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THE PATENTS ACT 1952

DECLARATION IN SUPPORT OF A CONVENTION APPLICATION FOR A PATENT

In support of the Convention Application made for a patent for an invention entitled:

Title of Invention: Tyre Grooving Apparatus and Method

I/~~We~~ Shizuo Katsurada, President

Full name(s) and address(es) of Declarant(s)

of Sumitomo Rubber Industries, Ltd.
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do solemnly and sincerely declare as follows:-

Full name(s) of Applicant(s)

~~1. I am/We are the applicant(s) for the patent~~

(or, in the case of an application by a body corporate)

1. I am/We ~~are~~ authorised by Sumitomo Rubber Industries, Ltd. the applicant(~~s~~) for the patent to make this declaration on its/~~their~~ behalf.

2. The basic application(~~s~~) as defined by Section 141 of the Act was/~~were~~ made

Basic Country(ies): in Japan

Priority Date(s): on 28 July, 1988

Basic Applicant(s): by Sumitomo Rubber Industries, Ltd.

~~3. I am/We are the actual inventor(s) of the invention referred to in the basic application(s)~~

Full name(s) and address(es) of inventor(s)

(or where a person other than the inventor is the applicant)

3. Satoru Kinuhata and Seiki Yamada

of 6-10, Konan-cho, 4-chome, Higashinada-ku, Kobe-shi, Hyogo 658 and 6-3, Shimohozumi, 3-chome, Ibaraki-shi, Osaka 567, both in Japan

(respectively)

~~is~~/are the actual inventor(s) of the invention and the facts upon which the applicant(~~s~~) is/~~are~~ entitled to make the application are as follows:

Set out how Applicant(s) derive title from actual inventor(s) e.g. The Applicant(s) is/are the assignee(s) of the invention from the inventor(s)

Sumitomo Rubber Industries, Ltd. is entitled by Contract of Employment between Satoru Kinuhata and Seiki Yamada as employees and Sumitomo Rubber Industries as employer, as a person who would be entitled to have the patent assigned to it if a patent were granted upon an application made by the inventors.

4. The basic application(~~s~~) referred to in paragraph 2 of this Declaration was/~~were~~ the first application(~~s~~) made in a Convention country in respect of the invention(~~s~~) the subject of the application.

Declared at Hyogo this 23 day of March 1990

Shizuo Katsurada

Signature of Declarant(s)

Shizuo Katsurada, President

P4 To: The Commissioner of Patents 11/81

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(57) Claim

1. A tyre grooving apparatus comprising:

(a) a tyre support device for rotatably support a tyre,

(b) a cutter support device which is rotatable,

(c) a pivotable arm which holds the cutter support device at the free end portion thereof,

(d) a vertically movable block having a rotatable shaft which pivotably holds the pivotable arm and a mechanism portion for standard movement,

(e) a horizontally movable block holding the vertically movable block and having a mechanism portion for standard movement and a mechanism portion for correction movement which can move the block at least in the transverse direction in parallel with the tyre support shaft of the tyre support device,

(f) a means for detecting the lateral runout of the tyre,

(g) a means for detecting the center deviation of the tyre, and

(h) a control means

and is characterized in that the control means comprises a standard movement operation portion which set the cutter at the theoretical cutting position, and a correction movement operation portion which calculates

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the amount of correction movement in accordance with input signals from the means for detecting the lateral runout of the tyre and the means for detecting cente deviation of tyre, and operates the mechanism portion for correction movement mounted on the horizontally movable block in accordance with the calculated value.

3. A tyre grooving method for grooving a tyre according to a standard program characterized by:

(a) a step of detecting lateral runout of the tyre.

(b) a step of detecting center deviation of the tyre.

(c) a step of correcting the grooving position of the cutter in accordance with the detected values of lateral runout and center deviation.

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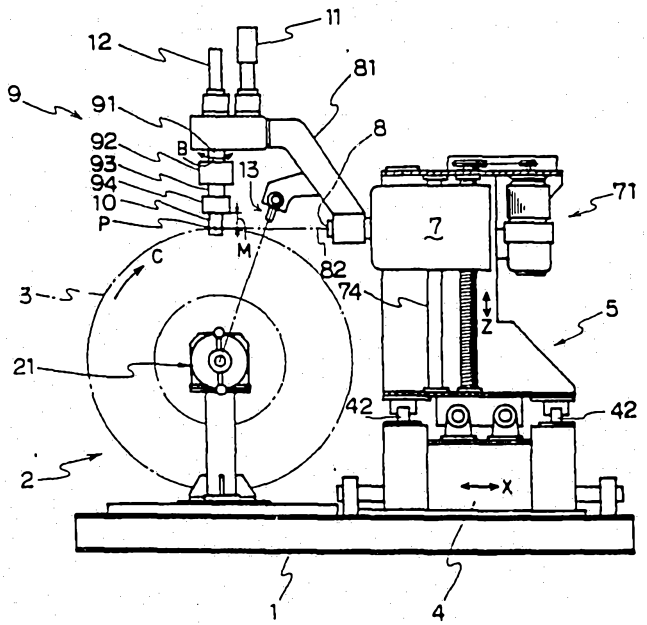


(57) Abstract

A tire grooving apparatus according to the present invention consists of at least a carriage (5) movable in a lateral direction parallel to a tire support shaft, a lift (7) provided on the carriage and vertically movable, and a pivotable arm (81) provided on the lift (7) and having a cutter support unit (9) at the free end portion thereof, characterized in that the apparatus is further provided with a means (13) for detecting a deviation of center line of a tire tread surface, or both this center line deviation detecting means (13) and a lateral vibration detecting means (14). A tire grooving method according to the present invention is characterized in that an actual measurement obtained by the center line deviation detecting means (13), or both an actual measurement obtained by the center line deviation detecting means (13) and an actual measurement obtained by the lateral vibration detecting means (14) are utilized for the correction of the quantity of movement of a cutter (10).

(57) 要約

本発明のタイヤグルービング装置は、少なくともタイヤ支持軸と平行な横方向に移動可能な移動台(5)と、前記移動台上にあって昇降自在な昇降台(7)と先端にカッタ支持装置(9)を有する前記昇降台(7)に設けられた回動アーム(81)とからなり、タイヤトレッド面のセンターずれ検出器(13)またはセンターずれ検出器(13)と横振れ検出器(14)の両方が設けられていることを特徴としている。

また、本発明のタイヤのグルービング方法は、カッタ(10)の移動量の補正に際しセンターずれ検出器(13)の計測値またはセンターずれ計測値と横振れ計測値の両方が利用されていることを特徴としている。

DESCRIPTION

TYRE GROOVING APPARATUS AND METHOD

TECHNICAL FIELD

The present invention relates to a tyre grooving apparatus and method wherein lateral runout and center deviation or only the center deviation are detected and thereby the cutting position of a cutter can be corrected.

BACKGROUND ART

Conventionally, the work of grooving a tyre for trial manufacturing and a limited scale production, namely carving the tread pattern grooves in a plain cured tyre without any tread pattern is generally performed by means of a hand cutter and it requires skills and a lot of time.

Taking the above-mentioned problems into consideration, the present applicant already proposed a tyre grooving apparatus, as shown in Fig 32, having, as main constructive features, a cutting device attached to a vertically movable carriage, which is moved in parallel and perpendicular directions against the tyre support shaft; a pivotable arm support shaft which is extended from the carriage; a pivotable arm attached to the support shaft; a cutter holder which is pivotably attached to the pivotable arm perpendicularly to the axis thereof; a cutter which is held by the end portion of the cutter holder; and the cutting position of the cutter arranged to be on the extended axis of the support shaft (Japanese Unexamined Patent Publication No. 54240/1988 and 177232/1986).

In the present specification, the cutting position of cutter means a peculiar point of cutter which is a certain distance (M) (including zero) from the bottom end of the cutter holder (refer to Fig. 1).

Carving of tread pattern grooves for plain tyre

by the tyre grooving apparatus is carried out by setting the cutting position of the cutter to the tangential line (Processing Standard Point for Tread) of plain tyre. Thus, since the cutting position of the cutter is kept always on the extended axis of the pivotable arm support shaft, namely on the tangential line of plain tyre, calculation of quantity of movement of the movable carriage and the pivotable arm becomes simple, the programming of computer programs becomes easy and accurate grooving becomes possible.

However, when lateral runout in the tyre-width direction caused by strain of tyre itself or deviation of tyre support occurs, even if grooving is carried out by the cutter of which movement is controled by a computer program so as to carve the prescribed tread pattern while the tyre is rotated, position of grooves from the tread center of tyres of the same size and specification differs to each tyre and positions of grooves which ought to be at the prescribed ones on right and left sides of the tread center C (the tyre equator) are different from each groove when a plurality of grooves are carved for a tyre, so that there arise problems about quality such as unstableness of tyre quality and decrease of strength.

To dispose the problems, the present applicant has provided a tyre grooving apparatus and method, wherein the lateral runout of the tyre is detected and the cutting position of the cutter is corrected in accordance with detected value.

However, even if the same kind of tyres are attached to the tyre supporting shaft of the tyre grooving apparatus in the same way, the tread center position does not always coinside with the theoretical tread center position set by the standard program for each tyre and the slight deviation sometimes occurrs because of the difference in dimensions on the right and left sides of the tyre arisen during curing, deformation caused by inner pressure, the improper engagement with a rim and the like.

Accordingly, as shown in Fig. 19, the quantity y of lateral runout on the side of the tyre is not always equal to the quantity of actual deviation of tread center TC to the tread center PC set by the standard program. Therefore, even if the lateral runout on the side of the tyre is detected and the position of cutter is corrected with the detected value (the cutter is moved to follow the lateral runout) and thereby the grooving is performed, the position to be cut cannot be set to a prescribed distance from the tread center of the tyre, and finally, the position of tread grooves from the tread center TC does not coincide with each tyre of the same kind.

Taking the above-mentioned problems of the conventional art into consideration, it is an object of the present invention to provide a tyre grooving apparatus and method wherein position of cutter is corrected so as for all the position of tread grooves from the tread center to coinside mutually among the same kind of tyre and for tread groove positions of a tyre to be at a prescribed ones on right and left sides of the tread center.

DISCLOSURE OF THE INVENTION

A tyre grooving apparatus of the present invention comprises:

(a) a tyre support device for rotatably supporting a tyre,

(b) a cutter support device which rotates freely,

(c) a pivotable arm which holds the cutter support device at the free end portion thereof,

(d) a vertically movable block having a rotatable shaft which pivotably holds the pivotable arm and a mechanism portion for standard movement,

(e) a horizontally movable block holding the vertically movable block and having a mechanism portion for standard movement and a mechanism portion for correction movement which can move the block at least in the transverse

direction in parallel with the tyre support shaft of the tyre support device,

(f) a means for detecting the center deviation of the tyre,

(g) a means for detecting the lateral runout of the tyre, and

(h) a control means

and is characterized in that the control means comprises a standard movement operation portion which set the cutter at the theoretical cutting position, and a correction movement operation portion which caluculates the quantity of correction movement of the cutter in accordance with input signals from the means for detecting the lateral runout of the tyre and the means for detecting center deviation of tyre, and operates the mechanism portion for correction movement mounted on the horizontally movable block in accordance with the calculated value.

Furthermore, a tyre grooving apparatus of the present invention comprises:

(a) a tyre support device for rotatably supporting a tyre,

(b) a cutter support device which rotates freely,

(c) a pivotable arm which holds the cutter support device at the free end portion thereof,

(d) a vertically movable block having a rotatable shaft which pivotably holds the pivotable arm and a mechanism portion for standard movement,

(e) a horizontally movable block holding the vertically movable block and having a mechanism portion for standard movement and the mechanism portion for correction movement which can move the block at least in the transverse direction in parallel with the tyre support shaft of the tyre support device.

(f) a means for detecting center deviation, and

(g) a control means

and is characterized in that the control means comprises a standard movement operation portion which set the

cutter theoretical cutting position, and a correction movement operation portion which calculates the quantity of correction movement of the cutter in accordance with input signal from the means for detecting center deviation of tyre, and operates the mechanism portion for correction movement mounted on the horizontally movable block in accordance with the calculated value.

Moreover, a tyre grooving method of the present invention is for grooving a tyre according to the standard program and is characterized by;

(a) a step of detecting lateral runout of the tyre.

(b) a step of detecting center deviation of the tyre.

(c) a step of correcting the grooving position for the cutter in accordance with the detected values of lateral runout and center deviation.

Futhermore, the tyre grooving method of the present invention is for grooving the tyre according to the standard program and is characterized by;

(a) a step of detecting the center deviation of the tyre,

(b) a step of correcting the grooving position for the cutter in accordance with the detected value of the center deviation.

Preferably, the grooving position for the cutter is corrected according to the correction program provided independently to the standard program.

Since the tyre grooving apparatus of the present invention comprises a horizontally movable block having the mechanism portion for standard movement and the mechanism portion for correction movement whereby it can move the cutter at least in parallel with a tyre support shaft, a vertically movable block having the mechanism portion for standard movement whereby it can move the cutter in the up-down direction, a means of detecting lateral runout and center deviation of the tyre or a means of detecting only center deviation, and a means of controlling the aforementioned portions, the horizontally movable block and the vertically movable block can be controlled according to the amount of

standard movement, and the amount of standard movement is followed by the amount of correcting movement according to the detected values of the detecting means so that the cutter can most suitably be positioned.

Moreover, according to the tyre grooving method of the present invention, the amount of standard movement of the horizontally movable block and the vertically movable block can be controlled in accordance with the standard program, and therewith the cutter can suitably be positioned by detecting of the lateral runout and center deviation of the tyre or only the center deviation thereof so that the amount of standard movement may be followed by the amount of corrected movement in accordance with the above detected values so that the cutter can most suitably the positioned.

BRIEF DESCRIPTION OF THE DRAWING

Figs. 1 and 2 are respectively a side view and a front view of one embodiment of tyre grooving apparatus of the present invention; Fig. 3 is a main functional block diagram of the tyre grooving apparatus shown in Figs. 1 and 2; Fig. 4 is a block diagram showing an electrical construction of a main portion in the tyre grooving apparatus; Fig. 5 is a flow chart in carrying out the grooving on the basis of the data of premeasured lateral and center deviations; Figs. 6 and 7 are respectively detailed flow charts of one embodiment relative to portions for detecting the lateral runout of the tyre and for detecting the center deviation on the tyre tread surface, and a grooving portion in Fig. 5, in which the center deviation is detected in only one point, Fig. 8 and 9 are respectively delailed flow charts of another embodiment relative to portions for detecting the lateral runout of the tyre and for detecting the center deviation on the tread surface, and the grooving portion in Fig. 5, in which the center deviation is detected in only one point; Figs. 10 and 11 are detailed flow charts of one embodiment relative to portions for detecting the

lateral runout of the tyre and for detecting the center deviation on the tread surface and the grooving portion in Fig. 5, in which the center deviation is detected in a plurarity of point; Fig. 12 is a flow chart in which the grooving is performed while detecting the lateral runout of the tyre; Fig. 13 and 14 are respectively detailed flow charts relative to portions for detecting the lateral runout and center deviation on the tyre tread surface, and a grooving portion in Fig. 12; Fig. 15 is a flow chart in which the grooving is performed on the basis of the data of the center deviation only; Figs. 16 and 17 are respectively detailed flow charts relative to a portion for detecting the center deviation on the tyre tread surface and the grooving portion in Fig 15; Fig. 18 is a diagram for explaining one embodiment of the method of detecting the center deviation; Fig. 19 is an explanatory illustration of lateral runout of tyre and center deviation of tread; Fig. 20 is a graph for showing the amount of correction movement of a cutter; Fig. 21 is an explanatory illustration of the construction of driving mechanism of horizontally movable block; Fig. 22 is a schematic illustration of a device for moving a center deviation detector; Figs. 23 to 31 are explanatory illustration of the examples of the method of detecting center deviation and Fig. 32 is a schematic illustration of a conventional grooving apparatus.

BEST MODE FOR CARRYING OUT THE INVENTION

The present invention is described in detail on the basis of embodiments, however the present invention is not limited to the embodiments. In the grooving apparatus shown in Figs. 1 and 2, numeral 1 is a bed, numeral 2 in a tyre support device mounted on the bed 1, on which a tyre 3 is supported by a tyre support shaft 21 and rotated by means of a motor 22 in the direction of an arrow C in Fig. 1. Numeral 4 is a base block which is movable along a guide bar being movably supported by rails on the bed 1 by means of a motor (not shown) in the

X-axis direction being perpendicular to the axis of a tyre support shaft 21. If the distance between the base block 4 and the tyre support shaft 21 is set to a specified value, the base block 4 is not required to be moved.

Numeral 5 is a horizontally movable block which is movable along a rail 42 on the base block 4 in the Y-axis direction being parallel with the tyre support shaft 21 and numeral 6 is a device for driving the horizontally movable block, which comprises a mechanism portion for standard movement and mechanism portion for correction movement as shown in Fig. 21.

Numeral 7 is a vertically movable block, which is movable along a guide shaft 74 on the horizontally movable block 5 by means of a device 71 for driving the vertically movable block in the Z-axis direction being perpendicular to the bed 1.

Numeral 81 is a pivotable arm, which is fixed to an arm support shaft 8 extended from the vertically movable block 7 in the X-axis direction and is rotated round the axis 82 of the arm support shaft 8 in the direction of the arrow A in Fig. 2 by means of a motor (not shown) of the vertically movable block 7.

