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Applicant: **T. SMEDEGAARD A/S**
Sydvestvej 57-59
DK-2600 Glostrup(DE)

Inventor: **Rasmussen, Leif**
Sydvestvej 57-59
Dk-2600 Glostrup(DK)

Representative: **Roerboel, Leif et al**
BUDDE, SCHOU & CO. A/S
Sundkrogsgade 10
DK-2100 Copenhagen O (DK)

Method of controlling an electric motor driving a centrifugal pump.

A method for controlling an electric motor (2) driving a centrifugal pump (3) having a diameter ratio D_1/D_2 less than approximately 1/2 and a varying fluid flow-through (Q), the motor (2) being connected to a supply mains (R,S,T) through a power-control device (1).

An electrical measuring signal (I) is produced, being proportional to the current drawn by the motor (2) or by the power-control device (1), and based on the known characteristics of the motor (2) and the pump (3), the electrical measuring signal (I) is processed so as to produce a control signal (f), being used as an input signal to the power-control device (1).

The electrical measuring signal (I) is processed in such a manner, that the control signal (f) causes the delivery pressure (H) of the pump (3) to be substantially constant over a large variation interval for the fluid flow-through (Q).

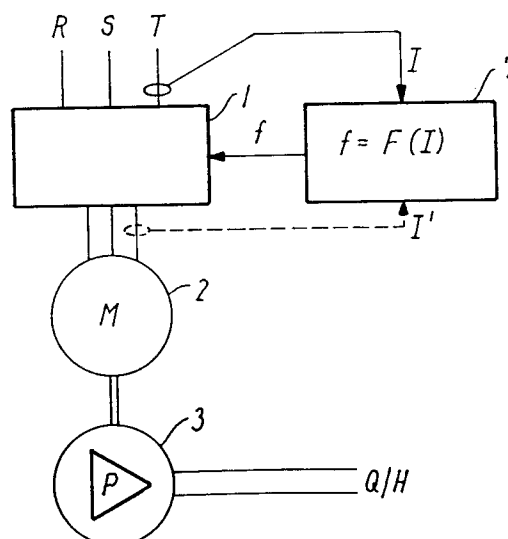


FIG. 2

TECHNICAL FIELD

The present invention relates to a method according to the preamble of claim 1 for controlling an electric motor driving a centrifugal pump.

The diameter ratio D_1/D_2 is the ratio between the impeller diameters at the fluid inlet to and the fluid outlet from the centrifugal pump.

BACKGROUND ART

Conventionally, such a motor-pump combination is controlled with a view to producing a constant pressure by measuring the output pressure and increasing the rotational speed of the motor, when the pressure decreases, and decreasing the rotational speed of the motor, when the pressure rises. Normally, the pressure is measured by means of a differential pressure sensor, producing one signal when the pressure is too low and another signal when the pressure is too high, and no signal when the pressure is correct. Then, these signals are used for regulating the rotational speed of the motor, thus achieving a substantially constant delivery pressure from the pump. The primary disadvantage with this arrangement is that the differential pressure sensor has a certain hysteresis, so that the regulating function does not occur continuously, but in steps, causing a certain variation in the delivery pressure of the pump.

DISCLOSURE OF THE INVENTION

According to the present invention, the disadvantage referred to above is remedied by proceeding as set forth in the characterizing clause of claim 1, in this manner achieving a more constant delivery pressure with varying fluid flow-through than has been possible with previously known methods, without the use of a differential pressure sensor. At the same time, a simplification is achieved, as the current measurement is relatively easy to perform, compared to the introduction of the relatively complex installation comprising a differential pressure sensor.

The present invention is based on the realization that in a pump-motor combination with a diameter ratio D_1/D_2 less than 1/2, and in which the delivery pressure of the pump is maintained constant, there exists a unique correlation between the current drawn by the motor and the rotational speed of the motor. Normally, the motor is a three-phase asynchronous motor, the rotational speed of which is controlled by means of a frequency converter.

If the asynchronous motor is replaced by a synchronous motor, which like the asynchronous motor may be constructed with a so-called wet-

running rotor, and in which the rotor can be in the form of a permanent-magnet rotor, the characteristic properties of the synchronous motor produce a substantially improved regulating characteristic with the above-mentioned regulating based on the current drawn, and the efficiency is also improved. If a frequency converter is used for the regulating function, the usual known starting problems for synchronous motors are easily solved by always letting the frequency converter start with a low frequency, i.e. a kind of "gentle start".

Alternatively, the motor can e.g. be a shunt motor for alternating or direct current, and the controlling of the rotational speed can be achieved by controlling a shunt-winding resistance.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following detailed portion of the present description, the invention will be explained in more detail with reference to the exemplary embodiments shown in the drawing, in which

fig. 1 shows a motor-pump arrangement being controlled in a known manner by a frequency converter, and

fig. 2 shows a motor-pump arrangement being controlled by means of the method according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 shows a motor 2, connected to a supply mains marked RST through a frequency converter 1. The motor 2 drives a centrifugal pump 3, the output pressure of which is monitored by means of a differential pressure sensor 4, in a known manner controlling a servo-motor 5, with which the frequency of the frequency converter 1 is controlled. When the pressure is too low, the differential pressure sensor 4 produces a signal to the servo-motor 5 to increase the frequency of the frequency converter 1, while when the pressure is too high, the differential pressure sensor produces a signal to the servo-motor to decrease the frequency of the frequency converter. The differential pressure sensor 4 has a certain hysteresis, so that the frequency of the frequency converter 1 is held constant within a certain pressure interval about the desired pressure.

