(19) DANMARK

(10) DK/EP 2677171 T3

(12) Oversættelse af europæisk patentskrift

Patent- og Varemærkestyrelsen

(51) Int.Cl.: *F 03 D 15/00 (2016.01)*

(45) Oversættelsen bekendtgjort den: **2018-11-05**

(80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2018-07-18**

(86) Europæisk ansøgning nr.: **13002852.5**

(86) Europæisk indleveringsdag: **2013-06-03**

(87) Den europæiske ansøgnings publiceringsdag: **2013-12-25**

(30) Prioritet: **2012-06-18 DE 102012012106**

(84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**

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(54) Benævnelse: **Vindmølle med et mellem planetgearet og generatoren placeret koblingsmiddel til udligning af aksial-, radial- og vinkelforskydning**

(56) Fremdragne publikationer:
**EP-A1- 2 075 466**
**DE-A1-102009 052 240**
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**US-A1- 2011 081 975**
**US-A1- 2012 003 096**
**US-B2- 8 075 442**

## DESCRIPTION

### FIELD OF THE INVENTION

The present invention relates to a wind power plant, having a planetary transmission, which is arranged for the purpose of converting a slow rotary motion of a rotor into a rapid rotary motion for operating an integrated medium-speed electric generator, comprising a transmission input shaft, which is connected indirectly to the rotor, and a transmission output shaft, which is connected to the generator indirectly via a generator shaft, wherein a coupling means is arranged between the generator and the planetary transmission.

The area of application of the invention extends to planetary transmissions of the kind encountered in the drive train of a wind power plant. Among the important features of such planetary transmissions are the dimensions and the weight. At the same time, important factors in the design of the transmission components are, not only the choice of materials and structural aspects, but also the prevailing forces and torques acting on the planetary transmission. Planetary transmissions of this kind are subject to extraordinary stresses due to the location at which they are installed and to the nonuniform changes in the load population.

### BACKGROUND OF THE INVENTION

DE 10 2006 051 546 A1 includes a wind energy plant having a twin-feed asynchronous generator, wherein a coupling is provided between the asynchronous generator and a transmission. This coupling serves to separate the generator mechanically from the drive train, ensuring that the transmission and the asynchronous generator are decoupled from one another during a phase shifter mode. The effective power required to maintain the rotational speed corresponds simply to the losses in the generator and the converter.

The generally known prior art discloses that, in the modularized version of the drive train, the transmission, which is generally a multi-stage planetary transmission with spur wheel stages, and the generator are mounted separately from one another and each one has a dedicated housing. The output shaft of the transmission and the output shaft of the high-speed generator are connected by an intermediate shaft. Medium-speed drive trains with a small number of spur wheel stages are already known from the prior art. If only planetary stages are used, the sun wheel shaft of the planetary stage on the generator side can be used as a shaft for connection to the generator.

US 8,075,442 B2 discloses a planetary transmission for converting a slow rotary motion of a rotor into a rapid rotary motion for operating an integrated medium-speed electric generator. The transmission and the generator are arranged coaxially and have joint support for the transmission output shaft and the generator input shaft. A coupling in radial alignment with the bearing is arranged between the generator and the transmission. Moreover, the forces produced by the rotor and the generator and acting on the abovementioned bearing are less than the static and dynamic torques due to the gearing. It would be more advantageous to avoid a joint bearing for the coaxial output shaft and the generator shaft.

The document DE 10 2009 052240 A1 discloses a wind power plant having a rotor, a planetary transmission, a transmission unit and a generator. The planetary transmission is arranged between the rotor and the generator and upstream of the transmission unit and is cardanically coupled to the transmission unit.