Numeral 9 is a cutter support device attached to and projecting perpendicularly from the pivotable arm 81 toward the aforementioned axis 82, wherein a cutter support frame 92 is attached to a support rod 91 which is supported by the pivotable arm 81, a cutter holder 94 is supported by the cutter suport frame 92 with an insulator 93 being located therebetween, and a cutter 10 is removably attached to a cutter holder 94 so that the cutting position P of the cutter is on the extended axis of the aforementioned axis 82, and further, there is employed such an arrangement that the cutter 10 can be heated by a power supply (not shown). Numeral 11 is a motor by which the cutter support device 9 is rotated in the direction of the arrow B so as to allow the position of the cutter to be changed. Numeral 12 is an actuator

which moves the cutter support device 9 independently in the up-down direction in order for the cutting position P of the cutter 10 to coincide with the axis 82.

Alternatively, in place of the actuator 12, cutting position P of the cutter 10 may be made coincident with the axis 82 by adjusting the position at which the cutter support device 9 is attached to the support shaft 91.

Numeral 13 is a center deviation detector which comprises, for example, a optical reflection-type displacement sensor and is capable of scanning along a scan shaft 803 in the direction of the arrow D by means of a driving device 84 (see Fig. 18). If the aforementioned center deviation detector 13 is fixed in the central position on the tyre tread surface to detect the radial runout of the tyre and the cutting position to be cut by the cutter is corrected, it can also serve as a radial runout detector.

Numeral 14 is a lateral runout detector for detecting the lateral runout of the tyre which is disposed opposing to a buttress on the side surface of the tyre at a predetermined distance m. For example, the detector may be an optical reflection type displacement sensor or the like of which the position is adjustable according to a tyre diameter by means of a holding device 141 provided on the tyre support device 2, wherein the detected value is input to a control device (not shown) and thereby the mechanism portion for correction movement of the device for driving a horizontally movable block is driven.

Next there is explained the grooving process using the apparatus having the aforementioned construction for grooving a tyre in reference to block diagrams shown in Figs. 3 and 4 and flow charts shown in Figs. 5 to 17.

As shown in Figs. 3 and 4, the tyre grooving apparatus of the present invention comprises a center deviation detecting means, a cutter heating device, a

cutter support device, a tyre support device, a rotating device, a mechanism portion for standard movement of the vertically movable block, a mechanism portion for standard movement of the horizontally movable block, a lateral runout detecting means, a mechanism portion for correction movement of the horizontally movable block, a mechanism portion for movement of the center deviation detecting means and a control means. The aformentioned control means includes a standard movement operating portion and correction movement operating portion as shown in Fig. 4. Each of the aforementioned standard movement operating portion and the correction movement operating portion contains a central processing unit (CPU) and a memory. The standard movement operating portion is connected through an input-output interface to the cutter heating device, the tyre support device 2, the cutter support device 9, the rotating device, the mechanism portion for standard movement of the vertically movable block and the mechanism portion for standard movement of the horizontally movable block. The correction movement operating portion is connected through the input-output interface to the center deviation detecting means, the lateral runout detecting means, the mechanism portion for correction movement of the horizontally movable block and the mechanism portion for movement of the center deviation detecting means. Furthermore, the standard movement operating portion and the correction movement operating portion are connected through the interface to each other.

The programs required for grooving operation such as a program for controlling the operation of the cutter 10 for a tyre having no runout, a program for controlling the rotation of tyre and a program for controlling the correction movement operating portion are stored in the memory in the aforementioned standard movement operating portion. The program required for the correcting operation such as a program for controlling the center deviation detecting means, a program for

controlling the lateral runout detecting means, a program for controlling the mechanism portion for correction movement of the horizontally movable block and a program for controlling the mechanism portion for movement of the center deviation detecting means are stored in the memory in the aforementioned correction movement operating portion.

There is explained a method of grooving by means of the apparatus for grooving a tyre having the aforementioned construction in reference to Figs. 5 to 17.

Fig. 5 is a flow chart in case of the grooving on the basis of the data of the lateral runout and center deviation measured in advance.

1) An origin mark is put on the side of the tyre and a detection mark is put on the tyre tread surface. Preferably, the aforementioned origin mark is put on the position coincident with any required wear indicator. Alternatively, the wear indicator itself may be used as the origin mark in place of the aforementioned marking. By way of example, the detection mark has a shape of a small projection which is 1 mm in width, 1 mm in height and 1mm in length and is formed by means of a concave provided in a metal mold when the tyre is cured. As far as the aforementioned detection mark is large enough to be detected by the center deviation detector 13, there is no particular limitation on its size. However, if it is too small, it is difficult to be detected. The minimum dimension which can be detected is, for example, 0.5 mm in width, 0.5 mm in height and 0.5 mm in length. The position in which the detection mark is put and the number thereof are properly selected according to the grooving method.

2) The power supply is turned ON, and the origin of each driving mechanism (device) is set.

3) The tyre 3 whose marked pattern tread should be grooved is fitted on the tyre support shaft 21 in

accordance with the aforementioned process, the lateral runout detector 14 is provided facing to side of the tyre buttress, and the center deviation detector 13 is provided facing to the tyre tread surface.

4) A tyre is positioned according to the origin mark of the tyre. Namely, the aforementioned origin mark provided on the side of the tyre is brought to be coinsident with the position of the lateral runout detector 14.

5) The lateral runout of the tyre and the center deviation of the tyre tread surface are detected. The examples of the detailed flow charts for this portion are shown in Fig. 6, 8 and 10.

6) The grooving is carried out while correcting the amount of movement of the cutter on the basis of the data of the aforementioned lateral runout and the center deviation. The examples of the detailed flow chart in relation to this portion are shown in Fig. 7, Fig. 9 and Fig. 11.

7) It is determined whether or not prescribed number of grooves have been grooved. If it is confirmed that the prescribed number of grooves have been grooved, the next step is followed and if not, the procedure returns to the steps of detecting lateral runout of the tyre and the center deviation of the tyre tread surface.

8) If the prescribed number of grooves have been grooved, each driving mechanism (device) is returned back to the origin.

9) The grooved tyre 3 is removed from the tyre support shaft 21.

10) The power supply is turned OFF and the grooving is finished.

Figs. 6 and 7 are the detailed flow charts respectively for the portions where the lateral runout of the tyre and the center deviation of the tyre tread surface are detected and for the portion of the grooving

operation in Fig. 5, and the flow charts are for one embodiment wherein the center deviation is detected at only one place.

(S1) Whether or not the origin mark on the side of the tyre tread is positioned to face the lateral runout detector 14 is confirmed.

(S2) The motor 22 fitted on the tyre support shaft 21 is driven under the control of the controlling means and the tyre 3 is rotated at the low speed in the direction of the arrow C in Fig. 1.

(S3) The lateral runout of the tyre is detected by the lateral runout detector 14.

(S4) The data of the lateral runout detected in the aforementioned step is stored in the memory in the correction movement operating portion.

(S5) The detection of the lateral runout of the tyre is carried on until the origin mark on the side of the tyre is detected.

(S6) When the origin mark is detected, the rotation of the tyre is stopped.

(S7) The detection mark on the tread surface is set to the detecting position of the center deviation detector.

(S8) The mechanism portion for moving a center deviation detector is driven under the control of the controlling means and the center deviation detector sca..

(S9) The detection mark on the tyre tread surface is detected by the detector 13.

(S10) The position of the detection mark measured by the center deviation detector 13 is stored in the memory in the correction movement operating portion.

(S11) When the scan is terminated, the center deviation detector 13 is returned back to the position of the origin under the control of the controlling means.

Fig. 18 is a diagram for explaining the aforementioned steps (S1) to (S11). In Fig. 18, numeral 31 is

a tyre tread surface, numerals 32A and 32B are detection marks provided on the tyre tread surface, numeral 84 is a mechanism portion for movement of the center deviation detecting means (a moving device), PC is a theoretical tread center, TC is an actual tyre tread center and X is an amount of the center deviation. In Fig. 18, the center deviation detector 13 scans in the direction of the arrow D.

After the data of the lateral runout and the center deviation are obtained according to the aforementioned steps, the grooving is performed. The detailed flow charts concerning the standard movement in the grooving process are identical with one another. Therefore the aforementioned portion of Fig. 7 is explained here and those of other drawings (Figs. 9, 11, 14 and 17) are omitted from the explanation of those drawings.

(G1) According to the standard program in the standrad movement operating portion, the following process is carried out.

(i) The mechanism portion for standard movement of the horizontally movable block is driven and thereby the cutter 10 is set at the theoretical center of the tyre.

(ii) The mechanism portion for standard movement of the horizontally movable block is driven again and thereby the cutter 10 is moved to the theoretical position for grooving.

(iii) The motor 11 of the cutter support device 9 is driven and thereby the direction of the cutter is set.

(iv) The motor 22 of the tyre support device 2 is driven and thereby the tyre 3 is rotated at the low speed in the direction of the arrow C in Fig. 1.

(v) The cutter heating device is turned on and thereby the cutter 10 is heated.

(vi) The mechanisum portion for standard movement of the vertically movable block and if necessary the

actuator 12 of the cutter support device 9 are driven, the cutter 10 is moved down by a predetermined amount, and thereby the cutting is performed by a predetermined depth.

(vii) The directional change, the lateral movement and the like of the cutter 10 are performed according to the predetermined grooving patern, and the cutting is swung up for finish when the predetermined grooving is completed.

(viii) The heating of the cutter 10 is stopped.

(ix) the cutter 10 is moved upward and is kept apart from the tread surface.

(x) The rotation of the tyre is stopped.

(G2) According the correction movement operating portion controlled by the command of the standard movement operating portion, the following process is carried out along with the aforementioned standard processing operation.

(i) The data of the lateral runout and the center deviation are read out from the memory of the correction movement operating portion.

(ii) In CPU of the correction movement operating portion, the data of the lateral runout is corrected based on the data of the center deviation and the amount of the correction movement of the cutter is calculated. In the example shown in Fig. 7, the detection of the center deviation is performed at only one point, and therefore that data of the lateral runout is corrected evenly by the data of the center deviation. Fig. 19 is a diagram for explaining the relationship between the amount of the lateral runout y and that of the center deviation x and Fig. 20 is a graph showing the amount of the correction movement of the cutter. The formula (I) shown in Fig. 20 is as follows:

$$LRO_1 = LRO_0 + x - y \qquad (I)$$

(wherein,

LRO_0: the amount of the cutter movement corrected by the data of the lateral runout

LRO_1: the amount of the cutter movement corrected by the data of the lateral runout and that of the center deviation

x: the amount of the center deviation

y: the amount of the lateral runout)

The formula (I) applied to the example shown in Fig. 19 is as follows:

$$LRO_1 = LRO_0 + (-|x|) - (+|y|)$$

(iii) The correction movement of the cutter is conducted according to the amount of the correction movement calculated by the above formula.

(iv) If the correction movement is performed by a predetermined amount in accordance with said correction movement, the correcting operation is terminated. If the predetermined amount is not reached, the correction movement is carried out until it is reached.

The example shown in Figs. 8 and 9 is almost similar to the example showin in Figs. 6 and 7. However, they differ only in that while the amount of the correction movement of the cutter is calculated at the time of the grooving in the example of Figs. 6 and 7, it is calculated when detecting the lateral runout of the tyre and the center deviation of the tread surface is performed in the example of Figs. 8 and 9. For that reason, the detailed description of the flow chart is omitted.

The examples in Figs. 10 and 11 are almost similar to ones in Figs. 6 and 7, but they are different in the following respect. Namely, while the center deviation is detected in only one place in Figs. 6 and 7, it is detected in a plurality of places in Figs. 10 and 11. Preferably, the center deviation is detected in 2 to

360 places in consideration of th workability and the economy.

In the following, the different points in the flow charts shown in Figs. 10 and 11 will be described.

(S21) When the first center deviation measurement is carried out, the tyre is rotated by a predetermined pitch and the second center deviation measurement is carried out.

(S22) The measurement of the center deviation is repeated as many times as the number of places having detection marks. After the completion thereof, the step of grooving is started.

(G3) In the step of grooving, the amount of the movement of the cutter is corrected in accordance with the following manner.

(i) The data of the lateral runout and that of the center deviation are read out from the memory, and thereby the data of the center deviation is corrected by that of the lateral runout. The amount of the center deviation x used in the above correction is caluculated according to the following formula (II):

$$x = \frac{\theta - \theta n}{\theta n+1 - \theta n} \times (X_{n+1} - X_n) + X_n \qquad (II)$$

(wherein,

X_n, X_{n+1}: the measured values of center deviations at n and n+1

θn, $\theta n+1$: rotational angles at n and n+1

θ: the rotational angle at the required position

X: the amount of the center deviation at the position whose rotational angle is θ.)

(ii) The amount of the correction movement of the cutter is calculated based on the aforementioned amount of the center deviation X according to the formula (I).

(iii) The correction movement of the cutter is performed on the basis of the aforementioned amount of the correction movement.

Fig. 12 is a flow chart showing the case of grooving while detecting the lateral runout of the tyre. It is similar to Fig. 5 except that the step of detecting the lateral runout of a tyre is moved to the step of grooving. Fig. 13 is a detailed flow chart of a portion for detecting the center deviation of the tyre tread in Fig. 12. The flow chart of Fig. 13 is similar to that of Fig. 6 excepting that Fig. 13 does not include the flow of the part for detecting the lateral runout, and therefore the detailed description will be omitted.

Fig. 14 is a flow chart of the steps for detecting the lateral runout and for grooving in Fig. 12. The flow chart of Fig. 14 is similar to that of Fig. 7 except that the position of the origin of the lateral runout is corrected in advance according to the data of the center deviation stored in the memory in the correction movement operating portion and thereby the lateral runout is detected, and the amount of the correction movement of the cutter 10 is calculated on the basis of the measured value of the above lateral runout. Therefore, the detailed description thereof will be omitted.

Fig. 15 is a flow chart showing the case of carrying out the correction movement of the cutter only by the measurement of the center deviation of the tyre without the detection of the lateral runout thereof. Fig. 15 is similar to Fig. 5 except that the step for detecting the lateral runout of the tyre is omitted, and therefore the detailed description will be omitted.

Fig. 16 is a detailed flow chart of the step for detecting the center deviation on the tread surface. Fig. 16 is similar to Fig. 10 except that the flow of the part for detecting the lateral runout is omitted, and therefore the detailed description will be omitted.

Fig. 1~ is a detailed flow chart of the grooving step in Fig. 15. By way of example, if the detection marks are provided at 360 places on the circumference of tyre at equal intervals and that the amounts of the center deviations among detection marks are linearly approximated according to the formula (II), the position of the tread center TC can be known with sufficient accuracy to avoid the practical trouble. Therefore, when there are a lot of places where the center deviation is detected as described above, it is not required to detect the lateral runout of the tyre. Though the example for providing the detection marks at 360 places on the circumference of tyre at equal intervals has been described, the number of the places where the detection marks are set is not limited to the above but can suitably be selected in consideration of the measuring accuracy, the workability and the like. However, if the detection marks are provided in at least two places, no practical trouble will occur.

Fig. 21 is an explanatory illustration of the construction of one embodiment of the device for driving the horizontally movable block 6. In the example shown in Fig. 21, the mechanism portion for standard movement comprises; a female screw body 65 having a driving gear 68 which is rotatably held by means of a bearing on the frame member 51 which is slidably provided over a pair of rails 42 mounted on the base 4; a driving motor 61 which is coupled to a ball screw shaft 62 which is engaged with the aforementioned female screw body 65 at one end thereof; and a supporting bearing 609 mounted on the base 4 for supporting the other end of the aforementioned ball screw shaft 62.

When the driving motor 61 is driven by the standard program, the ball screw shaft 62 is rotated and therewith the horizontally movable block 5 is moved by a required amount in the Y-axis direction. The mechanism portion for correction movement comprises; a supporting boss 66 where a plurality of splines are formed in the

axial direction, which has a driving gear 67 held rotatably on the frame member 51 through a bearing; a spline shaft 64 which is slidably engaged with the aforementioned supporting boss; a correcting motor 63 which is coupled to one end of the spline shapt 64; and a supporting bearing 610 mounted on the base 4 for supporting the other end of the aforementioned spline shaft 64. Here, the aforementioned driving gear 67 is engaged with a driven gear 68.

When the correction motor 63 is driven according to the correction program in this state, the spline shaft 64 is rotated and the driving gear 67 is rotated. The rotation of the driving gear 67 causes the rotation of the driven gear 68. Thereby, the horizontally movable block 5 is moved by a predetermined correction amount. Because the spline shaft 64 is slidably engaged with the supporting boss 66, the movement of the horizontally movable block 5 by the standard program is not prevented.

Fig. 22 is a schematic view of one embodiment of a device for moving the center deviation detector 84. In the embodiment shown in Fig. 22, the device for moving the center deviation detector 84 comprises; an ⊐-shaped frame member 801 fixed to the top of a bracket member 83 projecting from the approximately middle bottom surface of the rotating arm 81; a motor 802 provided on a side fragment of the aforementioned frame member 801; a scan shaft 803 connected to the driving shaft of the aforementioned motor 802 and including a ball screw or the like extended inside the ⊐-shaped frame member 801; a bearing material 804 provided on the inside surface of the other side fragment for rotatably supporting the end of the aforementioned scan shaft 803; a female screw body 805 which is engaged with the aforementioned scan shaft 803; and a guide shaft 806 provided between the aforementioned side fragments for preventing the aforementioned female screw body from being induced to rotate. The aforementioned female screw body 805 is

fitted with the center deviation detector 13. When the motor 802 is driven, the female screw body 805 scans in the direction of the arrow D.

