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(11) **EP 1 213 054 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention
of the grant of the patent:
03.05.2006 Bulletin 2006/18

(51) Int Cl.:
B02C 9/04 (2006.01)

(21) Application number: **01307803.5**

(22) Date of filing: **13.09.2001**

(54) **Process for milling corn**

Verfahren zur Vermahlung von Mais

Procédé pour le broyage de maïs

(84) Designated Contracting States:
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE TR**

(30) Priority: **13.09.2000 US 661139
13.09.2000 US 661136**

(43) Date of publication of application:
12.06.2002 Bulletin 2002/24

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EP 1 213 054 B1

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Description

[0001] The present invention relates to processes for milling corn (maize) and obtaining products such as flour and meal therefrom.

[0002] The corn kernel is a staple crop grown in many parts of the world. Corn is also known as Indian corn or maize and the flour, meal and oil obtained from corn are used as ingredients in many food products. Corn milling is an ancient practice to the human race. Historically, mill stones were utilized to grind the corn into meal. Wind and water powered mills developed several hundred years ago allowed for increased efficiency in the processing of corn. For the past hundred years, milling operations have typically utilized roll milling equipment in an effort to separate the components of the corn kernel for more particularized uses.

[0003] The corn kernel, as illustrated in Fig. 1, has a number of components, each being best suited for various uses. The process of modern dry corn milling seeks to segregate and separately process the below-identified parts of a kernel of corn as each part has a separate use. The hard outer shell is called the pericarp or the bran coat. The end of the corn kernel which adheres it to the corn cob is called the tip cap. The interior of the corn kernel consists of the endosperm and the germ. The endosperm is generally broken into two parts: soft endosperm and hard endosperm. For purposes of human consumption, the hard endosperm generally produces grits and corn meal, and the soft endosperm generally produces corn flour. The germ contains a much higher percentage of fat compared to the other parts of the kernel and is the source of corn oil.

[0004] Modern roll milling equipment utilizes contiguous rollers with varying sized corrugations and varying sized roller gap spacings to achieve the desired particle size fractionation. Typically, mills employ rollers in series with increasingly narrow gaps in a gradual milling process. More specifically, the various parts of the corn kernel are segregated and removed to differing processing pathways, often referred to as streams. Initially, after cleaning the hard outer shell, the kernel is fractured via a mechanical process thereby freeing and removing the germ from the remaining parts of the kernel—a step called degermination. The remaining parts of the kernel are broken up by a series of rollers. As this material is processed, the hard outer shell (bran) flakes are removed and the remaining soft and hard endosperm are further processed into differing streams by passing through a series of rollers and sifters which separate product by particle size. The end products of the dry corn milling operation are bran, grits, meal, flour, and high fat germ.

[0005] A flow scheme typical of prior art mills is illustrated in U.S. Patent No. 5,250,313. In Figure 5, of the '313 patent (reproduced herein as Figure 2), the incoming corn is cleaned, washed, tempered to the appropriate moisture content, fractured or degerminated, and dried. Various designs exist to carry out the step of degermination. For example, the Ocrim degerminator uses a spinning rotor having combination blades to operate against a horizontal, perforated cylinder that only allows partial kernels to pass. The rotor and breaker bars are set to break the corn against a spiral rotor bar and a cutting bar. Another known degerminator is the Beall degerminator. In the Beall degerminator, grinding occurs through an abrasive action of kernel against kernel, and kernel against a nested conical surface and screen. Impact-type degerminators are also used. An example is the Entoletor degerminator as illustrated in Fig. 3. The Entoletor includes a vertical drive shaft that operates a rotor. Kernels are fed downwardly towards the rotor where they are forced outwardly by centrifugal motion to impact a liner surface.

[0006] Generally, the product out of the degerminator is separated into a first stream which is relatively rich in endosperm and a second stream which is relatively rich in germ and bran. Specifically, with reference again to Fig. 2, the degerminated corn is aspirated to effect initial density separation of the fractured kernel. The tailings and liftings from the aspirators are further separated through additional aspiration or the use of gravity tables. In general, bran, whole germ and germ contaminated particles obtained via density separation are lighter than other constituent parts and may be partially removed via gravity separation to be directed through a series of germ rollers and sifters. Separated, primarily endosperm-containing streams from the gravity tables and aspirators may be directed to different break rollers depending on the particle size of the stream. For example, those primarily endosperm-containing streams having smaller particle sizes may be directed past the first and second break rollers, or as illustrated in Fig. 2, beyond to later break rollers.

[0007] The "break rollers" used in a gradual break process typically comprise corrugated rollers having roller gaps that cascade from wider roller gaps for the 1st break roller to more narrow roller gaps for subsequent break rollers. Roller gaps are the spacings between the exterior or "tip" portions of the corrugations on opposing rollers. The use of five break rollers is typical, and roller gaps may vary depending on the desired finished product. Typical roller gap distances on prior art systems range from about 0.25 mm (0.01 inches) to about 1.8 mm (0.07 inches), wherein smaller gaps result in finer particles. In general, the break rollers are operated such that opposing corrugated roller faces rotate at differing rates. Figure 4 contains examples of typical prior art roller corrugation configurations. Most configurations present a sharp edge and a dull edge as determined by the slope of the corrugation surface. Therefore, breaking may occur under a sharp to sharp, sharp to dull, dull to sharp, or dull to dull arrangement of opposing corrugations.

[0008] After break rolling, the further-broken particles are separated, typically by a sifting process. From there, larger particles are further rolled in a subsequent break roller (and the further-broken particles are again sifted), or they are passed on to drying or cooling steps or additional sifting steps to isolate finished products (flour, meal, grits, etc.). Of

course other products may be desired by particular purchasers. The remaining particles that fail to pass the post germ sifting steps are typically sent to a germ handling process (labeled oil recovery in Figure 2). The finer particles obtained from the germ roller siftings are processed in a manner generally similar to the finer particles from the break rollers.

[0009] Traditionally, large scale corn mills have employed a great degree of redundancy and repetitive processing of the grain. For example, as illustrated in Fig. 2, a traditional corn milling process involves an initial degermination step, followed by five separate roller, or breaking, steps each of which is followed by sifting steps. In addition, the prior art includes various shorter mill processes wherein fewer roller steps are utilized, germ streams are extracted from the mill stream earlier in the process, and valuable capital, space and time savings are achieved. See for example the process described in the '313 patent. The shortened mill regimes also dramatically reduce production expense by lowering the labor costs associated with the milling process due to the reduced maintenance and monitoring required of a much shorter process.

[0010] Nevertheless, even in the prior art "shortened" mill flow regimes, inefficiencies remain. For example, U.S. Patent No 4,189,503 (a parent from which the '313 patent is a continuation-in-part), teaches the use of a preferred degermination and rolling process to avoid breakage of the germ. These patents also teach the separation of degermination products into three streams, one of which is a "fine" stream relative to the others (see Figures 6, 7, and 8 of the '313 patent and accompanying text). The '313 and '503 patents specifically teach the reintroduction of this fine stream into the other less carefully graded streams after the other streams have been subjected to various other steps, such as tempering and drying (See Claim 8 of the '503 patent). The '313 and '503 patents therefore specifically teach the separation or gradation of post degermination product for the purpose of avoiding the addition of moisture to the separated fines (See '313 patent, Col. 11, Lines 4-14) followed by the subsequent reintroduction of the fine stream into a mixed stream. In fact, the '313 patent teaches a process wherein the product stream from the degerminator to the first break roll comprises bran, endosperm and germ. In addition, the reintroduction of the sifted "fines" streams into other streams "contaminates" the sifted stream and increase the flow across subsequent sifters.

[0011] US 2,460,389 describes solvent extraction as a step in a grain milling process.

[0012] EP 0,418,801 describes a process for milling cereals, in which the finished products are obtained by grain braking operations, separation operations and further milling operations.