Moreover, it is known from the generally known prior art that the primary aim in the case of medium-speed transmissions with a directly flanged-on generator is to reduce the overall length to a minimum. The housing of the transmission can simultaneously form the housing of the generator, and the

transmission and the generator are therefore flanged to one another. This design is so compact that the output shaft of the transmission usually drives the generator directly. Since axial and radial misalignment and angular positioning errors can occur in the integrated drive train between the transmission and the generator, possible sources being production and assembly tolerances and also imbalances and load-dependent deformations, it is worthwhile to compensate these in order as far as possible to transmit only the torque.

**DISCLOSURE OF THE INVENTION**

It is therefore the object of the present invention to provide a wind power plant, in particular the drive train of a wind power plant, comprising a planetary transmission and an integrated medium-speed electric generator, which compensates forces and torques caused by axial, radial and angular misalignment in order to transmit only the torque.

Starting from a wind power plant in accordance with the preamble of Claim 1 and Claim 2, the object is achieved in conjunction with each of the characterizing features thereof. Advantageous developments of the invention will become apparent from the following dependent claims.

The coupling means is arranged for the purpose of compensating axial, radial and angular misalignment between the planetary transmission and the generator shaft. An arrangement of this kind in conjunction with a suitable coupling means effectively compensates forces and torques caused by axial, radial and angular misalignment, with the result that only the torque from the planetary transmission to the generator is transmitted. Owing to the smaller population of forces acting on the generator, this allows a corresponding weight-optimized design of the generator.

The inventive concept can therefore be realized in that the coupling means is designed as a transmission output shaft

arranged between the planetary transmission and the generator shaft, designed as a sun wheel shaft and provided with universal-joint support on the generator side. In order, as above, to compensate axial, radial and angular misalignment between the planetary transmission and the generator, the transmission output shaft should have an appropriate length. The length of the transmission output shaft corresponds to at least twice a diameter of the transmission output shaft. Given an appropriate length, the radial misalignment can then be compensated by the angular misalignment, and the axial misalignment can be compensated by the universal-joint support.

According to a third preferred embodiment, on the generator side, the coupling means is arranged on a transmission output shaft with transmission-side gearing, which is arranged between the planetary transmission and the generator shaft and is designed as a sun wheel shaft. An embodiment of this kind allows a solution which saves installation space and shortens the drive train. The inventive concept can therefore be realized in that the generator-side coupling means comprises at least one dual-plate coupling. To compensate axial, radial and angular misalignment between the planetary transmission and the generator, either one coupling means or a plurality of coupling means can be connected in series. A combination of the abovementioned coupling means is likewise conceivable.

It is furthermore proposed that the generator-side coupling means is flanged to the sun wheel shaft, wherein a positive or nonpositive joint is provided between the flanged-on coupling means and the sun wheel shaft. In this way, it is possible, for example, to bring the axial end face of the sun wheel shaft and the axial end face of the coupling means into contact in order then to connect positively using connecting means, in particular screw or bolt elements.

In the case of the nonpositive joint between the flanged-on coupling means and the sun wheel shaft, means that increase

the friction coefficient are preferably provided axially on the end faces of the joints. The friction coefficient at the said locations is thereby increased and the nonpositive engagement is enhanced. Particularly suitable means for increasing the friction coefficient are films that increase the friction coefficient and coatings that increase the friction coefficient, these generally containing hard particles which, when the two end faces are pressed together, partially penetrate into the end faces and produce positive engagement at the micro level.

According to a measure which further improves the invention, it is proposed that a generator-side coupling flange is forged on the sun wheel shaft. Although forging the coupling flange directly on the sun wheel shaft or forming that end of the spur wheel shaft which faces the generator to give a flange requires a coupling means specially adapted to this purpose, it ensures an improved possibility of connection between the sun wheel shaft and the coupling means.

It is furthermore proposed that a coupling means that requires lubrication can be supplied with transmission oil for lubrication and cooling, wherein the coupling means that requires lubrication is sealed off in an oil-tight manner from the generator by a seal element. If the coupling means does not require any lubrication, sealing off the generator from the transmission by means of the seal element is advantageous.

