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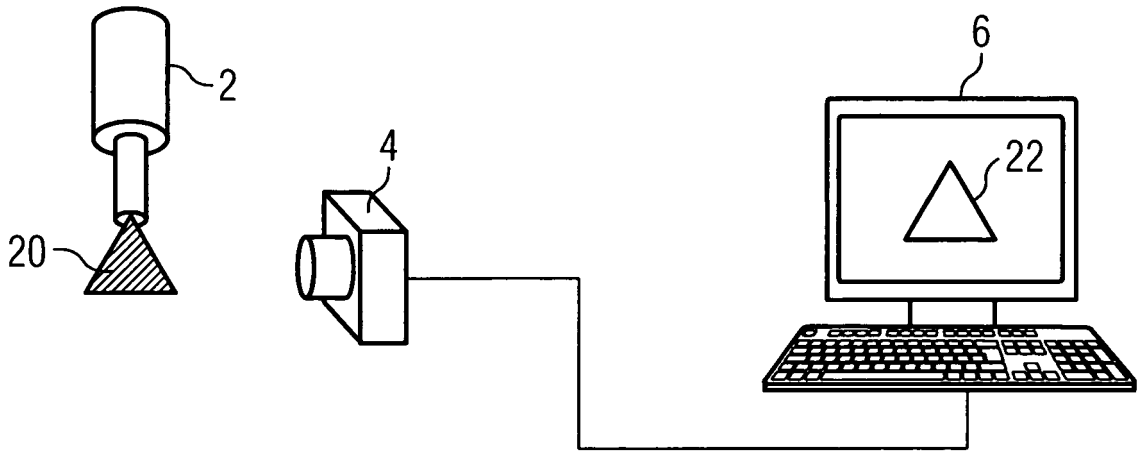
(71) Applicant: **SIEMENS AKTIENGESELLSCHAFT**
80333 München (DE)

(72) Inventors:
- **Draxler, Marcus**
  57123 Livorno (LI) (IT)
- **Leger, Cédric**
  56100 Pisa (IT)

(54) Method and test-device for testing an injector

(57) For testing an injector fluid is sprayed with the injector (2) under a given condition. At least one picture of the spray shape (20) is taken. A spray contour (22,24) of the picture of the spray shape (20) is determined. The spray contour (22,24) comprises a first and a second side (22_A,24_A,22_B,24_B) extending away from an source area (21) of the spray contour (22,24) corresponding to an area of the spray shape (20) of the injector (2) where the fluid exits the injector (2). Further, the spray contour (22,24) comprises a front line (22_C,24_C) facing away from the source area (21) connecting a first end of the first side (22_A,24_A) and a first end of the second side (22_B,24_B) of the spray contour (22,24). A distance (22_L0,24_L0) of the first ends of the first and respectively the second side (22_A,22_B,24_A,24_B) of the spray contour (22,24) is determined. A length (22_L, 24_L) of the front line (22_C,24_C) of the spray contour (22,24) is determined. A value is determined which is representative for the spray quality.

FIG 1



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Description

[0001] The invention relates to a method and a test-device for testing an injector.

[0002] The object of the invention is to create a method and a test-device for testing an injector, which enable in a simple way a precise testing of a spray quality of the injector.

[0003] The object of the invention is achieved by the features of the independent claims 1 and 2.

[0004] The invention is distinguished by a method for testing an injector and by a corresponding test-device. Under a given condition fluid is sprayed with the injector. At least one picture is taken of the spray shape. A spray contour of the picture of the spray shape is determined. The spray contour comprises a first and a second side extending away from a source area of the spray contour corresponding to an area of the spray shape of the injector where the fluid exits the injector. The spray contour further comprises a front line facing away from the source area connecting the first end of the first side and the first end of the second side of the spray contour. A distance of the first ends of the first and, respectively, the second side of the spray contour is determined. The length of the front line of the spray contour is determined. A value is determined which is representative for the spray quality dependent on the distance of the ends of the first and, respectively, the second side of the spray contour and dependent on the length of the front line of the spray contour.