[0013] EP 0,958,863 describes a flour milling method having a sorting step for raw wheat grains, wherein each milling step includes a breaking step and a grading step.

[0014] AT 380183, DE 37,10,602 and CH 271,100 describe milling methods comprising breaking and sorting steps, where DE 37, 10, 602 forms the basis for the pre-characterizing portion of claim 1.

[0015] US 5,114,079 describes a method for producing white flour from wheat grain comprising flattening, grinding and sifting steps.

[0016] US 2,108,655 describes a degerminator for use in corn, cereal, hominy and grit mills.

[0017] It is an object of the present invention to provide an improved process for milling corn. In particular, it is an object to provide a milling process of greater efficiency and requiring a reduced amount of processing equipment without loss of yield compared to prior art processes.

[0018] Accordingly the invention provides a method for processing grain kernels as set forth in Claim 1.

[0019] In preferred embodiment, the method further comprises : -

- a. breaking the kernels into pieces in a first breaking step;
- b. at least partially sorting the pieces into streams of different sized pieces;
- c. extracting at least one of the streams as a finished product stream; and
- d. breaking the pieces in the remaining streams in at least a second breaking step.

[0020] In another preferred embodiment, the method further comprises:-

- a. at least partially sorting the pieces from said second breaking step into second streams of different sized pieces;
- b. extracting at least one of the second streams as a finished product stream; and optionally
- c. further breaking the pieces in the remaining second streams in at least a third breaking step.

[0021] It is preferred that the grain is corn, namely Indian corn or maize.

[0022] Typically in the methods of the invention the first breaking step is a degermination step. Suitable degerminators include impact degerminators, Entoletor degerminators, Ocrim degerminators, or Beall degerminator. The method of operation of these degerminators is given above.

[0023] In an embodiment of the invention described in more detail below the methods comprise up to four concurrent and/or consecutive breaking steps, made up of one degermination step and three breakage steps. Some of the broken kernel pieces will pass through more than one breakage step before reaching the desired end product size, whereas other pieces may be removed as finished product after only the first or second breaking steps.

[0024] Typically, the second and any subsequent breaking steps utilize break rollers, which rollers are preferably corrugated rollers. After the breakage steps sorting of the broken kernel pieces is suitably achieved by use of a sifter, a hominy grader, a gravity table and/or an aspirator.

[0025] It is desirable for the finished product stream to comprise broken kernel pieces of substantially homogeneous size and grades - i.e. flour, meal, bran, grits or high fat germ.

[0026] Any of the short flow grain milling processes of the invention may be suitably carried out on a transportable grain from milling facility according to these aspects of the invention. In specific embodiments of the invention the short flow grain milling process facility is transported via truck, train, airborne transport and/or waterborne transport.

[0027] The present invention is an improvement upon the prior art in that the present process does not contaminate or intermix the separated streams with less specifically graded streams once the finished product stream has been isolated. This is of significant advantage as it results in a dramatic decrease in handling and a reduction or elimination of flow across subsequent process steps. The resultant increase in the through-put of product allows for the processing of an increased volume of corn in a given time, as well as the elimination of excess processing equipment.

[0028] The processes taught in the '313 and '503 patents contrast with that of the present invention by providing the contamination of the initially separated fine stream. With only a reference to fines, these patents do not teach or provide motivation to isolate finished product streams as early in the milling process as a post degermination sifting. This is different to the process of the present invention where a sifted end-product-grade stream is obtained from the initial degermination sifting or grading step and is directed towards storage or finished product handling (storage, packaging, quality control, etc.). If mixing of this stream occurs, it involves the blending of similarly sifted streams having particles of the same gradations, i.e., addition of a similar finished product stream.

[0029] The present invention utilizes a short flow corn mill having a dramatically reduced number of process steps with a commensurate reduction in processing and handling equipment, process monitoring and maintenance labour costs, and process space requirements. This mill design utilizes fewer, but more aggressive break subsystems, instead of five gradual break subsystems, to appropriately shorten the flow while providing exceptional quality and yield performance.

[0030] The present invention typically employs zero to three break rollers in series (or more if parallel operations or redundancies are desired for system stability, etc) and preferably from one to three break rollers.

[0031] Finished product grade material is withdrawn from process streams when it is first separated, without further intermixing of already separated streams and without a need for further production sifting. This separation occurs early in the short mill process, preferably as early as separation of the degermination stream.

[0032] In addition, one embodiment of the present invention includes the diversion of other streams at early points in the milling process to a separate hammer-mill process for the production of flour. This diversion of product to a hammer-mill process additionally eliminates product from the stream and further reduces the amount of handling, intermixing, and possible contamination of already separated streams with product of different gradations. Further, these diversions reduce the flow on rollers and on later portions of the mill. Therefore, efficiency is achieved by the rapid isolation and removal of finished product from the stream. Further, yield as well as efficiency is improved.

[0033] Average corn milling yields for the industry are 100 units of finished product per 180 units of raw corn starting material. The short flow milling technology of the present invention allows for a dramatically improved yield of 100 units of finished product per 129 units of raw corn, which is currently the best yield in the industry (it is believed that the industry best has been 100/135 prior to the new short flow technology of the invention).

[0034] The dramatic elimination of components and the accompanying conduits and transport equipment needed to combine such components, from as many as 450 machines to produce 118,181 kg/hr (260,000 lbs/hr) in known prior art large scale mill processes to fewer than 85 machines to produce 72,727 kg/hr (160,000 lbs/hr), allows for tremendous space savings.

[0035] In addition, monitoring and maintenance needs can be greatly reduced with the short flow process.

[0036] The process of the invention is illustrated by the accompanying drawings in which,

Fig. 1 is a enlarged diagram of a kernel of corn (maize) to display the constituent portions of the kernel;

Fig. 2 is a flowchart of a typical prior art gradual break milling process;

Fig. 3 is a front elevational view of a prior art Entoletor impact degerminator;

Fig. 4 is an illustration of prior art break roller corrugations;

Fig. 5 is a block diagram of the flow in a first preferred embodiment;

Fig. 6 is a block diagram of the flow in a second preferred embodiment.

[0037] In the present invention, kernels are received and the kernels may, optionally, be pre-treated in any manner required to maximize the production of the desired end product (grits, meal, flour, etc.). For example, the corn is most commonly cleaned through impact de-infestation or washing. The choice of a cleaning method will depend upon the desired end product, as even the cleaning steps may result in breakage of kernels or an alteration in the moisture content.

Additionally, pre-treatment may involve tempering or moisturizing of the corn with water, hot water and/or steam, although this is not necessary.

5 **[0038]** Because the corn kernel's constituent parts, as illustrated in Fig. 1 and as discussed above, comprise separate components of distinct character, each absorbs moisture differently and this differential absorption impacts degermination efficacy. For example, the pericarp or bran coat may be brittle without tempering, but tempering creates a more pliable bran coat that is more likely to be removed intact or as a particle of larger size. Similarly, tempering may aid the release of the germ still in connection with the tip-cap. This allows the removal of the tip cap with the germ and a reduction in the number of black tip-caps that may be further milled and result in discoloration of the finished product. In fact, the '313 patent teaches tempering as a method for the facilitating the shortened process. However, tempering necessarily increases production costs through energy expense for drying, and as a result tempering is not necessary to practice the process of the present invention.

10 **[0039]** After cleaning, and the optional and/or desired pre-treatment, the corn is degerminated. In the currently preferred embodiment, the corn is degermed without the use of tempering and is accomplished with an impact degerminator. This preferred method of degermination typically achieves breakage of the kernel into relatively large pieces, dislodging the germ. Degermination is followed by a separation step. Degermination may be followed by a drying step prior to separation if tempering is elected, or drying may occur at a later stage in the process.

