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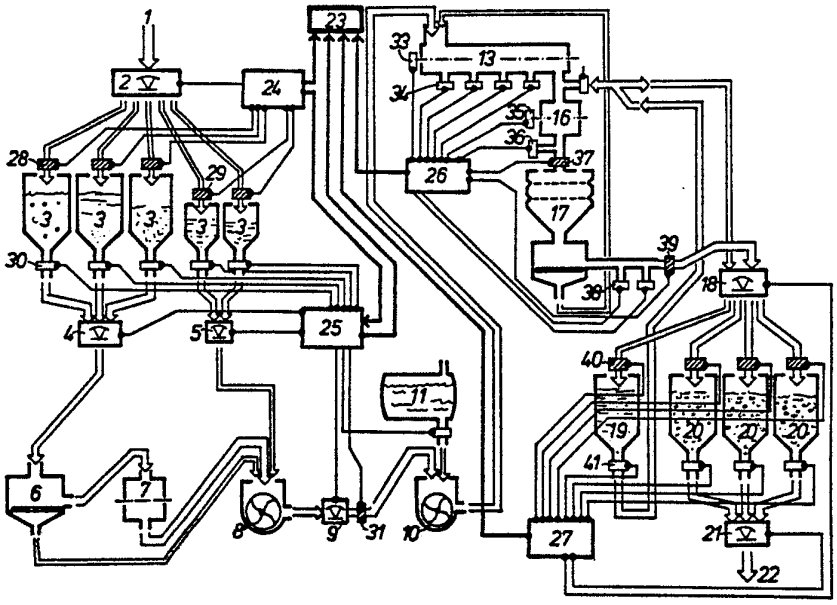

(57) Abstract

In order to produce pellets (22) in a pellet press plant according to a recipe which is currently adjusted in order that the physical qualities of the pellets becomes the best possible in relation to the overall production costs, a method is used where control takes place on the basis of current sampling of the composition of the raw materials (28, 29) and of the pellets (37, 39) and of a current recording of the raw materials (30, 4, 5) and the conditioning means (34, 38). In order to ensure this control a coordinating central computer (23) with secondary subordinate computers is used for control of raw materials (24, 25), economy (42), pellet production (26) and stock (27), which computers signal to the coordinating central computer (23) in order currently to adjust this (45, 48), whereafter the pellets are produced.

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METHOD FOR CONTROLLING A FODDER MIXING PLANT AND FODDER MIXING PLANT FOR CARRYING OUT THE METHOD.

The invention relates to a method for controlling a fodder mixing plant for the production of fodder pellets, whereby organic and inorganic raw materials are mixed, the mixture is conditioned by the adding of water and/or fat, the mixture is compressed for the formation of fodder pellets, the pellets are cooled and stored for subsequent delivery.

Fodder mixing plants of this type are being increasingly used due to a demand for a rational and economically advantageous method for manufacturing fodder pellets.

From the specification of Danish patent application no. 2163/83 a method is known for controlling a fodder dice pressing plant, which i. a. contains a fodder dice press comprising a ring die and a cooler for cooling the produced fodder dice, by which known method at least one parameter for the dice quality is measured between the fodder dice press and the cooler, whereafter this parameter is used for controlling the fodder dice press.

Control is thus effected on the basis of a measuring of the pellets after having been pressed out and prior to their being cooled in order thereby to establish the dust percentage. These measurements form the basis of the adjustment of those factors that influence the pellet and the pellet press, whether this be temperature, conditioning means and motor ef-

fect absorption.

This known adjustment plant is, however, not sufficient in order to achieve optimization of production since there is no possibility of allowing for changes in the composition of the raw materials, additives and the like before the quality of the fodder pellets is established by measuring of the finished pellets, and therefore this will involve a considerable delay and a consequent loss by the following adjustment.

It is the object of the invention to provide a method for controlling a plant with several production lines, where the pellets are manufactured on a current basis taking into account an overall evaluation and optimization of their quality, including their physical quality, and production price.