Next, the concrete example of the detection mark for the detection of the center deviation is described with reference to the drawings. The detection mark 32 is provided in an appropriate length in the peripheral direction as a small projection being about 1 mm in size, which is shaped through curing by a recess provided in a metal mould when curing the tyre. The aforementioned mark 32 may be of any type as far as it can be detected by the center deviation detector 13, and the recess may have any shape, for example, a shape of a concave groove. However, if it is too small, for example, is below about 0.5 x 0.5 mm, it is difficult to be detected. Furthermore, the detection mark may be provided in one place, or in some places intermittently on the full or a part of the periphery in a suitable length, or it may be continuously provided in the direction of the circumference. If the detection mark is provided in one place or some places, the rotational positioning of the tyre is to be carried out at the time of the detection, but if it is continuously provided on the full circumference, the aforementioned positioning is not required. Moreover, the detection marks 32 are not always provided on the both sides of the tread center TC but the mark may be provided on only one side or only one mark may be provided in the position of the tread center TC by selecting 0 (zero) for the constant distance a.

In the detecting method in Fig. 23, because the detection marks 32A and 32B are provided on both sides at a constant distance a from the tread center TC respectively, the distance b of the movement from the scan starting point ST to the tread center PC and the distance d of the movement beyond the tread center PC to the detection mark 32B are measured, and thereby the amount of the center deviation X can be calculated according to the following formula:

$$X = b - (d-a)$$

In the method for detecting deviations shown in Fig. 24, during the movement from the scan starting point ST to the tread center PC under the control of the standard program, the detection mark 32A is detected and then the amount e of movement up to the tread center PC is measured, and thereby the amount of the center deviation X can be calculated according to the following formula:

$$X = e - a$$

Moreover, in Fig. 25, the detection mark 32B, which is used, is provided on the side beyond the tread center PC set by the standard program, and the amount f of movement from the aforemenioned tread center PC beyound the detection mark 32B is measured, and thereby the amount of the center deviation X can be calculated by subtracting it from a constance distance a.

$$X = a - f$$

In an example of the method shown in Fig. 26 and 27, the detection mark is provided at an appropriate certain distance and the mark can be detected even if the amount of the distance are unknown. In Fig. 26, the distance b of movement from the scan starting point ST to the tread center PC by the standard program, and the distances c and d of movement respectively up to the detection marks 32A and 32B are measured, and thereby the amount of the center deviation X can be calculated according to the following formula:

$$X = b - c - \frac{d - c}{2}$$

In Fig. 27, both the distance e, which represents the movement from the detection mark on the side of the scan starting point ST to the tread center PC set by the standard program, and the distance f, which represents the movement from the tread center PC to the other detection mark 32B, are measured, and thereby the amount of the center deviation X can be calculated according to the following formula:

$$X = (e - f) / 2$$

Fig. 28 shows the detecting method in case that the constant distance a is 0 and one detection mark 32 is provided at the tread center TC of the tyre, wherein the distance c of movement from the scan starting point ST to the detection mark 32 and a distance b of movement to the tread center PC by the standard program are measured, and the mount of the center deviation X can be calculated by subtracting the former from the latter according to the following formula:

$$X = b - c$$

Figs. 29, 30 and 31 show examples of the detecting methods wherein the center deviation detector 13 is scanned right-wards and left-wards from the position of the tread center PC prespecified by the standard program. Fig. 29 shows a case that the detection marks 32A and 32B are provided on the both sides at a constant distance a from the tread center TC of the tyre, wherein the amount of the center deviation X can be calculated by subtracting the aforementioned constant distance a from the distance c or f of movements from the scan starting point ST to the detection mark 32A or 32B by scanning:

$$X = c - a \quad \text{or} \quad X = f - a$$

In the method shown in Fig. 30, the amount of the center deviation X can be calculated even if the constant distance a is unknown, wherein the center deviation detector 13 scans from the position of the tread center PC which is the scan starting point ST toward both sides and the distances c and f of movements to the detection marks 32A and 32B are measured, and the amount of the center deviation X can be calculated by finding the half of the difference therebetween according to the following formula:

$$X = (c - f) / 2$$

Furthermore, in Fig. 31 the constant distance a is 0 and one detection mark 32 is provided at the tread center TC of the tyre, wherein the center is deviated by a distance c detected from the scan starting point ST to the detection mark 32.

INDUSTRIAL APPLICABILITY

As described above, the present invention comprises; a horizontally movable block for moving a cutter in parallel with a tyre support shaft; a vertically movable block for moving it in the up-down direction; and a detector for detecting the lateral runout of the tyre and a detector for detecting the center deviation of the tyre or only the latter, wherein the detection marks provided on the tyre tread surface are detected by means of the center deviation detector which is mounted on the support base capable of transversely moving in parallel with the tyre support shaft and scans in the direction of the tyre support shaft the distance of movement from the scan starting point to the tread center PC set by the standard program is measured and the distance of movement from the scan starting point to the detection mark or the distance of movement from the detection mark to the aforementioned tread center PC is measured, and thereby the amount of

the center deviation X is calculated based on these data. Therefore, even if the cured tyre has a dimensional difference between right and left halves of its tread, or if the tyre is deformed by the internal pressure, or if the tyre is defectively engaged with a rim, the deviation between the tread center of the tyre and the cutter supporting device can be simply and surely measured for individual tyre. Thus, the horizontally movable block and the vertically movable block described above are controlled with the amount of the standard movement, and additionally the value detected by the lateral runout detector is corrected based on the value detected by the center deviation detector, and thereby the position of the cutter which is set according to the aforementioned amount of the standard movements is corrected by driving a mechnism portion for correction movement of the horizontally movable block in response to the corrected amount of the correction movement. Therefore, even if the center deviation is caused by the lateral runout of the tyre, or by the dimensional difference between right and left halves of its tread caused during the curing, or by the deformation due to the internal pressure, or by the defective engagement with the rim, the positions of grooves relative to the tread center of the respective tyre can be rightly fixed in predetermined places. Furthermore, because the amount of the standard movement is always controlled by the value set by the standard program and the mount of the correction movement based on the detected value of the lateral runout and center diviation can be corrected by the separate correction program, the construction of the computer program can be simple and small in size, and therewith a uniform grooving can be carried out.

Moreover, it is considered that when the detection marks are provided on the both sides of the tread center, both center deviations are respectively detected by the detection marks on both sides. If different absolute values are obtained, such difference

can be interpreted as a change of the relative positions of the detection marks to the tread center by the swelling deformation of the tyre after the curing or the like. In that case the detection accuracy can be improved by obtaining the average value, and further the calculation can be made simpler by positioning the scan starting point to the tread center set by the standard program.

Furthermore, the detection mark provided on the tread surface may be a small one, and therefore the characteristic of the tyre is not influenced, and there is another advantage that the center deviation detector can also be used as a device for detecting the longitudinal runout in the direction of the tyre diameter.

CLAIMS

1. A tyre grooving apparatus comprising:
(a) a tyre support device for rotatably support a tyre,
(b) a cutter support device which is rotatable,
(c) a pivotable arm which holds the cutter support device at the free end portion thereof,
(d) a vertically movable block having a rotatable shaft which pivotably holds the pivotable arm and a mechanism portion for standard movement,
(e) a horizontally movable block holding the vertically movable block and having a mechanism portion for standard movement and a mechanism portion for correction movement which can move the block at least in the transverse direction in parallel with the tyre support shaft of the tyre support device,
(f) a means for detecting the lateral runout of the tyre,
(g) a means for detecting the center deviation of the tyre, and
(h) a control means
and is characterized in that the control means comprises a standard movement operation portion which set the cutter at the theoretical cutting position, and a correction movement operation portion which calculates the amount of correction movement in accordance with input signals from the means for detecting the lateral runout of the tyre and the means for detecting center deviation of tyre, and operates the mechanism portion for correction movement mounted on the horizontally movable block in accordance with the calculated value.

2. A tyre grooving apparatus comprising:
(a) a tyre support device for rotatably supporting a tyre,
(b) a cutter support device which is rotatable,
(c) a pivotable arm which holds the cutter support device at the free end portion thereof,
(d) a vertically movable block having a rotatable shaft

which pivotably holds the pivotable arm and a mechanism portion for standard movement,

(e) a horizontally movable block holding the vertically movable block and having a mechanism portion for standard movement and the mechanism portion for correction movement which can move the block at least in the transverse direction in parallel with the tyre support shaft of the tyre support device,

(f) a means for detecting center deviation, and

(g) a control means

and is characterized in that the control means comprises a standard movement operation portion which set the cutter theoretical cutting position, and a correction movement operation portion which calculates the amount of correction movement in accordance with input signal from the means for detecting center deviation of tyre, and operates the mechanism portion for correction movement mounted on the horizontally movable block in accordance with the calculated value.

3. A tyre grooving method for grooving a tyre according to a standard program characterized by:

(a) a step of detecting lateral runout of the tyre.

(b) a step of detecting center deviation of the tyre.

(c) a step of correcting the grooving position of the cutter in accordance with the detected values of lateral runout and center deviation.

4. A tyre grooving method according to Claim 3, wherein the grooving position of the cutter is corrected by a correction program provided independently to the standard program.

5. A tyre grooving method according to Claim 3 or 4, wherein

(a) a step of detecting the lateral runout of the tyre, and

(b) a step of detecting the center deviation of the tyre

are performed before grooving.

6. A tyre grooving method according to Claim 3 or 4, wherein

(a) a step of detecting the lateral runout of the tyre is performed during grooving, and

(b) a step of detecting the center deviation of the tyre is performed before grooving.

7. A method for grooving a tyre according to a standard program characterized by

(a) a step of detecting the center deviation of a tyre at an interval of equal pitch around the full circumference, and

(b) a step of correcting the grooving position of a cutter on the basis of the detected value of the center deviation.

8. A tyre grooving apparatus, substantially as herein described with reference to Figures 1, 2, 3 and 4, or Figures 1, 2, 3, 4 and 21, Figures 1, 2, 3, 4 and 18, Figures 1, 2, 3, 4, 18 and 21, Figures 1, 2, 3, 4, 18 and 22, or Figures 1, 2, 3, 4, 18, 21 and 22.

9. A method for grooving a tyre according to a standard program, substantially as herein described with reference to the Examples depicted in Figures 5, 6 and 7 or Figures 5, 8 and 9 or Figures 5, 10 and 11 or Figures 12, 13 and 14, or Figures 15, 16 and 17 or Figures 5, 6, 7, 18, 19 and 20.

10. A grooved tyre when prepared by the method of any one of claims 3 to 7 or 9.

DATED this SEVENTEENTH day of JULY 1991
Sumitomo Rubber Industries, Ltd.

Patent Attorneys for the Applicant
SPRUSON & FERGUSON

ABSTRACT

A tire grooving apparatus according to the present invention consists of a movable block (5) movable at least in a lateral direction parallel with a tire support shaft, a vertically movable block (7) provided on the movable blocks, and a pivotable arm (81) provided on the block (7) and having a cutter support device (9) at the free end portion thereof, characterized in that the apparatus is further provided with a center deviation detector (13) for detecting a deviation of center line of a tire tread surface, or both the center deviation detector (13) and a lateral runout detector (14). A tire grooving method according to the present invention is characterized in that an actual measurement obtained by the center deviation detector (13), or both an actual measurement obtained by the center deviation detector (13) and an actual measurement obtained by the lateral runout detector (14) are utilized for the correction of the quantity of movement of a cutter (10).