Correspondingly, figure 2 shows a frequency converter 1, a motor 2 and a centrifugal pump 3, but in this case, the frequency of the frequency converter 1 is controlled by means of a control device 7, receiving an electrical measuring signal either I or I' , being proportional to the current I drawn by the frequency converter 1 and the current I' drawn by the motor 2 respectively. Based on this

signal, the control device 7 produces a frequency-control signal f , that is a function of the measuring signal I . In connection with this configuration, the transfer function for the control device 7 is preferably $F(I) = F_0 + K \sqrt{I}$, in which f_0 and K are constants that may be determined from the characteristics of the motor 2 and the centrifugal pump 3.

When the current I or the current I' rises, corresponding to an increase in the fluid flow Q through the centrifugal pump 3, the control device 7 will adjust the frequency f of the frequency converter 1 upwardly, so that the increase in the rotational speed of the motor 2 will compensate for the decrease in pressure H , when the fluid flow through the pump 3 increases. With a decreasing current I , the control device 7 will adjust the frequency f for the frequency converter 1 downwardly, so that the decrease in the fluid flow Q corresponding to the decrease in the current I , and the consequent increase in the pressure H , will be compensated by a reduction of the rotational speed of the motor.

It is conceivable that the method according to the invention may be used in connection with other types of motors 2 with associated power controllers 1, as it is sufficient to have a basic principle, according to which there will be produced an electrical measuring signal I , that is proportional to the current drawn by either the motor or the power-control device, and that this measuring signal I is processed so as to produce a control signal f for the power-control device 1 in such a manner, that the control signal f ensures a substantially constant output pressure from the pump.

The desired transfer function ($F(I) = f_0 + K \sqrt{I}$ or $F(I) = R_0 + kI$) for the control device 7 can be achieved by means of a self-balancing bridge circuit, in which an unbalance in the bridge causes a change in the control signal f until balance is achieved, and in which one branch of the bridge circuit comprises a first element that is proportional to the control signal f , and a second element that is proportional to $\sqrt{I}$ ($-K \sqrt{I}$) or I ($-kI$), so that balance is achieved for $f - K \sqrt{I} = f_0$, i.e. $f = f_0 + K \sqrt{I}$, or $f - kI = R_0$, i.e. $f = R_0 + kI$.

In those cases, in which the pump is connected to a pipe system or the like having a certain flow resistance, it may be an advantage that the delivery pressure of the pump increases with increasing fluid flow, thus compensating to some extent for the flow resistance in the pipe system. Thus, a dimensioning criterium could be that the pressure at the first consumer be maintained substantially constant.

Claims

1. Method of controlling an electric motor (2) driving a centrifugal pump (3) having a diameter ratio D_1/D_2 less than approximately 1/2 and a varying fluid flow-through (Q), said motor (2) being connected to a supply mains (R,S,T) through a power-control device (1), **characterized in**
 - a) that an electrical measuring signal (I) is produced being proportional to the current drawn by the motor (2) or by the power-control device (1),
 - b) that, based on the known characteristics of the motor (2) and the pump (3), the electrical measuring signal (I) is processed so as to produce a control signal (f), used as an input signal to the power-control device (1), and
 - c) that the electrical measuring signal (I) is processed in such a manner, that the control signal (f) causes the delivery pressure (H) of the pump (3) to be substantially constant over a large interval of variation for the fluid flow-through (Q).
2. Method according to claim 1, **characterized in** that the power-control device (1) is a frequency converter and the motor (2) is a three-phase synchronous motor.
3. Method according to claim 1, **characterized in** that the power-control device (1) is a frequency converter and the motor (2) is a three-phase asynchronous motor.
4. Method according to claim 2 or 3, **characterized in** that the control signal (f) is a frequency-adjustment signal and that $f = F(I)$.
5. Method according to claim 4, **characterized in** that $F(I) = f_0 + K \sqrt{I}$.
6. Method according to claim 1, **characterized in** that the motor (2) is a shunt motor for alternating or direct current, and that the power-control device (1) operates by controlling a shunt-winding resistance.
7. Method according to claim 6, **characterized in** that the control signal (f) is an adjustment signal for the shunt-winding resistance, and that $f = F(I)$.
8. Method according to claim 2, **characterized in** that $F(I) = R_0 + k \cdot I$.

9. Method according to any one of the preceding claims, **characterized in** that the control signal (f) is produced by means of a self-balancing bridge circuit, in which an unbalance causes a change of the control signal (f) until balance is achieved, and in which a bridge-circuit branch comprises a first element being proportional to the control signal (f) and a second element being proportional to the current (I) or the square root of the current ($\sqrt{I}$).