This is achieved by a method of the above mentioned type, said method being characteristic in that samples are currently taken of the raw materials before they are mixed, and the physical quality and nutritive content of the individual raw materials are analyzed, in that samples are currently taken of the mixture produced by the mixing and the nutritive content of the mixture is analyzed, in that the finished fodder pellets are currently analyzed in order to record their content of water and/or fat, in that the fodder pellets are currently analyzed after the adding of water and/or fat for recording of their physical quality and nutritive content, in that the physical state of the conditioning and cooling devices situated both before and after the pellet press or pellet presses is currently analyzed, in that the re-

sults of the individual samples and analyses are currently compared with predetermined values in order to establish any deviations, and in that the quantitative ratio between the raw materials is currently given different order of priority in accordance with the established deviations and/or the setting of the conditioning and cooling devices is changed for optimization of the nutritive content, physical quality and price of the fodder pellets.

There is hereby achieved a unique control and adjustment of a fodder mixing plant in that the adjustment ensures that the pellets are produced according to a recipe in order that the physical quality of the pellets, including their nutrient and water content, forms a decisive factor in the recipe together with the production costs of the manufacturing process. Hereby the recipe may be optimized in order that fodder pellets may be produced as economically as possible taking their quality into account.

By, as referred to in claim 2, currently monitoring these factors, the recipe may constantly be optimized during production, which ensures optimum pellet quality in relation to production costs.

The invention also relates to a fodder mixing plant for carrying out the mentioned method, said plant being of the type that comprises a number of raw material silos, sieves and grinders for processing the raw materials, at least one mixing plant for mixing raw materials supplied from the raw material silos, at least one fodder pellet press designed so that it can press together a mixture received from the mixing

device or mixing devices for the formation of fodder pellets, conditioning and cooling devices for conditioning and cooling of the fodder pellets, at least one finished product silo for receiving and storing of the finished fodder pellets, transport elements between the individual parts of the plant for transportation of the raw materials, the mixture and the fodder pellets as well as weighing means, said plant being characteristic in that the plant has means for measuring the raw materials designed for measuring on a current basis the physical quality and nutritive content of such raw materials as are suited for fodder pellet production before they are supplied into a raw material silo, in that the plant has means for measuring the mixture designed for measuring on a current basis the nutritive content of a mixture produced in a mixing device or mixing devices, in that the plant has a first set of pellet sampling means designed to measure the content of water and/or fat of pellets produced in the pellet press or presses, in that the plant has a second set of pellet sampling means designed to measure the content of water and/or fat of fodder pellets cooled in the cooling device, in that the plant has means for measuring the finished products designed to measure the amount of fodder pellets added to a finished products silo and dosage elements for delivering finished products from a finished products silo, whereby the plant has a central computer and subordinate computers designed to adjust the quantitative ratio between the raw materials and the amount of the conditioning means, such as water and/or fat, for optimization of the nutritive value, physical quality and price of the fodder pellets, said adjustment being made on the basis of data de-

rived from the means for measuring the raw materials, the means for measuring the mixture and from the first and second set of pellet sampling means and from the means for measuring the finished products.

Hereby is achieved a plant for use when carrying out the method according to the invention, which plant ensures an optimization of the production of fodder pellets and allows for changing conditions, whether these be raw materials or costs.

Finally it is expedient to construct the plant in the manner referred to in claim 4, whereby pellets are produced of the highest possible quality in relation to the production costs.

In the following the invention will be described in further detail with reference to the drawing, in which

fig. 1 shows a block diagram of a single press line in the plant from supply of raw materials to the discharging of the finished product,

fig. 2 shows a block diagram of the same press line showing the computers, and

fig. 3 shows a block diagram of the individual computers and their steps.

In fig. 1 is shown an example of a fodder mixing plant where, however, only a single pellet press 16 is shown. It will be understood, however, that the

method comprises control means for plants with any required number of pellet presses connected to the surrounding equipment, but the method is sufficiently clearly described on the basis of one single press 16.

The raw materials 1 are by way of a weight 2 supplied to the individual raw material silos 3 and may be of any organic or mineral sort.

The raw materials are discharged from the silos 3 and weighed 4 and 5 before they are delivered to a sieve 6 and mill or grinder 7 in order to end up in a mixer 8 to which may be added any required additives from the silos 3.

Via a weight 9 the material is carried to a further mixer 10 to which liquid may be added, such as water from a tank 11.

