness (μR_{END}) measurements of the

second jobs; and
 performing the second job, using the best second work parameter (P_{TARGET}), over the whole road surface (2).

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9. A method as claimed in Claim 8, wherein each second job comprises drawing along the road surface (2) a truck (17) mounted on rubber-tyred wheels (18), which are locked to skid on the road surface (2).

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10. A method as claimed in Claim 9, wherein each second job comprises wetting the road surface (2) with water prior to passage of the truck (17).

11. A method as claimed in Claim 9, wherein the second work parameter (P) is the number of passes of the truck (17) along the road surface (2).

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12. A method as claimed in Claim 8, 10 or 11, wherein the second jobs differ from one another solely by a second work parameter (P).

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13. A method as claimed in Claim 8, wherein each second job comprises subjecting the road surface (2) to mechanical smoothing or abrasion using a smoothing tool.

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14. A method as claimed in one of Claims 8 to 13, wherein the second calibration portion (16) differs from the first calibration portion (9).

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15. A method as claimed in one of Claims 8 to 14, and comprising the further step of slightly increasing the target macroroughness (MR_{TARGET}) to extrapolate the best first work parameter (V_{TARGET}), so as to take into account the effect of the second job on the macroroughness of the road surface (2).

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16. A method as claimed in one of Claims 1 to 15, wherein extrapolating the best first/second work parameter (V_{TARGET} ; P_{TARGET}) comprises determining a curve approximating the first/second job measurements in the work parameter (V; P)/roughness (MR ; μR) plane.

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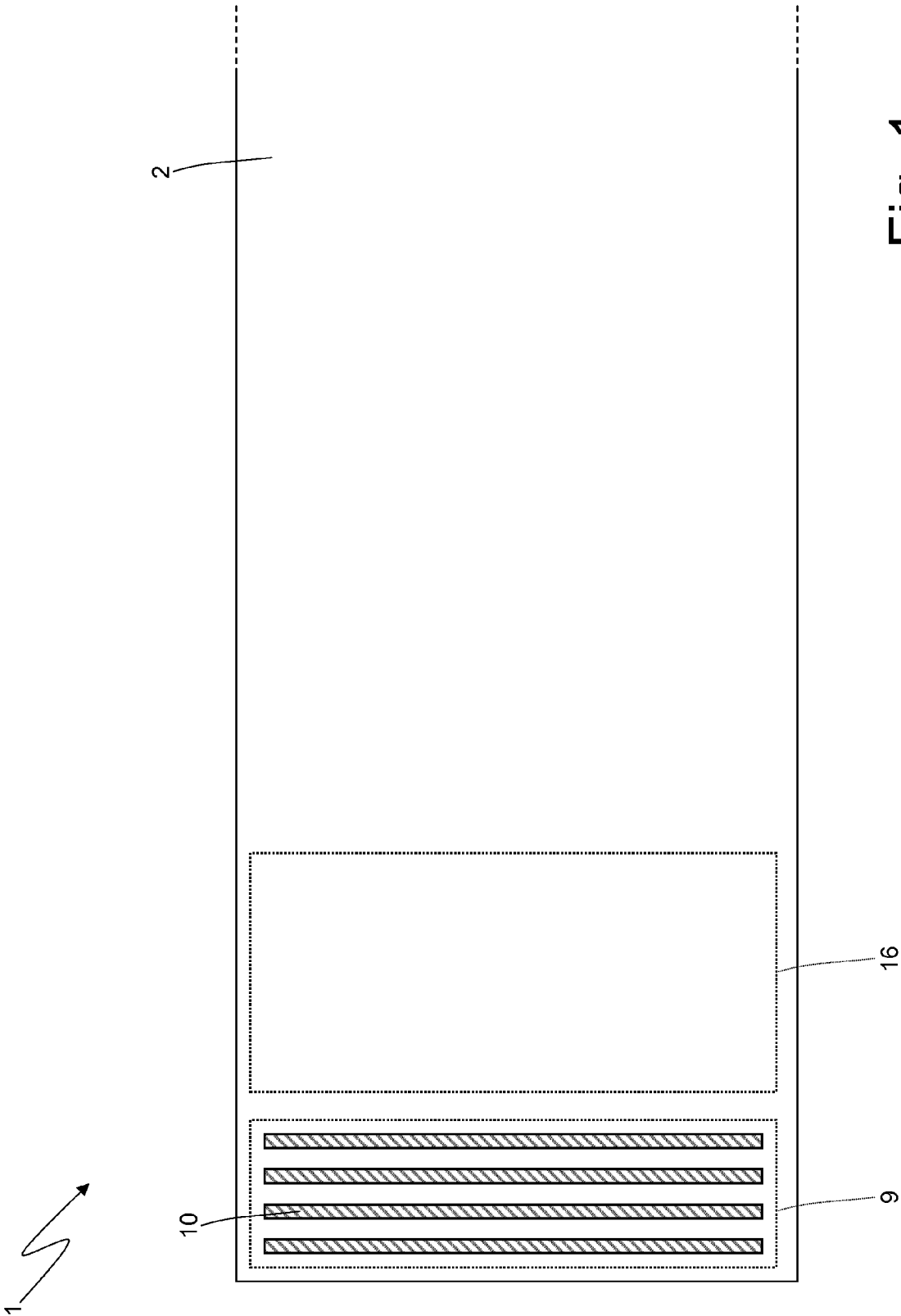