The invention includes the technical teaching that the coupling means has a current-insulating effect, or at least has means that have a current-insulating effect. Suitable materials include ceramic and polymer elements, in particular, however, glass fiber and carbon elements. Accordingly, the screw joint can have current-insulating bushes and/or current-insulating washers. Moreover, a current-insulating intermediate shaft, in particular an output shaft provided with double universal-joint support, made from said materials is conceivable.

## BRIEF DESCRIPTION OF THE DRAWINGS

Further measures that improve the invention are explained in detail below together with the description of a preferred illustrative embodiment of the invention, by means of the figures, in which:

Fig. 1 shows a schematic side view of a wind power plant,

Fig. 2 shows a schematic longitudinal section through the coupling means according to the invention in accordance with a second embodiment, as a transmission output shaft provided with universal-joint support on the generator side, and

Fig. 3 shows a schematic longitudinal section through the coupling means according to the invention in accordance with a third embodiment, wherein the transmission output shaft is a sun wheel shaft with a coupling means on the generator side.

## DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Figure 1 shows a side view of a wind power plant 1 with the essential subassemblies thereof. The wind power plant 1 has a tower 14, on which a pod 15 in the form of a machine housing mounted so as to be rotatable about a vertical axis is arranged. Secured against relative rotation in the pod 15 is a planetary transmission 2, which has a transmission input shaft 5 and a transmission output shaft 7. The transmission input shaft 5 is connected to a hub 16 of a rotor 3 having a plurality of rotor blades 17. The transmission output shaft 7 is connected in terms of rotation to a drive device to be driven, in the form of a generator 4.

The planetary transmission 2 is designed in such a way that it converts a slow rotary motion of the transmission input shaft 5 into a rapid rotary motion of the transmission output shaft 7. For this purpose, the planetary transmission 2 has two or

more planet wheel stages, which interact with the transmission output shaft 7 via a final spur wheel transmission. By means of the wind power plant 1, electric energy is produced by a process in which the rotor 3, to which a rotary motion is imparted by the wind, introduces the rotary motion on the transmission input shaft 5 into the planetary transmission 2. The planetary transmission 2 converts the rotary motion into a faster rotary motion and, finally, the rapid rotary motion is transmitted via the transmission output shaft 7 to the generator 4 in order to produce current.

According to figure 2, the compensation of axial, radial and angular misalignment between the planetary transmission 2 and the generator 4 is accomplished by means of a transmission output shaft 7, which is arranged between the planetary transmission 2 and the generator shaft 6, is designed as a sun wheel shaft 9 and is provided with universal-joint support on the generator side. The transmission output shaft 7 thus has only one joint 20, which is arranged on the inner circumferential surface of the generator shaft 6. The transmission output shaft 7 furthermore has a corresponding length, with the result that the radial misalignment is compensated by the angular misalignment, and the axial misalignment is compensated by the universal-joint support.

In figure 3, the coupling means is arranged on the generator side on the transmission output shaft 7. Moreover, the transmission output shaft 7, designed as a sun wheel shaft 9, is arranged between the planetary transmission 2 and the generator shaft 6. That end of the sun wheel shaft 9 which faces the generator is designed as a coupling flange 13. A dual-plate coupling 10 is arranged as a coupling means on the end face of the coupling flange 13. The arrangement of a toothed coupling 11 and/or of a link-type coupling 12 in the same position would likewise be possible. A seal element 22, which seals off the generator 4 from the transmission 2 in an oil-tight manner, is arranged radially between an outer circumference of the sun wheel shaft 9 and the transmission

housing 18.

It should be noted that features which have been described with reference to one of the above illustrative embodiments can also be used in combination with other features or steps of other illustrative embodiments described above. Reference signs in the claims are not to be regarded as restrictive.