From here the mixture of raw materials is carried to a conditioning plant 13, in which binders, water or steam may be added before the mixture is supplied into the actual pellet press 16.

If no pellets are to be produced in the plant, the raw material mixture may via a transport device 15 be carried to a silo 20, from which the raw material may be delivered.

After pressing in the press 16 the pellets are led through a cooler 17 and a sieve to a finishing device where water or fat can be added to the surface of the pellets before perhaps via a weight 18 they end up in

their several finished product silos 20. There may be provided a further silo 19 for pellets that, if required, are to be returned to the pellet press 16.

In fig. 2 is seen the same plant with a schematic view of the computers. These comprise a central computer 23, which coordinates and controls the whole plant.

The central computer 23 is connected to subordinate computer units of which one 24 controls the raw material stock via a connection to the weight 2 and the sampling points 28 and 29 for raw materials to the individual silos 3.

Moreover, a subordinate computer 25 controls the batching of the raw materials via dosage elements 30 being connected with the weights 4, 5 and 9 as well as with the sample point 31 for the mixture before adding water, if so required.

A subordinate computer unit 26 controls the pellet pressing by controlling the additives by means of valves 34 for the conditioning unit 13 with a drive motor 33 and a motor 35 and valve 36 as well as the sampling 37 of the pellets before cooling but after the dosage of fat and water has been sprayed onto the pellets on the die; afterwards any additives may further be added by a coating process.

Finally there is shown a subordinate computer unit 27 which controls the stock via the sampling 40, the dosage elements 41 and the weight 21.

All these subordinate computer units 24, 25, 26, 27 and a further subordinate computer unit 42 shown in fig. 3 for recording the costs are connected to the central computer 23.

In fig. 3 is shown in a schematic view the primary functions of each subordinate computer unit and the connections between the units.

The central computer 23 has the following steps and functions:

Receives and stores analysis of the biological and physical characteristics 43 of the raw materials,

Priority of the individual raw materials 44,

Recipe print out for the cheapest possible pellets 45,

Analysis of changes in the raw materials 46,

Analysis of energy consumption 47,

Current adjustment of recipe 48,

Adjustment of operation costs in relation to pellet quality 49, and

Adjustment of transport through the plant via subordinate computers 50.

The subordinate computer 24 has the following steps and functions::

Adjustment of raw materials to the silo plant 51, and

Sampling and quality control 52.

The subordinate computer 42 has the following steps and functions:

Maintenance programs for the machine elements 53,

Recording of operation hours 54,

Print out of maintenance order 55, and

Summary of operation costs 56.

The subordinate computer 25 has the following steps and functions:

Batching and mixing according to the recipe 57,

Recording of raw material consumption 58, and

Sampling and quality control 59.

The subordinate computer 26 has the following steps and functions:

Technological optimization of the pellet manufacturing 60,

Sampling and quality control 61,

Finishing with water and/or fat 62, and

Sampling and quality control 63.

Finally, the subordinate computer 27 has the following steps and functions:

Adjustment of finished products in the silo plant 64,

Sampling and quality control 65, and

Batching for distribution 66.

The method will now be described in closer detail.

When the recipe is composed from the beginning and thus before test production, this happens on the basis of the amount of the various raw materials placed in the raw material silos 3 and the exact analysis of the nutritive content of these raw materials, in order that when the nutritive content of the recipe in the form of protein, fat, amino acid etc. is known, the central computer 23 can calculate the cheapest possible composition of the recipe taking into account only the biological values of the raw materials. However, it is in practice difficult to compose a recipe merely on the basis of the biological values in that it is necessary to take into consideration the influence of the raw materials on the physical characteristics of the pellets.

This means that in practice there are certain limits as to the possibilities of the central computer 23

for optimization in that for each raw material it is necessary to state a minimum and maximum amount with which they can be included in the recipe depending on their influence on the quality of the pellets.

In order to prevent that the pellet product becomes more expensive, each individual raw material has, apart from its biological values, been given order of priority 44 depending on its influence on the quality of the finished product.

When the recipe has thus been optimized with the limits transmitted from the central computer 23 to the subordinate computer 25, the individual raw materials can be batched via the various weights 4, 5 and 9.