Fig. 1

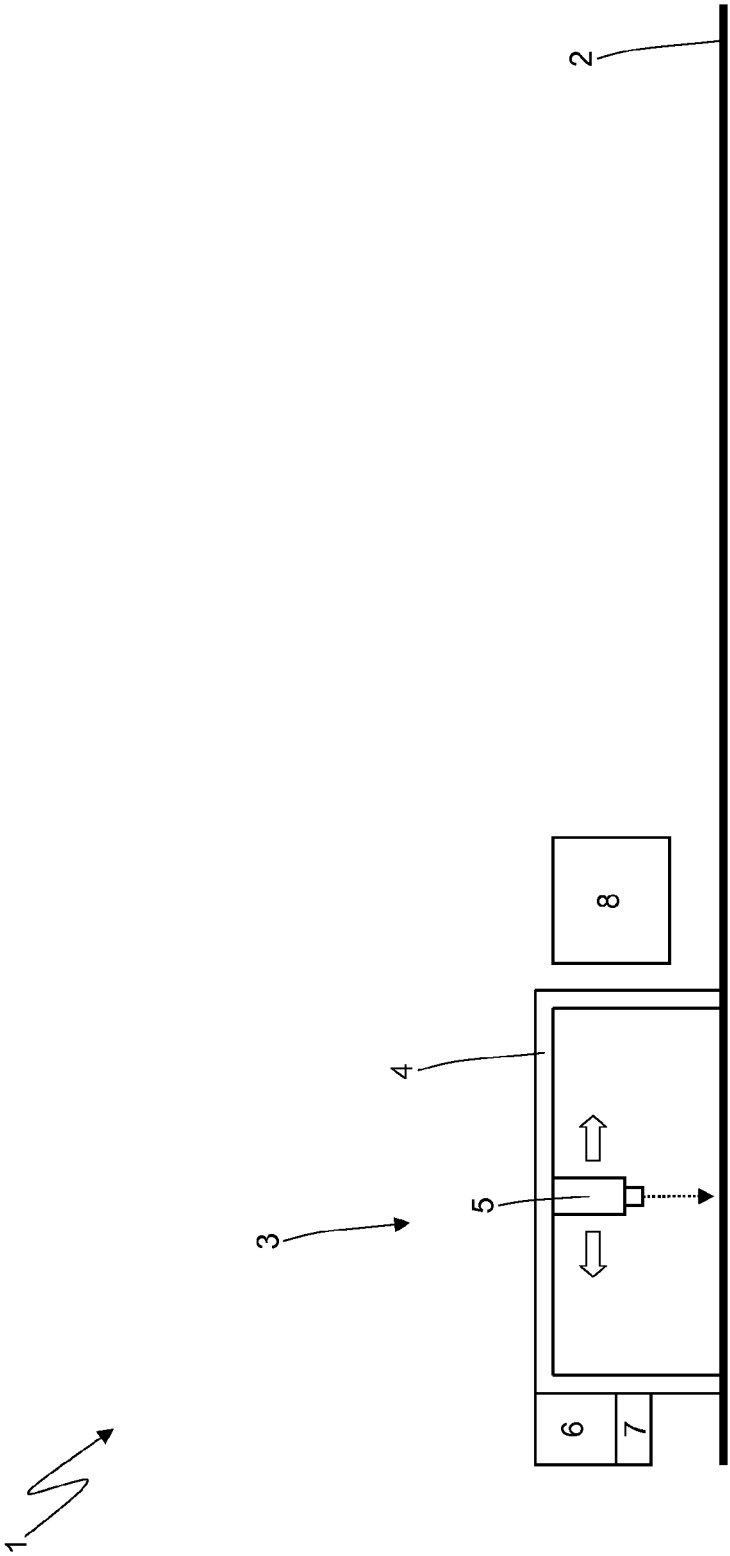


