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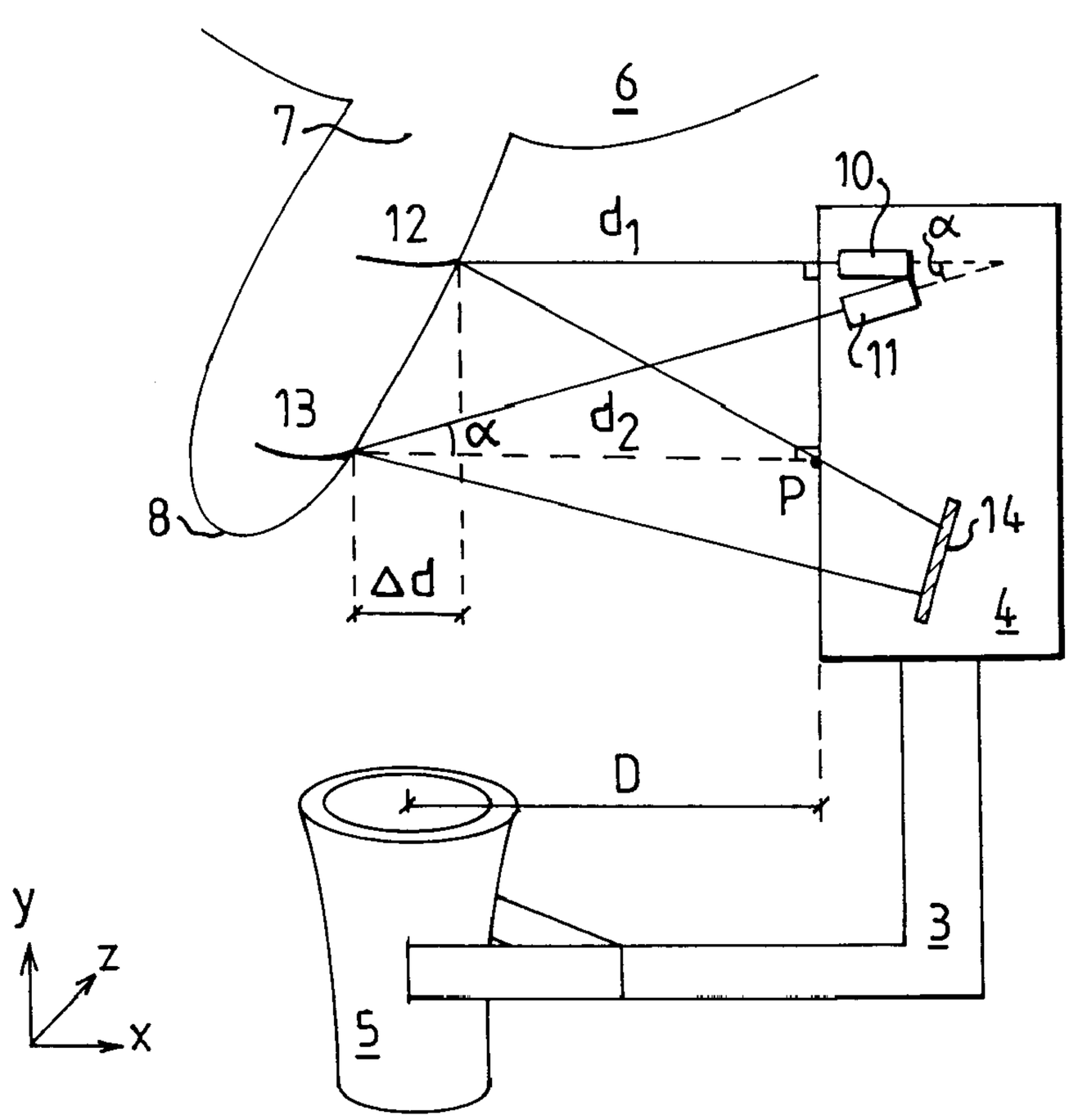
(54) Titre : APPAREIL ET PROCEDE PERMETTANT D'AMELIORER LA FIXATION DES GOBELETS TRAYEURS GRACE A DES MOYENS D'ILLUMINATION ET DE CAPTURE D'IMAGE

(54) Title: AN APPARATUS AND A METHOD FOR IMPROVING TEATCUP ATTACHMENT, BY USING ILLUMINATING AND IMAGE CAPTURING MEANS




(57) Abrégé/Abstract:
The present invention relates to an apparatus and a method for improving attachment of animal related means, such as a teatcup (5) onto a teat of an animal to be milked. Especially when a teat (7) is inclined, it may be difficult to find the right position before

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(57) Abrégé(suite)/Abstract(continued):
attachment of the teatcup (5). The apparatus comprises a first and a second illuminating sources (10, 11) by which a first and a second discrete areas (12, 13) are illuminated. An image capturing means (14) and a processing means (not shown) are used for determination and calculation of the correct teatcup position based on information about the teat tip (8) position. A described sequence is followed whereby the success rate of correct teatcup application is enhanced and thereby performance of the whole automated milking system.