List of reference signs

| | |
|---|---|
| 1 | wind power plant |
| 2 | planetary transmission |
| 3 | rotor |
| 4 | generator |
| 5 | transmission input shaft |
| 6 | generator shaft |
| 7 | transmission output shaft |
| 8 | sun wheel |
| 9 | sun wheel shaft |
| 10 | dual-plate coupling |
| 11 | toothed coupling |
| 12 | link-type coupling |
| 13 | coupling flange |
| 14 | tower |
| 15 | pod |
| 16 | hub |
| 17 | rotor blades |
| 18 | transmission housing |
| 19 | generator housing |
| 20 | joint |
| 21 | bearing |
| 22 | seal element |

Patentkrav

1. Vindmølle (1) med et planetgear (2), som er placeret til ændring af en langsom omløbsbevægelse på en rotor (3) til en hurtig omløbsbevægelse til drift af en integreret mellemhurtigt løbende elektrisk generator (4), omfattende en middelbart med rotoren (3) forbundet gearindgangsaksel (5) og en middelbart via en generatoraksel (6) med generatoren (4) forbundet gearudgangsaksel (7), idet der mellem generator (4) og planetgear (2) er placeret et koblingsmiddel, idet koblingsmidlet er placeret til udligning af aksial-, radial- og vinkelforskydning mellem planetgear (2) og generatoraksel (6), kendetegnet ved, at koblingsmidlet er en gearudgangsaksel (7) placeret mellem planetgear (2) og generatoraksel (6) udformet som solhjulsaksel (9) og kardanlejret på generatorsiden, og hvis længde i det mindste svarer til det dobbelte af en diameter på gearudgangsakslen (7).

2. Vindmølle (1) med et planetgear (2), som er placeret til ændring af en langsom omløbsbevægelse på en rotor (3) til en hurtig omløbsbevægelse til drift af en integreret mellemhurtigt løbende elektrisk generator (4), omfattende en middelbart med rotoren (3) forbundet gearindgangsaksel (5) og en middelbart via en generatoraksel (6) med generatoren (4) forbundet gearudgangsaksel (7), idet der mellem generatoren (4) og planetgearet (2) er placeret et koblingsmiddel, idet koblingsmidlet er placeret til udligning af aksial-, radial- og vinkelforskydning mellem planetgear (2) og generatoraksel (6), kendetegnet ved, at koblingsmidlet omfatter i det mindste en dobbeltlamelkobling (10).

3. Vindmølle (1) ifølge et af kravene 1 til 2, kendetegnet ved, at koblingsmidlet på generatorsiden er placeret ved en gearudgangsaksel (7) placeret mellem planetgear (2) og generatoraksel (6) og udformet som solhjulsaksel (9) med løbende fortanding på gearsiden.

4. Vindmølle (1) ifølge krav 3, med henvisning til krav 2,

kendetegnet ved, at koblingsmidlet er påflanget på solhjulsakslen (9), idet der mellem det påflangede koblingsmiddel og solhjulsakslen (9) er tilvejebragt en formlåse- eller en kraftlåseforbindelse.

5. Vindmølle (1) ifølge krav 4,
kendetegnet ved, at der ved friktionsforbindelsen mellem det påflangede koblingsmiddel og solhjulsakslen (9) aksialt ved endefladerne på forbindelsesstederne er tilvejebragt friktionsværdiforøgende midler.

6. Vindmølle (1) ifølge krav 3, med henvisning til krav 2,
kendetegnet ved, at en koblingsflange (13) på generatorsiden er smedet fast direkte på solhjulsakslen (9).

7. Vindmølle (1) ifølge et af de foregående krav,
kendetegnet ved, at et smøringspåkrævet koblingsmiddel skal forsynes med gearolie til smøring og afkøling, idet det småringspåkrævede koblingsmiddel i forhold til generatoren (4) er tætnet olietæt ved hjælp af et tætningselement (22).

8. Vindmølle (1) ifølge et af de foregående krav,
kendetegnet ved, at koblingsmidlet er strømisolerende eller i det mindste har strømisolerende midler.

