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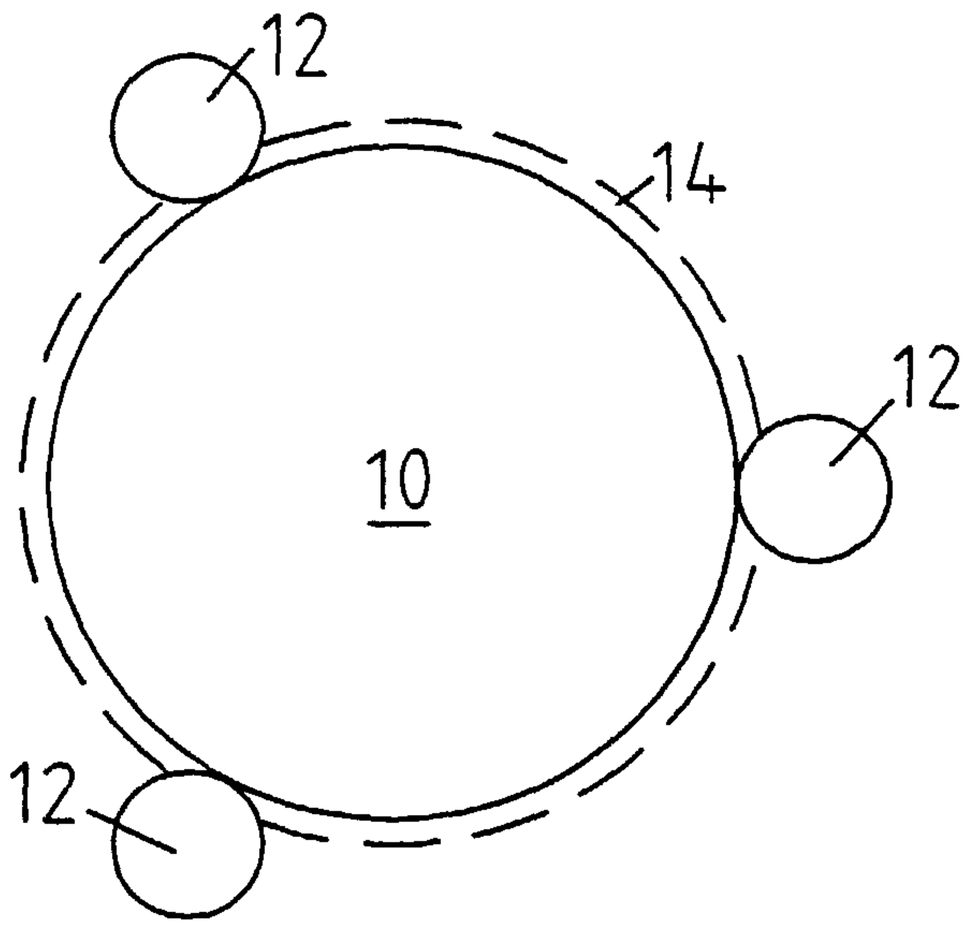

(57) Abrégé/Abstract:
The present invention concerns a wind power installation having a rotor with at least one blade and an adjusting device for the rotor blade. With increasing installation sizes and thus larger rotor blades larger drives are also required for rotor blade adjustment. Particularly in the case of damage such drives in turn require a higher level of logistical, time and material expenditure. In order to avoid those disadvantages there is provided an adjusting device with more than one drive. By virtue of that arrangement each drive only has to furnish a corresponding fraction of the power output, it can be of a correspondingly smaller design configuration, and it imposes a correspondingly lower loading on the subsequent components.

Abstract

The present invention concerns a wind power installation having a rotor with at least one blade and an adjusting device for the rotor blade.

With increasing installation sizes and thus larger rotor blades larger drives are also required for rotor blade adjustment. Particularly in the case of damage such drives in turn require a higher level of logistical, time and material expenditure.

In order to avoid those disadvantages there is provided an adjusting device with more than one drive.

By virtue of that arrangement each drive only has to furnish a corresponding fraction of the power output, it can be of a correspondingly smaller design configuration, and it imposes a correspondingly lower loading on the subsequent components.

