(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
30 October 2003 (30.10.2003)

PCT

(10) International Publication Number
WO 03/088762 A2

(51) International Patent Classification[7]: A23K

(21) International Application Number: PCT/GB03/01513

(22) International Filing Date: 4 April 2003 (04.04.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0208715.3 16 April 2002 (16.04.2002) GB

(71) Applicant *(for all designated States except US)*: **FORUM PRODUCTS LIMITED** [GB/GB]; 41-51 Brighton Road, Redhill, Surrey RH1 6YS (GB).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **RITCHIE, Daniel, Thomas, Exely** [GB/GB]; 19 Grange Lane, Condover, Nr. Shrewsbury, Shropshire SY5 7BE (GB). **STEINBOCK, Michael, Peter** [GB/GB]; Little Pinnock, Pluckley, Ashford, Kent TN27 0SS (GB).

(74) Agents: **WOODWARD, John** et al.; Venner, Shipley & Co., 20 Little Britain, London EC1A 7DH (GB).

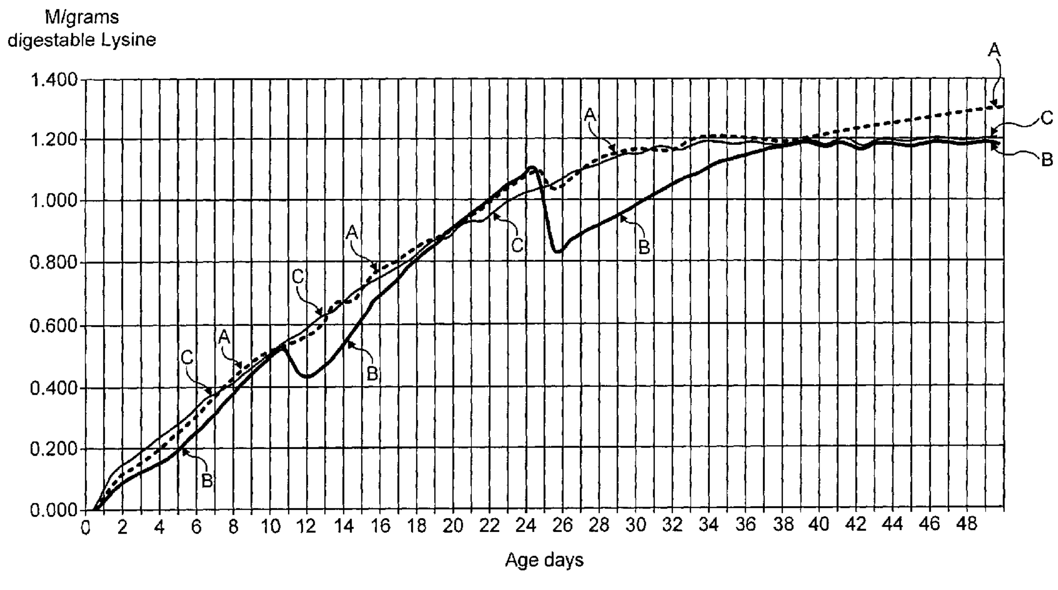
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: STRATEGIC LIVESTOCK FEEDING METHOD



(57) Abstract: A method of strategically supplementing livestock feed compound with a liquid nutrient additive during a growth period to achieve an optimum rate of growth of said livestock during said growth period comprising the steps of supplying the livestock with feed compound over a plurality of consecutive predetermined time periods during the growth period and adding said liquid nutrient on site to the feed compound to boost the nutrient level of the feed compound so that it substantially matches the level required to promote said optimum rate of growth of the livestock throughout the whole of the growth period.

WO 03/088762 A2

Strategic Livestock Feeding Method

This invention relates to a method for strategically supplementing livestock feed compound with a liquid nutrient additive during a growth period to achieve an optimum rate of growth for said livestock. The invention is particularly but not exclusively suitable for supplementing the growth rate of poultry (chickens, turkeys, ducks etc.) but it can also be applied to promoting growth in cattle and pigs.

Production of chickens on farms in the UK typically spans a growth period of 42 days. During this period, the birds are kept in sheds that may hold 20,000-50,000 birds. They are supplied with feed and water *ad libitum* through automated feeding and drinking systems.

During the growth period, birds are supplied typically with four different types of feed, given in consecutive periods throughout their lives. Each feed is manufactured off site in a compound feed mill and supplied to the user in granular or pellet form. The feed consists of a blend of ingredients such as wheat, soya, fishmeal, oils, minerals, vitamins, etc. and is formulated to provide all the essential nutrients that a bird requires for healthy and rapid growth. After precise blending through large-scale mixers, the mixed feed is extruded through pellet presses to produce the pelleted compound feed which is transported to the chicken farms and held in bulk bins from which it is mechanically distributed to feeding points in the sheds.