The weighed out amount is now carried forward for grinding and mixing, and from mixing to the actual pelletting plant which is controlled by the subordinate computer 26. This automatically controls the pelletting lines and optimizes the production thereof.

Concurrently with the production, a monitoring is made 61 of the physical quality of the pressed out pellets.

The result is recorded by the subordinate computer 26 in which is programmed the limits for the quality, as well as an upper and a lower control limit. At the same time the water content of the pellets is automatically measured 62.

If the test result is below or above the control li-

mits, the subordinate computer 26 will automatically interfere in various ways. If the quality is for example too poor, the subordinate computer may try to adapt the production process technologically, in order that a better quality is achieved. This may be effected by reducing the production speed in order that a higher degree of fusion in the die is produced, or by changing the fat content in order that fat will automatically be removed from the raw material mixture which amount of fat may instead be applied 38 to the pellets.

The temperature of the raw material mixture, which is conditioned by steam 34, can moreover be changed in a downward direction in order that more friction in the die is achieved. Moreover, a binder 34 can be added immediately prior to the pressing, in order that the pellets become better. Finally, the press rolls in the die may be adjusted in order that a better quality or larger capacity is achieved.

Should none of these changes help, the subordinate computer 26 will be in direct contact with the central computer 23, which will now optimize a new recipe with raw materials which are more capable of being pressed and therefore provide a better quality.

Should the sampling of the pellets show that the quality is better than necessary, the only solution is either to increase production or to apply a cheaper recipe.

In almost all cases it will be economically expedient that the subordinate computer 26 informs the central

computer 23 that the quality is better than necessary, and it will therefore optimize a new recipe which is cheaper than the one measured.

The central computer 23 will thus optimize a new recipe which will automatically be transferred to the subordinate computer 25 after an acceptance procedure, if so required.

The subordinate computer 25 now weighs out a new recipe, and since the central computer 23 controls the transport to the presses, this will record when the new recipe composition reaches the presses, whereafter it automatically in the subordinate computer 26 will test the new recipe in comparision to the previous recipe and establish its position within the set limits, and it will if necessary repeat this procedure until optimization has taken place.

It is moreover possible to optimize via the water content of the recipe, which is measured 39 directly after the cooling process 17. The water content may form an ingredient in the economical optimization of the recipe just as the water may be taken into consideration when changing the quality on line with the other factors, such as energy consumption and temperature.

Measuring 59 of the nutritive content of the cooled pellets may likewise form part of the recipe optimization since the subordinate computer 26 transfers these data to the central computer 23 in order to obtain the most exact composition of the recipe. Apart from optimization of the production processes, the

central computer 23 via the subordinate computer 27 includes control 64 of the stock in the finished product silos 19, 20, and control of the delivery 65 via a weighing out system 21.

In connection with this delivery of the finished product, data concerning the nutritive content may be collected from the subordinate computer 27 via a measuring instrument 41 in order that this may be compared with the guaranteed content, and these data can be transmitted via the subordinate computer 27 to the central computer 23, where they form part of the statistics and the quality control 65.

Also in connection with the weighing in of the raw materials to the raw material silo 3 control is exercised over the stock 64 via the subordinate computer 24, where the supplied raw material amount is recorded, and via the subordinate computer 25, where the consumed raw material amount is recorded.

Apart from optimization of the production processes the central computer 23 contains an information system, in which the energy consumption of the entire plant is controlled 47 just as the individual part processes are recorded.

Finally, a preventive maintenance program is incorporated in the central computer 23 via the subordinate computer 42, which controls hours of operation for each machine element 64 and prints out maintenance orders 65 according to a predetermined program.

When any repair work is carried out, such work is in-

putted in the subordinate computer 42 in order to be recorded in the maintenance program and to form part of the economic calculations of production costs 56.

By this method the quality of the product forms a decisive parameter in connection with optimization of the recipe, just as water content and any nutritive content in the manufactured pellets are recorded and together with the production costs are entered as a parameter in the optimization of the recipe.