FIG. 1

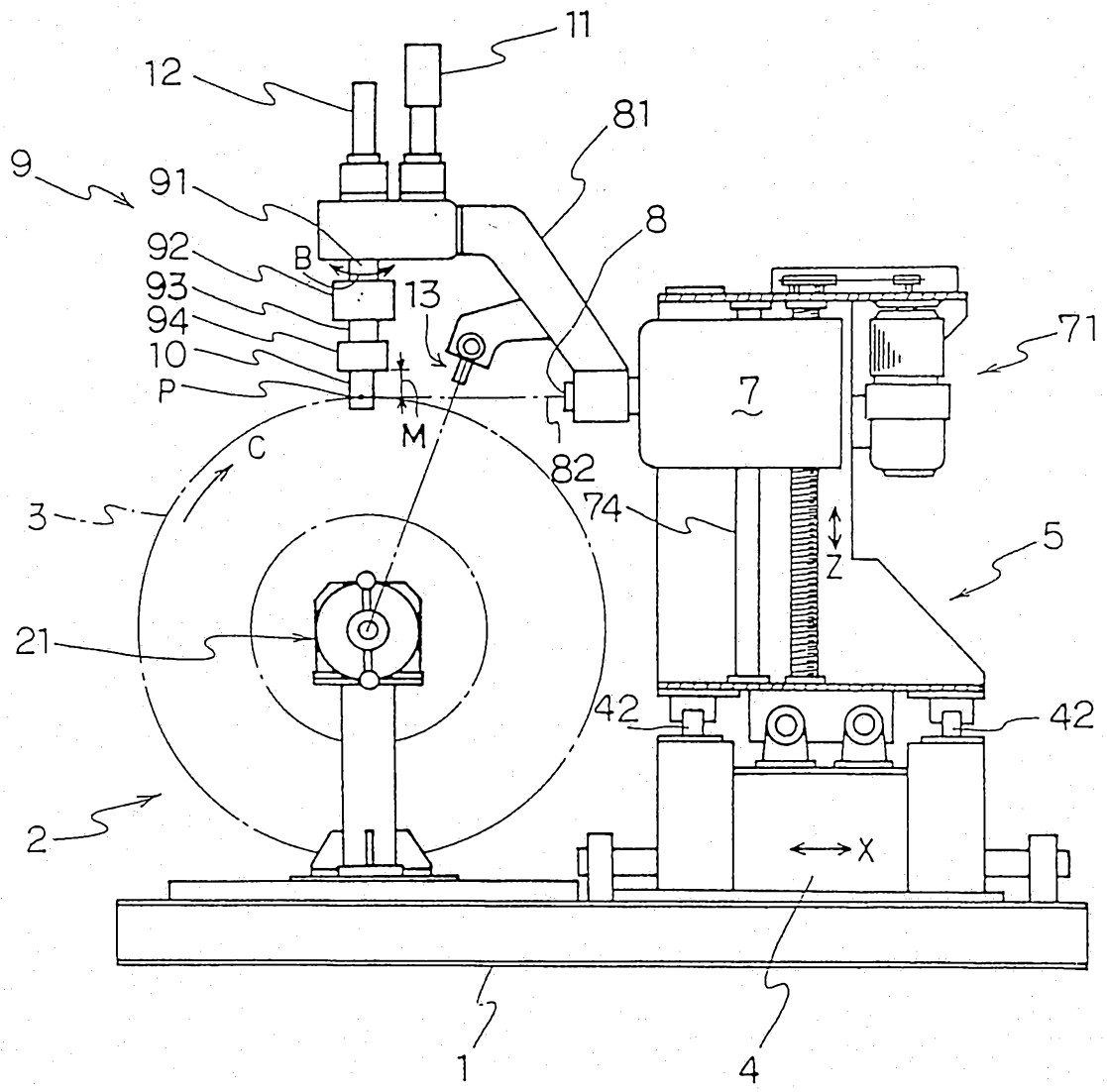


FIG. 2

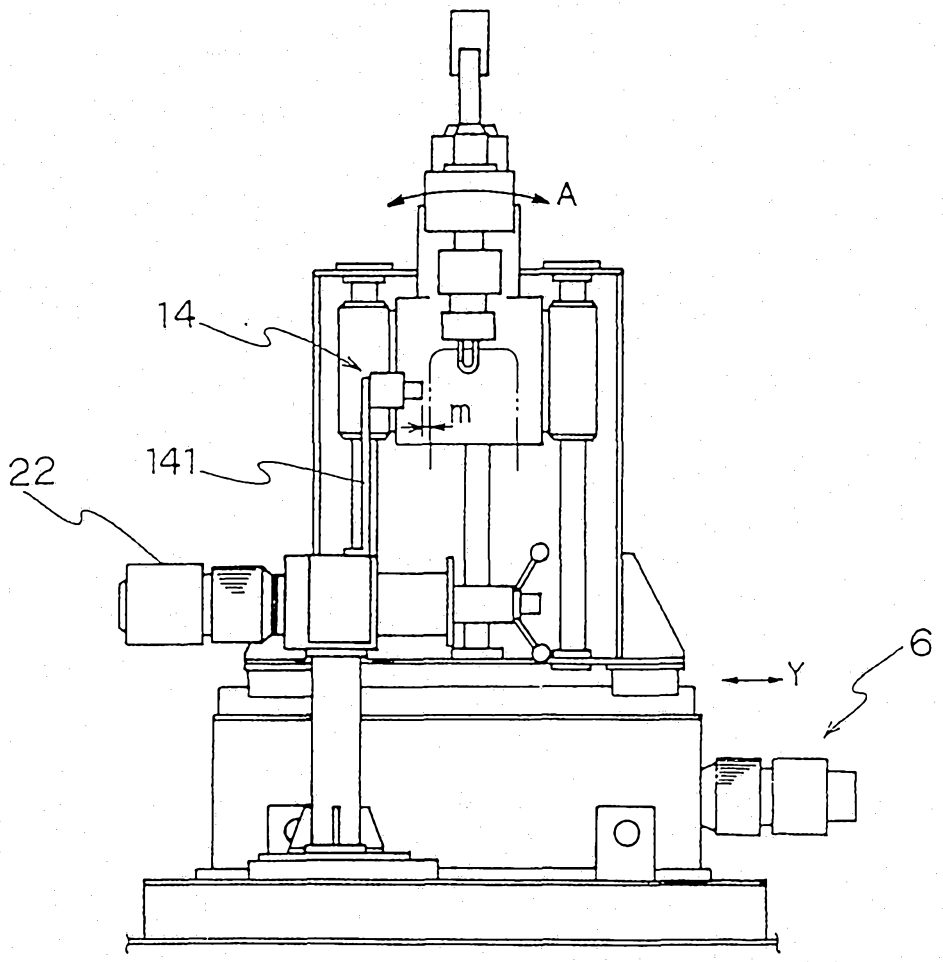


FIG. 3

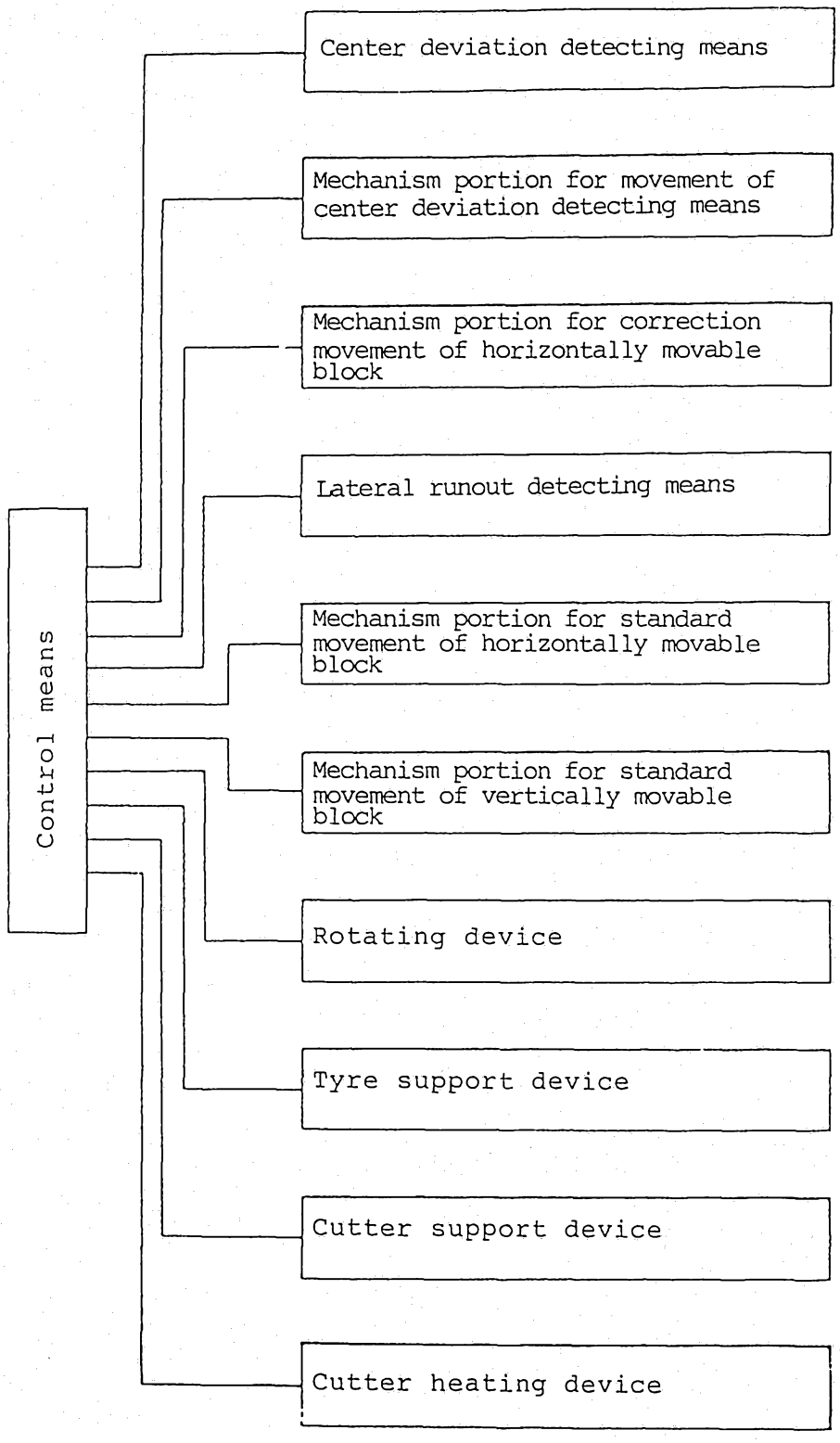

Control means
Center deviation detecting means
Mechanism portion for movement of center deviation detecting means
Mechanism portion for correction movement of horizontally movable block
Lateral runout detecting means
Mechanism portion for standard movement of horizontally movable block
Mechanism portion for standard movement of vertically movable block
Rotating device
Tyre support device
Cutter support device
Cutter heating device

FIG.4

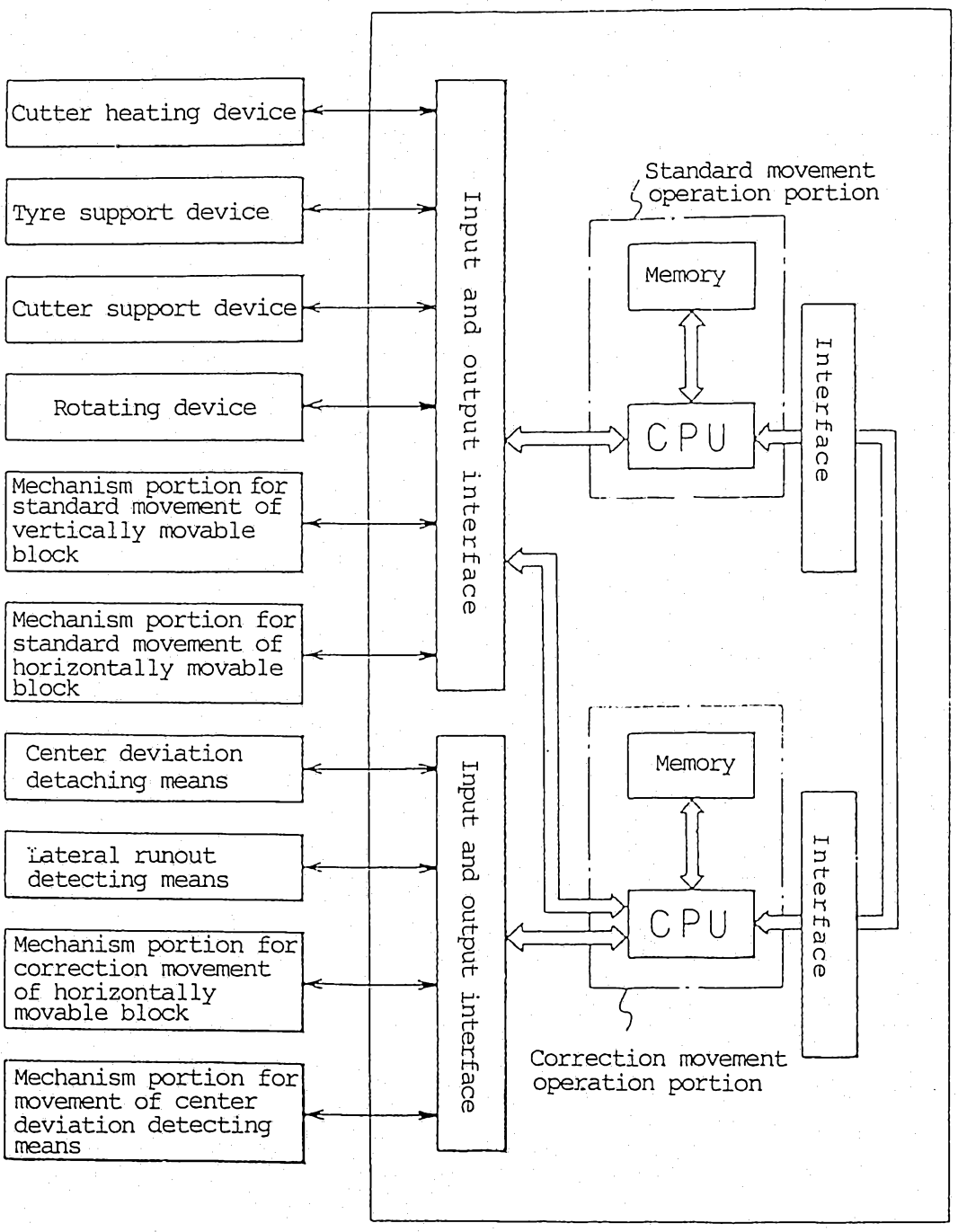

Cutter heating device
Tyre support device
Cutter support device
Rotating device
Mechanism portion for standard movement of vertically movable block
Mechanism portion for standard movement of horizontally movable block
Center deviation detaching means
Lateral runout detecting means
Mechanism portion for correction movement of horizontally movable block
Mechanism portion for movement of center deviation detecting means
Input and output interface
Input and output interface
Standard movement operation portion
Memory
CPU
Interface
Memory
CPU
Interface
Correction movement operation portion

FIG.5

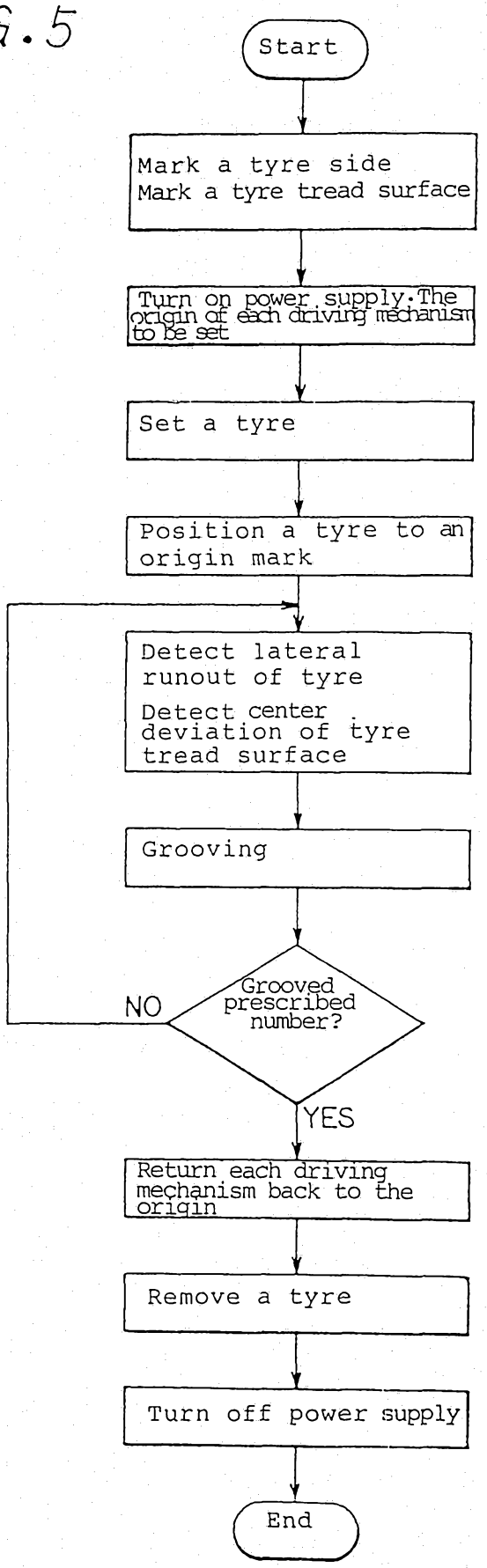

Start
Mark a tyre side
Mark a tyre tread surface
Turn on power supply. The origin of each driving mechanism to be set
Set a tyre
Position a tyre to an origin mark
Detect lateral runout of tyre
Detect center deviation of tyre tread surface
Grooving
Grooved prescribed number?
NO
YES
Return each driving mechanism back to the origin
Remove a tyre
Turn off power supply
End

FIG.6

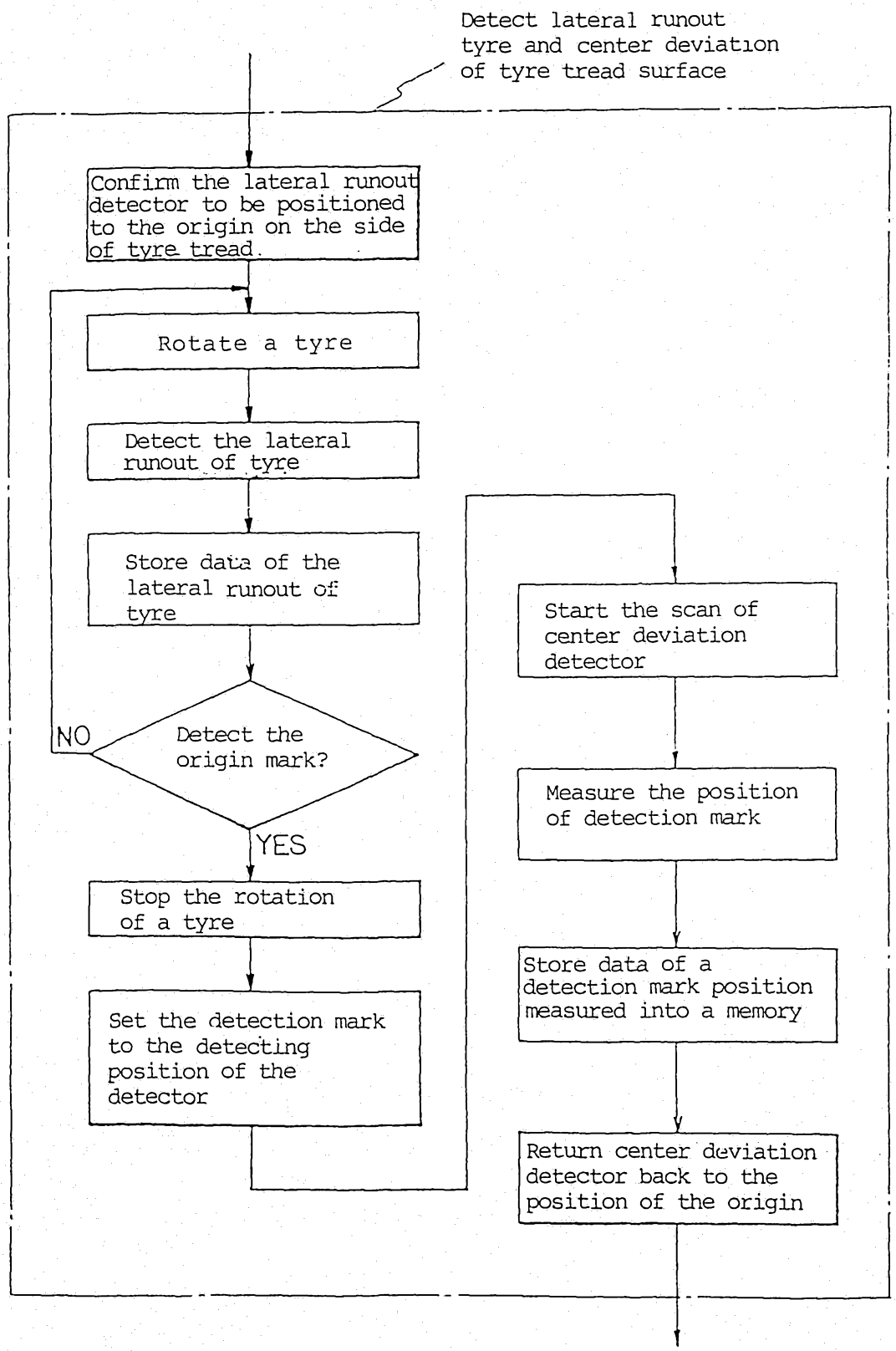

Detect lateral runout tyre and center deviation of tyre tread surface
Confirm the lateral runout detector to be positioned to the origin on the side of tyre tread.
Rotate a tyre
Detect the lateral runout of tyre
Store data of the lateral runout of tyre
Detect the origin mark?
NO
YES
Stop the rotation of a tyre
Set the detection mark to the detecting position of the detector
Start the scan of center deviation detector
Measure the position of detection mark
Store data of a detection mark position measured into a memory
Return center deviation detector back to the position of the origin