[0005] The spray shape is formed by many jets. The jets have different thicknesses and because of that different length. The different length of the jets leads to kinks and bends in the front line of the spray shape. The better the injector, or in particular the spray shape is, the less kinks and bends are in the front line and the shorter is the front line. The length of the front line of the spray contour in relation to the distance of the first ends of the first and, respectively, the second side of the spray contour is in particular representative for the spray quality of the injector. So, the length of the front line, normalized on the distance, enables to compare different spray shapes of different injectors. Further, the length of the front line, normalized on the distance, enables a quantification of the spray quality.

[0006] The given condition may be for example a temperature and/or a pressure of the fluid in the injector and/or outside of the injector. If there is a test chamber in which the fluid is sprayed for testing the injector, the given condition may further be a pressure and/or a temperature of the test chamber. The given condition further may relate on the sort of the fluid, and/or the embodiment of an injection nozzle of the injector and/or the embodiment of the test chamber. The given condition may further relate to an opening-time of the injector. The test chamber may be, for example, a combustion chamber of an internal combustion engine.

[0007] The invention is explained in the following with the aid of schematic drawings.

[0008] These are as follows:

Figure 1 a test-device,

Figure 2 two different spray contours,

Figure 3 a flow chart for testing an injector.

[0009] Elements of the same design and function that appear in the different illustrations are identified by the same reference character.

[0010] A test-device (figure 1) may comprise an injector 2, a camera 4, and a computer 6. The camera 4 is preferably a CCD camera through which many photos may be taken in a very short time interval. The time interval, for example, lasts some microseconds. In order to control the camera 4, the camera 4 is connected to the computer 6. The computer 6 may control the duration of the time interval and/or the amount of photos taken by the camera 4 during the time-interval. The camera 4 may take at least one, preferably more pictures of a first spray shape 20 which is produced by the injector 2 spraying a fluid. The computer 6 may save the pictures of the first spray shape 20, preferably in a memory unit of the computer 6.

[0011] The fluid may be sprayed into a test chamber, for example, a combustion chamber of an internal combustion engine which enables taking a picture of the spray shape 20. Preferably the fluid is sprayed under at least one, preferably, more given conditions. The given condition may be a temperature and/or a pressure of the fluid in the injector 2 and/or outside of the injector 2. If there is a test chamber in which the fluid is sprayed, the given condition may be a pressure in the test chamber and/or a temperature of the test chamber. Further, the given condition may relate on the sort of the fluid, and/or the embodiment of an injection nozzle of the injector 2 and/or the embodiment of the test chamber. The given condition may further relate on an opening-time of the injector during which the injector sprays the fluid once.

[0012] The first spray shape 20 of the injector 2 is conical and has and injector-specific cone angle. The spray shape may comprise a lot of jets. The jets may comprise different diameters and different lengths. For analyzing the first spray shape 20, preferably the pictures of the first spray shape 20 are digitalized and converted into black-and-white pictures. By digitalizing and/or converting of the pictures, there may be set a threshold for the conversion through which drops outside of the conical first spray shape 20 or small mistakes of the pictures are not converted. This contributes in a simple way to a proper picture processing of the picture of the first spray shape 20.

[0013] During the picture processing a first spray contour 22 of the picture of the spray shape 20 is made. The first spray contour 22 of the picture of the spray shape 20 comprises a first side 22_A (figure 2) and a second

side 22_B through which the cone angle of the spray contour 22 of the injector 2 is determined. The first and the second side 22_A, 22_B of the first spray contour 22 extend from an source area 21 of the first spray contour 22, which corresponds to that area of the spray shape 20 where the fluid exits the injector 2, towards a first end of the first and, respectively, the second side 22_A, 22_B of the first spray contour 22. The first spray contour 22 further comprises a front line 22_C facing away from the source area 21 of the first spray contour 22.

[0014] If the spray shape 20 would be perfect there were no jets and the front line 22_C of the first spray contour 22 would be totally straight. Then, the front line 22_C would have a length L which would have the same value like a distance 22_L0 between the first ends of the first and, respectively, the second side 22_A, 22_B of the first spray contour 22.