PATENT CLAIMS

1. Method for controlling a fodder mixing plant for the production of fodder pellets, whereby organic and inorganic raw materials are mixed, the mixture is conditioned by the adding of water and/or fat, the mixture is compressed for the formation of fodder pellets, the pellets are cooled and stored for subsequent delivery, c h a r a c t e r i z e d in that samples (28, 29) are currently taken of the raw materials before they are mixed, and the physical quality and nutritive content of the individual raw materials are analyzed, in that samples (31) are currently taken of the mixture produced by the mixing and the nutritive content of the mixture is analyzed, in that the finished fodder pellets are currently analyzed (37) in order to record their content of water and/or fat, in that the fodder pellets are currently analyzed (39) after the adding of water and/or fat for recording of their physical quality and nutritive content (59), in that the physical state of the conditioning and cooling devices (13 and 17) situated both before and after the pellet press or pellet presses (16) is currently analyzed, in that the results of the individual samples and analyses are currently compared with predetermined values in order to establish any deviations, and in that the quantitative ratio between the raw materials is currently given different order of priority in accordance with the established deviations and/or the setting of the conditioning and coolings devices (13 and 17) is changed for optimization of the nutritive content, physical quality and price of the fodder pellets.

2. Method according to claim 1, c h a r a c t e r i z e d in that the raw material consumption (46, 58), the operational costs of the fodder mixing plant (49) and energy consumption (47) as well as the properties of the raw materials (43) are currently recorded, and in that the quantitative ratio between the raw materials is currently given different order of priority and that the physical setting of the pellet press or pellet presses (16) is changed in accordance with the recorded values.

3. Fodder mixing plant for carrying out the method according to claims 1-2, said plant comprising a number of raw material silos (3), sieves (6) and grinders (7) for processing the raw materials, at least one mixing plant (8, 10) for mixing raw materials supplied from the raw material silos (3), at least one fodder pellet press (16) designed so that it can press together a mixture received from the mixing device or devices (8, 10) for the formation of fodder pellets, conditioning (13) or cooling devices (17) for conditioning and cooling of the fodder pellets, at least one finished product silo (20) for receiving and storing of the finished fodder pellets, transport elements (15) between the individual parts of the plant for transportation of the raw materials, the mixture and the fodder pellets as well as weighing devices (2, 4, 5, 9, 18, 21), c h a r a c t e r i z e d in that the plant has means (28, 29) for measuring the raw materials designed for measuring on a current basis the physical quality and nutritive content of such raw materials as are suited for fodder pellet production before they are supplied into a raw material silo, in that the plant has means

(31) for measuring the mixture designed for measuring on a current basis the nutritive content of a mixture produced in a mixing device or mixing devices, in that the plant has a first set of pellet sampling means (37) designed to measure the content of water and/or fat of pellets produced in the pellet press or presses (16), in that the plant has a second set of pellet sampling means (39) designed to measure the content of water and/or fat of fodder pellets cooled in the cooling device (17), in that the plant has means (40) for measuring the amount of finished products being supplied to a finished products silo (3) and dosage elements for delivering finished products from a finished products silo (3), whereby the plant has a central computer (23) and subordinate computers (24, 25, 26) designed in order to record the quantitative ratio between the raw materials and the amount of the conditioning means, such as water and/or fat, for optimization of the nutritive value, physical quality and price of the fodder pellets, such recording being made on the basis of data derived from the means (28, 29) for measuring the raw materials, the means (31) for measuring the mixture and from the first (37) and second set of pellet sampling means (39) and from the means (40) for measuring the finished product.

4. Fodder mixing plant according to claim 3, c h a r a c t e r i z e d in that the plant has subordinate computers (24, 27, 42) connected with the central computer (23) designed for controlling the stock of raw materials as well as finished fodder pellets and to perform the maintenance of the plant (53, 54, 55) and for calculation and print out of operational

costs (56).