Fig. 2

Fig. 3

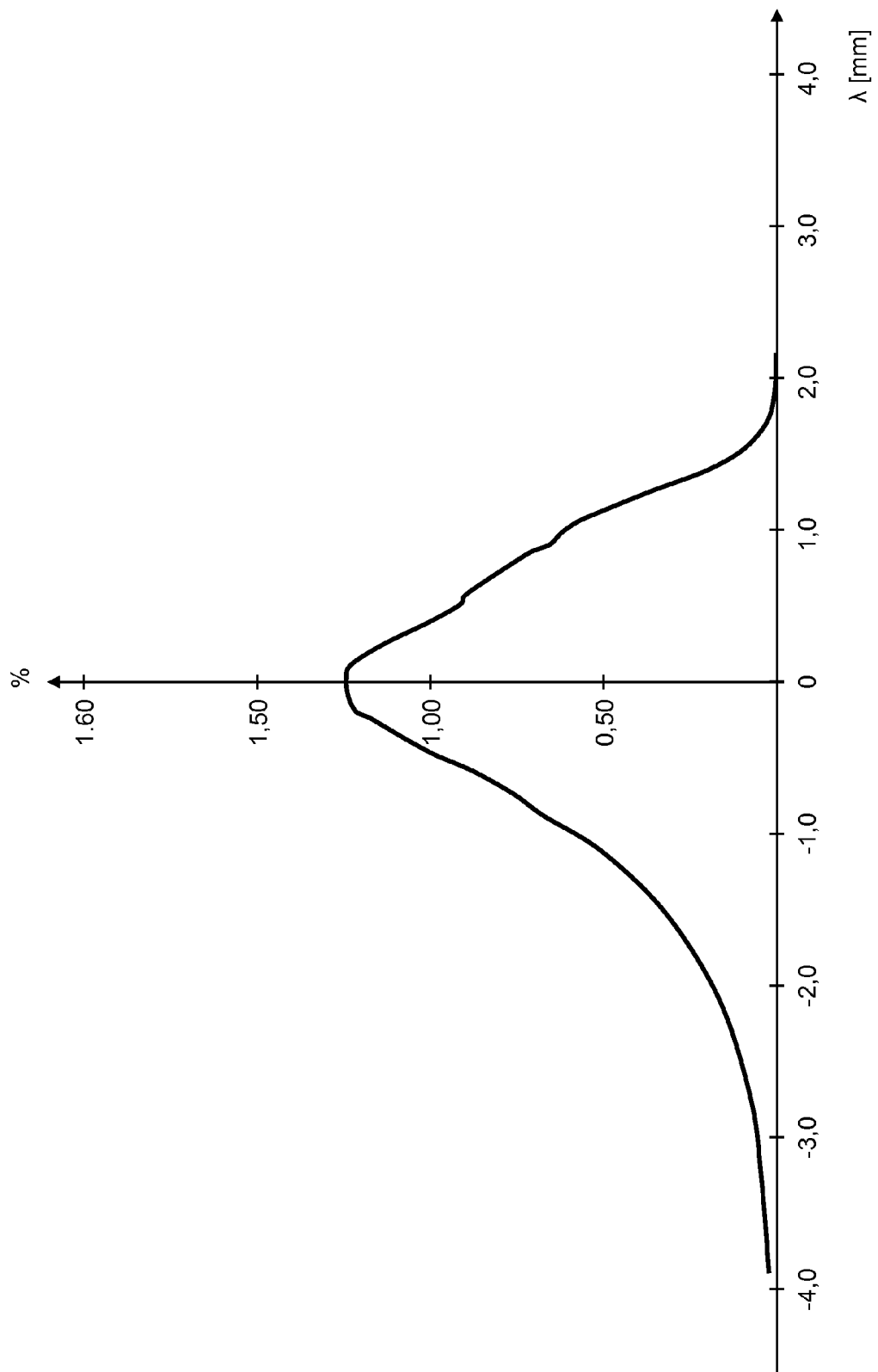