[0015] The same injector 2 with carbon deposits on an injection nozzle of the injector 2 or an other injector 2 having an other design produces a different spray shape 20. A second spray contour 24 may be determined dependent on the different spray shape 20. The second spray contour 24 comprises a first side 24_A, a second side 24_B, and a front line 24_C of the second spray contour 24. The front line 24_C of the second spray contour 24 extends from the area of the second spray contour 24, which corresponds to that area of the different spray shape 20 where the fluid exits the injector 2.

[0016] The distance 24_L0 of the first ends of the first and the second sides 24_B, 24_A of the second spray contour 24 may be approximately as long as the first distance 22_L0. However, the length L of the second front line 24_C of the second spray contour 24 is much larger than the length L of the first front line 22_C of the first spray contour 22. The worse the spray shape 20 is, the more kinks and bends shows the front line 22_C, 24_C and the longer is the front line 22_C, 24_C. So, the length L of the front line 22_C, 24_C may be representative for the spray quality.

[0017] For characterizing and quantizing the spray quality of the injector 2 and for comparing the spray quality of different injectors 2 having different designs a Leger-factor LF is introduced. The Leger-factor LF is dependent on the distance 22_L0, 24_L0 of the first ends of the first and, respectively, the second side 22_A, 22_B, 24_A, 24_B of the spray contour 22, 24 and dependent on the length L of the front line 22_C, 24_C. The Leger-factor corresponds to a normalization of the length L of the front line 22_C, 24_C of the spray contour 22, 24 on the distance 22_L0, 24_L0 of the first ends of the first and, respectively, the second side 22_A, 22_B, 24_A, 24_B of the spray contour 22, 24. Therefore, the Leger-factor is not dependent on different cone angles of the spray shape 20, on the resolution of the picture, and on a conversion of pixels of the pictures in different length-units.

[0018] Alternatively the spray quality may be characterized and quantizised without the Leger-factor dependent on the distance 22_L0, 24_L0 of the first ends of the first and, respectively, the second side 22_A, 22_B, 24_A, 24_B of the spray contour 22, 24 and dependent on the length L of the front line 22_C, 24_C of the spray contour 22, 24.

[0019] A program for testing an injector 2, especially for testing the spray quality of the injector 2 is saved preferably in a memory unit of the computer 6. The program starts in a step S1, preferably when the injector 2 produces the spray shape 20.

[0020] In a step S2, a picture of the spray shape 20 is taken by the camera 4. Additionally there may be taken a lot of pictures after short time-intervals.

[0021] In a step S3, the spray contour 22, 24 of the spray shape 20 is determined.

[0022] In a step S4, the length L of the front line 22_C, 24_C and the distance 22_L0, 24_L0 of the spray contour 22, 24 are determined.

[0023] In a step S5, preferably the Leger-factor LF is determined depending on the length L of the front line 22_C, 24_C and dependent on the distance 22_L0, 24_L0, according to the calculation described in the step S5. The bigger the Leger-factor is, the worse is the spray quality.

[0024] In a step S6, preferably the Leger-factor is showed by the computer 6, for example, on a display of the computer 6 and preferably the Leger-factor is saved in the memory unit of the computer 6.

Claims

1. Method for testing an injector comprising the steps of:

   - spraying fluid with the injector (2) under a given condition,
   - taking at least one picture of the spray shape (20),
   - determining a spray contour (22, 24) of the picture of the spray shape (20), the spray contour (22, 24) comprising a first and a second side (22_A, 24_A, 22_B, 24_B) extending away from an source area (21) of the spray contour (22, 24) corresponding to an area of the spray shape (20) of the injector (2) where the fluid exits the injector (2) and the spray contour (22, 24) comprising a front line (22_C, 24_C) facing away from the source area (21) connecting a first end of the first side (22_A, 24_A) and a first end of the second side (22_B, 24_B) of the spray contour (22, 24),
   - determining a distance (22_L0, 24_L0) of the first ends of the first and respectively the second side (22_A, 22_B, 24_A, 24_B) of the spray contour (22, 24),
   - determining a length (22_L, 24_L) of the front line (22_C, 24_C) of the spray contour (22, 24),
   - determining a value which is representative for

the spray quality dependent on the distance (22_L0, 24_L0) of the ends of the first and respectively the second side (22_A, 24_A, 22_B, 22_B) of the spray contour (22, 24) and dependent on the length (22_L, 24_L) of the front line (22_C, 24_C) of the spray contour (22, 24).