The genetic potential of the birds for growth drives their metabolic demand for nutrients. The nutrient demand is a function of actual bodyweight and the potential for body growth. In healthy chickens growing to 42 days of age, the nutrient demand increases in a curvilinear shape.

When only one type of feed is provided, there is a mismatch between the metabolic nutrient demand and nutrient supply and the effect is to produce either an over- or under-consumption of nutrients. This has the effect of either compromising the growth rate of the birds (and therefore extending the period of growth required to meet the target bodyweight) or, conversely, providing a luxury intake of nutrients leading to wasted nutrients. In either case, there is a significant adverse impact on the economics of chicken production.

This problem has been dealt with up to now by manufacturing four different types of feed to different nutrient density constraints, the farms having different feeding programmes that are set according to the nutritional requirements of the birds on the farm. For instance, a Starter feed might be fed from Day 1 to Day 10, a Grower feed from Day 11 to 20, a Finisher feed from Day 21 to 31 and a Withdrawal feed from Day 32 to 42. The nutrient density of the feeds decreases progressively from Starter through Grower and Finisher to Withdrawal. By giving four feeds of progressively lower nutrient density, the over- or under-supply of nutrients is reduced but, even within the period over which any one of these four feeds is provided, there are times when there is an over- or under-supply of nutrients. Practical constraints therefore lead to these nutritional compromises whereas theoretical optimum from a biological point of view would be to use a different specification of feed every day.

It is an object of the invention therefore to provide a method which overcomes or substantially reduces these disadvantages.

According to the invention therefore there is provided a method of strategically supplementing livestock feed compound with a liquid nutrient additive during a growth period to achieve an optimum rate of growth of said livestock during said growth period comprising the step of:

a) supplying livestock with feed compound over a plurality of consecutive predetermined time periods during the growth period; and
b) adding said liquid nutrient on site to the feed compound to boost the nutrient level of the feed compound so that said level substantially matches the level required to promote said optimum rate of growth of the livestock throughout the whole of the growth period.

The nutrient density of the compound at each successive period may be less than the nutrient density of the compound supplied to the livestock during the immediately preceding period but this is not essential.

In a preferred method, the livestock is supplied with a first "starter" feed compound of a first predetermined nutrient density for a first period of time within said feeding cycle; followed by a second "grower" feed compound over a second period of time within said feeding cycle; and a third "finisher" feed compound over a third period of time within said feeding cycle.

A fourth "withdrawal" feed compound may be supplied to the livestock over a fourth period of time within said feeding cycle.

In a preferred method, there are three consecutive periods within the growth period and the liquid nutrient is added to the feed compound fed to the livestock during all three periods.

The liquid nutrient is preferably sprayed onto the feed compound and the amount of liquid additive and the period of time it is sprayed onto the feed compound is controllable to boost the nutrient level thereof so that said level substantially matches the level required to achieve said optimum level of growth of the livestock throughout the whole of the growth period.

The method of the invention can also include the step of adding grains of wheat to the feed compound.

Preferably, the liquid additive includes lysine, methionine and a carbohydrase enzyme.

Medicinal compounds may also additionally be added to the feed compound through the growth period to ensure that diseases in the livestock which could be harmful to humans or the animals are eliminated from the livestock.

A preferred method of the invention and apparatus for performing said method will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a graph in which line C shows the increasing nutrient requirement of birds between 1 and 48 days of age, line B is the nutrient supply line (i.e. feed compound) and line A is the level required to achieve optimum growth of the livestock during the overall growth period;
Figure 2 is a table showing an example of strategically supplementing the nutrient compound fed to the livestock over a 48 day growth period;
Figure 3 illustrates an apparatus for performing the method of the invention;
Figure 4 shows in more detail a preferred delivery system for spraying additive onto the product processed by the apparatus shown in Figure 3; and
Figure 5 is the control system for the delivery system shown in Figures 3 and 4.

Referring to the drawings, line C in Figure 1 shows the nutrient requirement of birds between 1 and 48 days of age if they are to achieve their optimum weight when killed at the end of the 48 day period. Line B shows what happens if compound only is fed to the birds throughout the growth period as in the prior art. For period I (0-10 days) a Starter compound is fed to the birds for period II (11-24 days) a Grower compound having a decreased nutrient level is fed to the birds and for period III (25-38 days) a Finisher compound with a further decreased nutrient level is fed to the birds. It will be appreciated that the Starter, Grower and Finisher compounds all have different nutrient levels to satisfy the growth rate of the birds so the highest nutrient level will be used for the Starter compound whereas the Grower compound will have a decreased nutrient level and the Finisher compound will have a nutrient level lower than that of the Grower compound.