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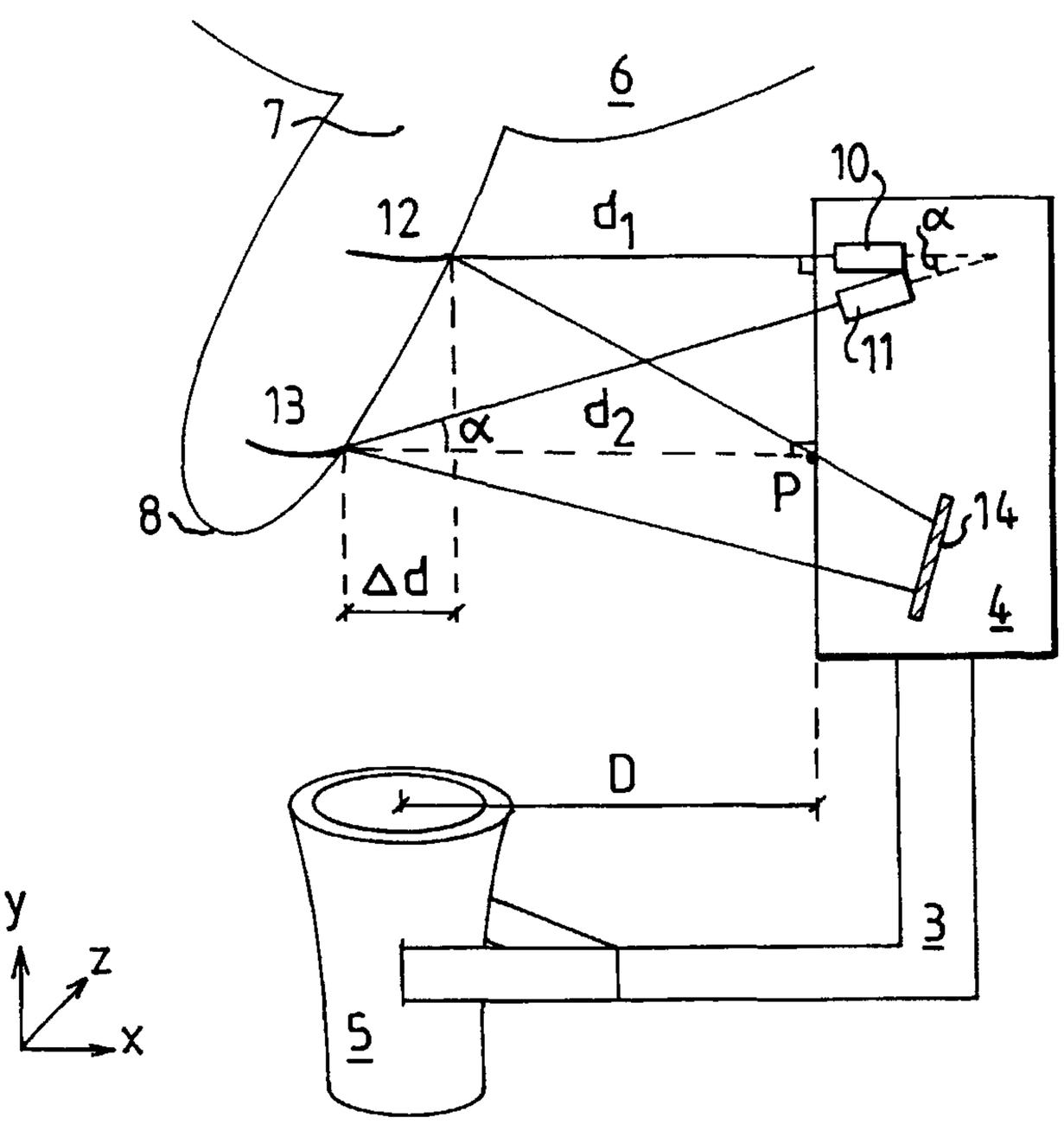


(57) Abstract: The present invention relates to an apparatus and a method for improving attachment of animal related means, such as a teatcup (5) onto a teat of an animal to be milked. Especially when a teat (7) is inclined, it may be difficult to find the right position before attachment of the teatcup (5). The apparatus comprises a first and a second illuminating sources (10, 11) by which a first and a second discrete areas (12, 13) are illuminated. An image capturing means (14) and a processing means (not shown) are used for determination and calculation of the correct teatcup position based on information about the teat tip (8) position. A described sequence is followed whereby the success rate of correct teatcup application is enhanced and thereby performance of the whole automated milking system.

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An apparatus and a method for improving teatcup attachment, by using illuminating and image capturing means.

## *Technical field of the invention*

The invention relates to an apparatus and a method for improving attachment of teatcups and other animal related means onto at least one teat of an animal to be cleaned or milked. In particular, the invention is adapted to enhance the success rate of correctly attaching a teatcup onto a teat in a clam and animal friendly way. The invention also reduces the risk for udder attachment of the teatcup instead of teat attachment.

## *Background of the invention*

Over the last decades, a variety of techniques and devices have been used for recognising teats and determining their positions prior to more or less automated milking. An automated milking machine of today normally manages the whole procedure of milking, including recognition of teats, determination of teat positions, attachment of teatcups, cleaning, pre-milking, milking and disinfecting the udder and teat region of the animal.

However, the steps of recognising teats, determining the teat positions and attaching teatcups are not always straightforward and many complications of different kinds and seriousness might occur. Some of these complications could be for example reflections from objects in the background or a folded teat in a teatcup, which even could be painful to the milking animal apart from making automatic milking difficult. Milking animals have individual features and various physical constitutions, just like humans and other species. Different animals' teats have various shapes, sometimes changing with their age and pregnancy situation, and the teats can be located differently on the animals' udders. Some milking animals have inclined and/or crooked teats leading to additional difficulties when attempts are made to determine the correct teat positions. In particular when a teat of an animal is strongly inclined, the position of the teat tip in the horizontal plane is different from

the position of the teat base near the udder in the same plane. Attachment of a teatcup onto a teat thus has to be very precise to reach a satisfactory success rate and to obtain a lenient, pleasant and healthy part of the milking procedure, which is easily accepted by the animals.

Complications of the above mentioned kinds during the attachment phase of a teatcup onto a teat has until today required at least attendance and sometimes attentive supervision by one or more operators, thereby removing some of the benefits of a reliable and fully automatic milking equipment. In order to improve automatic milking equipment and to make it more commercially interesting, improvements would be beneficial, especially concerning how to obtain a correct and reliable teat attachment of the animal related means, such as teatcups.

WO 97/15900 discloses a method of guiding a milking apparatus support towards a teat of an animal, whereby a sheet of light is illuminated towards a region expected to contain an udder and teats. A movement of the support means carrying the teatcup in vertical direction follows the initial illumination of a teat candidate in order to attach the teatcup.

However, during the vertical upward movement of the arrangement described in WO 97/15900, the sheet of light easily illuminates the udder somewhere above the teat to be illuminated, whereby the support responds with a backward movement since it is adapted to keep a predetermined distance to the illuminated object. Through the backward movement, the teatcup, which is fixed to the support means is moved backwards and whereby correct teatcup attachments are made difficult.

***Summary of the invention***

The object of the invention is to solve the above-mentioned problems that prior art is afflicted with. This could be done by means of an apparatus for determining the position in space of at least one teat, and in particular for determining the position in space of at least one teat tip, which is a teat end portion of a milking animal, comprising control means and a robot arm, movable in response to said control

means, moving a support means carrying at least one animal related means, such as a teatcup, said support means being provided with an image capturing means and a first illuminating light source illuminating a first discrete area of the teat. The apparatus is characterised in that

said support means further being provided with a second illuminating light source adapted to illuminate a second discrete area of the teat;

said control means being adapted to determine a position of the teat based on information provided by illumination with the first illuminating light source, and to determine a position of the teat tip based on information provided by illumination with the second illuminating light source; and

the support means being adapted to move in response to the, by said control means, determined position of the teat tip, while attaching the at least one animal related means, such as a teatcup, onto the teat.

Furthermore, a method is introduced, which has the object of solving the above-stated problems. It is solved by a method for determining the position in space of at least one teat, and in particular for determining the position in space of at least one teat tip, which is a teat end portion of a milking animal, comprising control means and a robot arm, movable in response to said control means, moving a support means carrying at least one animal related means, such as a teatcup, said support means being provided with an image capturing means and a first illuminating light source illuminating a first discrete area of the teat, The method is characterised by the steps of

illuminating a second discrete area of the teat with a second illuminating light source;

determining a position of the teat based on information provided by illumination with the first illuminating light source, and determining a position of the teat tip based on information provided by illumination with the second illuminating light source; and

moving the support means in response to the, by said control means,

determined teat tip position, while attaching the at least one animal related means, such as a teatcup, onto the teat.