(Figure 1)

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Wind power installation

The present invention concerns a wind power installation having a rotor with at least one blade and an adjusting device for the rotor blade.

Such wind power installations have long been known in the state of the art and are also described in the specialist literature. Thus for example in the work by Erich Hau in 'Windkraftanlagen', ['Wind power installations'], Springer-Verlag, 2nd edition, 1996, pages 231 ff.

That adjusting device must be designed in such a way that it can put the rotor blade or, in the case of central rotor blade adjustment, the rotor blades, into a predeterminable position in an acceptable time. For that purpose, a motor is frequently provided in the state of the art, and that motor must have a minimum power output which is predetermined by the rotor blades and the loads thereof.

Irrespective of considerations relating to the use and the design of transmission arrangements, it can be easily prognosticated that, with an increasing size of installation, the rotor blades also become larger and therefore the motor used for rotor blade adjustment must also furnish a higher power output. That higher power output inevitably results in the motor being of larger dimensions.

Therefore the object of the present invention is to develop a wind power installation of the kind set forth in the opening part of this specification, in such a way that the stated disadvantages in the state of the art are avoided.

In accordance with the invention that is achieved in that the adjusting device has at least two drives. In that way the necessary force for adjustment of the rotor blade or rotor blades can be applied simultaneously at a plurality of locations to the blade root. Therefore, according to the number of drives, each drive acts on the subsequent components only with a corresponding fraction of the overall force required. That in turn permits those components to be of a smaller design configuration.

In addition it is possible in accordance with the invention to use available drives which are already now available in large numbers and which are already tried-and-tested in continuous operation. In addition apparatuses and methods for the handling thereof are already known and tried-and-tested.

In a particularly preferred embodiment of the invention the drives are electric motors, more specifically preferably dc motors. In the case of a fault those electric motors can be connected to an existing emergency power supply, for example in the form of a battery.

It is also possible to use three-phase asynchronous motors as the electric motors. To produce a braking torque, those motors, after the three-phase current flowing during the rotor blade adjustment procedure is switched off, are supplied with a direct current so that a stationary magnetic field is produced in the asynchronous motors. In that way the motors which are still rotating can be braked and a braking torque is maintained in the stationary motors.

In regard to the further operating procedure involved in pitch regulation, attention is also to be directed to German patent application No 197 31 918.1. Insofar as the configurations in the present invention are concerned, the man skilled in the art would also be able to make use of the structure described therein. As far as may be necessary the content of the aforementioned application is also content of the present application.

Further advantageous embodiments of the invention are set forth in the appendant claims.

An embodiment of the invention is described hereinafter with reference to the accompanying drawings in which:

Figure 1 is a simplified representation of a rotor blade root with a plurality of drives,

Figure 2 is a simplified representation of a control according to the invention, and

Figure 3 is a simplified representation of a control according to the invention by means of a dc motor.

Figure 1 shows in greatly simplified form a rotor blade root 10, at the periphery of which are arranged three adjusting drives 12. The rotor blade root 10 itself has an external tooth arrangement 14 at its outer periphery, which is indicated by a broken line.

The adjusting drives 12 are arranged at uniform spacings at the periphery of the rotor blade root. The adjusting drives preferably engage by way of a tooth arrangement a rotary ball connection which is installed in the form of a rotary mounting for the rotor blade and by way thereof adjust the rotor blade. Admittedly, it would theoretically be basically possible for the adjusting drives also to directly engage the rotor blade, but under some circumstances that is undesirable as the rotor blade root - like also the rest of the rotor blade - comprises glass fibre-reinforced plastic material (GRP) or the like and the fact of the adjusting drives directly engaging in the rotor blade could result in damage to the rotor blade. By virtue of simultaneous operation of all three drives 12, each drive 12 only has to apply a third of the overall power output required, which is necessary for adjustment of the rotor blade 10.

In addition due to the fact that each of the adjusting drives only has to apply a part, in the specific example illustrated, only a third, of the overall force required, the dimensioning thereof can also be smaller than when only a single adjusting drive 12 is used.