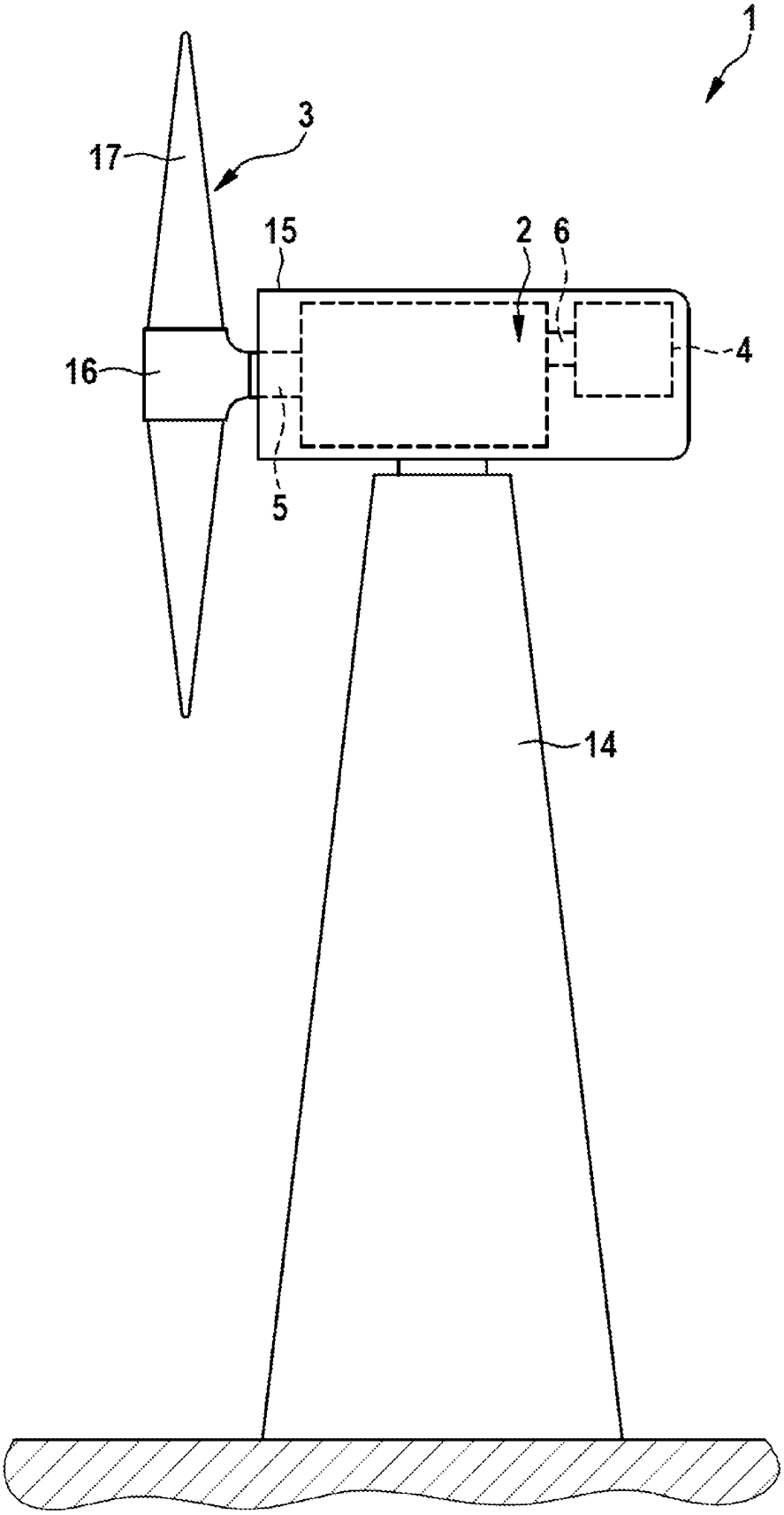


Fig. 1