FIG. 7

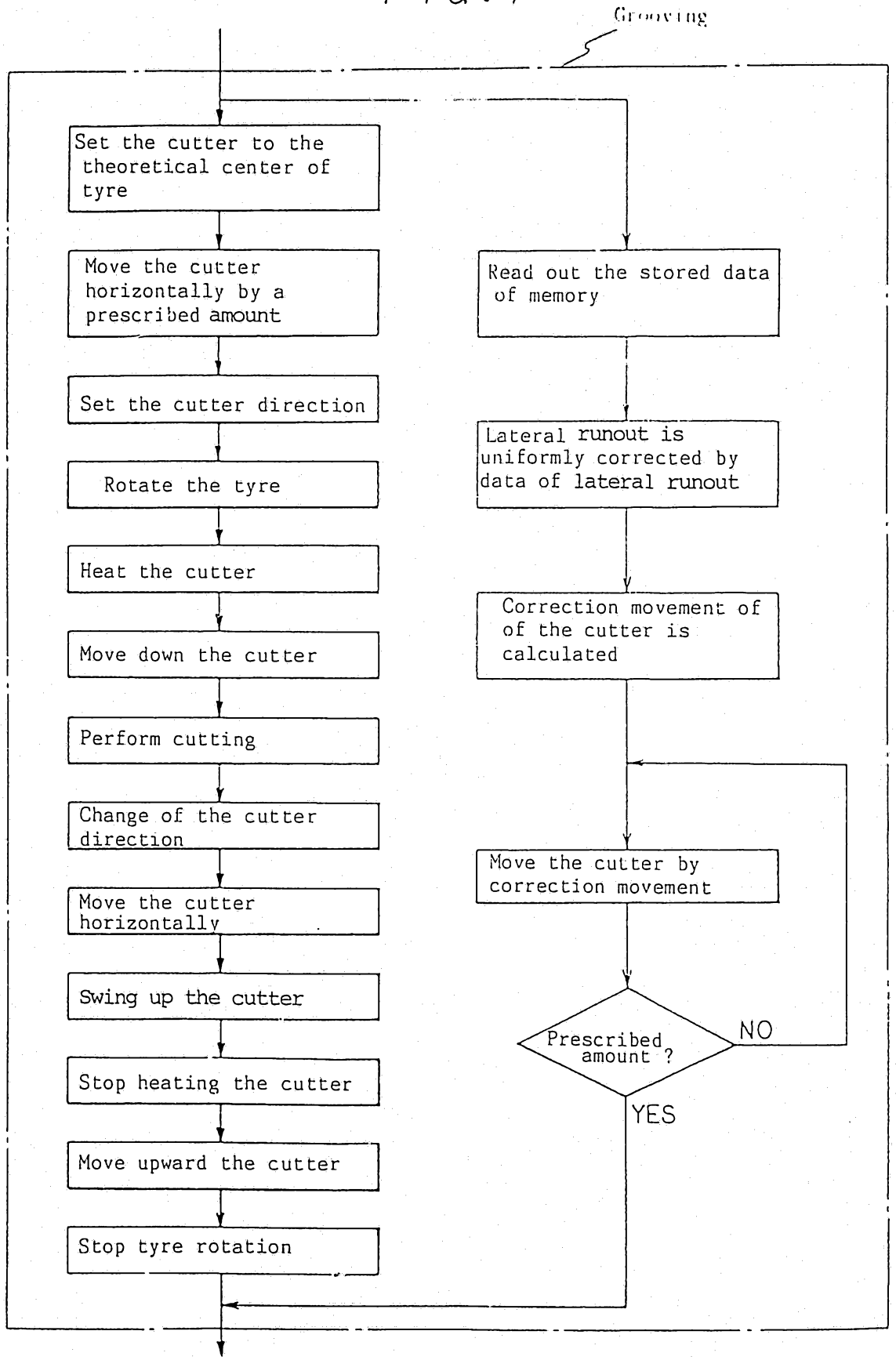

Grooving
Set the cutter to the theoretical center of tyre
Move the cutter horizontally by a prescribed amount
Set the cutter direction
Rotate the tyre
Heat the cutter
Move down the cutter
Perform cutting
Change of the cutter direction
Move the cutter horizontally
Swing up the cutter
Stop heating the cutter
Move upward the cutter
Stop tyre rotation
Read out the stored data of memory
Lateral runout is uniformly corrected by data of lateral runout
Correction movement of of the cutter is calculated
Move the cutter by correction movement
Prescribed amount ?
NO
YES

FIG.8

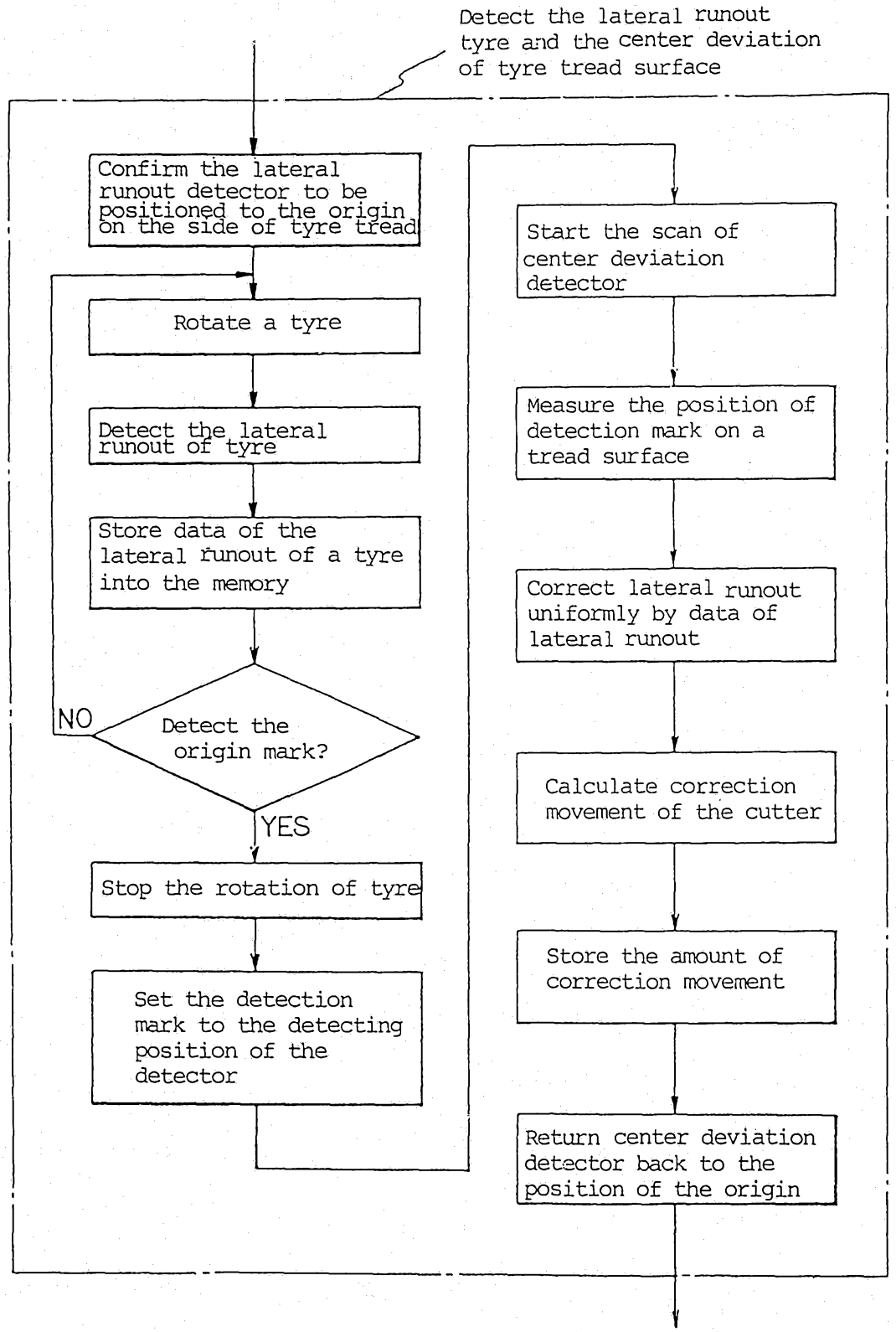

Detect the lateral runout tyre and the center deviation of tyre tread surface
Confirm the lateral runout detector to be positioned to the origin on the side of tyre tread
Rotate a tyre
Detect the lateral runout of tyre
Store data of the lateral runout of a tyre into the memory
NO
Detect the origin mark?
YES
Stop the rotation of tyre
Set the detection mark to the detecting position of the detector
Start the scan of center deviation detector
Measure the position of detection mark on a tread surface
Correct lateral runout uniformly by data of lateral runout
Calculate correction movement of the cutter
Store the amount of correction movement
Return center deviation detector back to the position of the origin

FIG.9

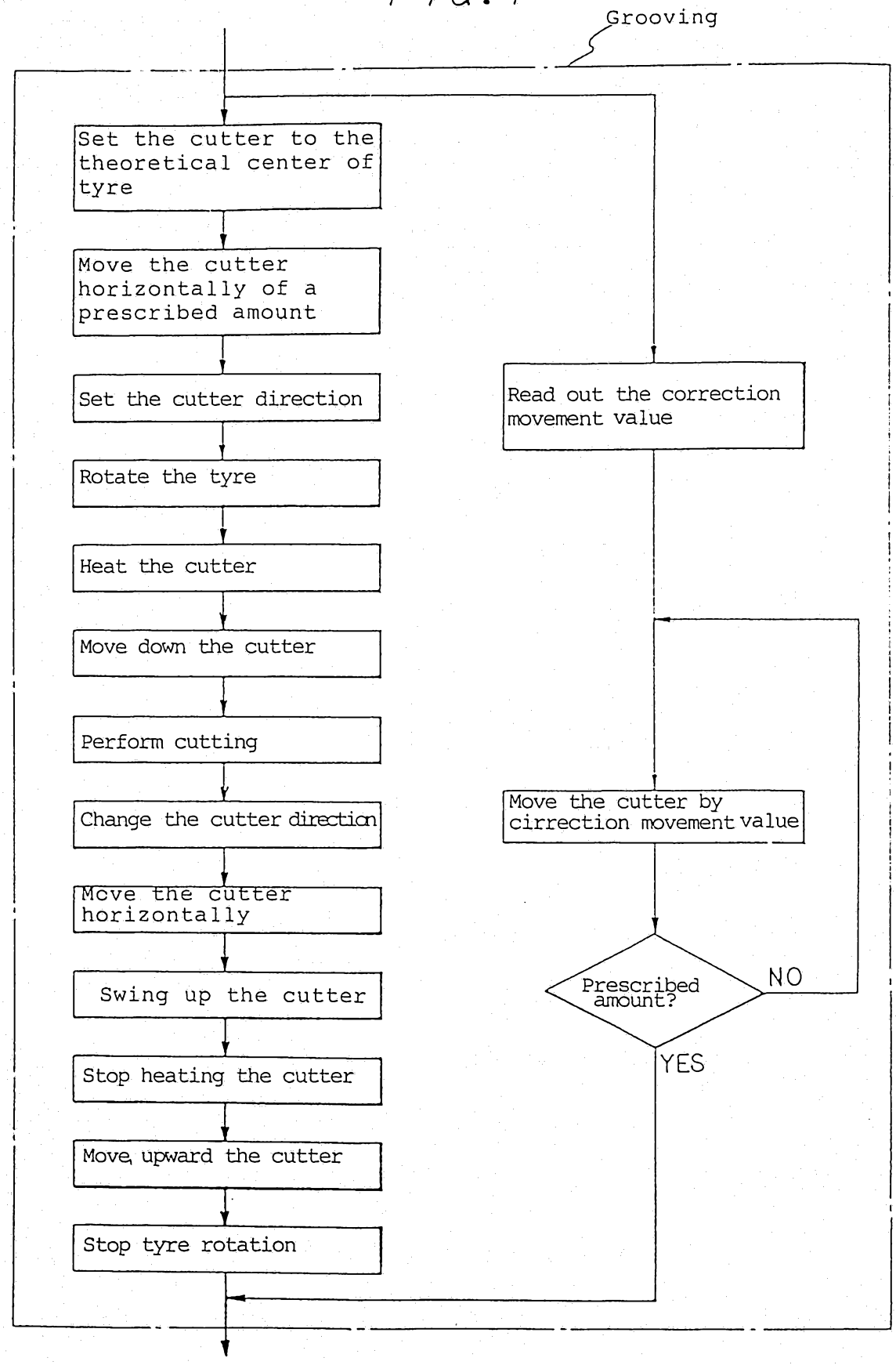

Grooving
Set the cutter to the theoretical center of tyre
Move the cutter horizontally of a prescribed amount
Set the cutter direction
Rotate the tyre
Heat the cutter
Move down the cutter
Perform cutting
Change the cutter direction
Move the cutter horizontally
Swing up the cutter
Stop heating the cutter
Move upward the cutter
Stop tyre rotation
Read out the correction movement value
Move the cutter by cirrection movement value
Prescribed amount?
NO
YES

FIG.10

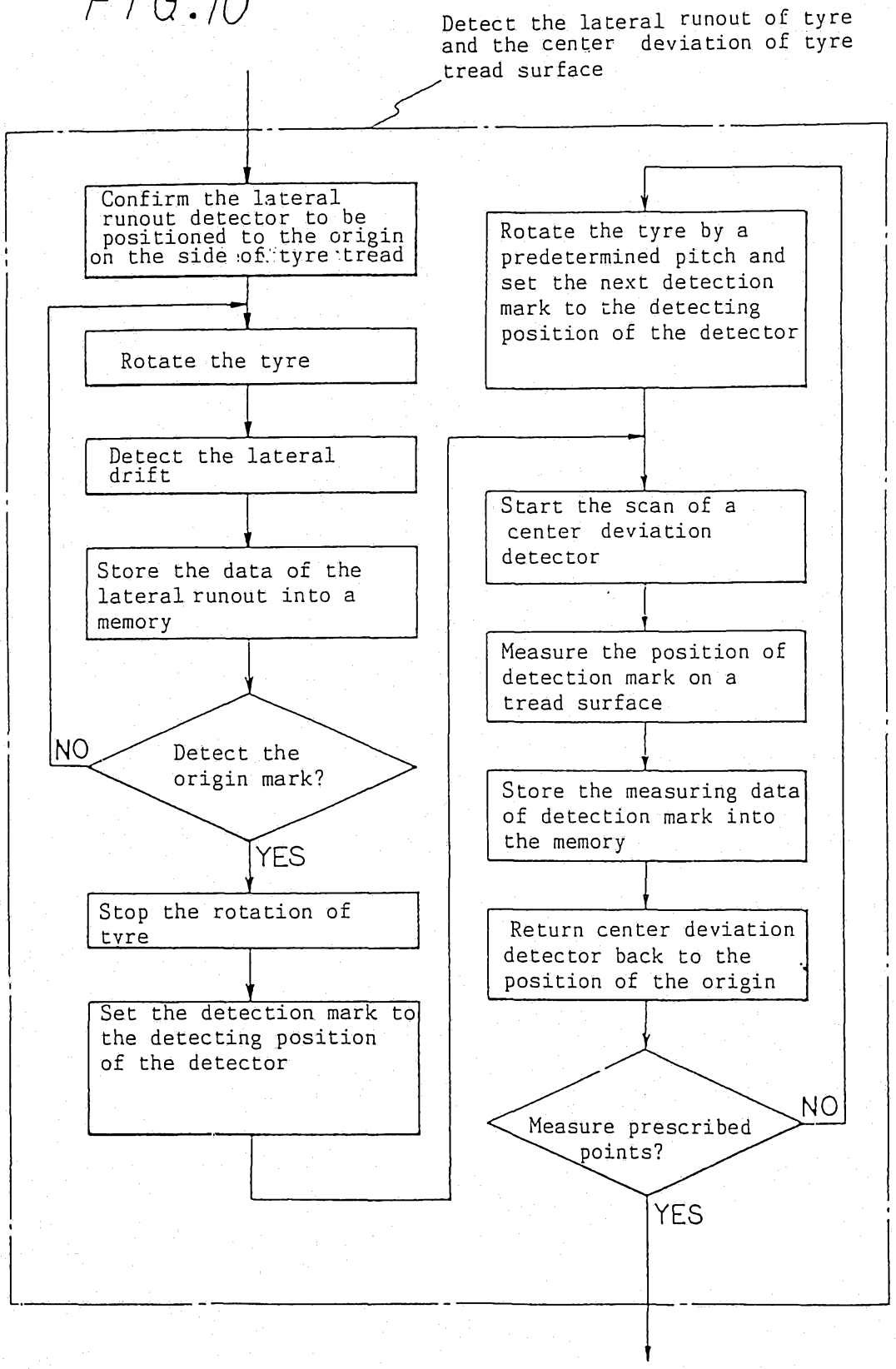

Detect the lateral runout of tyre and the center deviation of tyre tread surface
Confirm the lateral runout detector to be positioned to the origin on the side of tyre tread
Rotate the tyre
Detect the lateral drift
Store the data of the lateral runout into a memory
Detect the origin mark?
NO
YES
Stop the rotation of tyre
Set the detection mark to the detecting position of the detector
Rotate the tyre by a predetermined pitch and set the next detection mark to the detecting position of the detector
Start the scan of a center deviation detector
Measure the position of detection mark on a tread surface
Store the measuring data of detection mark into the memory
Return center deviation detector back to the position of the origin
Measure prescribed points?
NO
YES