In the event of damage to one of the adjusting drives 12, it can still be handled manually, if of suitable dimensions, and can be replaced for example using a block and tackle, within the pylon of the wind power installation.

Figure 2 shows a control arrangement. The control arrangement has a central control unit 20 and a plurality of components 22 which can be in the form of measurement value pick-ups and/or reference value generators and/or input means. By way of those components, items of information are made available to the control unit 20, and from those items of information the control unit 20 derives control data required for actuation of the adjusting drives 12.

Referring to Figure 2, one or more of the components 22 can, for example, take the form of input means for predetermining the position of the rotor blade or blades that is desired for a given instantaneous loading. One or more of the components 22 can, for example, take the form of measuring means for ascertaining the instantaneous loading of selected portions of the wind power installation. Such control data can be used by the control unit 20 to adjust the position of the rotor blade by means of the adjusting drives 12.

Those control data can influence for example a switching device 24 which supplies the adjusting drives 12 which are in the form of three-phase asynchronous motors either with a three-phase current for adjustment of the rotor blades 10 or with a direct current for producing a braking torque in the adjusting drives 12.

In that way the adjusting drives can exert a braking action in the event of spontaneous changes in load at the rotor blades, for example with gusty winds which abruptly and briefly change in direction, so that meaningful rotor blade adjustment is not possible.

The three adjusting drives 12 are so designed that the further adjusting function of the rotor blades can be maintained even if one of the three adjusting drives fails. The entire wind power installation therefore does not have to be shut down if - for whatever reasons - an adjusting drive should fail, because then the respectively necessary pitch regulation effect can still be maintained by the two adjusting drives which remain.

If one of the adjusting drives fails, the loads which are then applied to the two remaining adjusting drives are admittedly greater than previously, but it will be noted that each adjusting drive is so designed that it can be operated in an overload mode even for a prolonged period of time. In that respect therefore each individual adjusting drive is somewhat oversized so that, in the situation where one of the adjusting drives fails, a drive can still be operated in an overload mode for a certain period of time in order to initiate a safe stop for the wind power installation or to bring the rotor blades into the feathered position.

Figure 3 shows by way of example one of the drives 12 which is connected by way of a relay 24 to the normal operating voltage. In this case the relay 24 is in the working position.

If now a power failure occurs the relay 24 is also de-energised and the contacts of the relay will switch over and in their rest position connect the adjusting drive 12 to the battery 26 so that, in such a situation, movement of the rotor blade into the feathered position and thus stoppage of the installation is reliably and safely possible. Deep discharge of the battery is tolerated in that case (with disapproval) and is to be preferred to the installation being in an indeterminate condition, with an unclear rotor blade pitch setting.

In a wind power installation in accordance with an embodiment of the invention, at least one rotor blade may be adjustable asynchronously with respect to one or more other rotor blades. Also, at least one portion of at least one rotor blade may be adjustable asynchronously with respect to at least one further adjustable portion of the same rotor blade or another rotor blade or adjustable portion thereof. In this embodiment, the adjusting device for adjusting the rotor blade has an adjusting motor and an adjusting transmission driven thereby, and the control unit 20 receives an actual value relating to the instantaneous position of the rotor blade and adjusts the rotor blade by way of the adjusting device. In this embodiment, the control unit 20 can effect adjustment of the rotor blade without delay with acquisition of the values received, whether measured, input or otherwise.

CLAIMS

1. A wind power installation having a rotor with at least one rotor blade and an adjusting device for adjusting the pitch angle of the rotor blade, characterised in that the adjusting device comprises at least two electric-motor drives, wherein each of the electric-motor drives comprise a tooth arrangement which engages with a tooth arrangement at the root of the rotor blades such that a force of adjustment of the rotor blade is applied to the root of the rotor blade at various locations by each electric-motor drive.

2. A wind power installation according to claim 1 characterised in that the electric-motor drives are electric dc motors.

3. A wind power installation according to claim 1 characterised in that the electric-motor drives are three-phase asynchronous motors and that the three-phase asynchronous motors are at times supplied with direct current.

4. A wind power installation according to any one of claims 1 to 3 characterised in that the drives of the adjusting device are coupled to each other.