15 **[0040]** The post-degermination sifter is herein referred to as a "hominy grader." The hominy grader segments the broken corn into various streams depending on granulation-the size of the product granules. The finer granulated streams, such as low fat meal and flour streams are directed as finished product from the hominy grader to eliminate excessive handling and deterioration of product quality. Optionally, the meal stock may be directed towards a hammer-mill or flour grinder if greater flour output is desired. By extracting finished product as soon as possible, the mill flow can be greatly reduced as further sifting of an already isolated stream is not required.

20 **[0041]** The medium granulated streams from the hominy grader are sent to directly to aggressive 2nd and 3rd (in series) break roll subsystems via aspirators. When sent directly to the 2nd break roll subsystem, the stream does not pass first through the 1st break roll subsystem. When sent directly to the 3rd break roll subsystem, the stream does not pass first through either the 1st or 2nd break roll subsystems. Therefore, the present invention allows for the processing of a greater volume without increasing a greater load on a particular roller. The aspiration step helps to break apart combined particles and further separate any remaining bran, germ or other non-endosperm material from the endosperm material. Preferred aspirators comprise cascading angled surfaces having periodic ports in the sidewalls to allow a cross stream of air to "blow" loosened bran from the falling particles. The liftings removed via aspiration can be directed to bran processing as a high value input.

25 **[0042]** The coarse granulated streams from the hominy grader are sent to gravity tables via aspiration. From the gravity tables, a lighter germ and germ-contaminated stream can be directed onward to an oil or germ recovery process. The remaining portions of the coarse product stream are sent to the aggressive 1st break roll (in series) via aspiration.

30 **[0043]** No whole corn kernels that reach these later stages are resent to degermination since the degerminator is effectively breaking the corn in one step. From each sifting step, including the hominy grader and the post 1st, 2nd, and 3rd break siftings, finished product flour and meal are isolated and removed from the mill stream.

35 **[0044]** With specific reference to Figure 5, a first preferred embodiment of the present invention operates as follows. The input corn is cleaned and degerminated prior to arrival at the hominy grader. In the hominy grader, a number 6, 12, 30, and 62 wire mesh screen is employed to separate the particles from degermination. Alternative screen sizes may be employed to produce finished product having the desired particle size profiles and ranges. The overs (particles that do not pass through) the number 6 screen are directed towards a gravity table via aspiration. From the gravity table, the lighter germ and germ contaminated material is removed and directed to a germ or oil recovery process. It has been found that at or above 95% of the germ is removed from the process stream at this point.

40 **[0045]** The heavier particles from the gravity table are directed to a first break roller. The overs from the number 12 screen of the hominy grader are directed towards a second break roller via aspiration. The overs from the number 30 screen of the hominy grader are directed towards a third break roller via aspiration. Finally, the overs from the number 62 screen of the hominy grader are directed onward as finished product meal, whereas those portions that pass the number 62 screen are directed onward as finished product flour. Upon inspection, typically based on fat content, the meal finished product stream can optionally be diverted for grinding in to flour.

45 **[0046]** Although the present invention is described with reference to a sharp meal obtained between number 30 and number 62 wire screens, meal may be classified or obtained from other ranges as is known to those in the art. For example, a meal top screen typically ranges from about a number 30 to about a 46 and a meal bottom screen typically ranges from about a 46 to about a 72. Similarly flour can be that portion that passes screens ranging from about a number 46 screen to about a number 72 screen. Therefore, although specific number wire mesh screens are referenced herein to describe the preferred embodiments, it is understood that the present invention may be practiced to achieve alternate finished product particle profiles.

50 **[0047]** The first break roller typically employs rollers having approximately 6 corrugations per cm (equivalent to 14

EP 1 213 054 B1

corrugations per inch) with a dull to dull arrangement. The roller distance is typically adjusted after production begins. These adjustments allow operators to achieve target percentages for the differently sized particles coming off the rollers - i.e., the percentage of the roller output that falls into each screen size in the post-roller sifting step. It will be appreciated by the skilled person, however, that the corrugations, roller set-up and product output goals disclosed herein are preferred
5 embodiments and that the present invention can be modified to maximize the overall mill output of a variety of particular product streams (meal, flour, grits etc.).

[0048] From the first break roller, rolled particles are sifted with a number 12, 30 and 62 wire mesh screen. Flour and meal are removed as finished product from the milling stream, as before. The overs from the number 12 screen are sent to the second break aspirator (along with the overs from the number 12 screen of the hominy grader), and the overs of
10 the number 30 screen are sent to the third break aspirator.

[0049] The second break rollers typically employ 6 corrugations per cm (equivalent to 14 corrugations per inch), and a dull to dull configuration. From the second break roller, rolled particles are sifted with a number 12, 30 and 62 wire mesh screen. Flour and meal are removed as finished product from the milling stream, as before. The overs from the number 12 screen are sent to the germ or oil recovery, and the overs of the number 30 screen are sent to the third break
15 aspirator. Removal of the largest remaining particles from this step to oil recovery and germ processing further reduces the milling stream and limits the fat content of the remaining product.

[0050] The third break rollers employ approximately 8 corrugations per cm (equivalent to 20 corrugations per inch), a dull to dull configuration. From the third break roller, rolled particles are sifted with a number 22, 30, and 62 wire mesh screen. Flour and meal are removed as finished product, as before. Overs from the 30 screen are directed to grinding, such as a hammer mill process to produce flour. Overs from the 22 screen are directed towards a bran dusting step to
20 abrade remaining bran. The bran recovered from the bran duster is suitable to be used as a bran flour or in other bran product process. The remains from the bran dusting process may, if desired be directed to re-enter the process at the hominy grader.

[0051] All grinder stock (including the overs from the number 30 screen of the third break sifter and some or all finished product meal if meal production is not desired) is ground, through a process such as hammer milling to generate flour. Simple sifting with a flour screen (here a 62 wire screen) may be used to isolate additional finished product flour and redirect the overs of the flour screen for additional grinding. Throughout the process disclosed in Fig. 5, at sifting steps
25 in particular, additional screens can be included. This adds the advantage of further separating streams with potentially valuable uses.

[0052] In another preferred embodiment, illustrated in Fig. 6, the streams from the gravity table separator are further divided to include diversion to a gravity table germ aspirator. From the gravity table germ aspirator, product is directed to a gravity table germ roller and sifter. The gravity table roller preferably employs approximately 5 corrugations per cm (equivalent to 12 corrugations per inch). The gravity table germ roller sifter employs a number 12, 30 and 62 wire mesh screen. Flour and meal finished products are directed onward as before. The overs of the number 12 screen are directed
30 to germ or oil recovery processing, and the overs of the number 30 screen are directed onward to third break rollers via aspiration.

[0053] It has been found that the preferred embodiment described in Fig. 6 is capable of producing meal and flour in accordance with the data shown in Table 1 below. Further, Table 2 illustrates the percentage of product obtained from the various sifting steps.

[0054] It will be apparent to those skilled in the art that the short flow design of the present invention provides a finished product much faster in the milling process than typical full scale milling operations (hominy grader vs. 1st or 2nd break sifter). Each break sifter on the short flow produces finished product as contrasted with typical milling methods where secondary handling and sifting are required.

[0055] Further, intermediate product streams are reduced to flour unlike other systems which use germ, tailings and purifier subsystems to reclaim poorer quality meal streams. This provides very high quality meal/flour with minimal equipment, reduced monitoring and maintenance needs, and superior yield performance. The basic milling philosophy behind the development of a shorter corn milling flow is to produce finished product faster, cheaper and better. This and the other objectives of the present invention are achieved through the application of the preferred mode and the invention as claimed herein.