One advantage of the present invention is that teat attachment can be done from a position right below the teat tip, leading to a reduced rate of folded teats and wrongly attached teatcups.

Utilisation of the present invention according to the application will improve operation of automated milking equipment and provide a way of obtaining a lenient, pleasant and healthy treatment and milking procedure, which easily can be accepted by the milking animals. Furthermore, it will support the conception of a reliable and fully automatic milking equipment requiring a minimum of supervision by operators and which can be of substantial commercial value.

Another of the advantages of using two light sources in comparison to only one light source, is the ability to continue to follow a teat, even though one of the light sources has lost its target. This might be when the teat is searched for or the light source is directed towards an area other than the teat to be illuminated, for instance towards an area situated below the teat.

According to an aspect of the present invention there is provided an apparatus for determining the position in space of at least one teat, comprising control means and a robot arm, movable in response to said control means, moving a support means carrying at least one animal related means, said support means being provided with an image capturing means and a first illuminating light source illuminating a first discrete area of the teat, wherein

said support means further is provided with a second illuminating light source adapted to illuminate a second discrete area of the teat;

said control means is adapted to determine a position of the teat based on information provided by illumination with the first illuminating light source, and

to determine a position of the teat tip based on information provided by illumination with the second illuminating light source;

the support means is adapted to move in response to the determined position of the teat tip, while attaching the at least one animal related means onto the teat; and

the support means is adapted to adjust its position in response to the control means by alternately using information provided by detection of illumination from the first illuminating light source and information provided by detection of illumination from the second illuminating light source.

According to another aspect of the present invention there is provided a method for determining the position in space of at least one teat, comprising control means and a robot arm, movable in response to said control means, moving a support means carrying at least one animal related means, said support means being provided with an image capturing means and a first illuminating light source illuminating a first discrete area of the teat, the method comprising:

illuminating a second discrete area of the teat with a second illuminating light source;

determining a position of the teat based on information provided by illumination with the first illuminating light source, and determining a position of the teat tip based on information provided by illumination with the second illuminating light source;

moving the support means in response to the determined teat tip position, while attaching the at least one animal related means onto the teat; and

adjusting the position of the support means in response to the control means by alternately using information provided by detection of illumination from the first illuminating light source and information provided by detection of illumination from the second illuminating light source.

## *Short description of the drawings*

The present invention will now be discussed in more detail with reference to preferred embodiments of the present invention, given only by way of example, and illustrated in the accompanying drawings, in which:

Fig 1 shows a perspective view of a milking apparatus as a whole with its main parts outlined including support means.

Fig 2 depicts the support arrangement more in detail with operating principle of illuminating means and image capturing means.

Fig 3 shows one of many possible arrangements of illuminating means and image capturing means, both accommodated in their housing.

Fig 4 shows an alternative embodiment of the invention utilising a set-up with a different geometry.

Fig 5 is a diagrammatic flow chart displaying the sequence of attaching a teatcup onto a teat according to the invention.

***Detailed description***

With reference to Fig 1, a principle drawing is shown of a first embodiment according to the present invention. The embodiment comprises a milking robot 1 in connection with a movable robot arm 2, moving in response to commands from a control means (not shown). A support means 3, such as a rod or bar, associates the robot arm 2 with at least one housing 4 and with various animal related means, such as a teatcup 5, a teat cleaner, teat brush, teat disinfecting mouthpiece or nozzle, etc. At least one light illuminating means is used for illuminating various parts of a milking animal, such as udder 6, teats 7 and/or teat tips 8. The illumination will be described in more detail in the following.

For clarity, the same notations have been used for the same features in all figures throughout the document.

Furthermore, referring to Fig 2, an inclined teat of a milking animal is illuminated by a first illuminating light source 10 as well as by a second illuminating light source 11. Each illuminating source in this case is a laser, which illuminates a plane of light, by means of optical arrangements, such as a 2-dimensionally dispersing lattice (not shown). A first discrete area 12 on the teat 7 is illuminated by the first illuminating light source 10, which first discrete area 12 is situated substantially in the same horizontal plane as the first illuminating light source 10. Towards the teat tip 8, a second discrete area 13 is illuminated by the second illuminating light source 11. The separation between the two illuminated discrete areas 12, 13 is due to an inclination angle $\alpha$ separating the beams from the illuminating lasers 10, 11. However, although the laser beams are illuminated from the light sources 10, 11 with a relative inclination angle $\alpha$, the reflections from the teat 7, i.e. the first and

the second illuminated discrete areas 12, 13 respectively, will be in parallel on the teat 7.

The direction of the second illuminating laser 11 downwards prevents its illuminated laser plane from hitting the top region of the teatcup 5 instead of hitting the target, i.e. the teat 7 to be illuminated. This is particularly the case when the teatcup 5 is raised for attachment and approaches the vicinity of the teat tip 8. By means of this downward directed second illuminating laser 11, it is possible to illuminate the teat tip 8 longer during the raise operation of the teatcup 5 without blocking the illuminated laser beam and hence without losing any positioning information about the current teat tip 8 position.

In case a teat 7 is inclined and/or crooked, there will be a difference between a distance $d_1$ from the first light source 10 to the first illuminated discrete area 12, and a distance $d_2$ in parallel with $d_1$ from the second illuminated discrete area 13 to a position p on the housing, in the vertical plane perpendicular to the illuminated light beam from the first illuminating light source 10. This difference in distances is denoted $\Delta d$.

The distance $\Delta d$ may be critical if it exceeds a margin of error which allows for attaching the teatcup 5 onto a teat 7 without complications. The above-mentioned margin is specific for each system, so no general value can be mentioned here. However, attachment of a teatcup 5 onto a teat 7 must be made with great precision to prevent the conceivable problems that already have been mentioned from occurring, and to give the farmer or any other operator well-founded confidence in the reliability of the milking apparatus.

Geometrical accuracy requirements, which requirements are specific for each system, set certain limitations concerning the angle between the at least two laser light planes and hence concerning a minimum separation between light sources and detector. In order to get an image of the teat 5 from longer distance, it is necessary to arrange one of the light sources in the substantially horizontal plane. According to one embodiment, it is conceivable to use only one pivoting illuminating light source

as long as it can be used in various directions. This pivoting illuminating light source would function as substitute for at least one of illuminating light sources 10, 11 and provide the same conditions but with less illuminating light sources. Instead of, or in combination with, a pivoting illuminating light source, the same optical illumination result can be achieved by using optical arrangements, for example optically reflecting mirrors arranged to reflect the illumination from at least one illuminating light source in different directions.

According to the first embodiment of the invention and still referring to Fig 2, an image of the illuminated teat 7 is reflected onto a detector surface 20 (see Fig 3) of an image capturing means 14 accommodated or in association with the housing 4. The captured images show the projections of the first and second discrete illuminated areas 12, 13 on different heights, depending on the distances $d_1$ and $d_2$.