5. A wind power installation according to claim 3 characterised in that the three-phase asynchronous motors are electrically coupled to each other by a transformer.

6. A wind power installation according to any one of claims 1 to 5 characterised by measuring means (22) for ascertaining the instantaneous loading of selected portions of the wind power installation and by control means (20) which ascertain the position of at least one rotor blade, that is desired for an instantaneous loading, and correspondingly adjust same by means of the adjusting device.

7. A wind power installation according to any one of claims 1 to 6 with at least two rotor blades characterised in that at least one rotor blade is adjustable asynchronously with respect to the other or others.

8. A wind power installation according to any one of claims 1 to 7 characterised in that at least one portion of at least one rotor blade is adjustable asynchronously with respect to at least one further adjustable portion of the same rotor blade.

9. A wind power installation according to any one of claims 1 to 7 characterised in that at least one portion of at least one rotor blade is adjustable asynchronously with respect to at least one adjustable portion of another rotor blade.

10. A wind power installation according to any one of claims 1 to 5 and 7 to 9 characterised in that the position of the rotor blade or blades, that is desired for a given instantaneous loading, can be predetermined by way of input means connected to control means (20) for positioning the rotor blade or blades.

11. A wind power installation according to any one of claims 6 and 10 characterised in that at least one of the electric-motor drives of the adjusting device has an adjusting transmission driven thereby, wherein the control means (20) receive an actual value relating to the instantaneous position of the rotor blade and adjust the rotor blade by way of the adjusting device.

12. A wind power installation according to any one of claims 6, 10 and 11 characterised in that the control means (20) effect adjustment of the rotor blade without delay with acquisition of measurement values.