[0056] Of course, these benefits make possible the method of the present invention for easily transportable, on-site milling applications. Simply put, when the process may be simplified to eliminate redundancy in rolling and sifting, eliminate steps required to attain a finished product, and reduce monitoring and maintenance needs, the milling process can be taken from an isolated production facility and milling may be instituted on location - for example in a mobile milling facility capable of traveling to the source of the starting material.
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EP 1 213 054 B1

TABLE 1 ROLLER SETTING DATA

Roll	Corrugations/ cm	Roll Set Up	Prod Distribution Target	Prod Distribution Target
1 st Break	6/cm	Dull to Dull	7% + 12 mesh	9% max + 12 mesh
GTG	5/cm	Dull to Dull	20% + 12 mesh	22% max + 12 mesh
2 nd Break	6/cm	Dull to Dull	8% + 12 mesh	10% max + 12 mesh
3 rd Break	8/cm	Dull to Dull	3% + 22 mesh	5% max + 22 mesh

TABLE 2

HOMINY GRADER SIFTER 11350 KG/HR HEAD FEED

Meal	Meal Sieving		Flour	
	Wires	%		
Fat	1.40%	+ 20	Trace	Fat 1.17%
Moist	11.70%	+25	1.14%	Moist 12.56%
		-70	1.00%	

1ST BREAK SIFTER DISTRIBUTION 2951 KG/HR HEAD FEED

Meal	Meal Sieving		Flour	
	Wires	%		
Fat	1.12%	+ 20	Trace	Fat 0.98 %
Moist	10.80%	+25	0.71%	Moist 13.50%
		-70	0.85%	

GT GERM SIFTER DISTRIBUTION 2634 KG/HR HEAD FEED

Meal	Meal Sieving		Flour	
	Wires	%		
Fat	3.51%	+20	Trace	Fat 2.26%
Moist	13.26%	+25	0.86%	Moist 12.70%
		-70	0.22%	

2ND BREAK SIFTER DISTRIBUTION 3905 KG/HR HEAD FEED

Meal	Meal Sieving		Flour	
	Wires	%		
Fat	1.33%	+20	Trace	Fat 1.49%
Moist	13.55%	+25	1.54%	Moist 13.12%
		-70	0.34%	

3RD BREAK SIFTER DISTRIBUTION 6901 KG/HR HEAD FEED

Meal	Meal Sieving		Flour	
	Wires	%		
Fat	1.22%	+20	Trace	
Moist	13.10%	+ 25	0.70%	
		-70	0.02 %	

Claims

1. A method for processing kernels of grain in a mill stream to produce a desired end product comprising the steps of:

- cleaning the kernels of grain;
- breaking the kernels of grain into two or more parts;

separating the parts according to selected size classes wherein at least one separation step occurs directly after each breaking step;
 removing at least one of said size classes as a desired end product from the mill stream directly from each separation step;

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characterized in that the method further comprises the steps of:

diverting one or more of the remaining size classes to a germ oil recovery process;
 diverting one or more of the remaining size classes of grain to an aspirator and aspirating said size class of grain; and
 diverting the aspirated grain to a break roller.

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2. A method according to Claim 1, wherein the breaking step is a degermination step; and wherein there are at least two separation steps, wherein the first separation step occurs directly after degermination; further comprising breaking the grain further using break rollers in-between separation steps; and diverting the remaining size classes to one or more other locations.

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3. A method according to any previous claim wherein the grain is corn.

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4. A method according to Claim 1 wherein two of the size classes removed from the mill stream after the first separation step are flour and meal.

5. A method for providing grain milling services comprising the steps of:

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transporting a short flow grain milling facility to a location, and instituting therein a short flow grain milling process according to the method of any of Claims 1-4;
 receiving grain into the short flow grain milling process;
 generating a finished product from said short flow grain milling process.

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6. A method for milling corn comprising the steps of:

transporting a short flow grain milling facility comprising a cleaner, a degerminator, a first sifter, at least one roller, and a second sifter, and instituting therein a short flow grain milling process according to the method of any of Claims 1-4;
 processing grain to produce a selected finished product using said short flow grain milling process wherein at least a portion of the selected finished product is obtained directly from the first sifter.

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7. A method according to Claim 5 or 6 wherein the short flow grain milling facility is transported via truck, train, airborne transport and/or waterborne transport.

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8. A method according to Claim 2, wherein the grain is corn, comprising the steps of:

(a) diverting at least one of the remaining size classes from the first separation step to a first break roller having first roller settings which breaks that size class into two or more parts; separating the parts according to size class in a second separation step immediately after they pass through the first break roller; removing at least one of said size classes from the mill stream directly from the second separation step, and directing the remaining size classes to one or more locations;

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(b) diverting at least one of the remaining size classes from the first separation step to a second break roller having second roller settings which breaks that size class into two or more parts; separating the parts according to size class in a third separation step immediately after they pass through the second break roller; removing at least one of said size classes from the mill stream directly from the third separation step, and directing the remaining size classes to one or more other locations; and

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(c) diverting at least one of the remaining size classes from the first separation step to a third break roller having third roller settings which breaks that size class into two or more parts; separating the parts according to size class in a fourth separation step immediately after they pass through the third break roller; removing at least one of said size classes from the mill stream directly from the fourth separation step, and directing the remaining size classes to one or more other locations.

55

9. A method according to Claim 8 wherein two of the size classes removed from the mill stream after the first, second, third, and fourth separation steps are flour and meal.

5 10. A method according to Claim 8 wherein the first and third break roller steps comprise rollers having different corrugations per inch.

10 11. A method according to Claim 8 wherein at least one of the remaining size classes after the second separation step is directed to the second break roller and at least one of the remaining size classes after the second separation step is directed to the third break roller; and at least one of the remaining size classes after the third separation step is directed to the third break roller.

Patentansprüche

15 1. Verfahren zum Verarbeiten von Getreidekernen in einem Mahlstrom, um ein gewünschtes Endprodukt zu produzieren, das die folgenden Schritte umfasst:

Reinigen der Getreidekeme;

Brechen der Getreidekeme in zwei oder mehr Teile;

20 Trennen der Teile in Übereinstimmung mit ausgewählten Größenklassen, wobei wenigstens ein Trennschritt direkt nach dem Brechschrift erfolgt; und

Entfernen wenigstens einer der Größenklassen als ein gewünschtes Endprodukt aus dem Mahlstrom direkt von jedem Trennschritt;

25 **dadurch gekennzeichnet, dass** das Verfahren ferner die folgenden Schritte umfasst:

Abzweigen einer oder mehrerer der verbleibenden Größenklassen für einen Keimöl-Gewinnungsprozess;

Abzweigen einer oder mehrerer der verbleibenden Größenklassen des Getreides zu einem Sauggebläse und

Absaugen der Getreide-Größenklasse; und

30 Abzweigen des abgesaugten Getreides zu einer Schrotmühle.

35 2. Verfahren nach Anspruch 1, bei dem der Brechschrift ein Entkeimungsschritt ist; und bei dem wenigstens zwei Trennschritte vorgesehen sind, wobei der erste Trennschritt direkt nach der Entkeimung erfolgt; ferner umfassend das Brechen des Getreides und ferner Verwenden von Schrotmühlen zwischen den Trennschritten; und Abzweigen der verbleibenden Größenklassen zu einem oder mehreren anderen Orten.

3. Verfahren nach einem vorhergehenden Anspruch, bei dem das Getreide Mais ist.

40 4. Verfahren nach Anspruch 1, bei dem zwei der Größenklassen, die nach dem ersten Trennschritt aus dem Mahlstrom entfernt werden, Schrotmehl und Feinmehl sind.

5. Verfahren für die Bereitstellung von Getreidemahldiensten, das die folgenden Schritte umfasst:

45 Transportieren einer Kurzstrom-Getreidemahlanlage an einen Ort und darin Ausführen eines Kurzstrom-Getreidemahlprozesses gemäß dem Verfahren nach einem der Ansprüche 1-4;

Empfangen von Getreide in dem Kurzstrom-Getreidemahlprozess;

Erzeugen eines fertig gestellten Produkts aus dem Kurzstrom-Getreidemahlprozess.