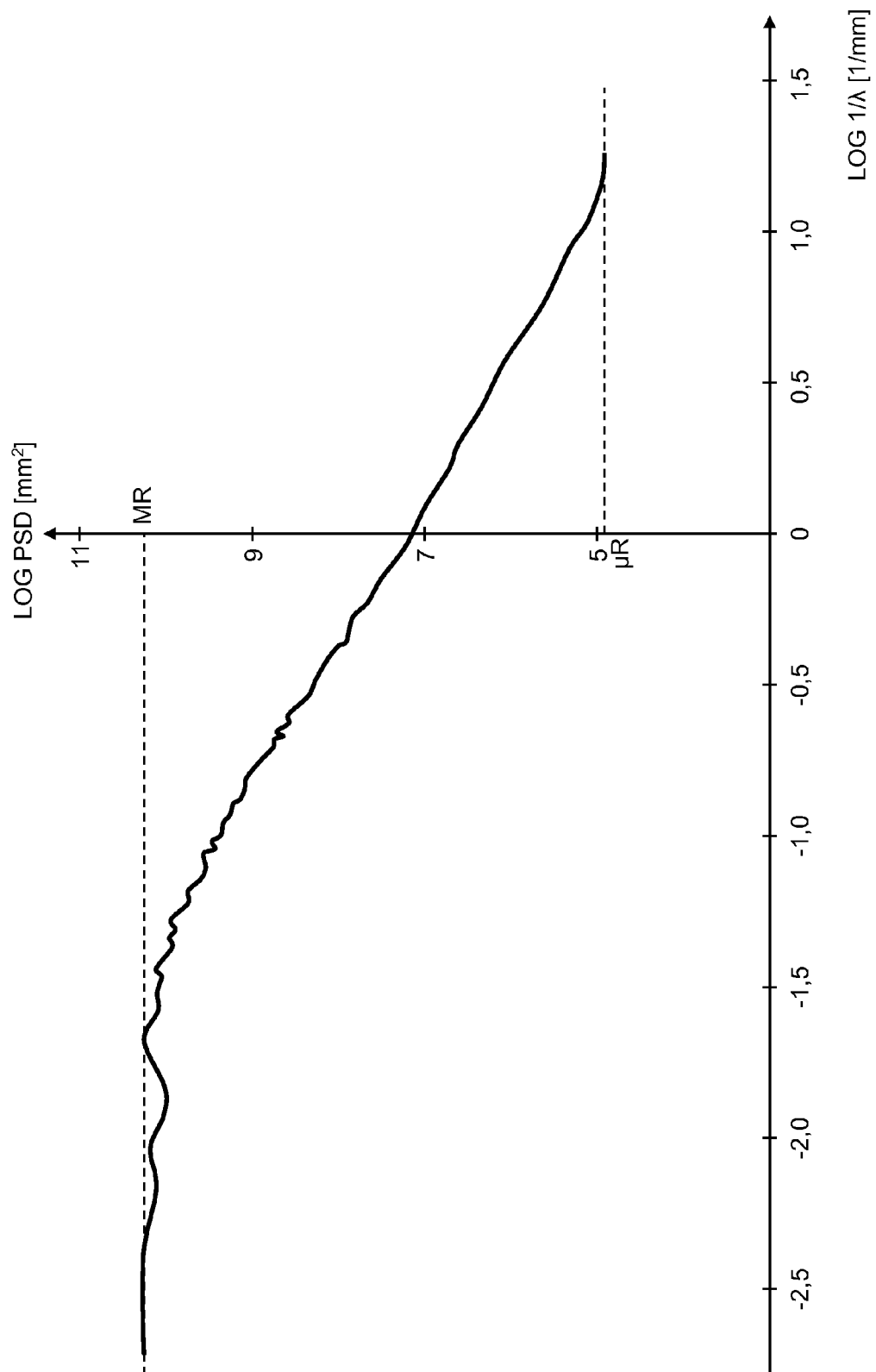