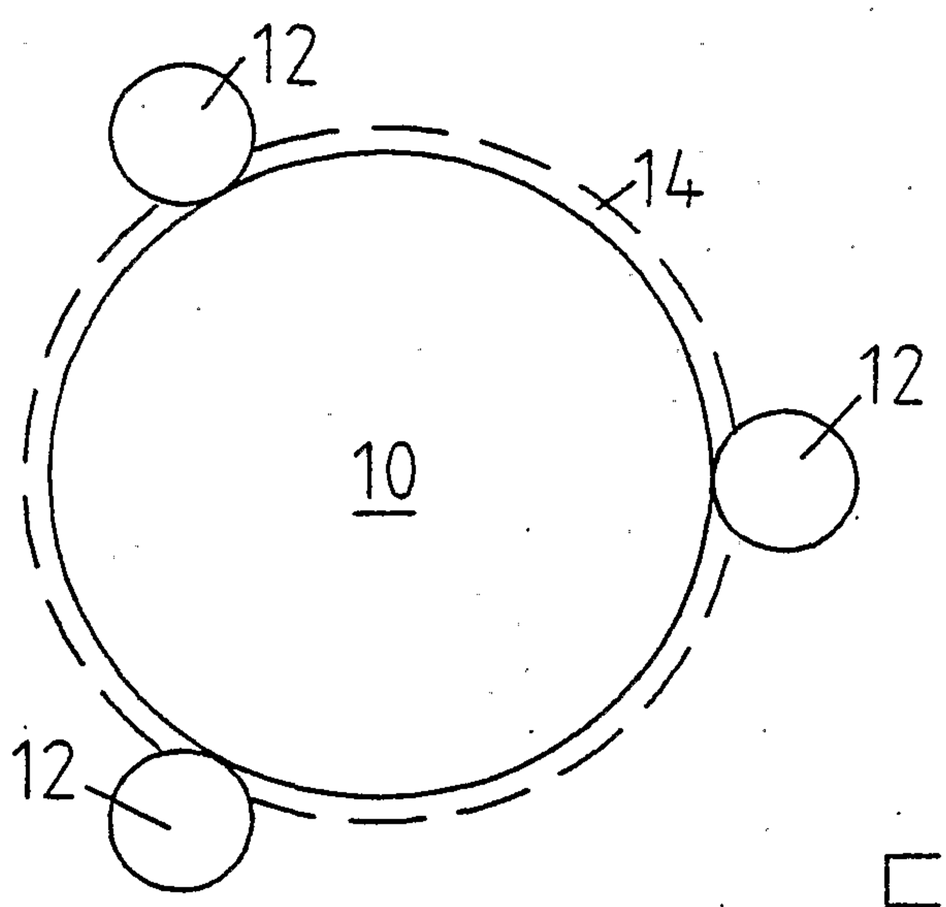


Fig. 1

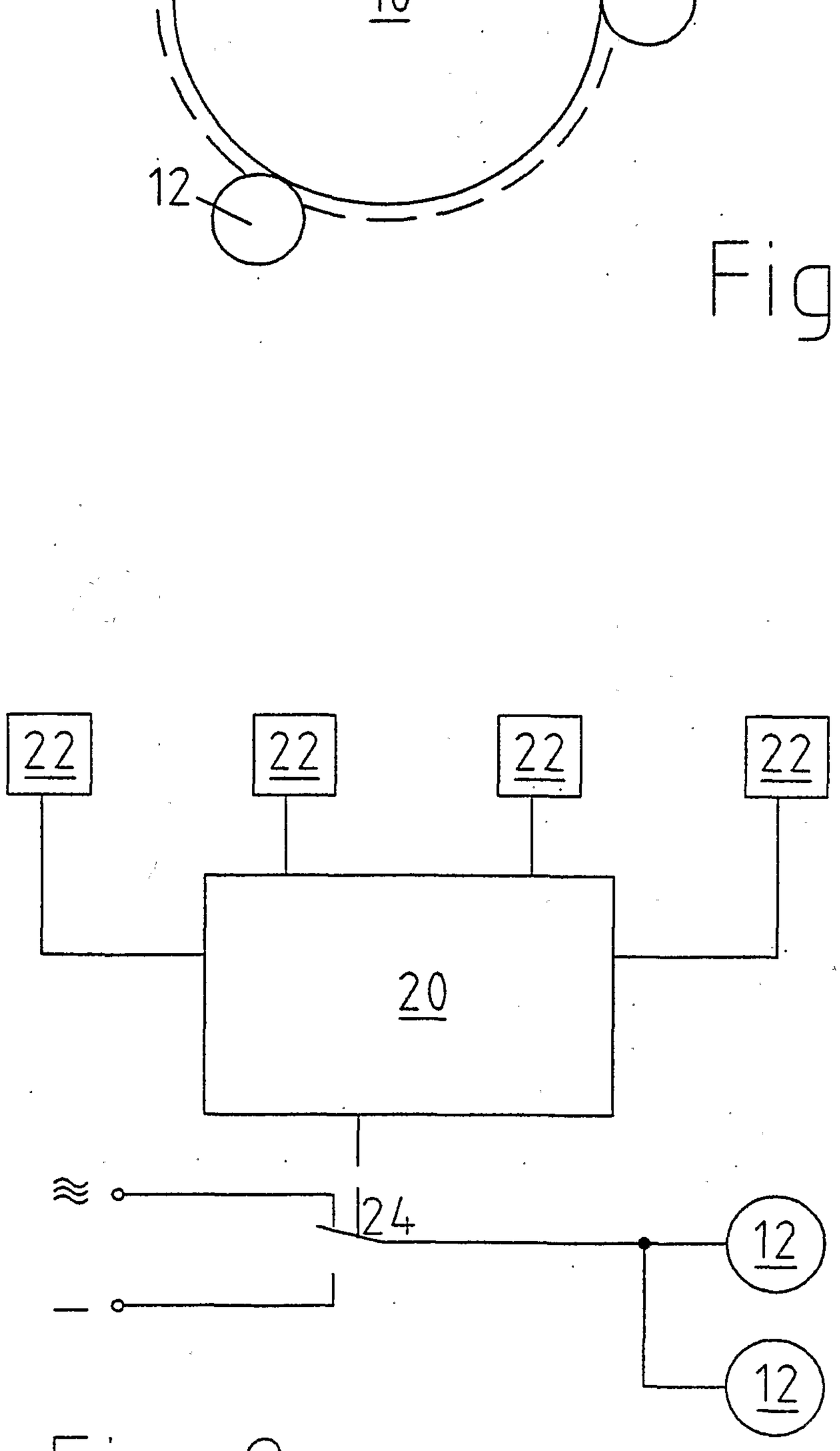