50 6. Verfahren zum Mahlen von Mais, das die folgenden Schritte umfasst:

Transportieren einer Kurzstrom-Getreidemahlanlage, die einen Reiniger, einen Entkeimer, einen ersten Sieb, wenigstens eine Walze und einen zweiten Sieb umfasst und darin Ausführen eines Kurzstrom-Getreidemahlprozesses gemäß dem Verfahren nach einem der Ansprüche 1-4;

55 Verarbeiten von Getreide, um ein ausgewähltes fertig gestelltes Produkt unter Verwendung des Kurzstrom-Getreidemahlprozesses zu produzieren, wobei wenigstens ein Teil des ausgewählten fertig gestellten Produkts direkt von dem ersten Sieb erhalten wird.

7. Verfahren nach Anspruch 5 oder 6, bei dem die Kurzstrom-Getreidemahlanlage mit einem Lastkraftwagen, einem

EP 1 213 054 B1

Zug, einem Flugzeugtransport und/oder einem Schiffstransport transportiert wird.

8. Verfahren nach Anspruch 2, bei dem das Getreide Mais ist und das die folgenden Schritte umfasst:

- 5 a) Abzweigen wenigstens einer der verbleibenden Größenklassen von dem ersten Trennschritt zu einer ersten Brechwalze mit ersten Walzeneinstellungen, die diese Größenklasse in zwei oder mehr Teile bricht; Trennen der Teile entsprechend der Größenklasse in einem zweiten Trennschritt direkt nach ihrem Durchlauf durch die erste Brechwalze; Entfernen wenigstens einer der Größenklassen aus dem Mahlstrom direkt von dem zweiten Trennschritt und Lenken der verbleibenden Größenklassen zu einem oder mehreren Orten;
- 10 b) Abzweigen wenigstens einer der verbleibenden Größenklassen von dem ersten Trennschritt zu einer zweiten Brechwalze mit zweiten Walzeneinstellungen, die diese Größenklasse in zwei oder mehr Teile bricht; Trennen der Teile entsprechend der Größenklasse in einem dritten Trennschritt direkt nach ihrem Durchlauf durch zweite Brechwalze; Entfernen wenigstens einer der Größenklassen aus dem Mahlstrom direkt von dem ersten Trennschritt und Lenken der verbleibenden Größenklassen zu einem oder mehreren anderen Orten; und
- 15 c) Abzweigen wenigstens einer der verbleibenden Größenklassen von dem Trennschritt zu einer dritten Brechwalze mit dritten Walzeneinstellungen, die diese Größenklasse in zwei oder mehr Teile bricht; Trennen der Teile entsprechend der Größenklasse in einem vierten Trennschritt direkt nach ihrem Durchlauf durch die dritte Brechwalze; Entfernen wenigstens einer der Größenklassen aus dem Mahlstrom direkt von dem vierten Trennschritt und Lenken der verbleibenden Größenklassen zu einem oder mehreren anderen Orten.

20 9. Verfahren nach Anspruch 8, bei dem zwei der Größenklassen, die von dem Mahlstrom nach dem ersten, dem zweiten, dem dritten und dem vierten Trennschritt entfernt werden, Schrotmehl und Feinmehl sind.

25 10. Verfahren nach Anspruch 8, bei dem der erste und der dritte Brechwalzenschritt Walzen mit unterschiedlichen Riffelungen pro Zoll aufweisen.

30 11. Verfahren nach Anspruch 8, bei dem wenigstens eine der verbleibenden Größenklassen nach dem zweiten Trennschritt zu der zweiten Brechwalze gelenkt wird und wenigstens eine der verbleibenden Größenklassen nach dem zweiten Trennschritt zu der dritten Brechwalze gelenkt wird; und wenigstens eine der verbleibenden Größenklassen nach dem dritten Trennschritt zu der dritten Brechwalze gelenkt wird.

Revendications

35 1. Procédé pour traiter des grains de céréale dans un flux de broyage afin de produire un produit final voulu comprenant les étapes consistant à :

nettoyer les grains de céréale ;

briser les grains de céréale en deux morceaux ou plus ;

40 séparer les morceaux selon des catégories de taille sélectionnées, dans lequel au moins une étape de séparation survient directement après chaque étape de brisure;

enlever au moins l'une desdites catégories de taille comme produit final voulu du flux de broyage directement à partir de chaque étape de séparation ;

caractérisé en ce que le procédé comprend en outre les étapes consistant à :

45 dévier une ou plusieurs des catégories de taille restantes vers un processus de récupération d'huile de germe;

dévier une ou plusieurs des catégories de taille restantes de céréale vers un aspirateur et aspirer ladite catégorie de taille de céréale ; et

50 dévier la céréale aspirée vers un rouleau briseur.

2. Procédé selon la revendication 1, dans lequel l'étape de brisure est une étape de dégermination; et dans lequel il y a au moins deux étapes de séparation, dans lequel la première étape de séparation survient directement après la dégermination ; comprenant en outre l'étape consistant à briser la céréale davantage en utilisant des rouleaux briseurs entre les étapes de séparation ; et à dévier les catégories de taille restantes vers un ou plusieurs autres emplacements.

3. Procédé selon une quelconque revendication précédente, dans lequel la céréale est du maïs.

EP 1 213 054 B1

4. Procédé selon la revendication 1, dans lequel deux des catégories de taille enlevées du flux de broyage après la première étape de séparation sont la farine et la farine brute.

5. Procédé pour fournir des services de broyage de céréale comprenant les étapes consistant à :

transporter une installation de broyage de céréale à flux court à un emplacement, et instituer à l'intérieur un processus de broyage de céréale à flux court selon le procédé de l'une quelconque des revendications 1 à 4 ; recevoir les céréales dans le processus de broyage de céréale à flux court ; générer un produit fini à partir dudit processus de broyage de céréale à flux court.

6. Procédé pour broyer le maïs comprenant l'étape consistant à :

transporter une installation de broyage de céréale à flux court comprenant un nettoyeur, un dégerminateur, un premier tamis, au moins un rouleau, et un second tamis, et à instituer à l'intérieur un processus de broyage de céréale à flux court selon le procédé de l'une quelconque des revendications 1 à 4 ; traiter la céréale pour produire un produit fini en utilisant ledit processus de broyage de céréale à flux court dans lequel au moins une partie du produit fini sélectionné est obtenue directement du premier tamis.

7. Procédé selon la revendication 5 ou 6, dans lequel l'installation de broyage de céréale à flux court est transportée par camion, train, transport aérien et/ou transport fluvial/maritime.

8. Procédé selon la revendication 2, dans lequel la céréale est du maïs, comprenant les étapes consistant à :

(a) dévier au moins l'une des catégories de taille restantes provenant de la première étape de séparation vers un premier rouleau briseur ayant des premiers réglages de rouleau qui brise ladite catégorie de taille en deux morceaux ou plus ; séparer les morceaux selon la catégorie de taille dans une deuxième étape de séparation immédiatement après qu'ils sont passés à travers le premier rouleau briseur ; retirer au moins l'une desdites catégories de taille du flux de broyage directement à partir de la deuxième étape de séparation, et diriger les catégories de taille restantes vers un ou plusieurs emplacements ;

(b) dévier au moins l'une des catégories de taille restantes provenant de la première étape de séparation vers un deuxième rouleau briseur ayant des deuxièmes réglages de rouleau qui brise ladite catégorie de taille en deux morceaux ou plus ; séparer les morceaux selon la catégorie de taille dans une troisième étape de séparation immédiatement après qu'ils sont passés à travers le deuxième rouleau briseur ; retirer au moins l'une desdites catégories de taille du flux de broyage directement à partir de la troisième étape de séparation, et diriger les catégories de taille restantes vers un ou plusieurs autres emplacements ; et

(c) dévier au moins l'une des catégories de taille restantes provenant de la première étape de séparation vers un troisième rouleau briseur ayant des troisièmes réglages de rouleau qui brise ladite catégorie de taille en deux morceaux ou plus ; séparer les morceaux selon la catégorie de taille dans une quatrième étape de séparation immédiatement après qu'ils sont passés à travers le troisième rouleau briseur ; retirer au moins l'une desdites catégories de taille du flux de broyage directement à partir de la quatrième étape de séparation, et diriger les catégories de taille restantes vers un ou plusieurs autres emplacements.