The apparatus follows a sequence based on an algorithm for keeping both distances $d_1$ and $d_2$ in correspondence with a predetermined distance D to simplify the teat attachment as much as possible and enhance the success rate of correctly accomplished teatcup attachment.

However, when $\Delta d$ is large because of an inclined and/or crooked teat 7, it is important to use the right discrete illuminated area when determining the distance from to the teat 7 to any well-defined position, such as for example p, in the vertical plane in parallel with the housing 4. When the support means 3 with integrated housing 4 and animal related means, such as a teatcup 5, is moved in any direction, the apparatus alternates between positional adjustments based on the first illuminated discrete area 12 and adjustments based on the second illuminated discrete area 13.

In one embodiment, this alternation is done with sequence of alternately twinkling illuminating light sources 10, 11. Such alternating twinkling of the light sources 10, 11 reduces unwanted reflections from the light source, which for the moment is not used for measuring and determining the distance. A twinkling procedure like the above simplifies image processing of the captured image. However, in another

embodiment, both lasers 10, 11 are steadily illuminating, while the image processing unit is adapted to compensate with respect to these two steadily illuminating light sources 10, 11. Both methods described here yield the same qualitative results.

The distance D is a fixed distance, preferably around 100 mm. Since D is constant, once the correct relative distance between the teat 5 and/or teat tip 8 and some predefined point of the housing 4, such as for instance p, is found, the apparatus is adapted to maintain this relative distance, also if the animal moves during the attachment phase, thereby facilitating teatcup attachment even though the conditions may not be the easiest possible during the attachment phase.

Fig 3 shows the housing 4, which accommodates optical arrangements 10, 11, 14 according to the invention. An image capturing means 14 captures images which are transformed into information signals and furthermore are delivered to image processing means (not shown). Here they are used for recognition of teats 7 and determination of animal related distances. The image capturing means 14, preferably a camera, digital camera and/or a video camera (CCD-camera), comprises a detector surface 20 onto which images are projected. The detector surface 20 may include for instance a detector array of several detector elements, so-called pixels, convenient for transforming a captured image into an image signal.

Furthermore, the housing accommodates the first and the second illuminating light sources 10, 11, preferably illuminating lasers, of which one of them illuminates the substantial horizontal plane and the other illuminates another plane, separated by an angle $\alpha$. When the housing 4 is moved upwards, for instance when a teat 7 is searched for and/or the teatcup 5 is raised for teat attachment, it is conceivable that the light beams from the illuminating light sources 10, 11 may be blocked by an udder 6 hanging down in front of the housing 4. If this blocking would occur, the apparatus no longer could manage to recognise teats 7 and determine the distances and thereafter calculate the teat positions. For this reason, the housing 4 is provided with a means 24, preventing the udder to block illuminated light beams from the

first and second illuminating light sources 10, 11 as well as preventing from shading of the image capturing means 14. The preventing means 24 keeps the optical components 14, 30, 32 of the housing 4 clean and is found on top of the housing 4 in Fig 3 and somewhat resembles a peak of a cap.

In another embodiment according to Fig 4, the present invention is realised using a different geometry. This different geometry has at least one advantage, in comparison with the above described first embodiment, since it deals with the unwanted situation when optical components 14, 30, 32 comprised in the housing 4 are blocked. Such blocking especially occurs when the housing 4 is raised and consequently is blocked by an udder 6 hanging down in front of for instance the detector surface 20 of the image capturing means 14. In Fig 4 is shown a first illuminating light source 30 and a second illuminating light source 32. The illuminating light sources 30, 32 illuminate a first discrete area 34 on a teat candidate and a second discrete area 36 respectively. By comparing the two parallel distances $d_1$ and $d_2$ in the same vertical plane between the teat and the housing 4, it is possible to determine a difference in distances $\Delta d$ in analogy with the above-described method.

Fig 5 shows a diagrammatic operational flow chart of the invention. Beginning on top of the flow chart, the functional algorithm of the apparatus starts (step 101) with switching off a possible vacuum level (step 102) in a teatcup followed by recognition of a teat candidate (step 103). The recognition is followed by the substantially horizontally directed illumination of the teat candidate with the first illuminating light source 10, which light source 10 is denoted first laser in the flow chart of Fig 5 (step 104). If the illumination from the first light source 10, which illumination is called first stripe in the flow chart, can be detected by the image capturing means 14 (step 105), the support means 3 is moved in a way that the teatcup 5 is centred under the so-called first stripe (step 106). After this initial adjusting movement, the sequence continues with switching off the first illuminating light source 10 at the same time as the second illuminating light source 11 is switched on (step 107). In accordance with one embodiment, the second

illuminating light source 11 is directed downwards with an inclination angle $\alpha$ with respect to the first illuminating light source 10 (see Fig 2). If no first stripe can be detected (step 105) from the first illuminating light source 10 by the image capturing means 14, the sequence returns back to the initial switching off a possible vacuum level (step 102) and further continues along the sequence from there.

If illumination, called stripe in the flow chart, from the second illuminating light source 11 is detected (step 108) by the image capturing means 14, the sequence continues with controlling whether the vacuum level is switched off (step 112). If no laser stripe is detected (step 108) from the second illuminating light source 11, a control of the vacuum level is done (step 109). If there is no vacuum, vacuum is applied (step 110) and otherwise the control is followed by a raise of the support means 3 (step 111), whereby the sequence returns back to switching on the first illuminating light source 10 (step 104). On the other hand, if reflection was detected (step 108) and no vacuum was applied (step 112), the support means 3 carrying the housing 4 as well as the animal related means, such as a teatcup 5, is lowered (step 113), whereby the sequence also from here returns back to switching on the first illuminating light source 10 (step 104).

In case the control of whether the vacuum level was switched off (step 112) results in a negative answer, a check is carried out of whether the teatcup 5 has been attached in a correct way (step 114). Should the answer be negative, the second illuminating light source 11 is switched on (step 115) followed by a check of whether reflection from the second illuminating light source 11, i.e. the second stripe according to the flow chart of Fig 5, can be detected by the image capturing means 14 (step 116).

It no reflection of a second stripe (step 116), i.e. reflection from the second illuminating light source 11 can be detected, the sequence returns back to its starting point or at least to the switching off vacuum (102), since the attachment of a teatcup 5 onto a teat 7 has been unsuccessful. Consequently, a new attempt at attaching the teatcup 5 must be made. However, in the other case when reflection of a second

stripe can be detected (step 116) by the image capturing means 14, leads to a further and more precise movement of the support means 3 in order to finally centre the teatcup 5 right below the teat tip 8 (step 117).

After having centred the teatcup under the teat tip 8, the support means is raised (118) followed by another check of whether the teatcup 5 is correctly attached to the teat 5 or not (step 114). If the teatcup 5 is correctly attached, the sequence is brought to an end (step 119) and a program for further treatment and/or milking may begin.