Fig. 2

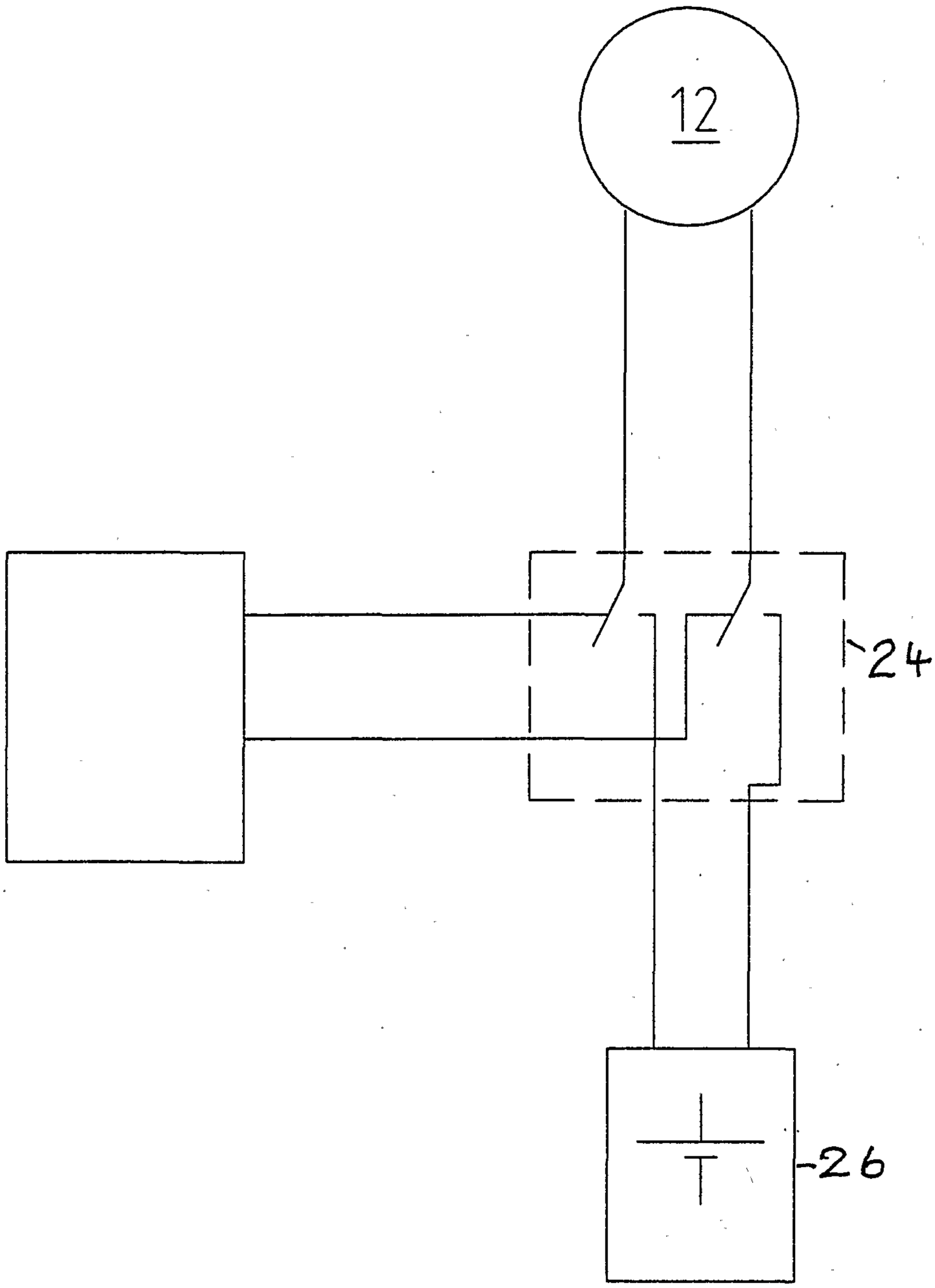