Fig. 1

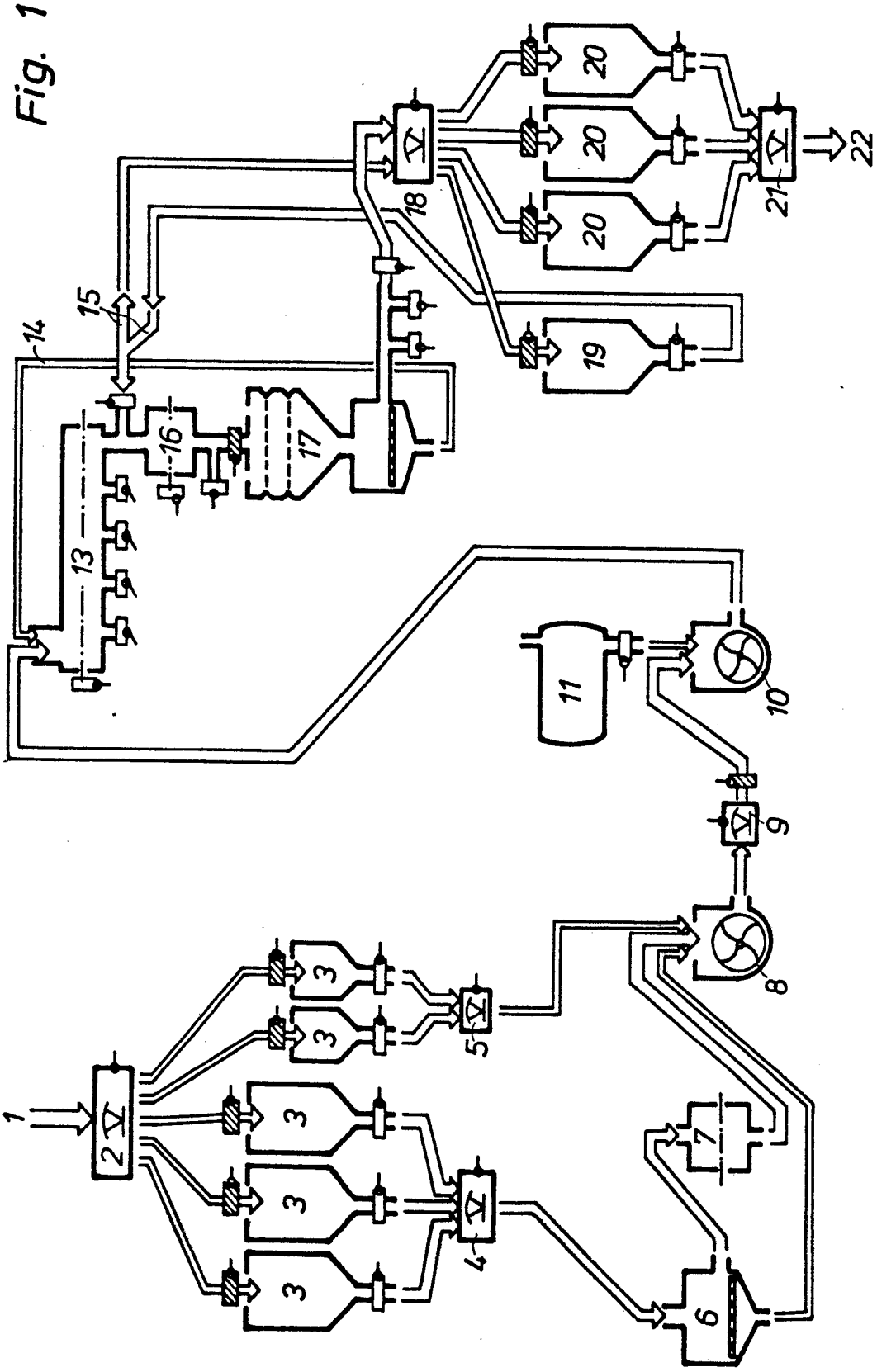
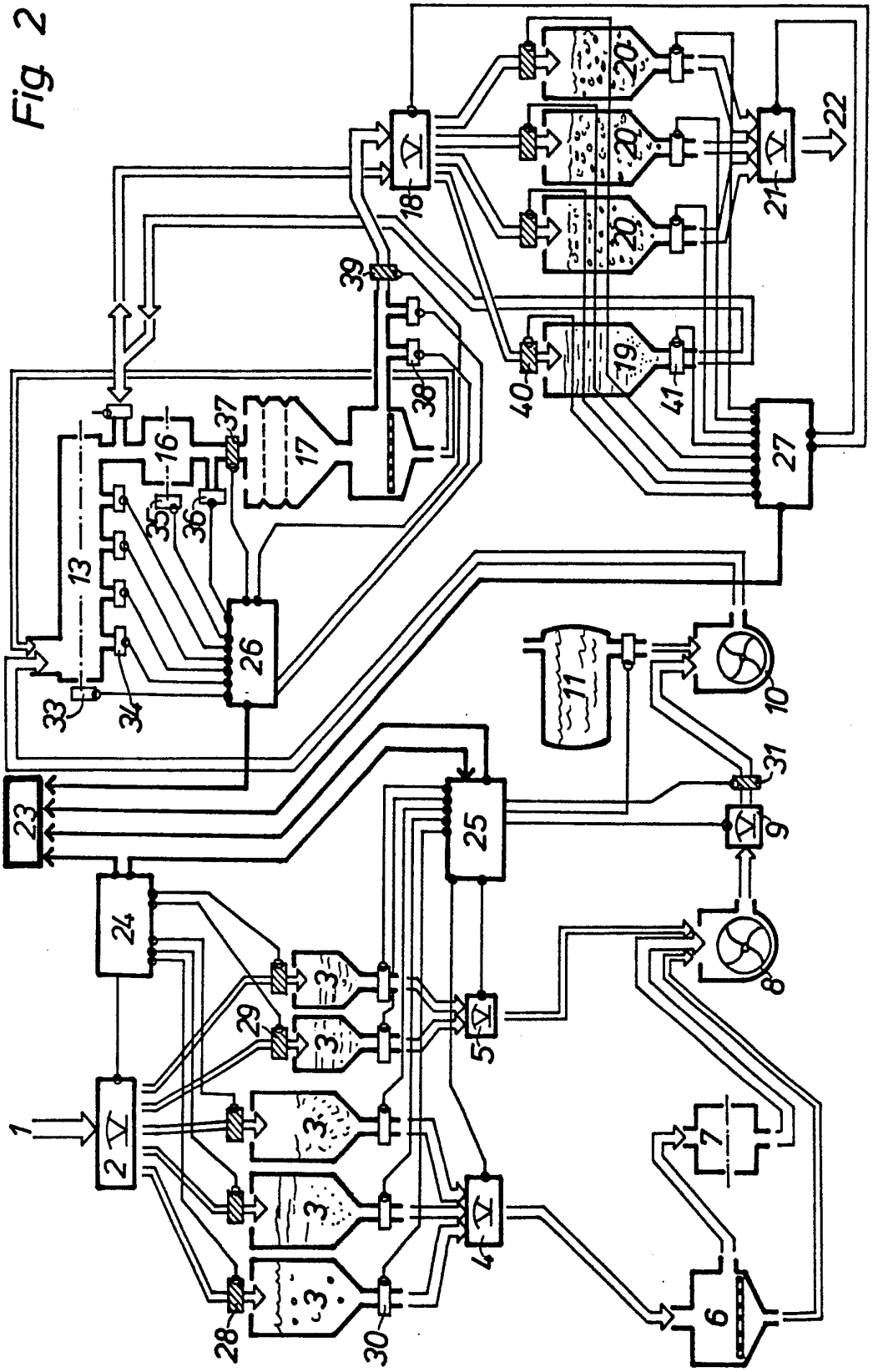