FIG. 11

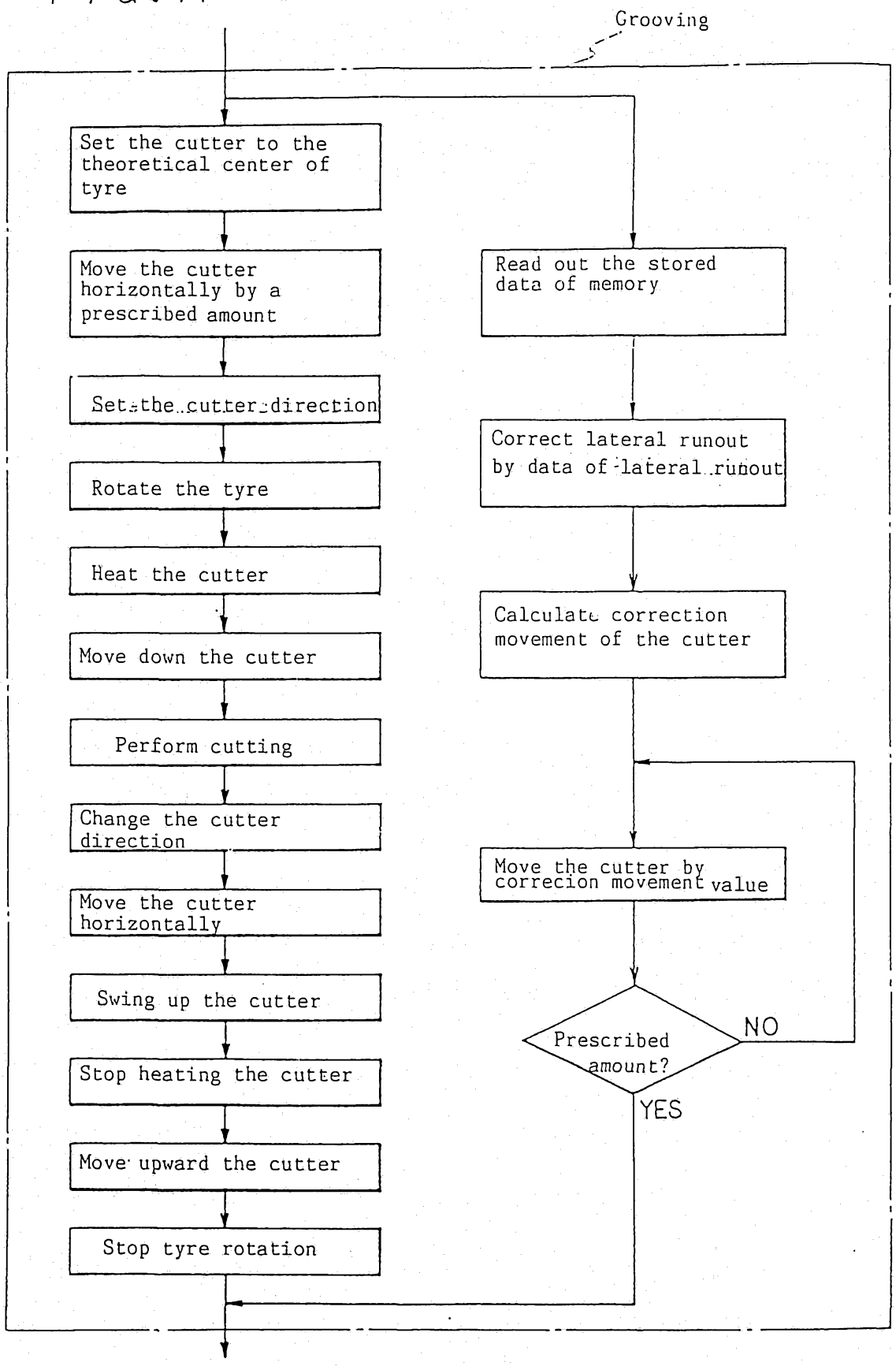

Grooving
Set the cutter to the theoretical center of tyre
Move the cutter horizontally by a prescribed amount
Set the cutter direction
Rotate the tyre
Heat the cutter
Move down the cutter
Perform cutting
Change the cutter direction
Move the cutter horizontally
Swing up the cutter
Stop heating the cutter
Move upward the cutter
Stop tyre rotation
Read out the stored data of memory
Correct lateral runout by data of lateral runout
Calculate correction movement of the cutter
Move the cutter by correcion movement value
Prescribed amount?
NO
YES

FIG.12

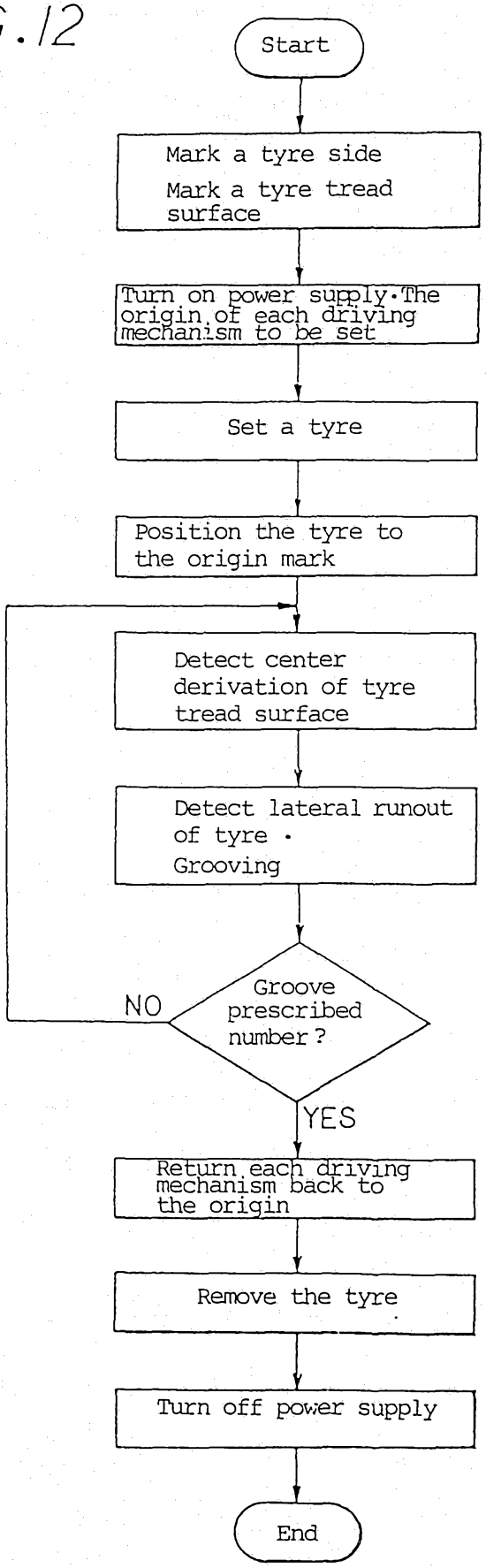

Start
Mark a tyre side
Mark a tyre tread surface
Turn on power supply·The origin of each driving mechanism to be set
Set a tyre
Position the tyre to the origin mark
Detect center derivation of tyre tread surface
Detect lateral runout of tyre ·
Grooving
Groove prescribed number ?
NO
YES
Return each driving mechanism back to the origin
Remove the tyre
Turn off power supply
End

FIG. 13

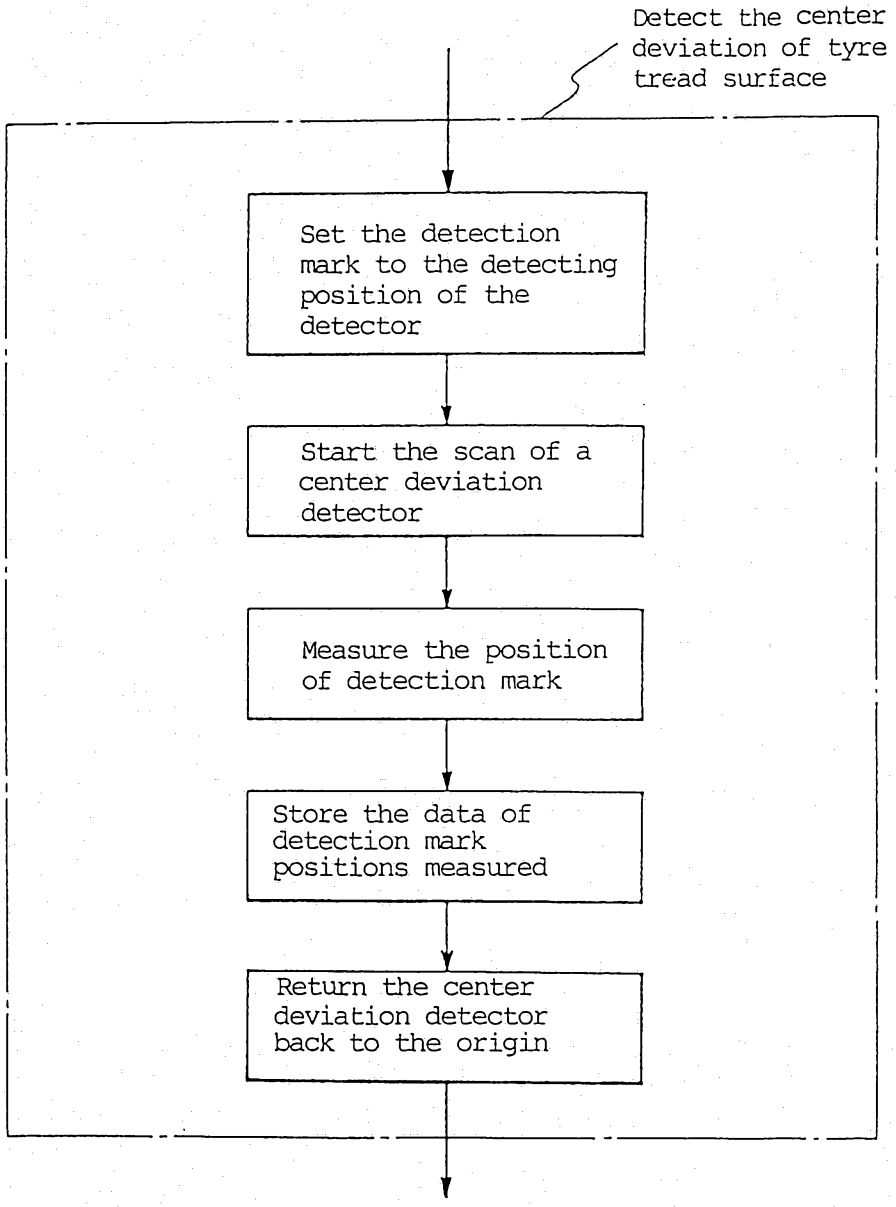

Detect the center deviation of tyre tread surface
Set the detection mark to the detecting position of the detector
Start the scan of a center deviation detector
Measure the position of detection mark
Store the data of detection mark positions measured
Return the center deviation detector back to the origin

FIG. 14

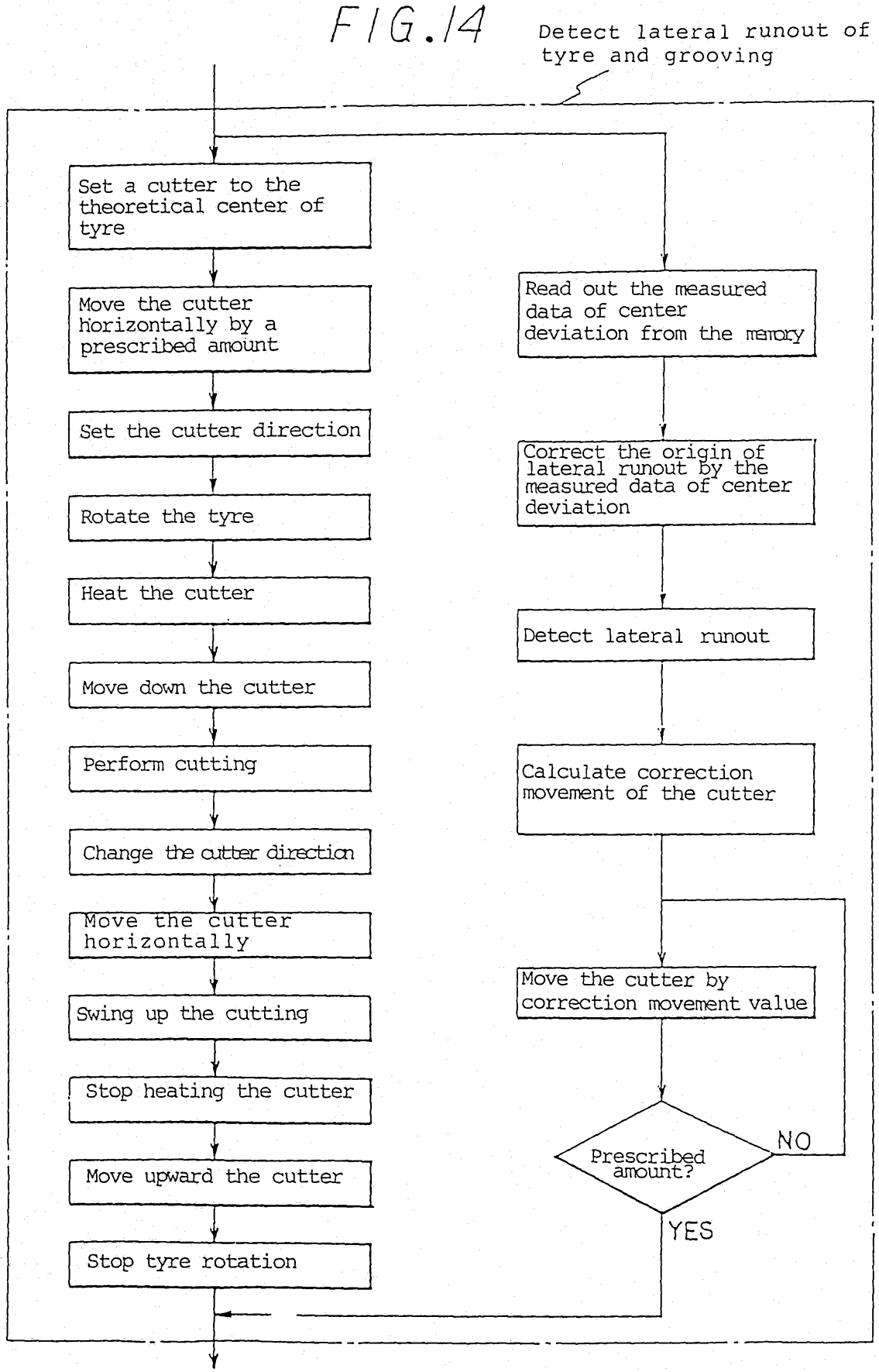

Detect lateral runout of tyre and grooving
Set a cutter to the theoretical center of tyre
Move the cutter horizontally by a prescribed amount
Set the cutter direction
Rotate the tyre
Heat the cutter
Move down the cutter
Perform cutting
Change the cutter direction
Move the cutter horizontally
Swing up the cutting
Stop heating the cutter
Move upward the cutter
Stop tyre rotation
Read out the measured data of center deviation from the memory
Correct the origin of lateral runout by the measured data of center deviation
Detect lateral runout
Calculate correction movement of the cutter
Move the cutter by correction movement value
Prescribed amount?
NO
YES

FIG. 15

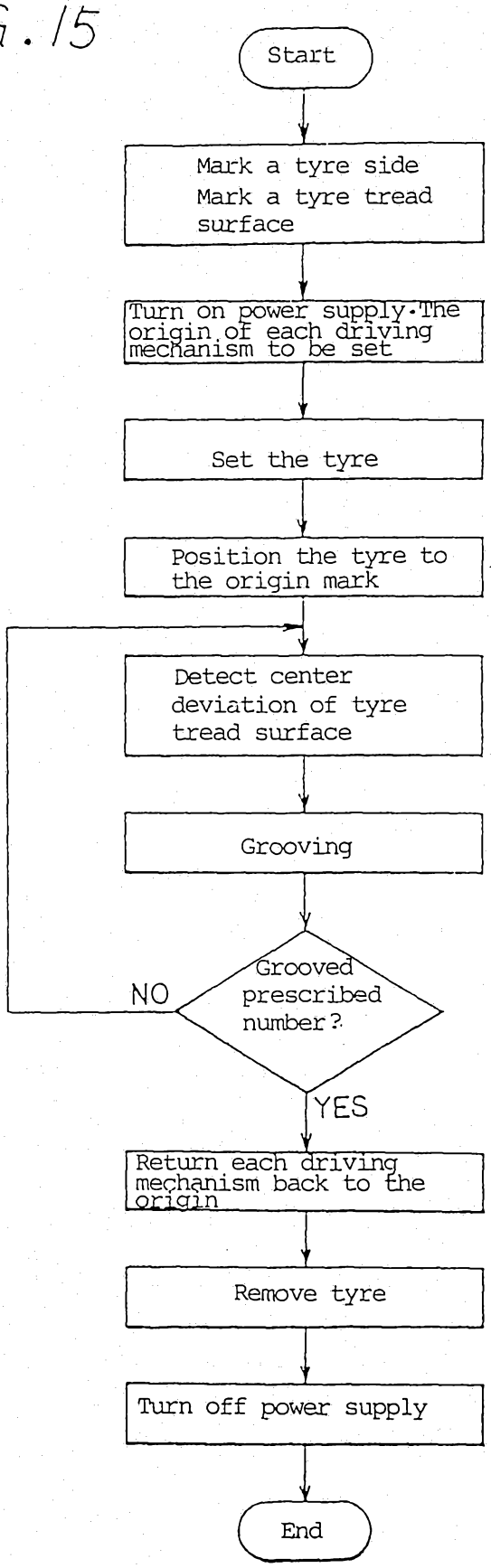

Start
Mark a tyre side
Mark a tyre tread surface
Turn on power supply·The origin of each driving mechanism to be set
Set the tyre
Position the tyre to the origin mark
Detect center deviation of tyre tread surface
Grooving
Grooved prescribed number?
NO
YES
Return each driving mechanism back to the origin
Remove tyre
Turn off power supply
End