As the above-described sequence is gone through, it can be seen as a twinkling procedure between the first and the second illuminating light sources 10, 11. In this case, twinkling means an alternately switching procedure of the first and the second illuminating light sources 10, 11. Twinkling is used to provide good conditions without disturbing reflections for the image capturing means 14 to detect the searched position in space, which will be interpreted and referred to as the teat tip 8.

This sequential method, which utilises twinkling has the advantage, that the teat shape, especially with an inclined and/or a crooked anatomy of the teat 7, can be followed closely in a zigzag pattern by utilising detected and processed positional information alternately from both of the first and the second illuminating light sources 10, 11. Such zigzag manoeuvring enhances the correct teatcup attachment rate substantially and hence the reliability and efficiency of the automated milking equipment.

As already mentioned, twinkling light sources 10, 11 are not a necessity in a system of the above described kind. By using image processing, a sequence without twinkling but with steadily illuminating light sources can be realised just as well. As described above, both methods lead to the same results, but in different ways.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. An apparatus for determining the position in space of at least one teat, comprising control means and a robot arm, movable in response to said control means, moving a support means carrying at least one animal related means, said support means being provided with an image capturing means and a first illuminating light source illuminating a first discrete area of the teat, wherein

said support means further is provided with a second illuminating light source adapted to illuminate a second discrete area of the teat;

said control means is adapted to determine a position of the teat based on information provided by illumination with the first illuminating light source, and to determine a position of the teat tip based on information provided by illumination with the second illuminating light source;

the support means is adapted to move in response to the determined position of the teat tip, while attaching the at least one animal related means onto the teat; and

the support means is adapted to adjust its position in response to the control means by alternately using information provided by detection of illumination from the first illuminating light source and information provided by detection of illumination from the second illuminating light source.

2. An apparatus according to claim 1, wherein the apparatus is for determining the position in space of at least one teat tip, which is a teat end portion of a milking animal.

3. An apparatus according to claim 1 or 2, wherein the at least one animal related means comprises a teatcup.

4. An apparatus according to any one of claims 1 to 3, wherein

the first illuminating light source is directed perpendicular to vertical plane and towards an expected area of finding the teat; and

the second illuminating light source is inclined with respect to the first illuminating light source towards an expected area of finding the teat tip, whereby blocking of the illumination between the second illuminating light source and the teat tip is prevented.

5. An apparatus according to claim 4, wherein

the second illuminating light source is inclined downwards with an angle towards opening of the teatcup, whereby blocking of the illumination between the second illuminating light source and the teat tip is prevented.

6. An apparatus according to claim 5, wherein

the first and the second illuminating light sources are adapted to alternately illuminate light when the support means is moved in vertical direction.

7. An apparatus according to claim 5, wherein

the support means is adapted to move step-wise in response to received information from the alternately illuminating light sources.

8. An apparatus according to claim 5, wherein

the support means is adapted to move step-wise in a zigzag-pattern in response to received information from the alternately illuminating light sources.

9. An apparatus according any one of claims 1 to 8, wherein

a housing is provided with a means preventing optical components accommodated in the housing to be blocked by objects.

10. An apparatus according to claim 9, wherein said objects comprise an udder hanging down in front of the housing.

11. An apparatus according to any one of claims 1 to 10, wherein

the first and/or the second illuminating light sources illuminate structured and/or monochromatic light.

12. An apparatus according to claim 11, wherein the structured and/or monochromatic light comprise illumination from a laser source and/or infrared source.

13. An apparatus according to any one of claims 1 to 12, wherein

the first and the second illuminating light sources are combined in one pivotally arranged and movable illuminating light source adapted to illuminate in different directions.

14. A method for determining the position in space of at least one teat, comprising control means and a robot arm, movable in response to said control means, moving a support means carrying at least one animal related means, said support means being provided with an image capturing means and a first illuminating light source illuminating a first discrete area of the teat, the method comprising:

illuminating a second discrete area of the teat with a second illuminating light source;

determining a position of the teat based on information provided by illumination with the first illuminating light source, and determining a position of the teat tip based on information provided by illumination with the second illuminating light source;

moving the support means in response to the determined teat tip position, while attaching the at least one animal related means onto the teat; and

adjusting the position of the support means in response to the control means by alternately using information provided by detection of illumination from the first illuminating light source and information provided by detection of illumination from the second illuminating light source.

15. A method according to claim 14, wherein the method is for determining the position in space of at least one teat tip, which is a teat end portion of a milking animal.

16. A method according to claim 14 or 15, wherein the at least one animal related means comprises a teatcup.

17. A method according to any one of claims 14 to 16, further comprising:

directing the first illuminating light source perpendicular to vertical plane and towards an expected area of finding the teat; and

inclining the second illuminating light source with respect to the first illuminating light source towards an expected area of finding the teat tip, whereby blocking of the illumination between the second illuminating light source and the teat tip is prevented.

18. A method according to claim 17, further comprising

inclining the second illuminating light source downwards with an angle towards opening of the teatcup, whereby blocking of the illumination between the second illuminating light source and the teat tip is prevented.

19. A method according to claim 18, further comprising

adapting the first and the second illuminating light sources to alternately illuminate light when the support means is moved in vertical direction.

20. A method according to claim 19, further comprising

adapting the support means to move step-wise in response to received information from the alternately illuminating light sources.

21. A method according to claim 19, further comprising

adapting the support means to move step-wise in a zigzag-pattern in response to received information from the alternately illuminating light sources.

22. A method according to any one of claims 14 to 21, further comprising

providing a housing with a means preventing optical components accommodated in the housing to be blocked by objects.

23. A method according to claim 22, wherein said objects comprise an udder hanging down in front of the housing.

24. A method according to any one of claims 14 to 23, wherein

the first and/or the second illuminating light sources illuminate structured and/or monochromatic light.

25. An apparatus according to claim 17, wherein the structured and/or monochromatic light comprise illumination from a laser source and/or infrared source.