Fig. 4



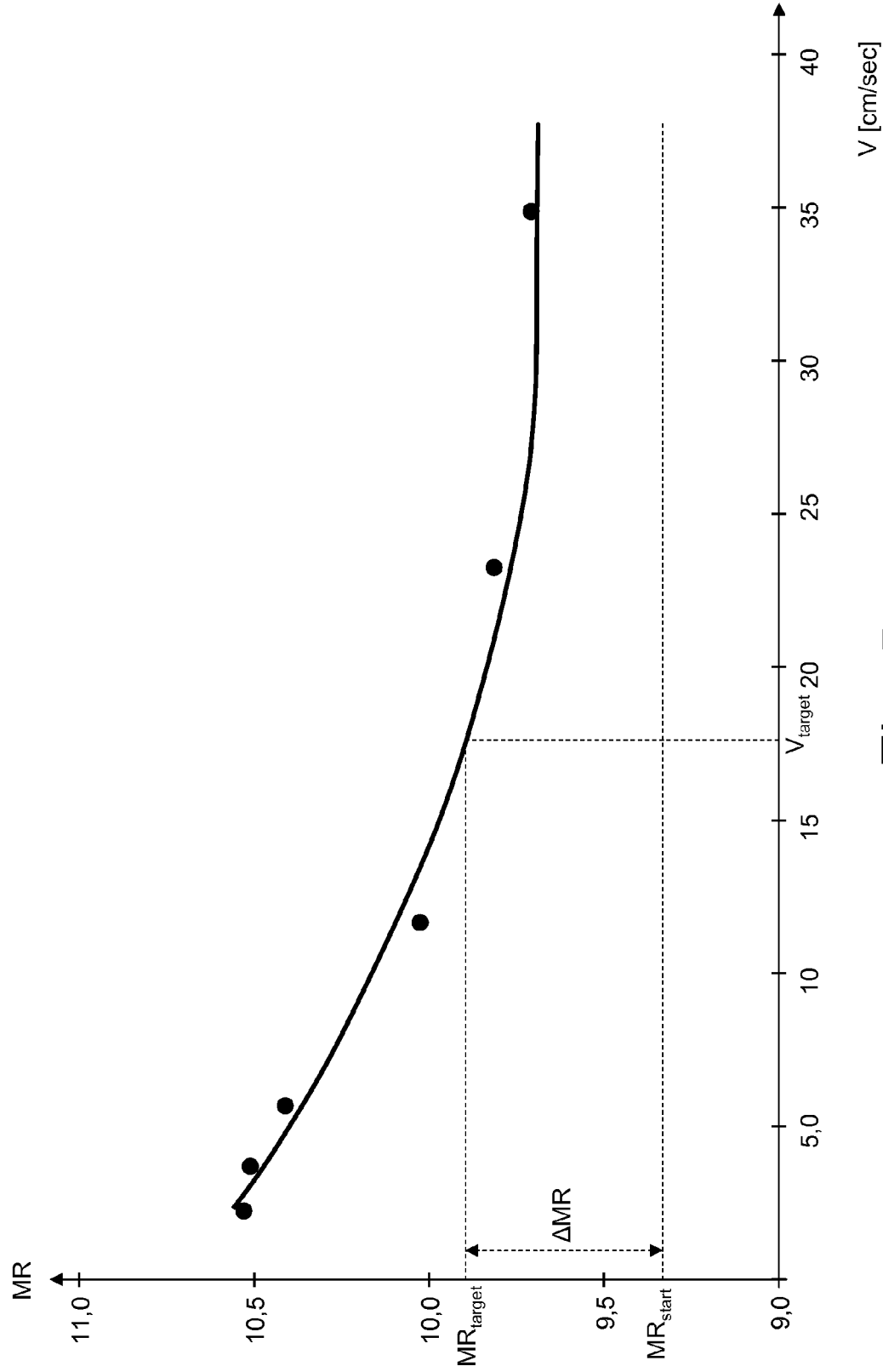


Fig. 5