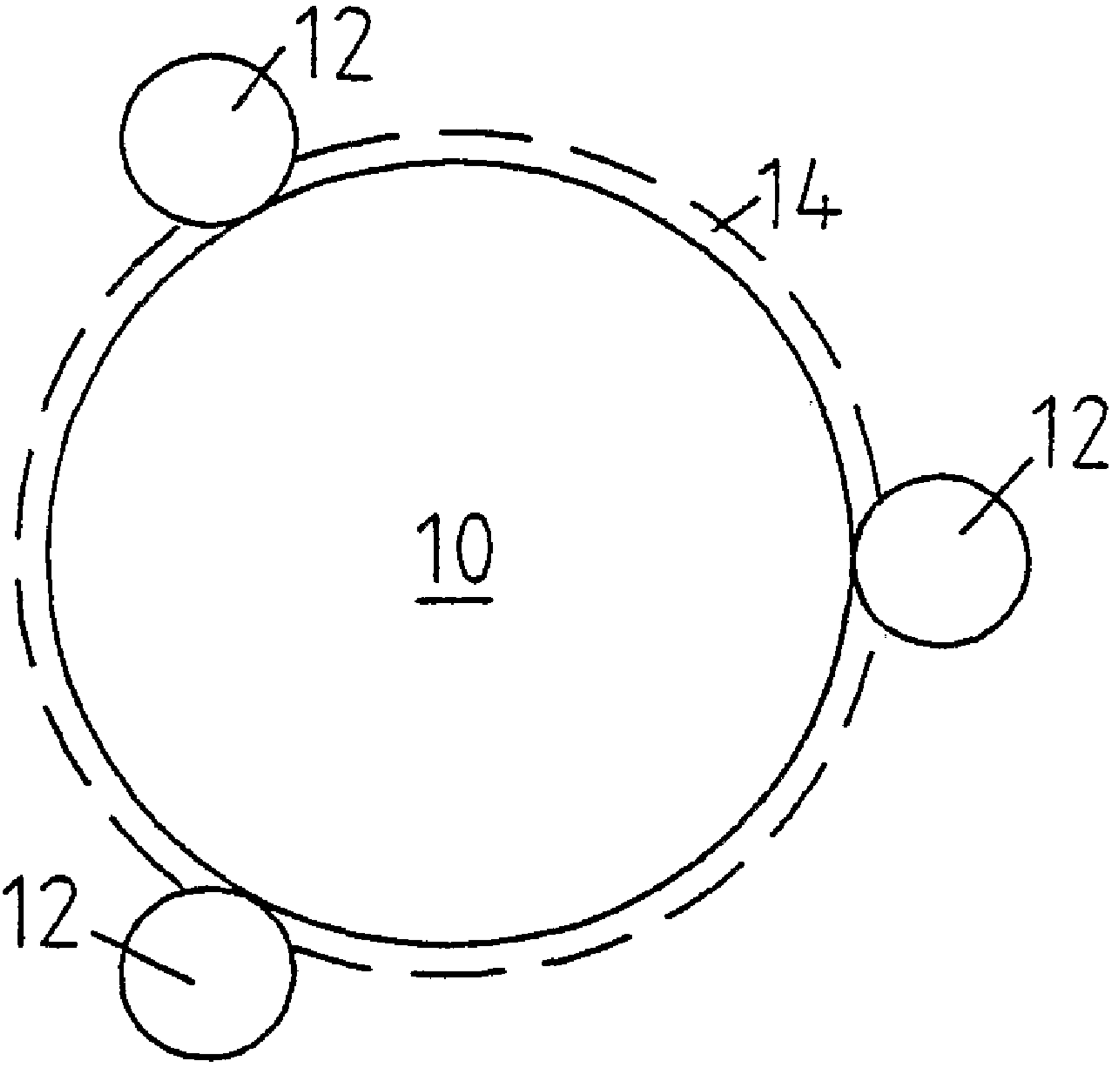


Fig. 3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