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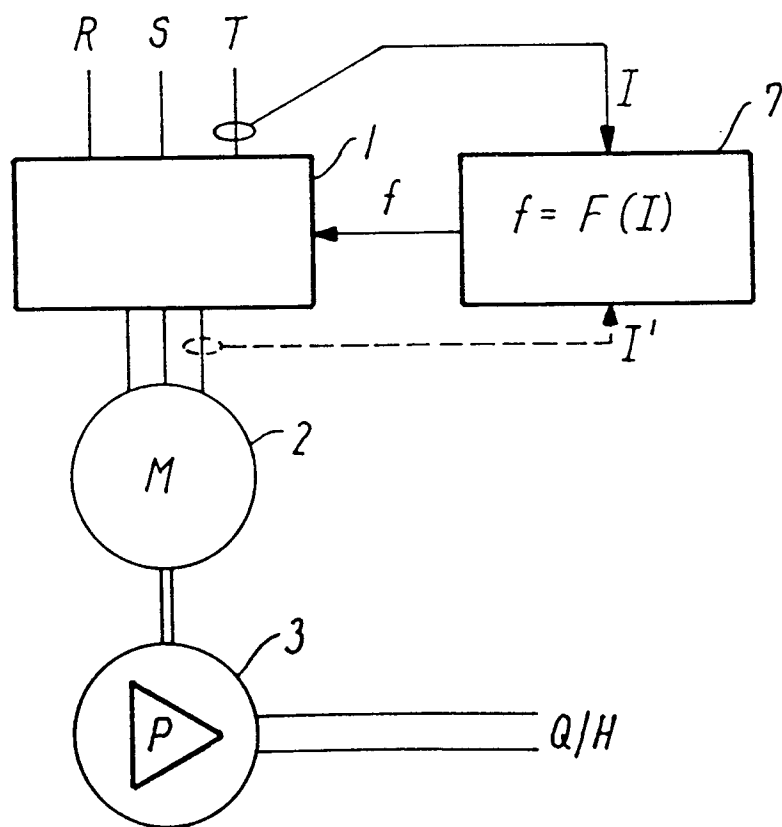
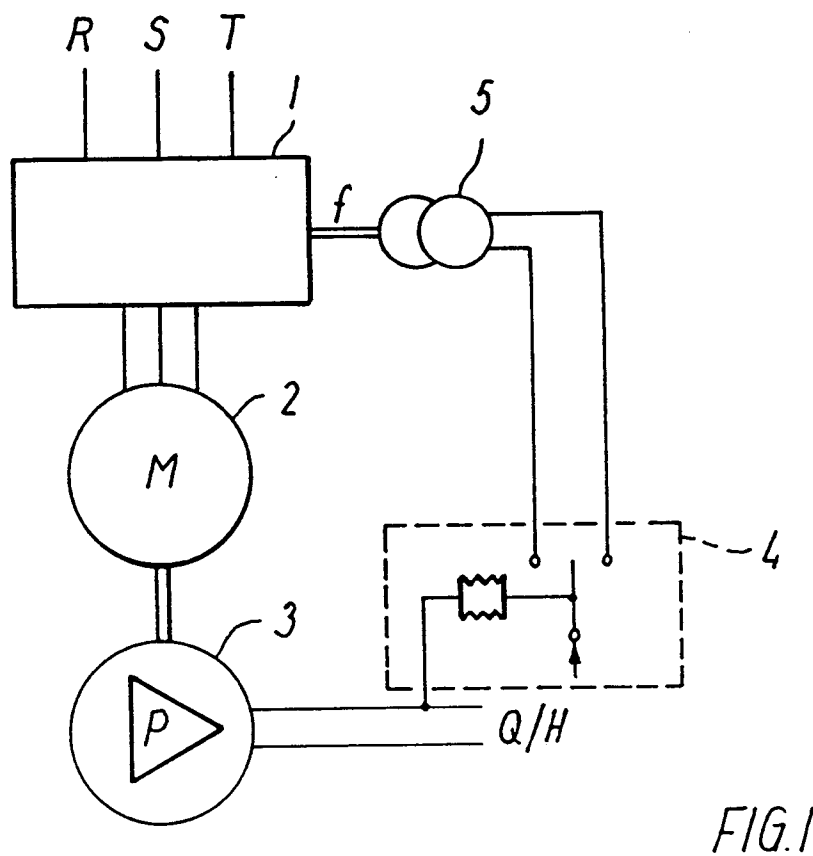
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European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

EP 93 11 3211

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	EP-A-0 226 858 (WILO-WERK) * the whole document *	1	F04D15/00

A	DE-A-2 946 049 (HOECHST) * the whole document *	1,3,4	

A	DE-A-3 824 057 (LOEWE PUMPENFABRIK) * the whole document *	1,4	

			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			F04D
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 19 OCTOBER 1993	Examiner ZIDI K.
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