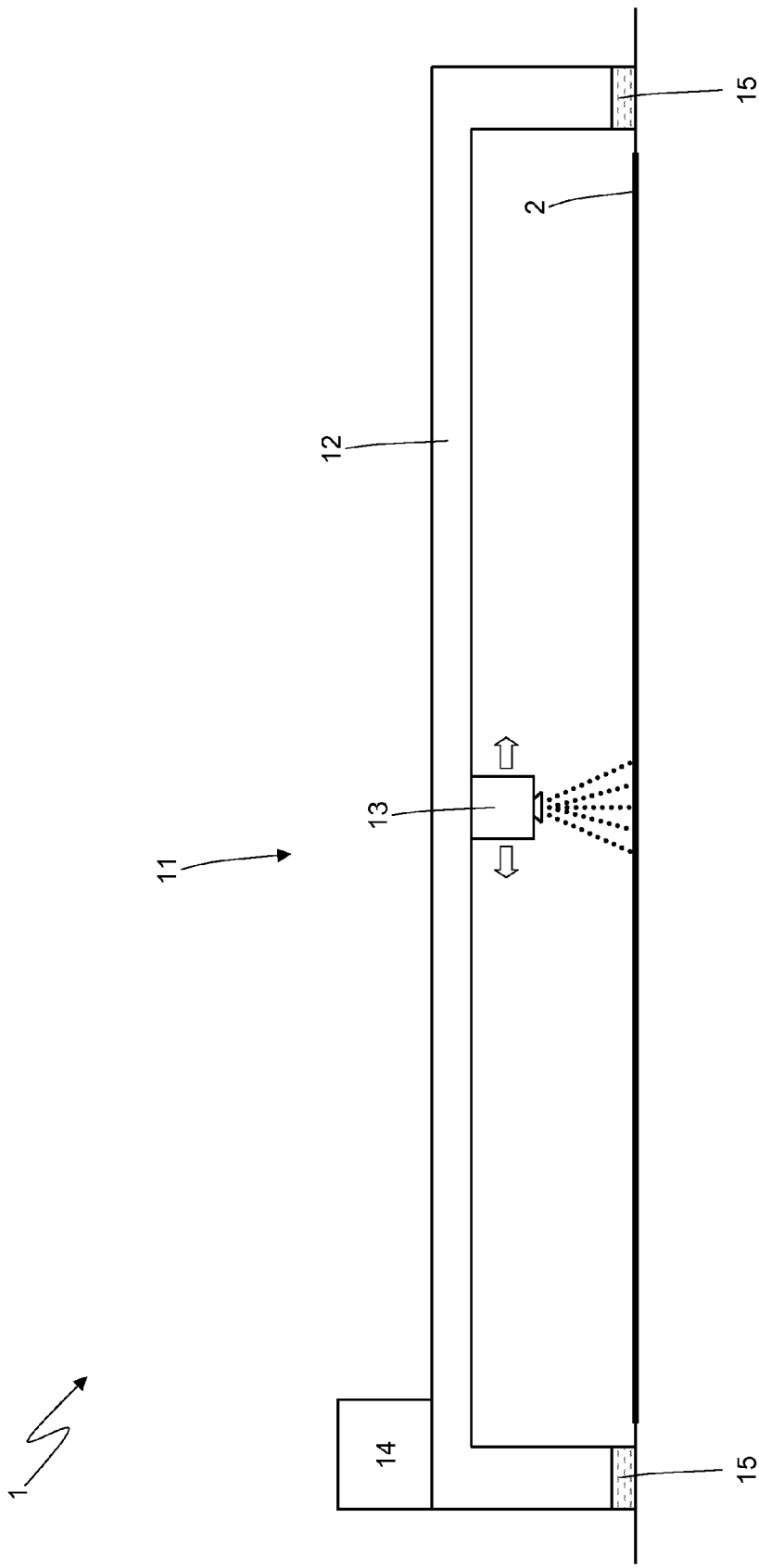


Fig. 6