As the nutrient level of the Starter, Grower and Finisher compounds has to be predetermined to cover the relevant feed period, it is fixed for that period. Accordingly, when it is fed to the birds initially it will not meet their optimum nutrient level requirement but it will progressively more closely match that optimum level as time elapses throughout the growth period. This deficiency is indicated by saw toothed shaped line B in the graph shown in Figure 1 and it can be seen that at certain times the nutrient contribution from the feed compound is less than the optimum level required which means that the birds do not grow at their optimum rate whereas in other periods the nutrient contribution exceeds the optimum level which is wasteful as the birds are receiving nutrients which are in excess of their needs. The saw-tooth effect in this line B demonstrates the decrease in nutrient intake at the time of change-over from a high-density feed to a feed of a lower nutrient density. This arises because there is no immediate increase in feed consumption when the birds are changed to a feed of lower nutrient density to compensate for the lower density. The resulting gap between nutrient requirement and nutrient supply leads to a failure of the birds to grow to their full potential.

The present invention addresses this problem by providing a method of strategically varying and supplementing the nutrient level of the feed compound throughout the growth period to keep the nutrient level required by the birds as near as possible to match the optimum level required to achieve the predetermined growth rate required throughout the whole of the growth period.

Figure 2 shows an example of the amount of liquid nutrient additive that needs to be added to the compound feed to boost the intake by the birds of key nutrients at times of nutrient deficiency. It can be seen that the nutrient level needs to be supplemented more during the initial part of a feed period and it is gradually reduced to zero towards the end of the feed period as the compound itself will provide the required level of nutrients. In the illustrated example, only 3 feed periods are shown namely Starter, Grower and Finisher. However, a 4^{th} or more periods can be used. For instance, a Withdrawal Feed period can be used during which compound is fed to the birds which have achieved their optimum weight but which need a period of additive free feed to prevent a residue being left in the meat rendering them unsuitable for human consumption. It will be seen from the example that the average amount of liquid additive added to the feed compound over the whole growth period is approximately 0.36%.

By using the method of the invention, the times when there is a nutrient shortfall during the feeding of any one of the diets is minimised and the growth of the birds is optimised and held closer to the optimum without giving wasteful and therefore costly luxury and/or potentially polluting levels of nutrients to the birds which they do not need.

The major components of the liquid additive are lysine, methionine and a carbohydrase enzyme. Lysine and methionine are the first and second limiting amino acids respectively for lean-tissue growth in chickens and the enzyme enhances the feeds digestibility.

The constitution of the liquid is only preferred and does not form part of the invention. It is its strategic addition to the feed compound throughout the growth period to bring the lysine supply level (Line B in Figure 1) up to the optimum nutrient requirement level (Line C in Figure 1) so that the lysine intake can be matched with the metabolic requirement of the birds which is the first aspect of the invention.

Referring now to Figure 3, there is shown an example of an apparatus which can be used to carry out the method of the invention. This apparatus is the subject of our earlier UK patent application No. 0200323.4.

The method of the invention can be put into practice using an apparatus such as that shown in Figure 3 which consists of a first hopper 6 for the manufactured feed compound which is supported above the ground on legs 7 and has an outlet 8 in its base. A supply pipe 8a is connected to the base of the hopper and extends into the upper region of a weighing station 20 where it terminates in a vertical down-pipe section 10. An optional second hopper 1 can also be provided for wheat grain, which is supported above the ground on legs 2 and has an outlet 3 in its base. A supply pipe 3a is connected to the outlet 3 in the base of the hopper and extends into the upper region of the weighing station 20 where it terminates in a vertical down-pipe section 5. Both ends 5 and 10 of the supply pipes 3a, 8a are positioned above the open top of a weighing bucket 21 which forms part of a weighing device (not shown). The weighing bucket 21 is positioned above a third hopper 23 which has an outlet 24 in its base connected to a pipe 24a which runs to a feed building 25 wherein it is connected to a feeder pipe 26. Down-pipes 27a,b,c connect the feeder pipe 26 to feed trays 28a,b,c respectively. Flexible centreless augers 3B,8B are mounted respectively in the supply pipes 3a,8a, powered by motors 4 and 9. A container 11 for liquid additive is connected to a pump 13 by a pipe 12.