26. Automated milking system, comprising means for carrying out a method as defined in any one of claims 14 to 25.

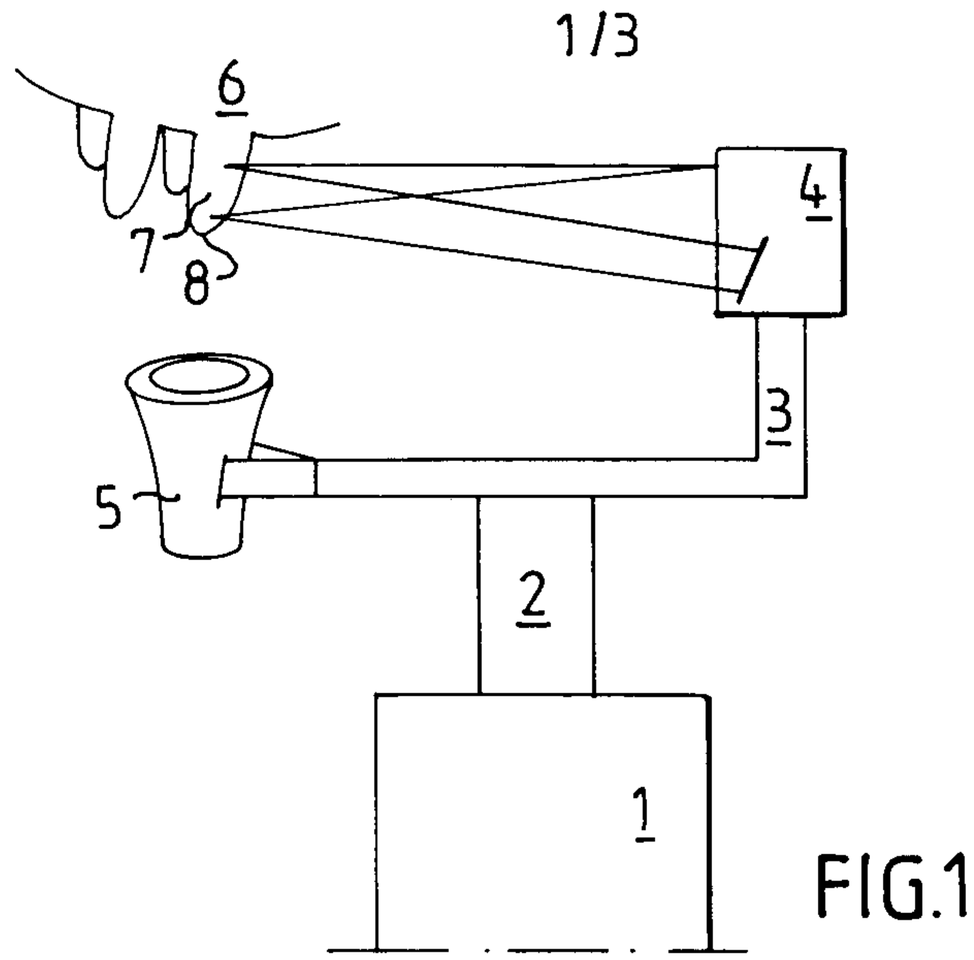



FIG.1

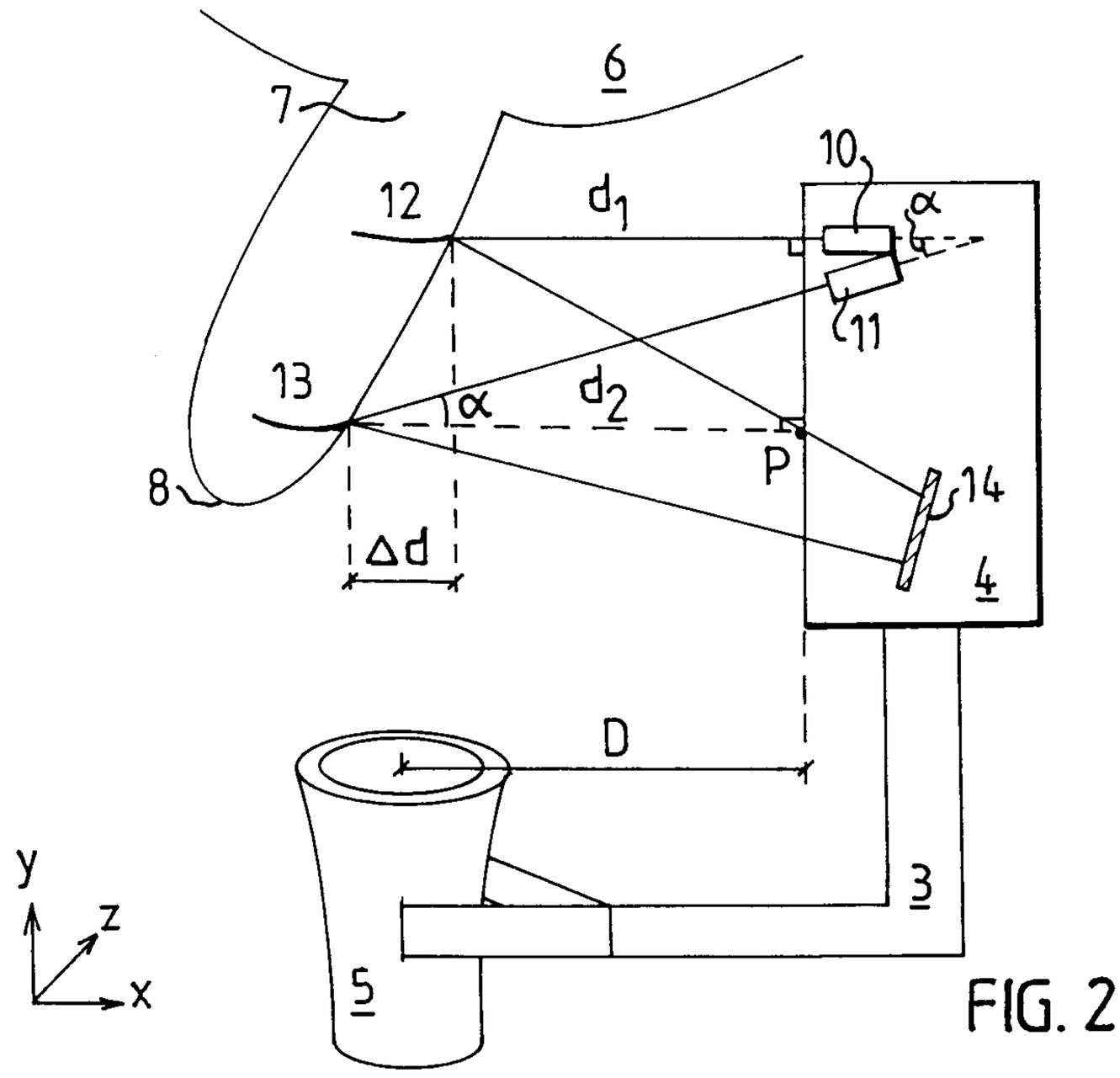



FIG. 2

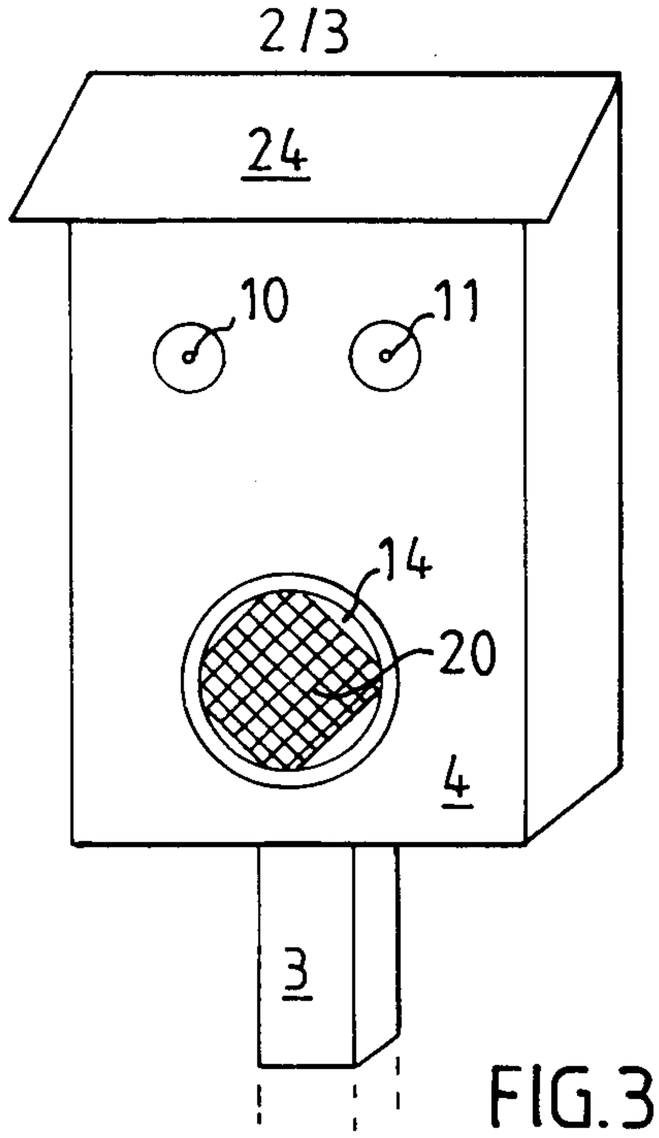



FIG.3

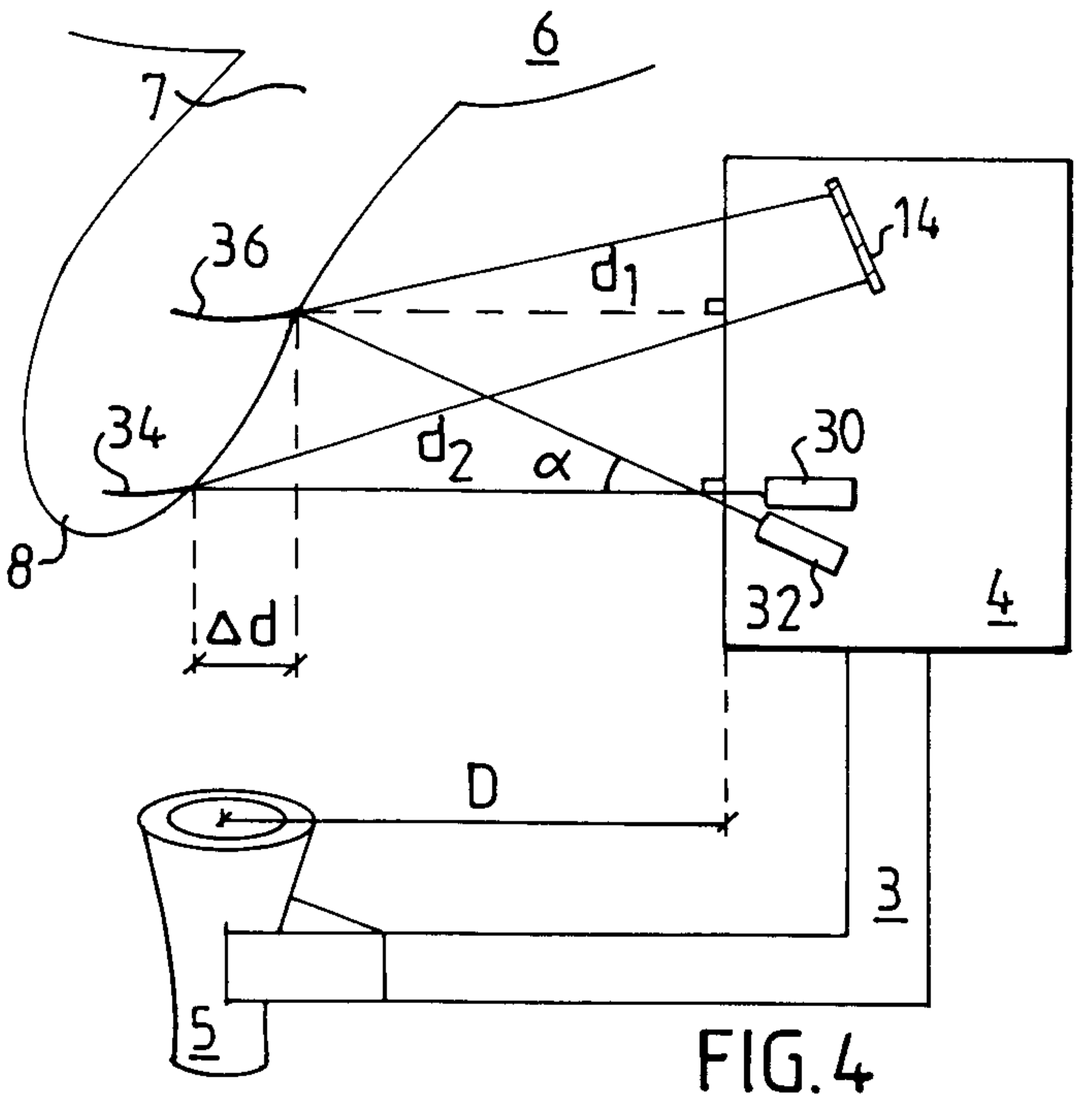



FIG.4

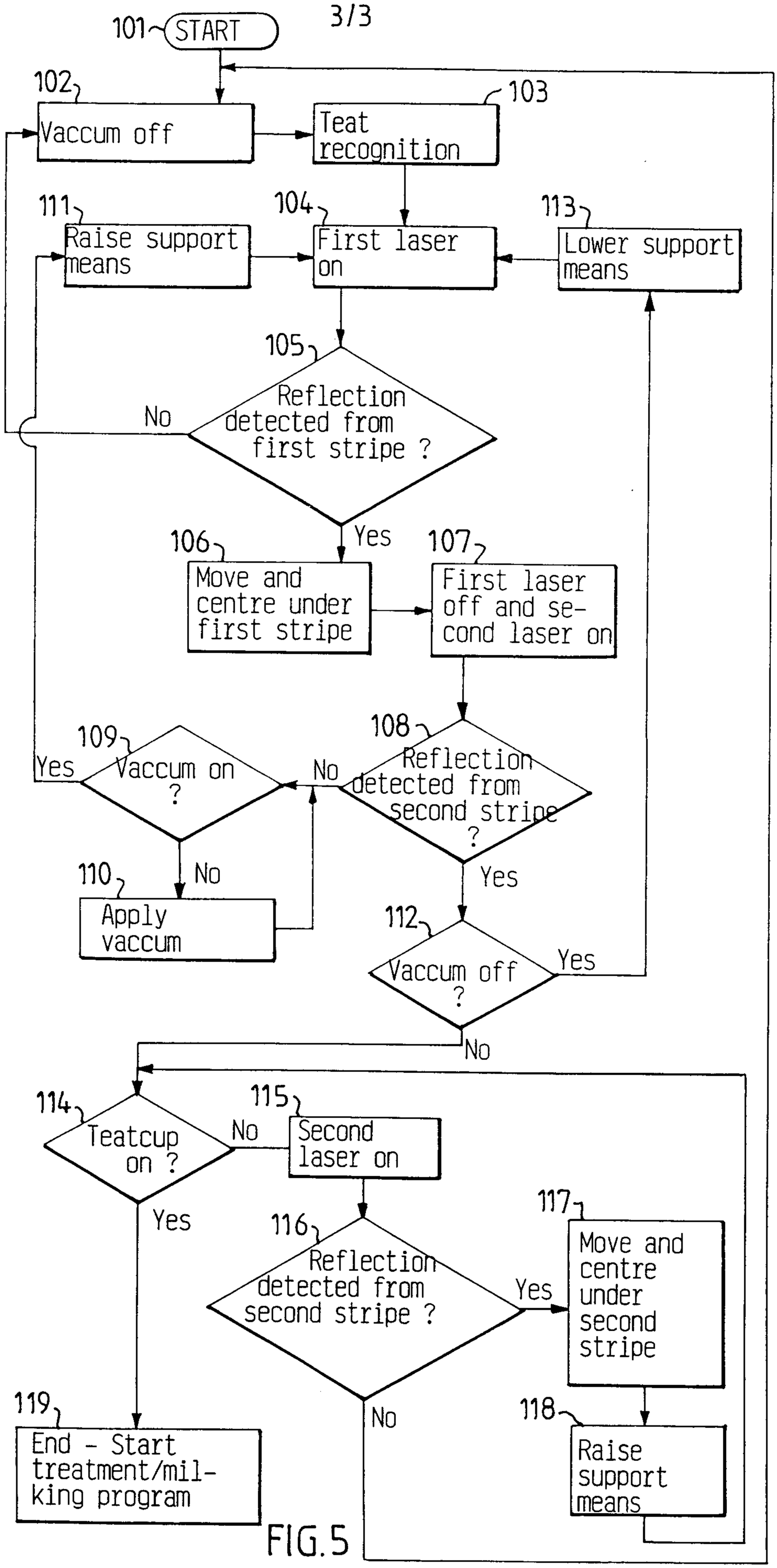