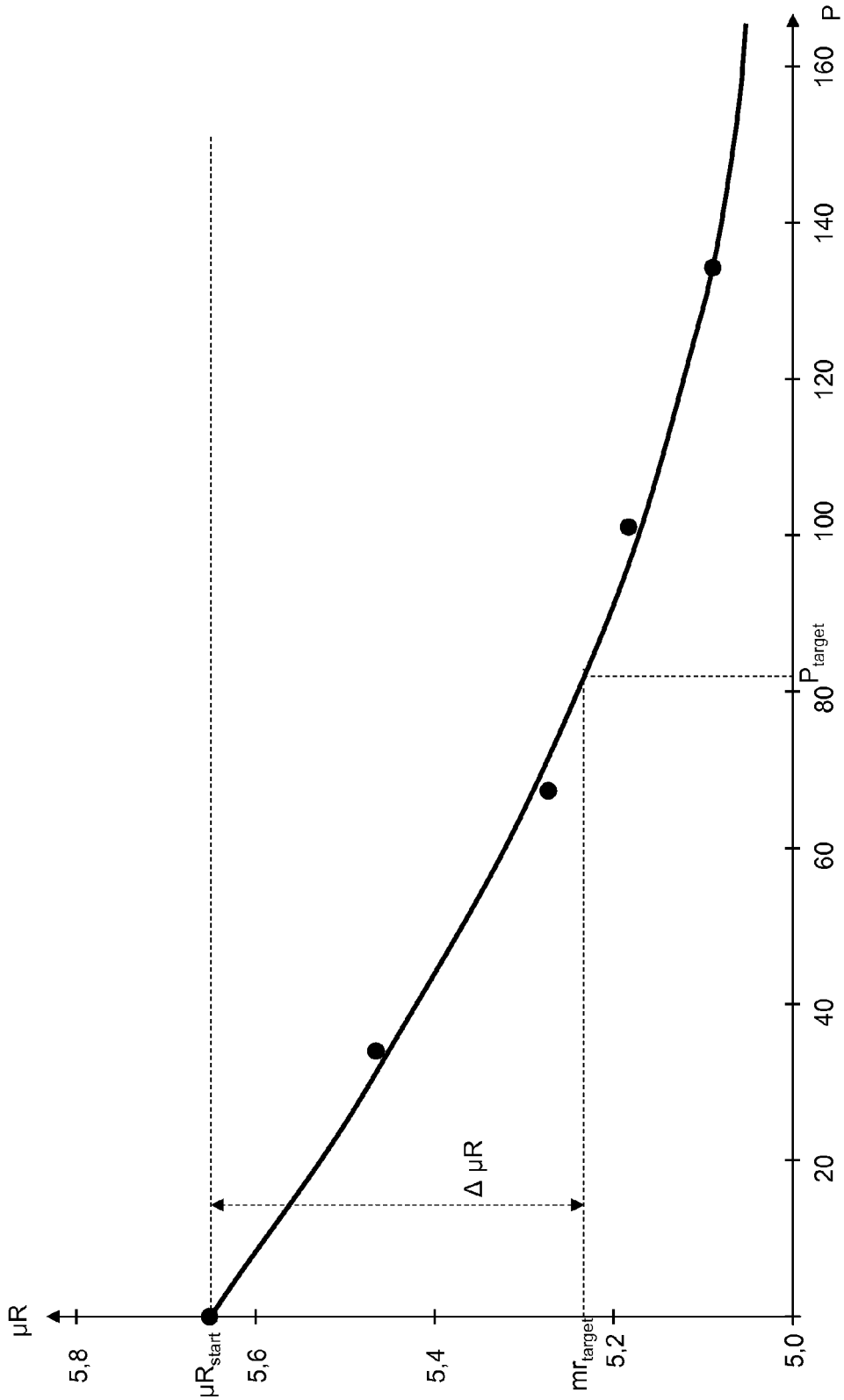
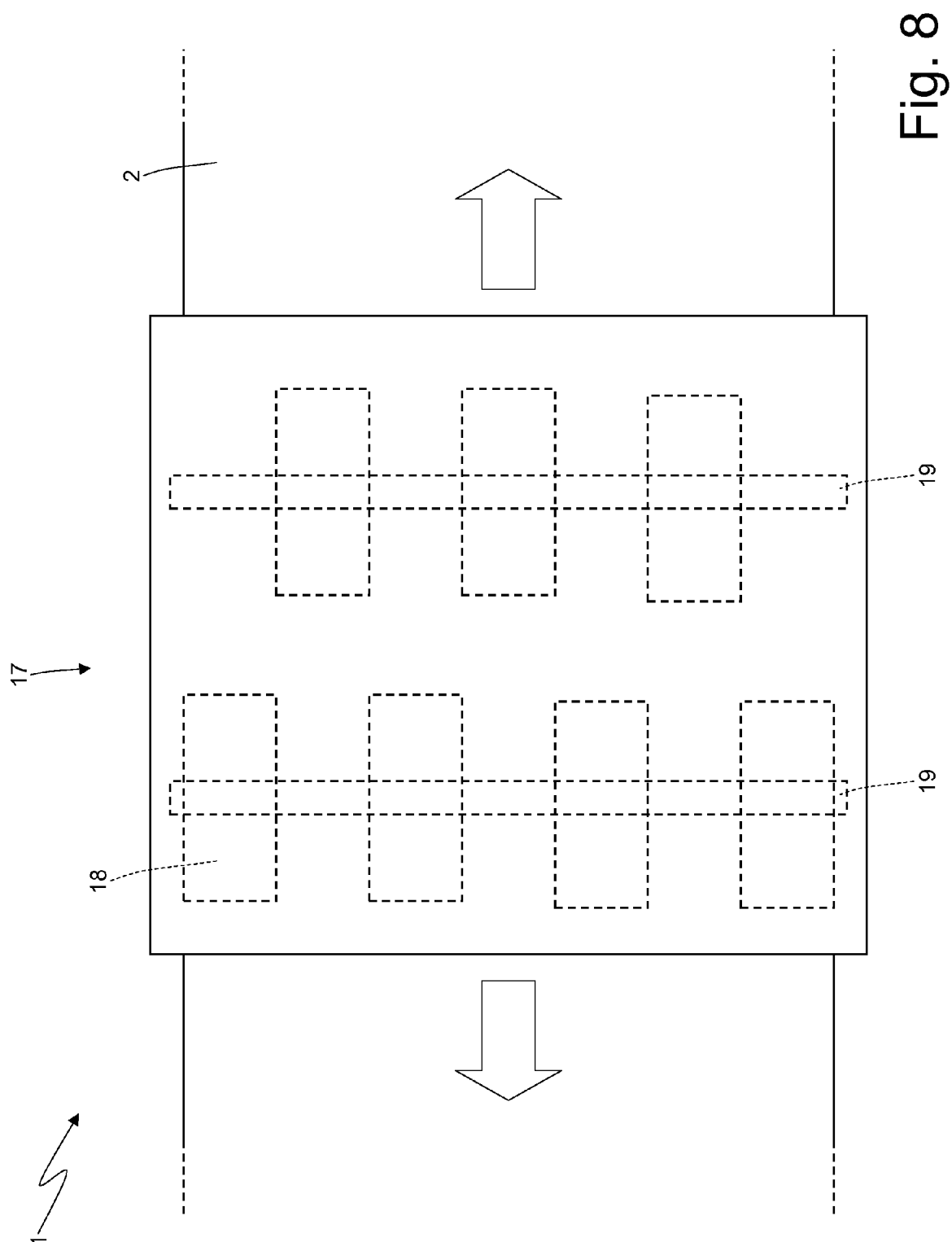