It will be noted however that the pump 13 is mounted on top of the container 11, the outlet of the pump being connected by a pipe 12 to the weighing station 20. A non-return valve 16 and a filter 17 are mounted in the pipe 12 between the pump 13 and the weighing station 20. Inside the weighing station 20 the pipe 12 is connected to a manifold 18 (shown in more detail in Figure 4) which is connected by a pipe 19 to spray-heads 19a mounted around the circumference of the down-pipe section 10 of the supply pipe 8a from the first hopper 6.

The operation of the liquid supply pump 13 and hence the delivery of liquid additive from the container 11 to the manifold 18 and spray heads 19a, is controlled by a control unit 30 which monitors the operation of the auger motors 4 and 9.

Figure 4 is a view on an enlarged scale of the delivery system for the liquid additive supplied from the liquid container 11 to the spray heads 19a. The system comprises pump 13, liquid delivery pipe 12 connecting the container 11, non-return valve 16 and filter 17 to the manifold 18. Manifold outlet pipes 19 connect the manifold 18 via adjustable flow valves 19b to the spray heads 19a. The pump 13 is electrically connected to a control means 30 which monitors the operation of the auger motors 4,9. The operation of the control means 30 will be described in more detail later with reference to Figure 5. The container 11 has a capacity of 1000 litres, but this is preferred rather than essential.

Figure 5 is a schematic diagram of the control means 30 for the delivery system shown in Figures 3 and 4, and comprises a first sensor 33, which is connected to the auger motor 4 for the optional second hopper 1, and a second sensor 34 which is connected to the auger motor 9 for the first hopper 6. Both sensors 33,34 are connected to a relay 35 which has a 3-way selector switch 26, positionable in an 'off', an 'A' or a 'B' position. The relay 35 is connected to a motor drive unit 37 which receives electrical 240V single-phase mains supply power through a cable 40 via an electrical filter 38 to prevent power surges. The output from the motor drive unit 37 is a screened power cable 39 which is connected to the pump 13 on the liquid container 11. The relay 35 incorporates a known programmable timer which sets a maximum time that a 'run' signal will be sent to the motor drive unit 37. The motor drive unit 37 is provided with a function whereby a delay can be programmed into the unit between when it receives a signal from the relay 35 to when it supplies power via the output power cable 39 to the liquid feed pump 13.

In order to carry out the method of the invention using the apparatus shown in Figure 3 in accordance with the program shown in Figure 2, the hopper 6 is filled with the required amount of Starter Feed compound to cover days 1-10. Once the Starter Feed in hopper 6 has nearly all been fed to the livestock, it is refilled with Grower Feed compound for days 11-24. Once this Grower Feed has nearly all been fed to the livestock, the hopper is again refilled with the required amount of Finisher Feed compound for days 25-48. One batch of feed compound can be placed on top of the preceding batch in the hopper 6 and each batch can either be placed in the hopper 6 manually or fed thereto from one or more other hoppers (not shown).

Feed compound from the hopper 6 falls through the outlet 8 into the supply pipe 8a and is conveyed by the auger 8B powered by motor 9 to the down-pipe section 10 where it falls under gravity into the weighing bucket 22.

When the auger motor sensor 34 detects that the motor 9 is running, a signal is sent to the relay 35. If the relay selector switch 36 is set to the corresponding motor, (position 'A' for the motor 4 or position 'B' for the motor 9), an electrical run-signal is sent to the motor drive unit 37, for the duration of time programmed into the maximum run-period timer within the relay 35. Once the motor drive unit 37 receives the signal when the programmed delay time has elapsed, electrical power is converted from the single phase 240 volt mains supply, (via the electrical filter 38) into a 3-phase supply and conducted along the output power cable 39 to the pump 13 on the container 11.

The pump 13 then draws liquid from the container 11 out through the supply pipe 12, and supplies it via non-return valve 16 and filter 17, to the manifold 18 located inside the weighing station 20. The liquid additive then leaves the manifold 18 through the manifold outlet pipes 19 and passes via the adjustable flow valves 19b to the spray heads 19a which are arranged circumferentially around the end region of the vertical down-pipe section 10 of the supply pipe from the second hopper 6. The ends of the spray heads 19a face inwardly towards the centre of the pipe. As the feed compound from the first hopper 6 falls under gravity through the down-pipe section 10, liquid from container 11 is sprayed from the spray-heads 19a onto the falling feed, thereby coating it before it reaches the weighing bucket 22.