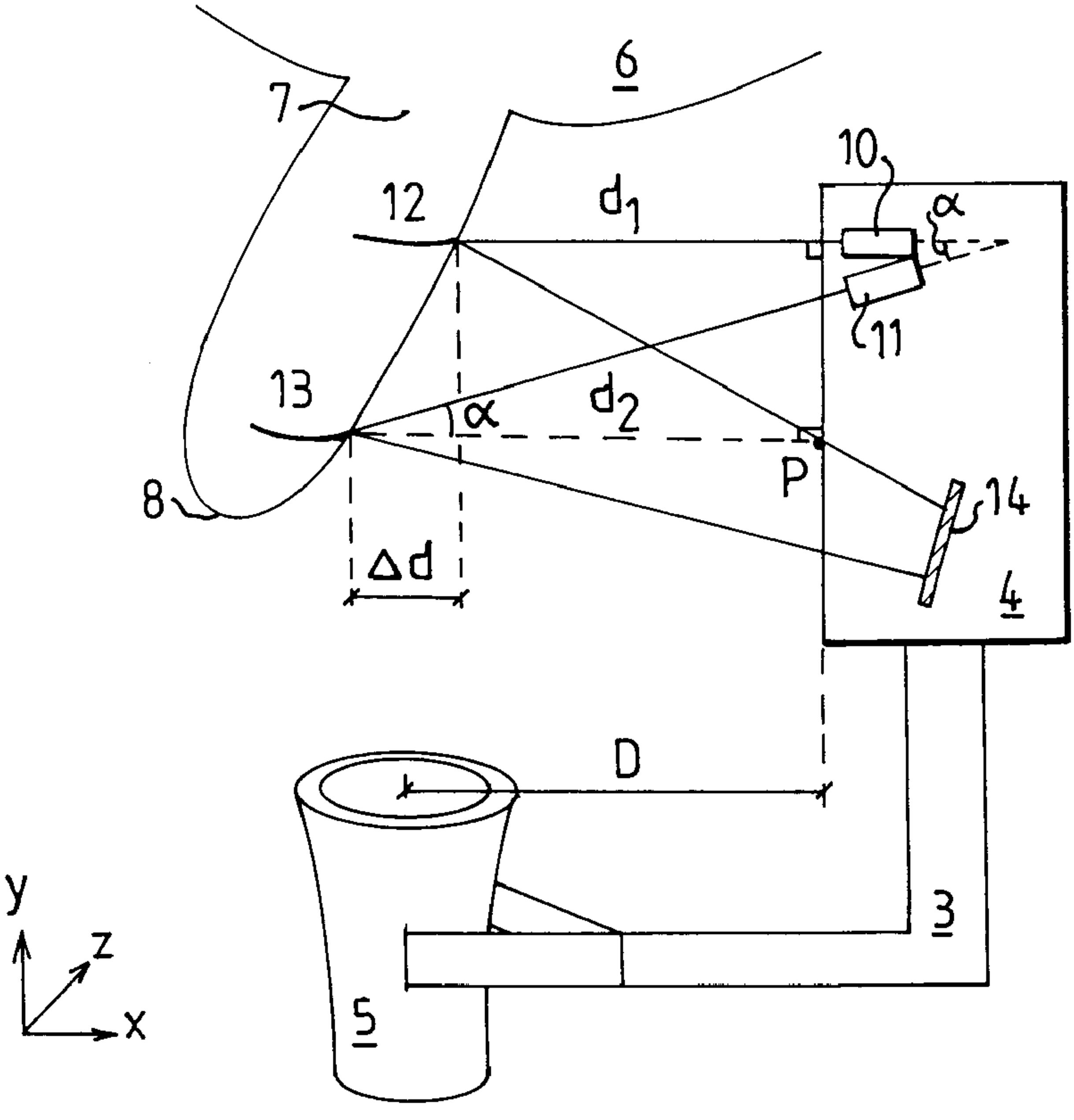

101 START
102 Vaccum off
103 Teat recognition
111 Raise support means
104 First laser on
113 Lower support means
105 Reflection detected from first stripe ?
No
Yes
106 Move and centre under first stripe
107 First laser off and second laser on
108 Reflection detected from second stripe ?
No
Yes
109 Vaccum on ?
Yes
No
110 Apply vaccum
112 Vaccum off ?
Yes
No
114 Teatcup on ?
No
Yes
115 Second laser on
116 Reflection detected from second stripe ?
Yes
No
117 Move and centre under second stripe
118 Raise support means
119 End - Start treatment/milking program

FIG.5


7
6
10
12
$d_1$
α
11
13
α
$d_2$
P
8
14
4
Δd
D
3
5
y
z
x