FIG.16

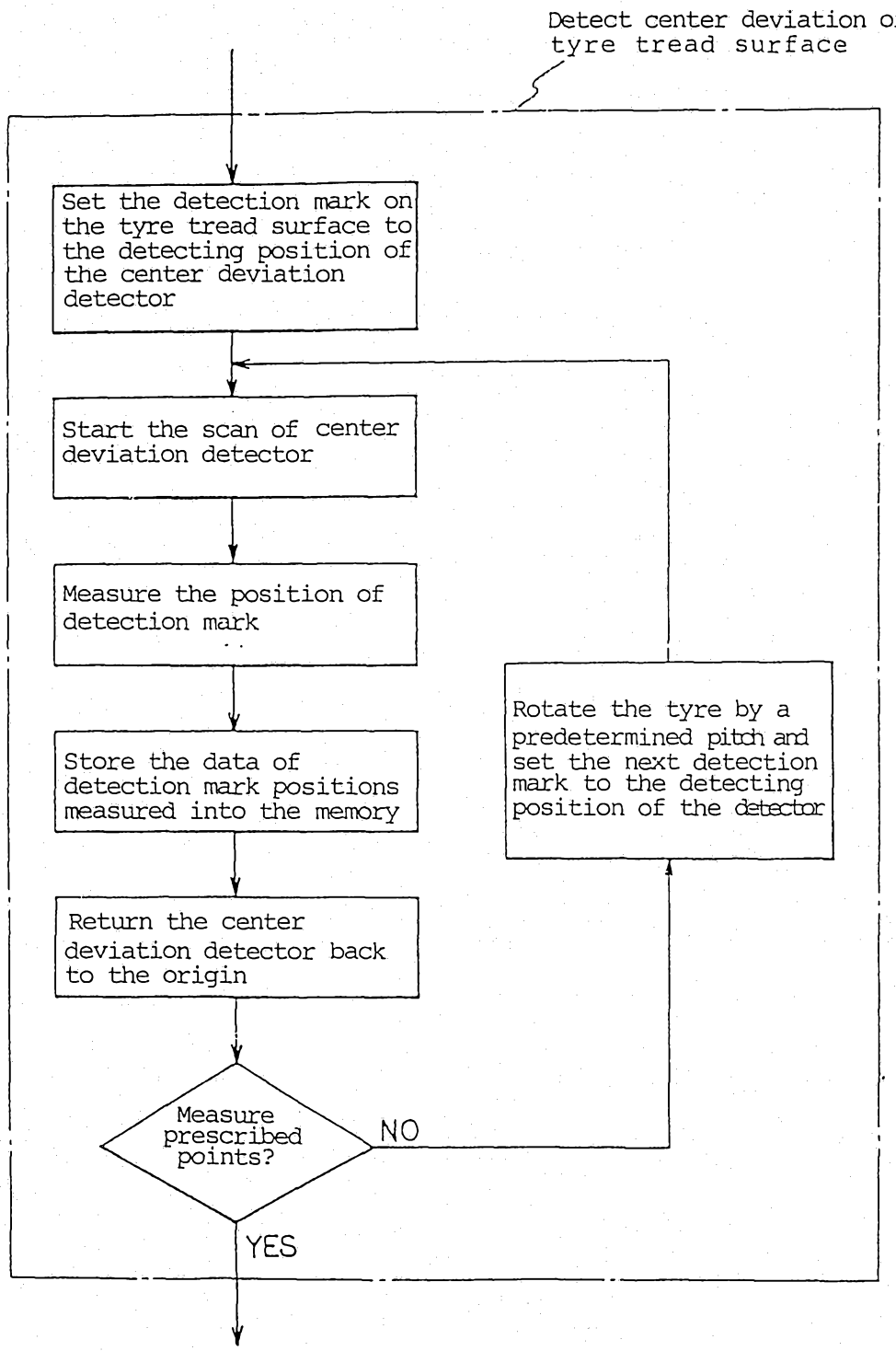

Detect center deviation of tyre tread surface
Set the detection mark on the tyre tread surface to the detecting position of the center deviation detector
Start the scan of center deviation detector
Measure the position of detection mark
Store the data of detection mark positions measured into the memory
Return the center deviation detector back to the origin
Measure prescribed points?
NO
YES
Rotate the tyre by a predetermined pitch and set the next detection mark to the detecting position of the detector

FIG.17

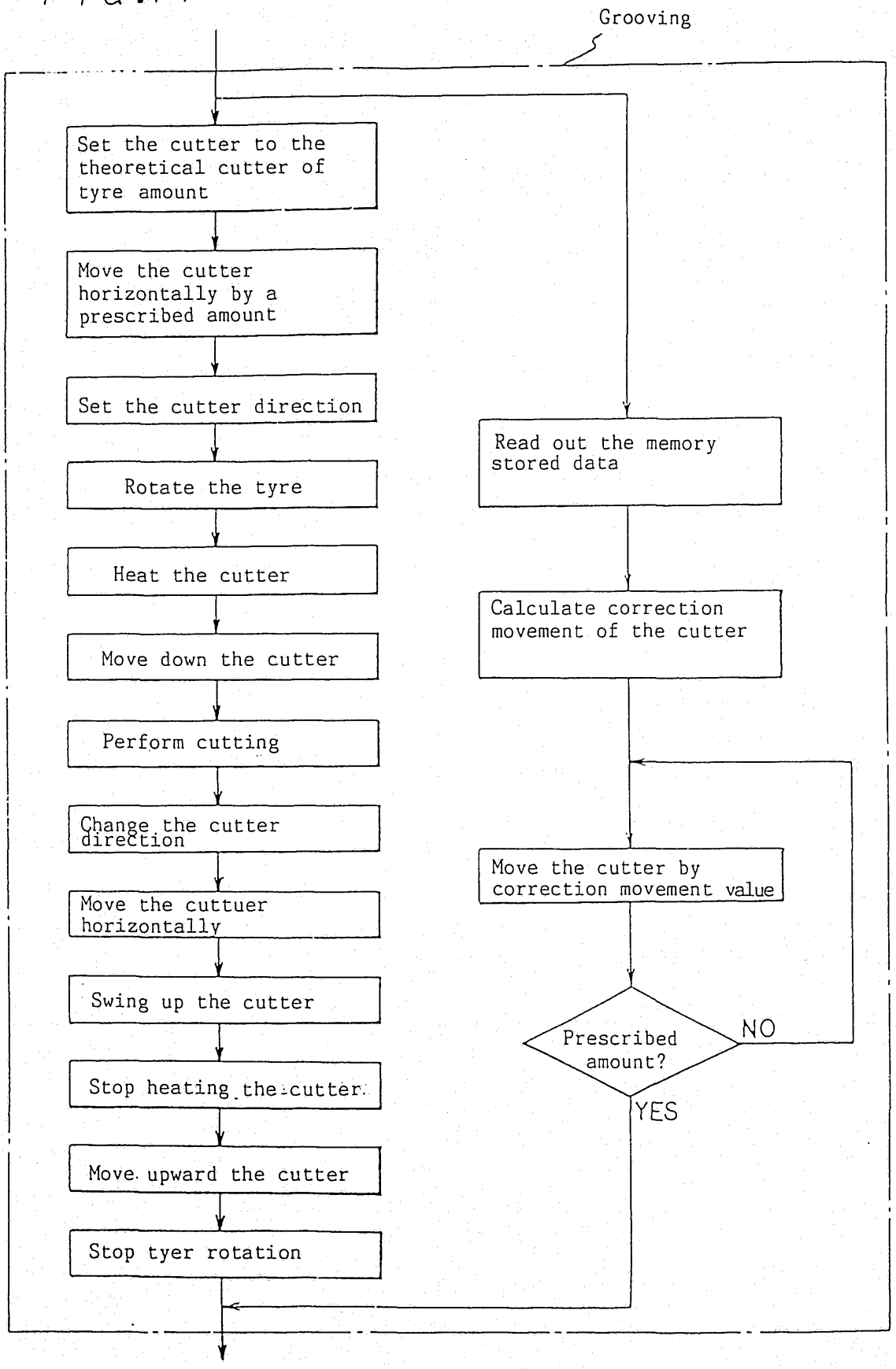

Grooving
Set the cutter to the theoretical cutter of tyre amount
Move the cutter horizontally by a prescribed amount
Set the cutter direction
Rotate the tyre
Heat the cutter
Move down the cutter
Perform cutting
Change the cutter direction
Move the cuttuer horizontally
Swing up the cutter
Stop heating the cutter
Move upward the cutter
Stop tyer rotation
Read out the memory stored data
Calculate correction movement of the cutter
Move the cutter by correction movement value
Prescribed amount?
NO
YES

FIG.18

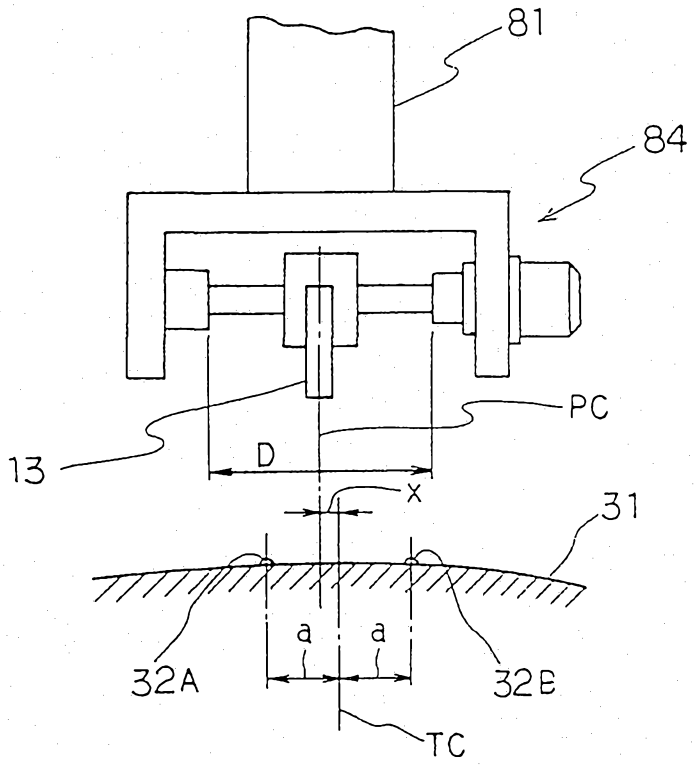


FIG.19

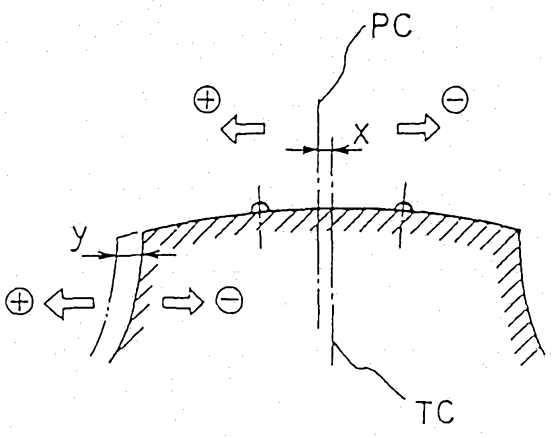

PC
⊕
⊖
x
y
⊕
⊖
TC

FIG.20

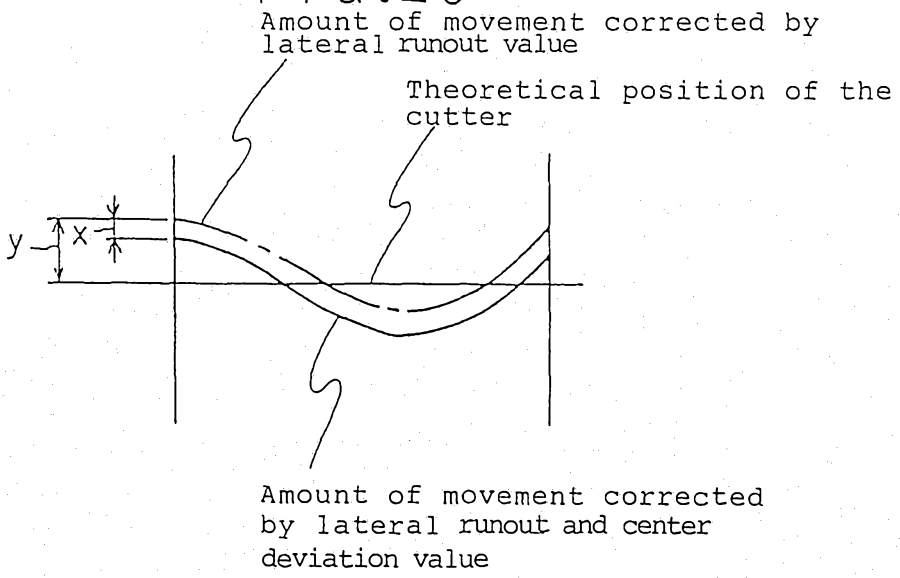

Amount of movement corrected by lateral runout value
Theoretical position of the cutter
y
x
Amount of movement corrected by lateral runout and center deviation value