The auger 3B from the second hopper 1 can optionally simultaneously convey wheat grain along its corresponding supply pipe 3a to the down-pipe section 5 where it also falls under gravity into the weighing bucket 21. When the weighing device (not shown) detects that the required pre-determined weight of feed has been reached, the motors 4 and 9 driving the augers 3B,8B stop, thus halting delivery of feed compound and the optional wheat grain from the hoppers 1 and 6. The motor sensors 33,34 simultaneously detect that the motors 4 and 9 are not running so the relay 35 to which they are connected stops the 'run' signal being sent to the motor drive unit 37. This cuts off the supply of electrical power to the liquid pump 13 thus stopping further liquid being sprayed from the spray heads 19a around the down-pipe 10.

The base 22 of the weighing bucket 21 is then opened to allow the feed mixture in the bucket 22 to fall into the third hopper 23 located below it. The motor 29 drives the auger 24B within the supply pipe 24a to convey the feed mixture from the hopper 23 via outlet 24 along the pipe up into the feed pipe 26 whereby it falls under gravity via down-pipes 27a,b,c into the feed trays 28a,b,c respectively.

From the foregoing description, it can be seen that the liquid additive is added as the feed compound falls under gravity past the spray heads 19a, so there is no chance of it coagulating in the supply pipe 8a and the auger 8B cannot jam. The function of the control means 30 is to stop the spray of liquid additive as soon as the conveyance of compound stops when the required weight of compound has been reached, thus preventing wastage of liquid additive.

The method of the present invention is designed to be used on site, i.e. at farm level so that nutrient intakes can be manipulated, as required, in each shed according to the nutritional and/or health status of the birds in any specific shed at any specific time. This overcomes the problems of prior art methods where supplementation of feed has been dealt with at earlier points in its manufacture and its supply to the birds does not allow for flexibility in supplementation according to the immediate demands of birds on site.

It will be appreciated that the amount of liquid additive to be introduced into the feed compound over the growth period, for instance, as shown in the example in the table of Figure 2 can readily be programmed on site by the user so that it occurs automatically. If necessary, the program can be set up or altered remotely using a modem.

Although the described example relates to chicken nutrition, the invention also extends to and includes methods and apparatus for strategically supplementing the feed of other classes of livestock such as cattle, pigs or even fish.

Claims

1. A method of strategically supplementing livestock feed compound with a liquid nutrient additive during a growth period to achieve an optimum rate of growth of said livestock during said growth period comprising the steps of:
   a) supplying livestock with feed compound over a plurality of consecutive predetermined time periods during the growth period;
   b) adding said liquid nutrient on site to the feed compound to boost the nutrient level of the feed compound so that said level substantially matches the level required to promote said optimum rate of growth of the livestock throughout the whole of the growth period.

2. A method according to claim 1 wherein step (a) comprises:
   (i) supplying the livestock with a first "starter" feed compound of a first predetermined nutrient density for a first period of time within said growth period;
   (ii) supplying the livestock with a second "grower" feed compound over a second period of time within said growth period;
   (iii) supplying the livestock with a third "finisher" feed compound over a third period of time within said growth period.

3. A method as claimed in claim 2 comprising the additional step of supplying the livestock with a fourth "withdrawal" feed compound over a fourth period of time within said growth period.

4. A method as claimed in claim 2 comprising adding liquid nutrient on site to said "starter", and/or "grower" and/or "finisher" feed compounds.

5. A method as claimed in any preceding claim wherein the liquid additive is sprayed onto the feed compound.

6. A method as claimed in claim 5 wherein the amount of liquid additive and the period of time it is sprayed onto the feed compound is programmable to boost

the nutrient level thereof so that said level substantially matches the level required to achieve said optimum level of growth of the livestock at any point in growth period.

7. A method as claimed in any preceding claim including the step of adding grains of whole wheat to the feed compound.

8. A method as claimed in any preceding claim wherein the liquid additive includes lysine, methionine and a carbohydrase enzyme.

9. A method as claimed in any preceding claim wherein medicinal compounds are additionally added to the feed compound at any point in the growth period.