Fig 2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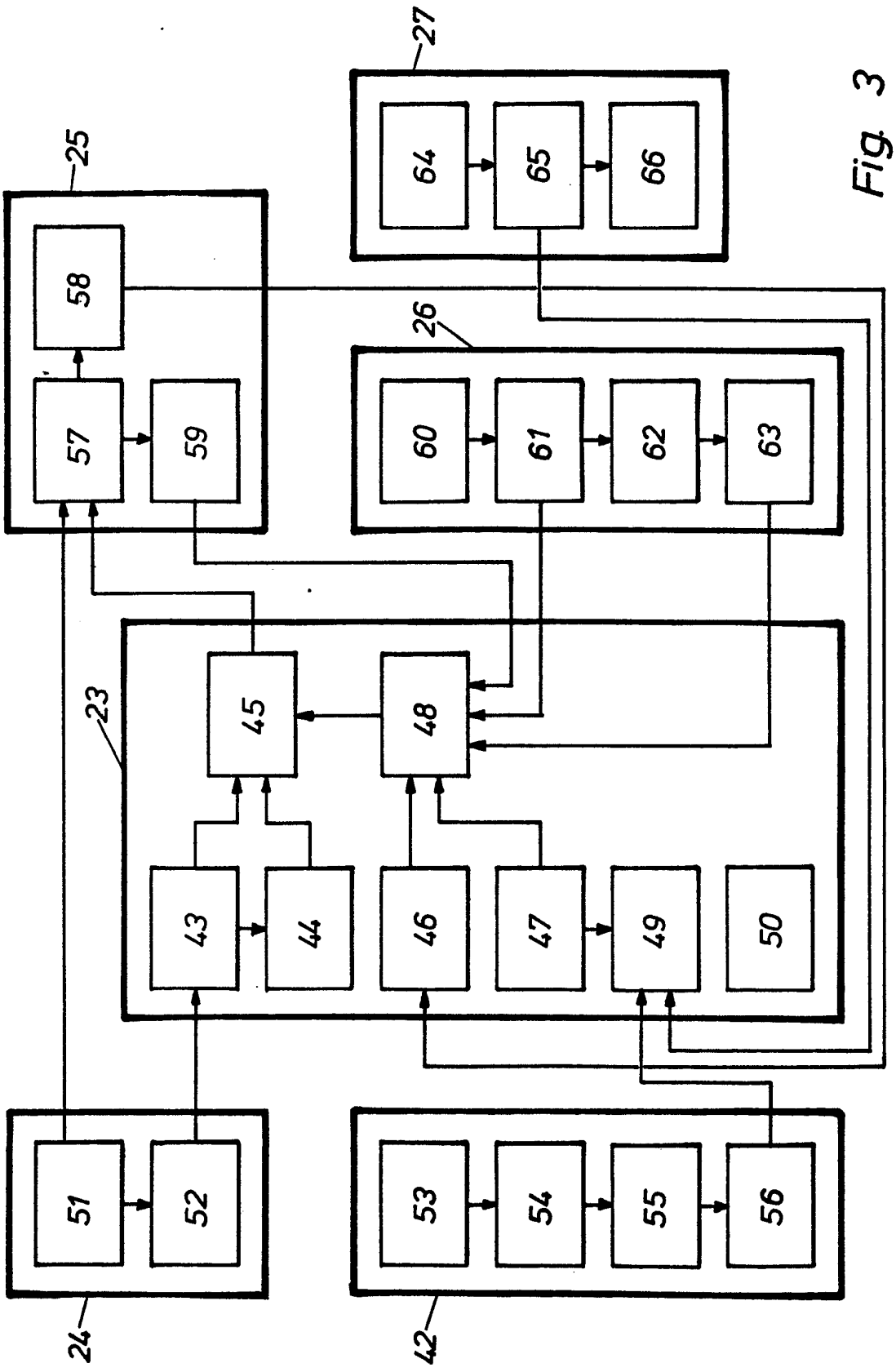
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Fig 3