Fig. 7



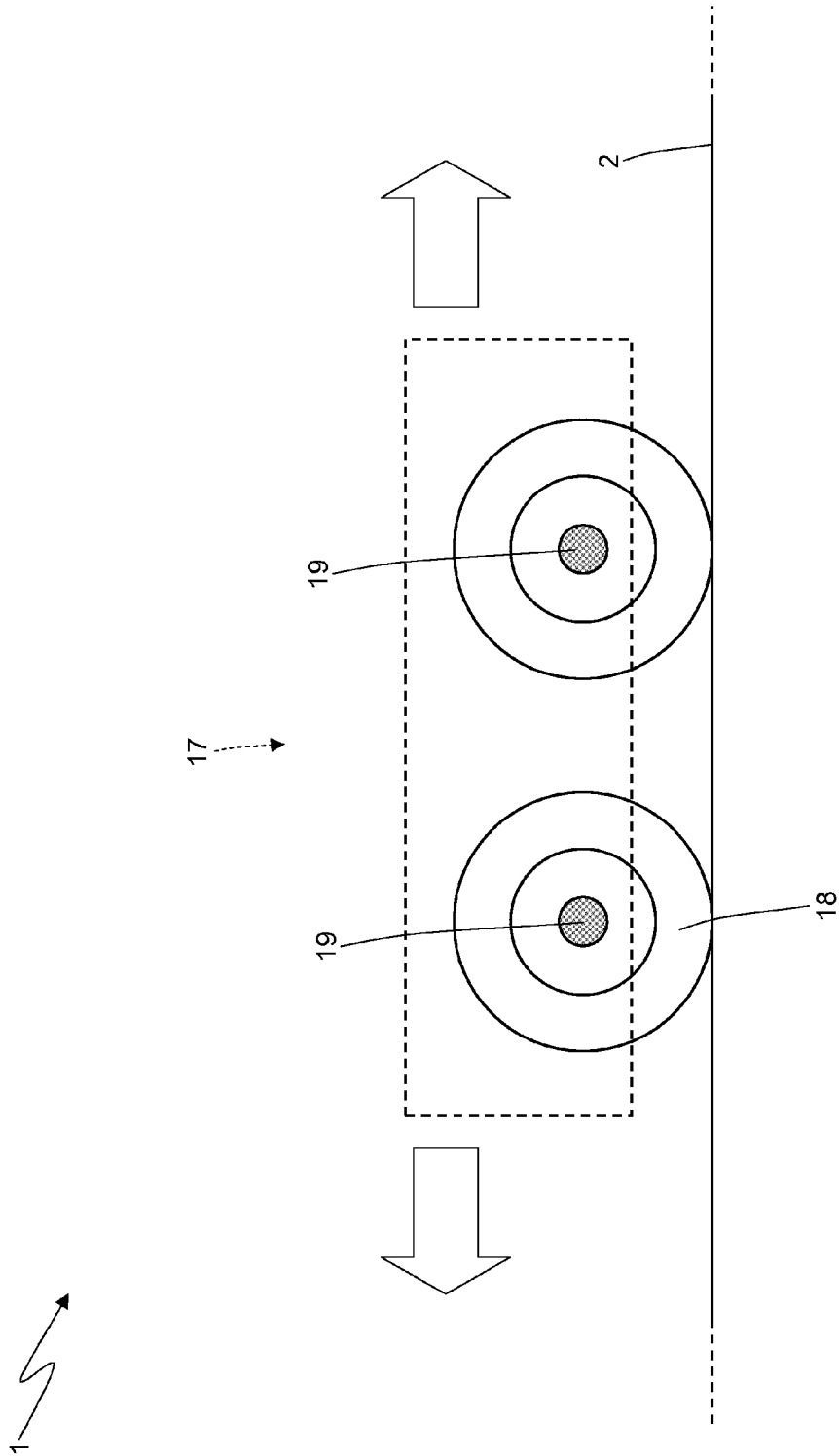


Fig. 9



EUROPEAN SEARCH REPORT

Application Number
EP 12 19 0459

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 7 850 395 B1 (BRENNER MARK W [US] ET AL) 14 December 2010 (2010-12-14) * abstract * * column 1, line 45 - line 50 * * column 5, line 9 - column 29, line 13; figures 1-40 *	1-16	INV. E01C23/01
A	FR 724 435 A (M. ADRIEN CHABAL [FR]) 27 April 1932 (1932-04-27) * the whole document *	1	
A	DE 102 08 988 A1 (BAULABOR DR ING RICHTER [DE]) 18 September 2003 (2003-09-18) * the whole document *	1	
			TECHNICAL FIELDS SEARCHED (IPC)
			E01C
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 11 February 2013	Examiner Beucher, Stefan
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 12 19 0459

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11-02-2013

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 7850395	B1	14-12-2010	NONE
FR 724435	A	27-04-1932	NONE
DE 10208988	A1	18-09-2003	NONE

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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Patent documents cited in the description

- US 7850395 B1 [0006]