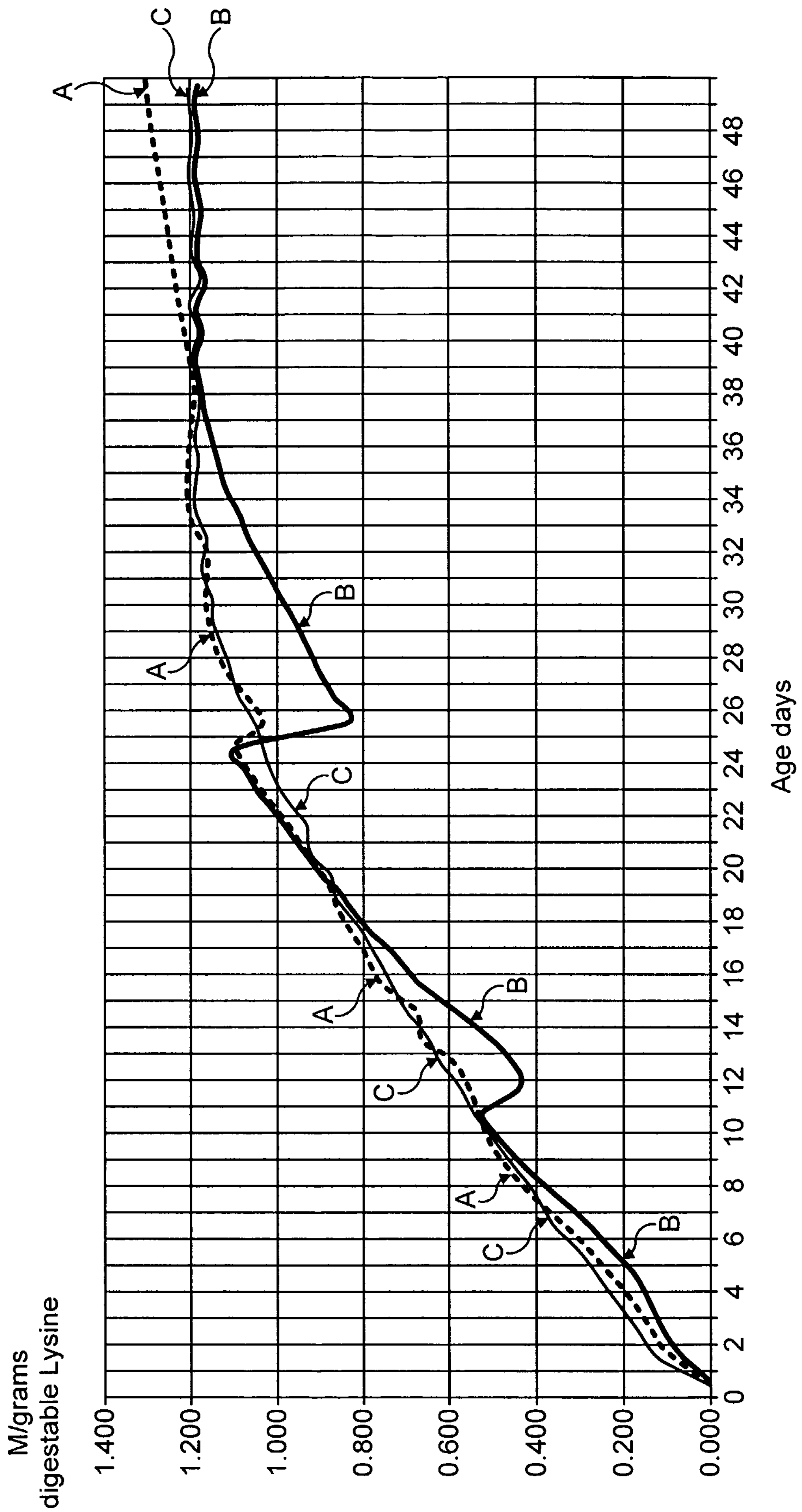

M/grams
digestable Lysine
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
Age days
A
B
C

FIG. 1

Feed	Day	KG of additive per ton of feed compound
Starter feed	0	20.00
	1	20.00
	2	20.00
	3	20.00
	4	20.00
	5	17.00
	6	15.00
	7	10.00
	8	6.00
	9	3.00
	10	0.00
Grower feed	11	15.00
	12	18.00
	13	17.00
	14	10.00
	15	8.00
	16	6.00
	17	4.00
	18	2.00
	19	0.00
	20	0.00
	21	0.00
	22	0.00
	23	0.00
	24	0.00
Finisher feed	25	12.00
	26	12.00
	27	12.00
	28	11.00
	29	10.00
	30	8.00
	31	6.00
	32	5.00
	33	5.00
	34	4.00
	35	3.00
	36	2.00
	37	1.00
	38	0.00
	39	0.00
	40	0.00
	41	0.00
	42	0.00
	43	0.00
	44	0.00
	45	0.00
	46	0.00
	47	0.00
	48	0.00
	49	0.00