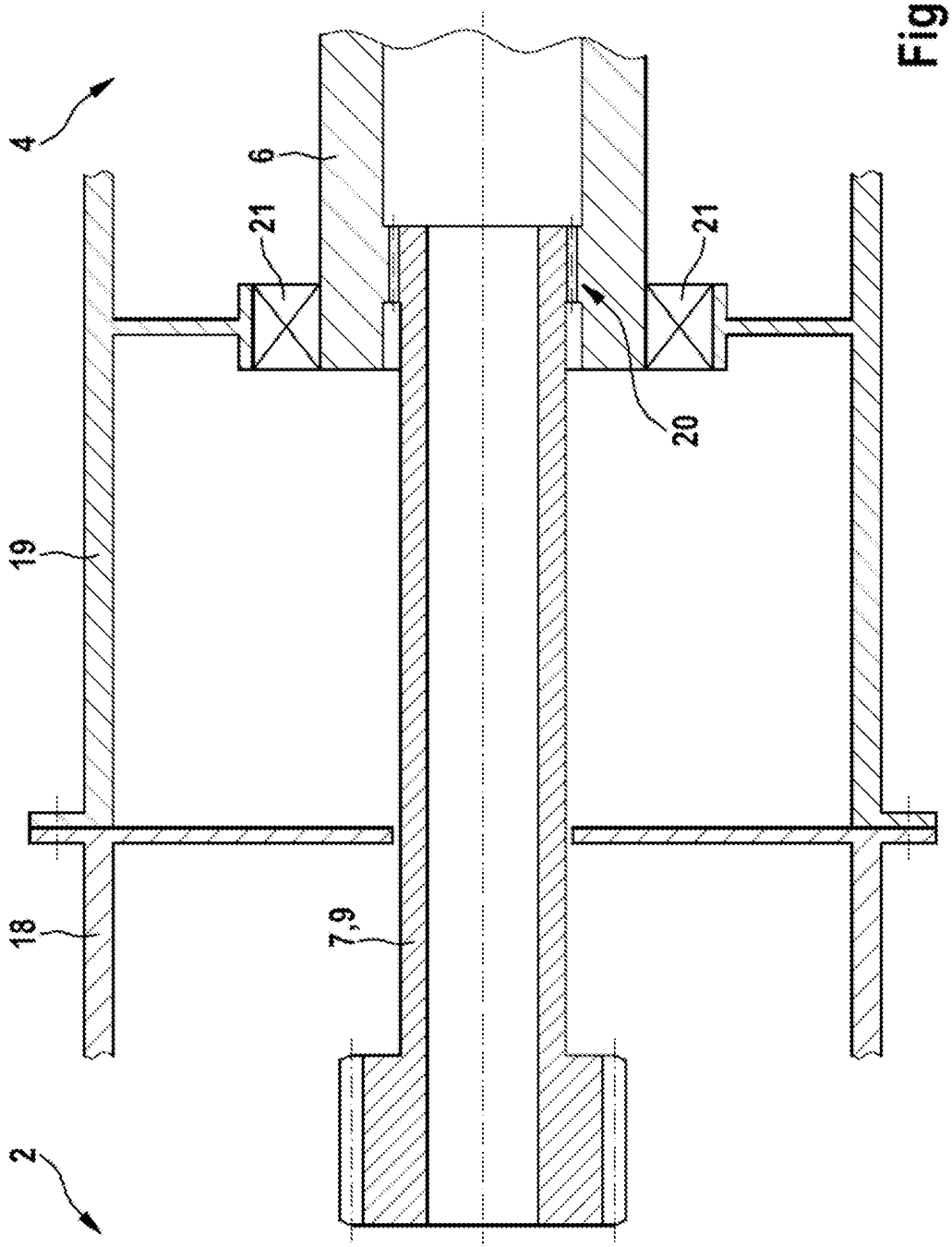


Fig. 2

Fig. 3