FIG.21

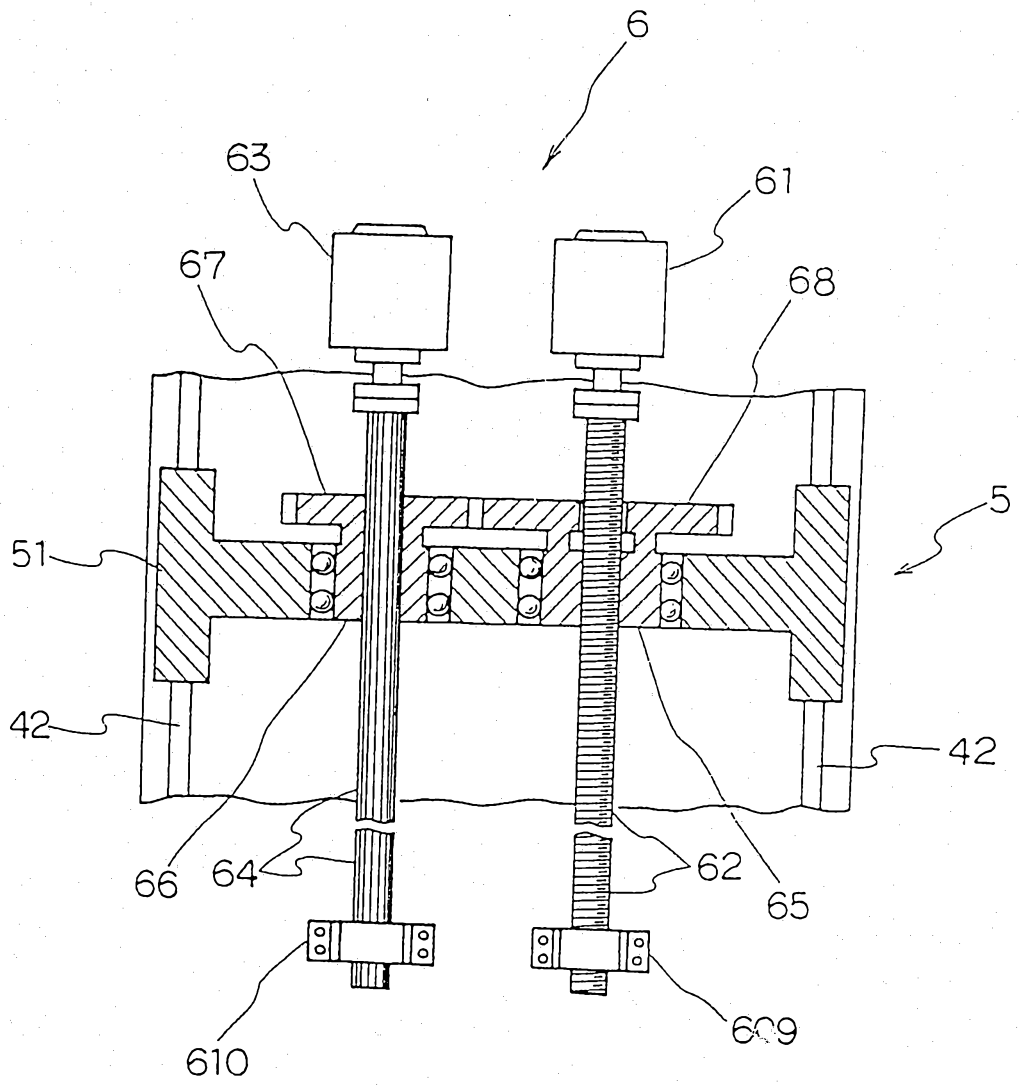


FIG.22

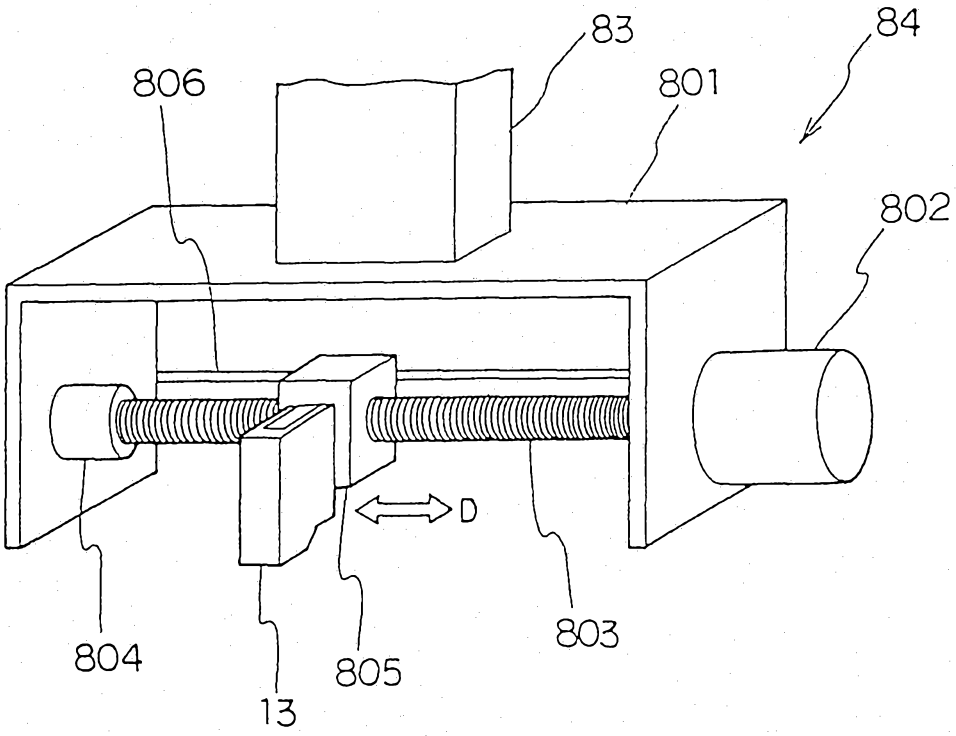


FIG.23

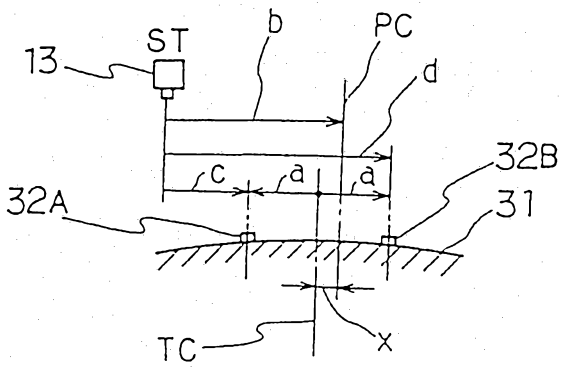


FIG.24

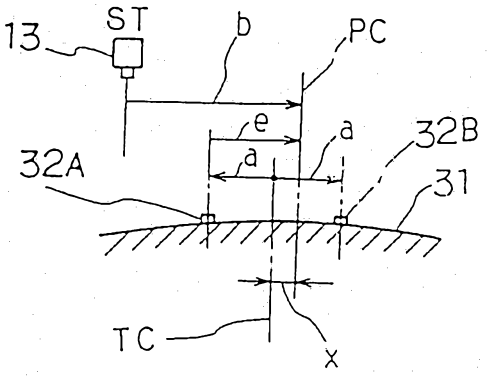


FIG.25

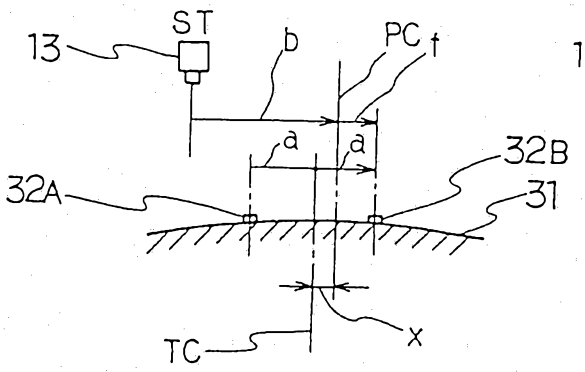


FIG.26

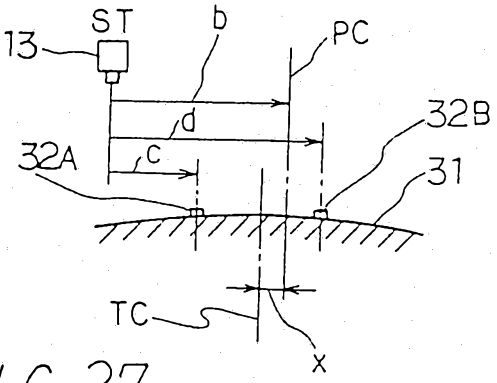


FIG.27

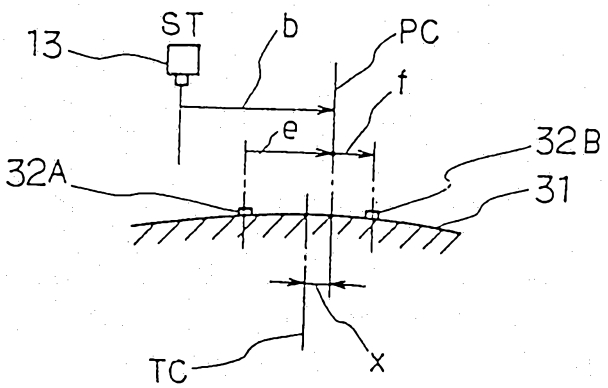


FIG.28

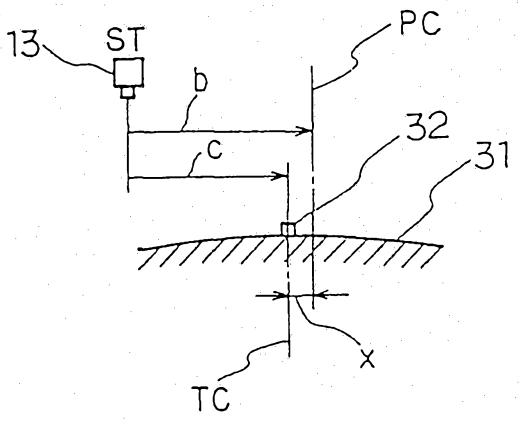


FIG.29

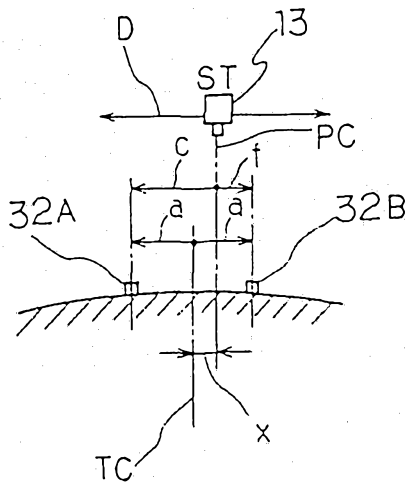


FIG.30

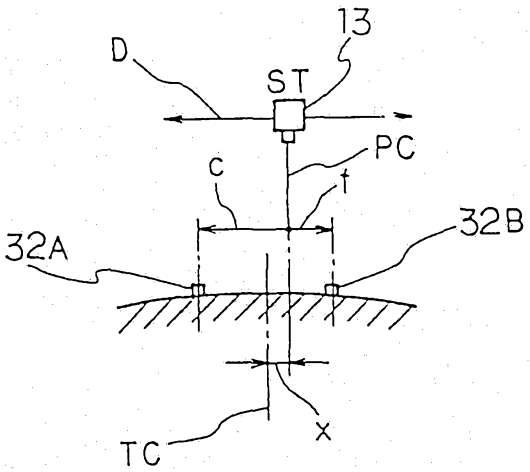


FIG.31

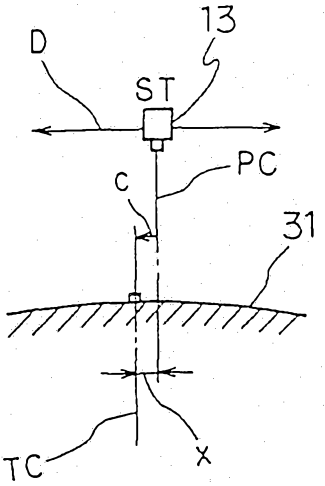
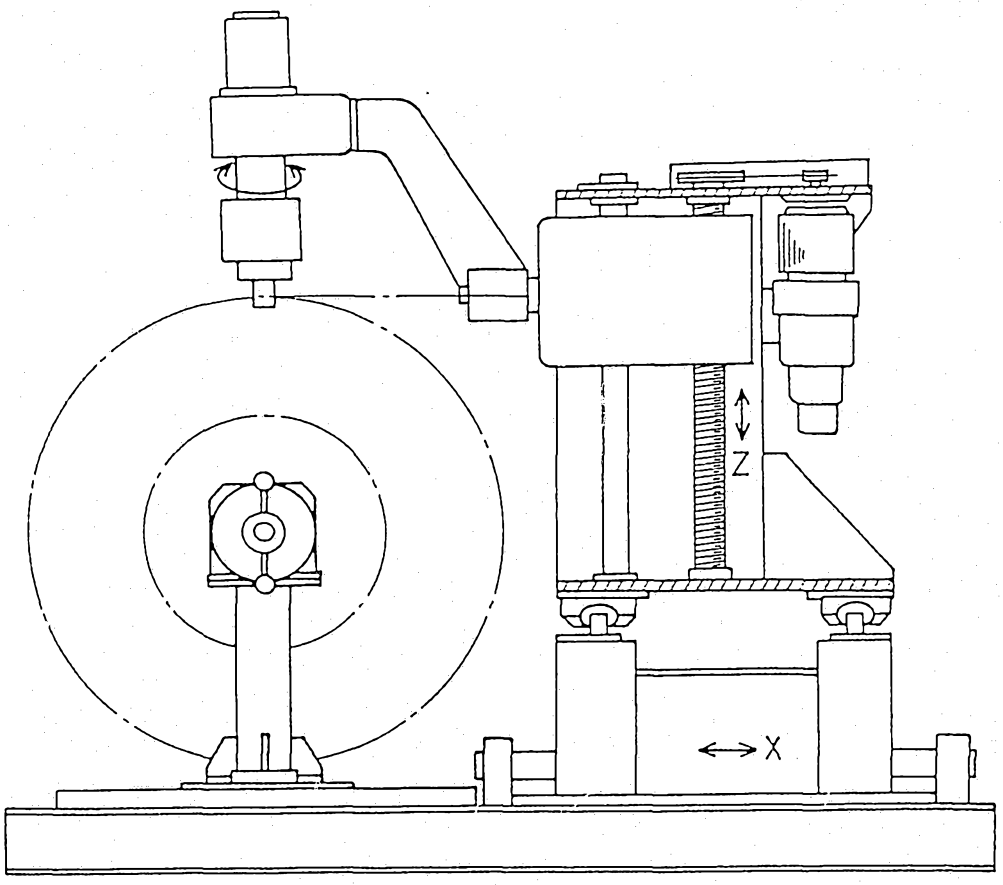


FIG.32



INTERNATIONAL SEARCH REPORT

International Application No PCT/JP89/00776

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl[4] B29D30/68

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC	B29D30/68, B23C1/10, 1/11, 1/12

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

Jitsuyo Shinan Koho	1964 - 1988
Kokai Jitsuyo Shinan Koho	1971 - 1988

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
Y	JP, A, 63-54240 (Sumitomo Rubber Industries, Ltd.) 8 March 1988 (08. 03. 88) P.2, left column, line 14 to right column, line 1, lower left column, lines 3 to 10 & AU, A1, 5292786	1 - 7
Y	JP, A, 61-177232 (Sumitomo Rubber Industries, Ltd.) 8 August 1986 (08. 08. 86) P.1, left column, line 5 to right column, line 5 & EP, A2, 190914	1 - 7
Y	JP, A, 59-215849 (Sumitomo Rubber Industries, Ltd.) 5 December 1984 (05. 12. 84) P.2, right column, line 15 to lower left column, line 3 (Family : none)	1 - 7
Y	JP, A, 48-55486 (Robert Distic) 3 August 1973 (03. 08. 73) P.13, lower right column, lines 4 to 16 (Family : none)	1 - 7

* Special categories of cited documents: [10]

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

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

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

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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

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

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
October 20, 1989 (20. 10. 89)	October 30, 1989 (30. 10. 89)
International Searching Authority	**Signature of Authorized Officer**
Japanese Patent Office	

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

A	JP, A, 57-120428 (Brad Ragan Inc.) 27 July 1982 (27. 07. 82) (Family : none)	1 - 7
A	JP, A, 55-2100 (The Goodyear Tire & Rubber Co.) 9 January 1980 (09. 01. 80) (Family : none)	1 - 7
A	JP, A, 56-162633 (The Goodyear Tire & Rubber Co.) 14 December 1981 (14. 12. 81) (Family : none)	1 - 7

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [1]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers ....., because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim numbers ....., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claim numbers ....., because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [2]

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

A	JP, A, 59-70553 (Sumitomo Rubber Industries, Ltd.) 21 April 1984 (21. 04. 84) (Family : none)	1 - 7
A	JP, A, 59-70554 (Sumitomo Rubber Industries, Ltd.) 21 April 1984 (21. 04. 84) (Family : none)	1 - 7

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [1]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers ..... , because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim numbers ....., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claim numbers ...., because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [2]

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.

国際調査報告

国際出願番号PCT/JP89/00776

I. 発明の属する分野の分類

国際特許分類（IPC） Int. Cl⁴
B29D30／68

II. 国際調査を行った分野

調査を行った最小限資料

分類体系	分類記号
IPC	B29D30／68, B23C1／10, 1／11, 1／12

最小限資料以外の資料で調査を行ったもの

日本国実用新案公報　1964－1988年
日本国公開実用新案公報　1971－1988年

III. 関連する技術に関する文献

引用文献のカテゴリー※	引用文献名　及び一部の箇所が関連するときは、その関連する箇所の表示	請求の範囲の番号
Y	JP, A, 63－54240（住友ゴム工業株式会社） 8. 3月. 1988（08. 03. 88） P.2左欄第14行－右欄第1行，左下欄第3－10行 &AU, A1, 5292786	1－7
Y	JP, A, 61－177232（住友ゴム工業株式会社） 8. 8月. 1986（08. 08. 86） P.1左欄第5行－右欄第5行&EP, A2, 190914	1－7
Y	JP, A, 59－215849（住友ゴム工業株式会社） 5. 12月. 1984（05. 12. 84） P.2右欄第15行－左下欄第3行（ファミリーなし）	1－7
Y	JP, A, 48－55486（ロベルト・デステイク） 3. 8月. 1973（03. 08. 73） P.13右下欄第4－16行（ファミリーなし）	1－7

※引用文献のカテゴリー
「A」特に関連のある文献ではなく、一般的技術水準を示すもの
「E」先行文献ではあるが、国際出願日以後に公表されたもの
「L」優先権主張に疑義を提起する文献又は他の文献の発行日若しくは他の特別な理由を確立するために引用する文献（理由を付す）
「O」口頭による開示、使用、展示等に言及する文献
「P」国際出願日前で、かつ優先権の主張の基礎となる出願の日の後に公表された文献
「T」国際出願日又は優先日の後に公表された文献であって出願と矛盾するものではなく、発明の原理又は理論の理解のために引用するもの
「X」特に関連のある文献であって、当該文献のみで発明の新規性又は進歩性がないと考えられるもの
「Y」特に関連のある文献であって、当該文献と他の1以上の文献との、当業者にとって自明である組合せによって進歩性がないと考えられるもの
「&」同一パテントファミリーの文献

IV. 認証

国際調査を完了した日	国際調査報告の発送日
20. 10. 89	30.10.89

国際調査機関	権限のある職員
日本国特許庁（ISA/JP）	4F 6949 特許庁審査官　中山時夫

様式PCT／ISA／210（第2ページ）（1981年10月）

第2ページから続く情報

	（Ⅲ欄の続き）	
A	JP, A, 57－120428（ブラッド・ラガン・Inc.） 27. 7月. 1982（27. 07. 82）（ファミリーなし）	1－7
A	JP, A, 55－2100（ザ・グッドイヤー・タイヤ・アンド・ラバー・コンパニー） 9. 1月. 1980（09. 01. 80）（ファミリーなし）	1－7
A	JP, A, 56－162633（ザ・グッドイヤー・タイヤ・アンド・ラバー・コンパニー） 14. 12月. 1981（14. 12. 81）（ファミリーなし）	1－7

Ⅴ. ☐ 一部の請求の範囲について国際調査を行わないときの意見

次の請求の範囲については特許協力条約に基づく国際出願等に関する法律第8条第3項の規定によりこの国際調査報告を作成しない。その理由は、次のとおりである。

1. ☐ 請求の範囲＿＿＿＿は、国際調査をすることを要しない事項を内容とするものである。

2. ☐ 請求の範囲＿＿＿＿は、有効な国際調査をすることができる程度にまで所定の要件を満たしていない国際出願の部分に係るものである。

3. ☐ 請求の範囲＿＿＿＿は、従属請求の範囲でありかつPCT規則6.4(a)第2文の規定に従って起草されていない。

Ⅵ. ☐ 発明の単一性の要件を満たしていないときの意見

次に述べるようにこの国際出願には二以上の発明が含まれている。

1. ☐ 追加して納付すべき手数料が指定した期間内に納付されたので、この国際調査報告は、国際出願のすべての調査可能な請求の範囲について作成した。
2. ☐ 追加して納付すべき手数料が指定した期間内に一部分しか納付されなかったので、この国際調査報告は、手数料の納付があった発明に係る次の請求の範囲について作成した。
   請求の範囲＿＿＿＿
3. ☐ 追加して納付すべき手数料が指定した期間内に納付されなかったので、この国際調査報告は、請求の範囲に最初に記載された発明に係る次の請求の範囲について作成した。
   請求の範囲＿＿＿＿
4. ☐ 追加して納付すべき手数料を要求するまでもなく、すべての調査可能な請求の範囲について調査することができたので、追加して納付すべき手数料の納付を命じなかった。

追加手数料異議の申立てに関する注意

☐ 追加して納付すべき手数料の納付と同時に、追加手数料異議の申立てがされた。

☐ 追加して納付すべき手数料の納付に際し、追加手数料異議の申立てがされなかった。

Ⅲ. 関連する技術に関する文献（第2ページからの続き）

引用文献のカテゴリー*	引用文献名及び一部の箇所が関連するときは、その関連する箇所の表示	請求の範囲の番号
A	JP, A, 59－70553（住友ゴム工業株式会社） 21. 4月. 1984（21. 04. 84）（ファミリーなし）	1－7
A	JP, A, 59－70554（住友ゴム工業株式会社） 21. 4月. 1984（21. 04. 84）（ファミリーなし）	1－7