9. Procédé selon la revendication 8, dans lequel deux des catégories de taille retirées du flux de broyage après les première, deuxième, troisième et quatrième étapes de séparation sont de la farine et de la farine brute.

10. Procédé selon la revendication 8, dans lequel les première et troisième étapes avec rouleau briseur incluent des rouleaux ayant différentes ondulations par pouce.

11. Procédé selon la revendication 8, dans lequel au moins l'une des catégories de taille restantes après la deuxième étape de séparation est dirigée vers le deuxième rouleau briseur et au moins l'une des catégories de taille restantes après la troisième étape de séparation est dirigée vers le troisième rouleau briseur ; et au moins l'une des catégories de taille restante après la troisième étape de séparation est dirigée vers le troisième rouleau briseur.

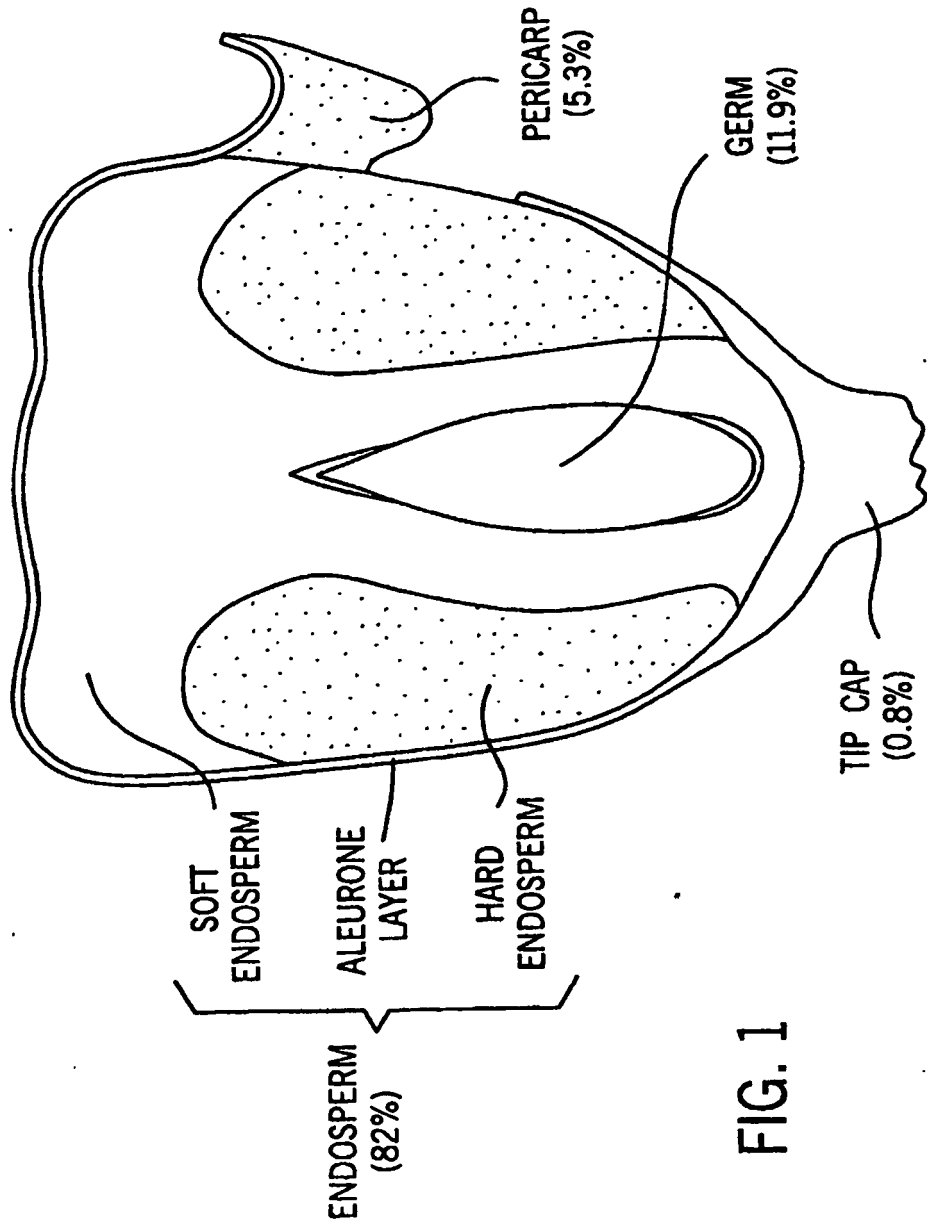


FIG. 1

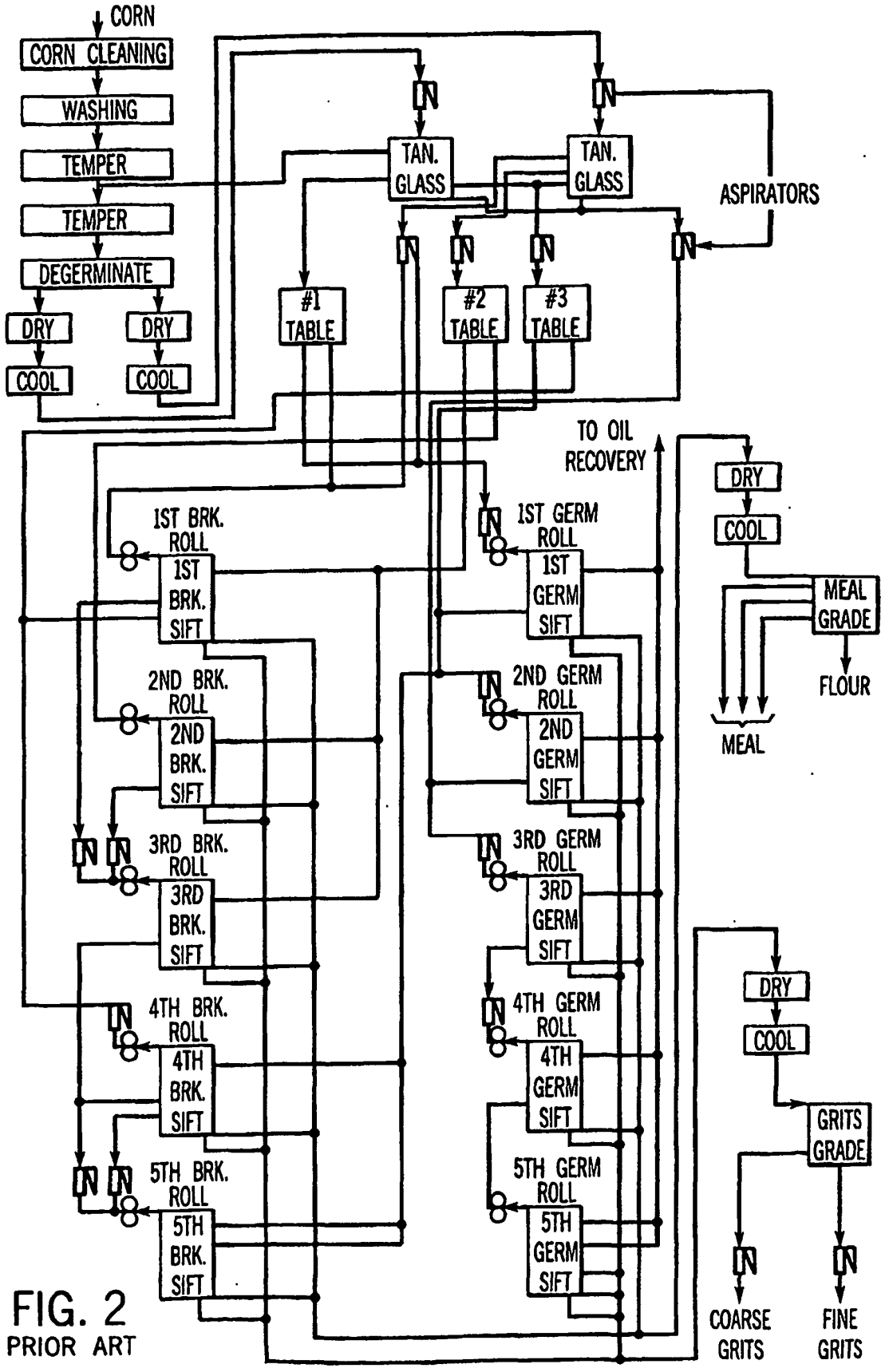
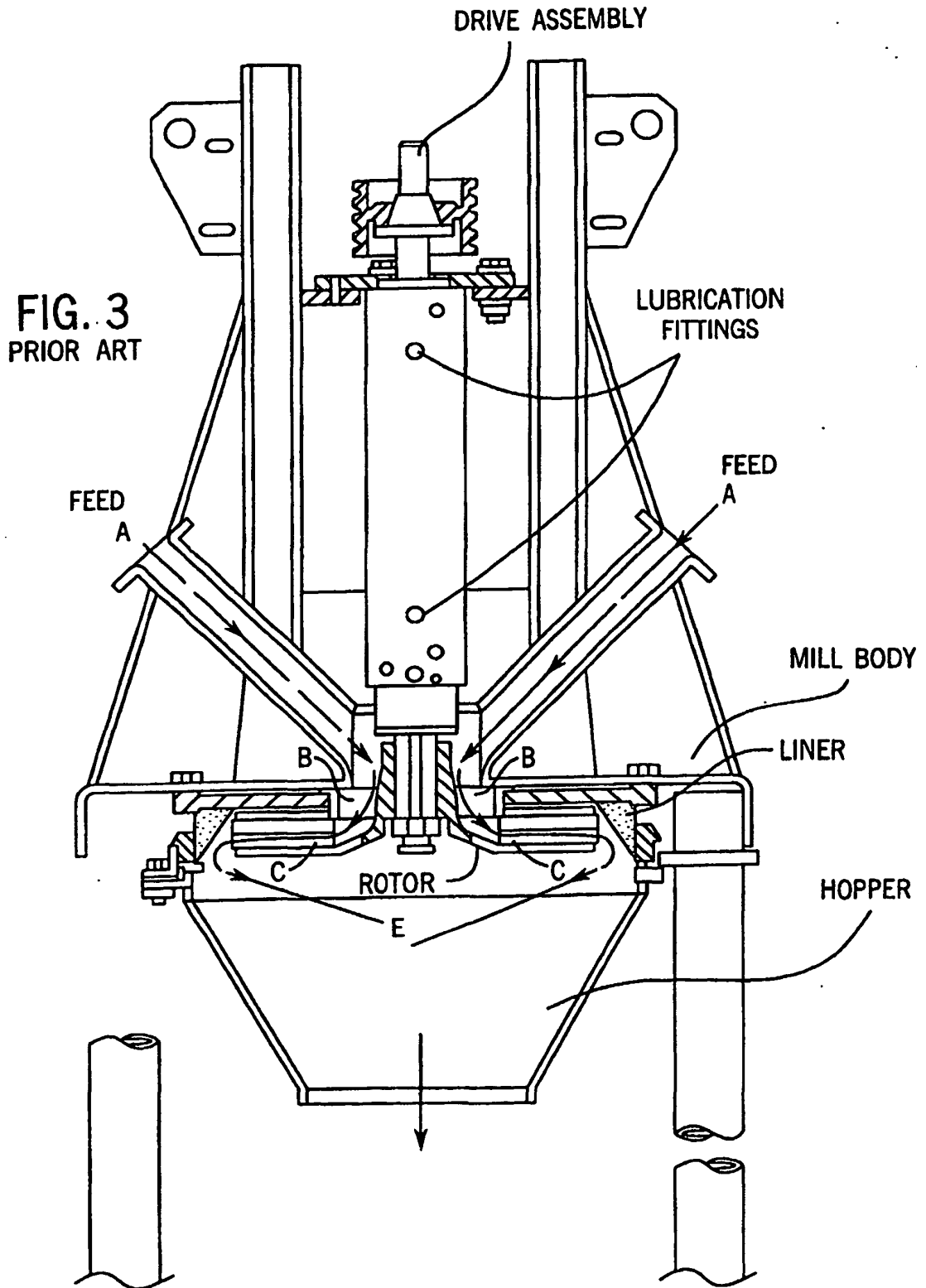