FIG. 2

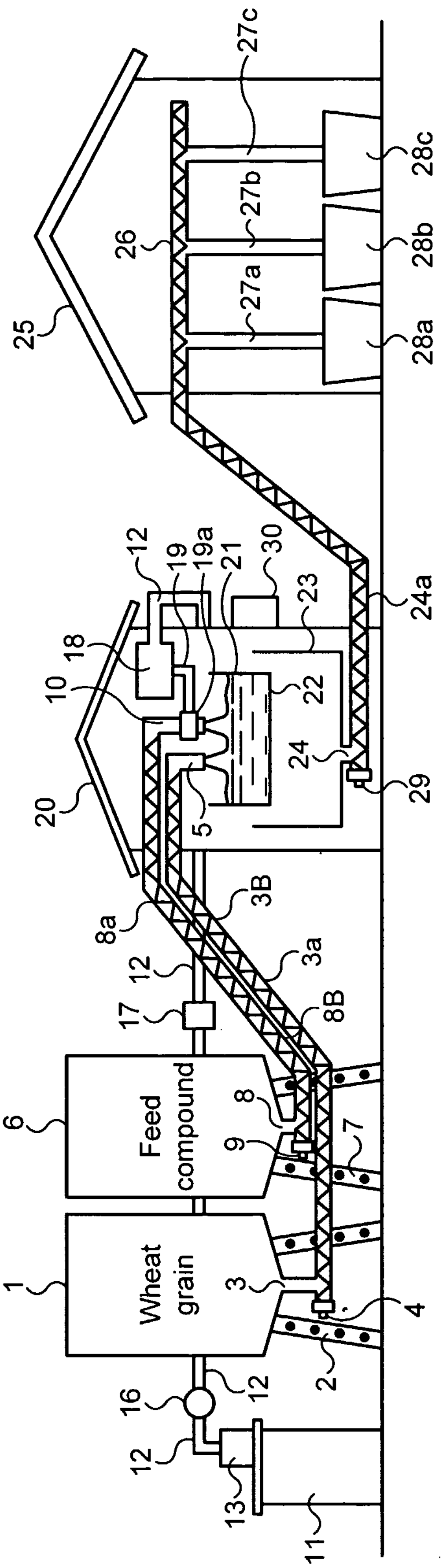

Wheat grain
Feed compound
1
2
3
4
5
6
7
8
9
10
11
12
13
16
17
18
19
19a
20
21
22
23
24
24a
25
26
27a
27b
27c
28a
28b
28c
29
30
3a
3B
8a
8B