INTERNATIONAL SEARCH REPORT

International Application No PCT/DK87/00045

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 [4]

A 23 N 17/00

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC	A 23 N 17/00
US Cl	99:325, 326, 334, 342, 426, 439; 137:2-7; 364:468, 469, 476, 496, 500; 366:603; 426:630, 635

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

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	WO, A1, 81/03076 (BETA CORPORATION OF ST. LOUIS) 29 october 1981 See claims 1, 4-6 and fig. 1. & EP, 0050150 GB, 2085195 US, 4340937 AU, 71593/81 AU, 541107 NL, 8120149	1-4
X	US, A, 4 561 781 (SPERRY CORPORATION) 31 December 1985 See claims 1, 5, 11.	1-4
X	DE, A1, 2 208 946 (WIENEKE FRANZ) 6 September 1973 See claims 1, 3, 10, 11.	1-4
A	EP, A1, 0 040 406 (GEBRÜDER BÜHLER AG) 25 november 1981 & DK, 2163/81	1-4

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
1987-07-23	1987 -07- 27
International Searching Authority	**Signature of Authorized Officer**
Swedish Patent Office	Inga-Karin Petersson

L.E.

Form PCT/ISA/210 (second sheet) (January 1985)

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category*	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	Derwent's abstract no 46021 K/19, SU 938 909.	1-4