2. Test-device for testing an injector (2), the test-device being adapted to:

- spraying fluid with the injector (2) under a given condition,
- taking at least one picture of the spray shape (20),
- determining a spray contour (22, 24) of the picture of the spray shape (20), the spray contour (22, 24) comprising a first and a second side (22_A, 24_A, 22_B, 24_B) extending away from an source area (21) of the spray contour (22, 24) corresponding to an area of the spray shape (20) of the injector (2) where the fluid exits the injector (2) and the spray contour (22, 24) comprising a front line (22_C, 24_C) facing away from the source area (21) connecting a first end of the first side (22_A, 24_A) and a first end of the second side (22_B, 24_B) of the spray contour (22, 24),
- determining a distance (22_L0, 24_L0) of the first ends of the first and respectively the second side (22_A, 24_A, 22_B, 24_B) of the spray contour (22, 24),
- determining a length (22_L, 24_L) of the front line (22_C, 24_C) of the spray contour (22, 24),
- determining a value which is representative for the spray quality dependent on the distance (22_L0, 24_L0) of the ends of the first and respectively the second side (22_A, 24_A, 22_B, 24_B) of the spray contour (22, 24) and dependent on the length (22_L, 24_L) of the front line (22_C, 24_C) of the spray contour (22, 24).

FIG 1

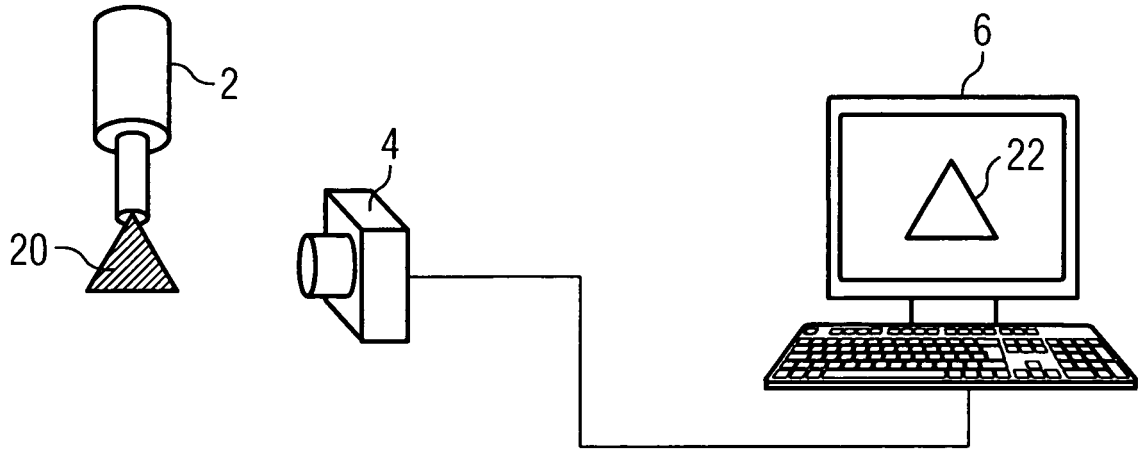


FIG 2

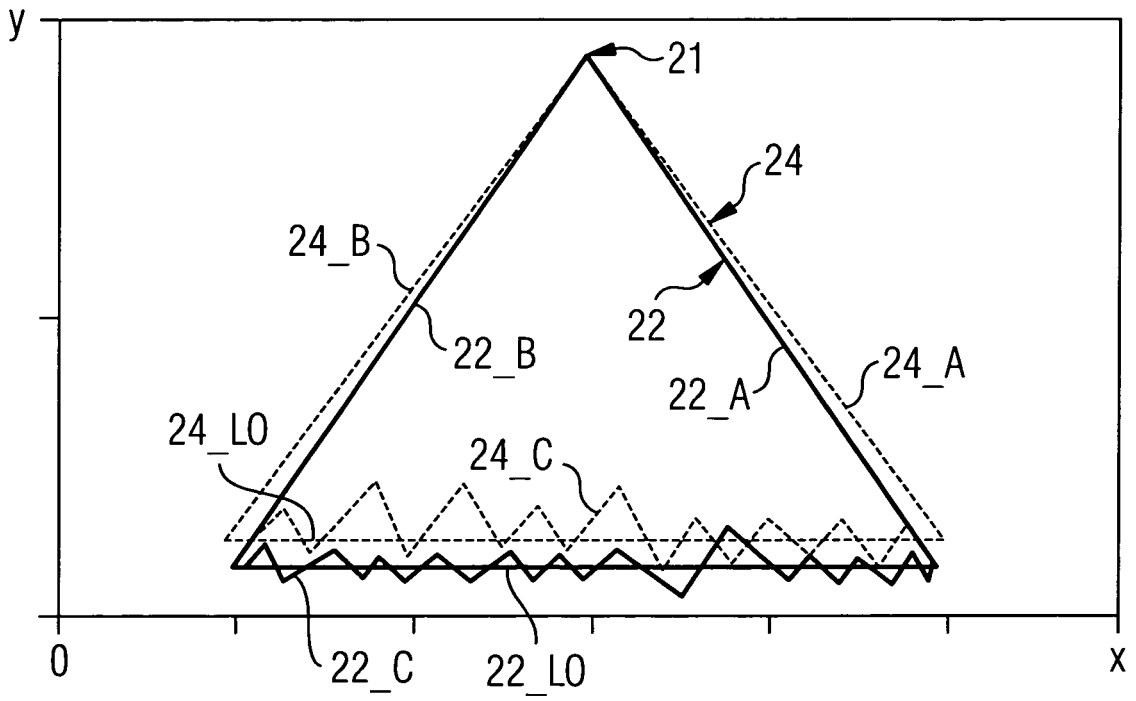
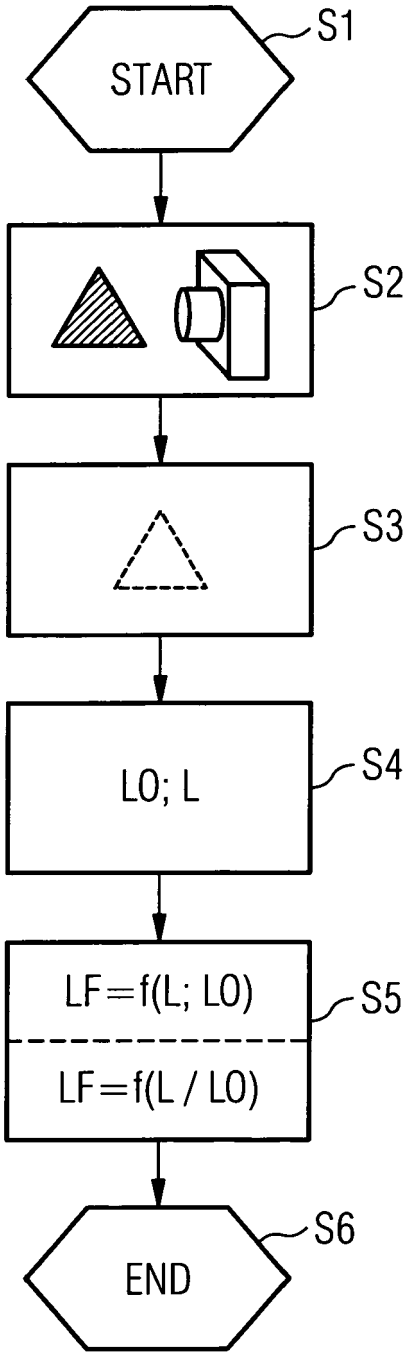


FIG 3



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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	27 March 2006	Blanc, S

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