FIG. 3

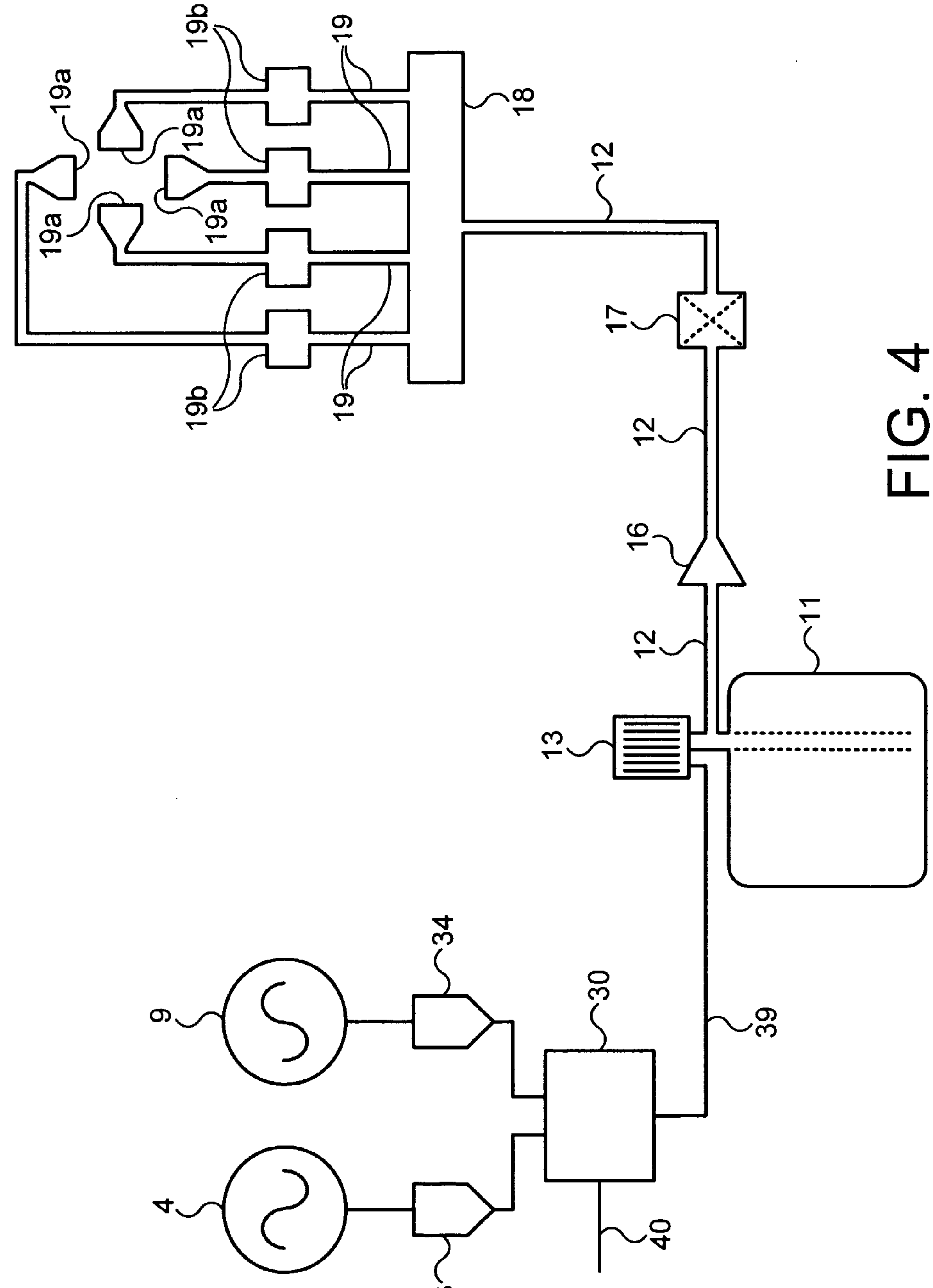


FIG. 4

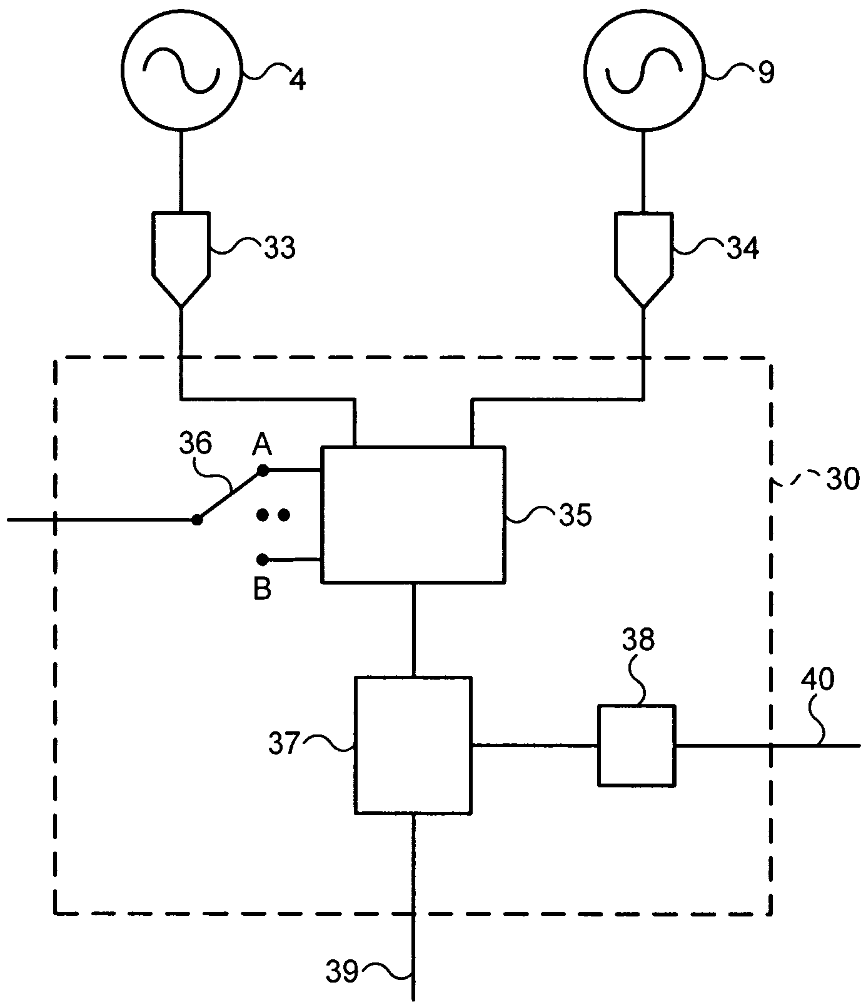


FIG. 5