FIG. 2
PRIOR ART



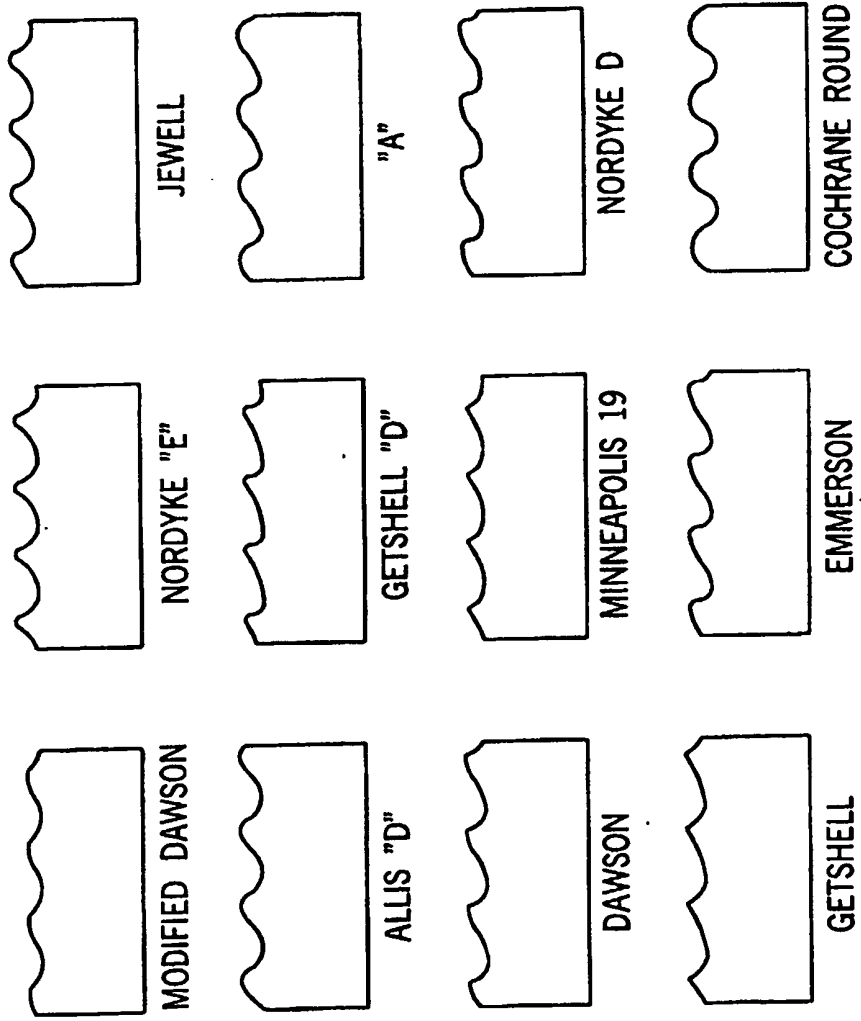


FIG. 4
PRIOR ART

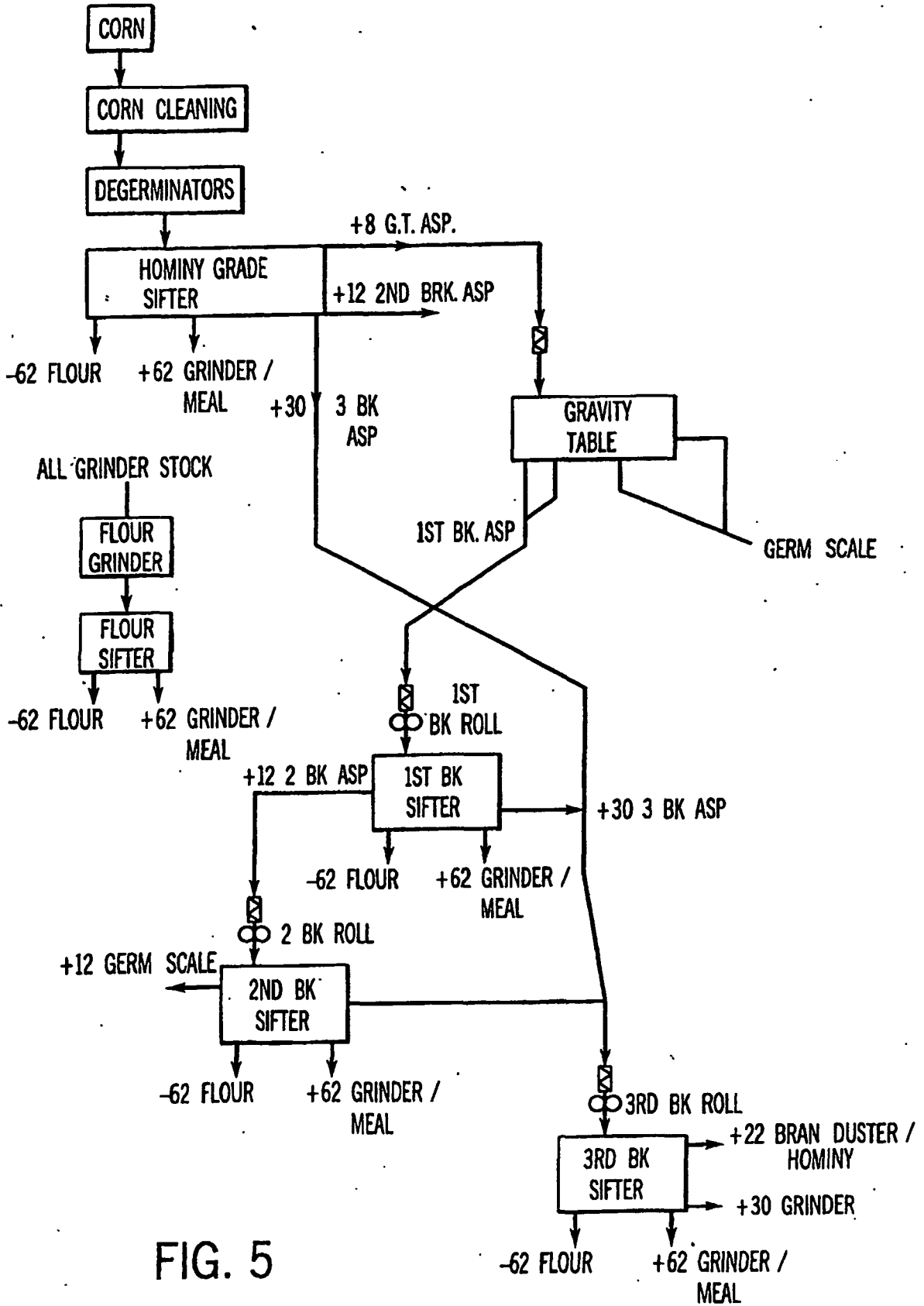


FIG. 5

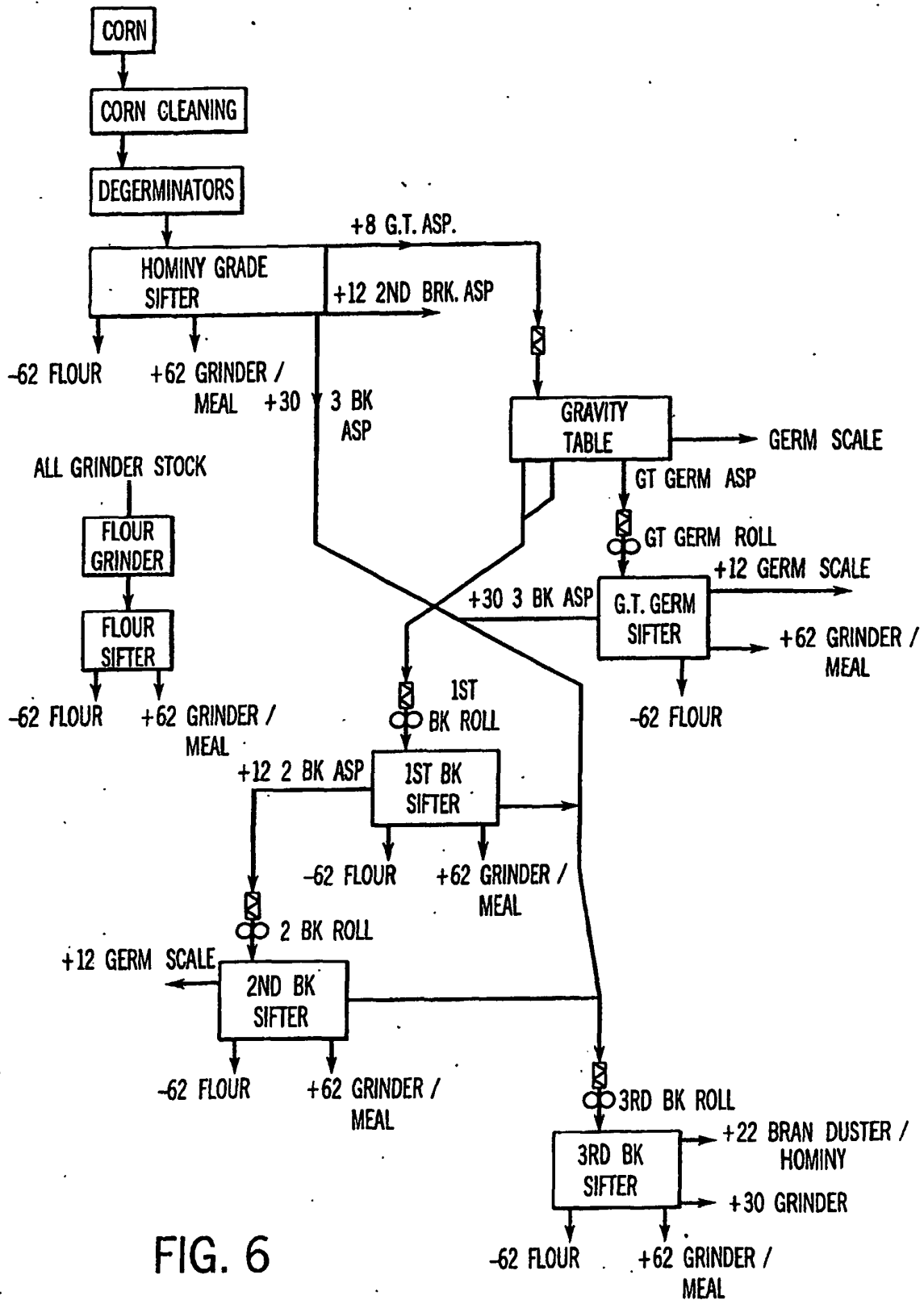


FIG. 6