ABSTRACT OF THE DISCLOSURE

A single shaft-type rice polishing machine in which a spiral rice feed roll, a grinding roll, and a rice conveying spiral roll consisting of two frustoconical sections and a friction polishing roll are mounted in end to end engagement on a single common rotary shaft in the order mentioning the individual sections, the resultant grain with rice shaft, and a stationary threaded annular feed rate adjusting member disposed around the first portion of the rice conveying roll in peripheral spaced relationship to the latter and a movable rice feed rate adjusting member disposed around the second portion of the rice conveying roll in peripheral spaced relationship to the latter.

BACKGROUND OF THE INVENTION

The present invention relates to rice polishing machines in general, and to combination grinding and friction-type rice polishing machines, in particular.

Conventional rice polishing machines are generally classified into two types, that is, the so-called friction-type rice polishing machine and the so-called grinding-type rice polishing machine. The most significant difference between the above-mentioned two types of rice polishing machines resides in the fact that these machines employ different processing rolls. The processing roll of the friction-type rice polishing machine is formed of a metallic casting rotatably mounted on a suitable support shaft within the processing chamber of the machine and having a smooth peripheral surface on which two or three angularly spaced, raised bulging portions extend in the longitudinal direction of the roll. When rotated, the roll is adapted to press and hull the unpolished rice grains which are fed to the roll in a compact state by a preceding spiral feed roll disposed adjacent to the inlet port of the machine, whereby the individual grains are caused to frictionally rub among themselves until the husks of the grains are removed from the grains proper in the form of rice-bran. Since in the friction-type rice polishing machine the husks of the rice grains are removed from the grain proper in the form of rice-bran, as the result of the mutual frictional rubbing action among the individual grains, the resultant polished rice grains maintain configurations substantially similar that prior to the polishing process. That is, the polished rice grains can be produced in a high yield. However, since the husks of unpolished rice grains are generally smooth, during the initial stage of the polishing process by the frictional processing roll, the grains tend to slip among themselves and the coefficient of friction of the grains is insufficiently low for frictional polishing resulting in a low polishing efficiency. Therefore, during the entire rice processing operation by the frictional processing roll, there is a period in which substantially no processing operation is carried out on the rice grains. If, in order to compensate for such insufficient coefficient of friction, the rice polishing operation is carried out with a greater pressure, there will be a large number of broken grains, which lowers the yield of rice grains having a perfect and acceptable state.

On the other hand, the processing roll of the grinding-type rice polishing machine is formed of an emery stone rotatably mounted on a suitable support shaft within the processing chamber of the machine and has a porous or rough peripheral surface. The emery stone roll is adapted to directly grind the husks of material rice grains and remove the grain husks as rice-bran instead of a mutual frictional rubbing of the grains. Therefore, even if the unpolished rice grains have smooth husk surfaces, the grains can be easily ground and the grinding process can be carried out at a high efficiency. However, generally the emery stone roll grinds unpolished rice grains to the extent that the resultant polished grains have rather flat configurations much different from those which the unpolished grains had prior to such grinding process, thereby making it very difficult to produce polished rice grains with a high yield.

In view of the above difficulties, there has been proposed an improved combination friction and grinding-type rice polishing machine which possesses the advantages inherent in both the friction-type and grinding-type rice polishing machines, while eliminating the disadvantages inevitable to both the above-mentioned prior art rice polishing machines, and which can efficiently process material rice grains with a high yield.

As mentioned above, since the husks of the rice grains have smooth surfaces and the coefficient of friction of the grains is insufficiently low, when the rice grains are processed by the above-mentioned combination friction and grinding-type polishing machine, during the initial stage of the processing operation, the grinding process section of the machine initially processes the grains. The grinding process section is adapted to inflict flaws on the entire husks of the material rice grains so as to increase the coefficient of friction of the grains and at the same time to render the flawed husk and embryos thereof into finely divided states so that they can be easily separated from the grain proper and the husk partially processed rice grains which have the husks and embryos removed therefrom in the manner mentioned above are then fed to the next processing stage, or the friction polishing section of the machine, in which the grains are finally polished, by frictionally rubbing among themselves, into desired polished rice grains which maintain configurations substantially similar to that prior to the process. Thus, by the use of this improved combination friction and grinding-type rice polishing machine, material rice grains can be easily removed from the husks and embryos under relatively low pressure and can be polished to high yield while limiting the amount of broken grains to a minimum.

Such being the case, such improved rice polishing machines have been widely employed in Japan. A large number of such machines have been exported overseas to countries such as the United States and various countries in Southeast Asia, for example. As a result the machine has gained favorable comments throughout these countries. However, it has been found that the present combination friction and grinding-type rice polishing machine has its own disadvantages, that is, in the machine, the polishing section roll is different from the friction polishing section roll in number of rotations and in dimension, there are disadvantages that the grinding roll and friction roll must be mounted on separate shafts requiring at least in addition, separate bearing mechanisms for supporting the shafts, separate pressure adjusting means for the shafts, respectively, and connecting means for connecting
the two processing sections are also required. Accordingly, such rice polishing machine inevitably has a large size which may be suitably operated in a large scale rice polishing mill without any trouble, but such machine is not convenient to for use by an individual, small-scale rice dealer.

Furthermore, close observation using magnifying lenses of partially processed or ground rice grains from the grinding section, or of rice grains having a number of flaws inflicted on their husks, showed that some of the ground rice grains have husks with relatively few flaws thereon while the others have husks with relatively many flaws thereon. This means that some of the rice grains were subjected to the grinding process to different degrees than the others.

In order to overcome the above disadvantages of the prior art combination grinding and friction-type rice polishing machine and to obtain polished rice grains having a uniform quality, it has been found that it is necessary to uniformly grind the husks of all of the individual rice grains to be polished and to mount the grinding and friction polishing rolls on a single common shaft.

With the purpose in mind, heretofore, attempts have been made to manufacture rice polishing machines which can satisfy these requirements, but they have failed to produce satisfactory results because of the following reasons.

As mentioned above, since the peripheral speed of the grinding roll is quite different from that of the friction polishing roll because of the fact that the former is a roll having the proper or rough peripheral surface while the latter is a roll having the smooth surface and the former performs grinding process on material rice grains while the latter performs polishing by causing partially processed or ground individual rice grains to frictionally rub among themselves, it is very difficult to mount both rolls on a single, common shaft. And since the pores in the rough peripheral surface of the grinding roll are often clogged with the rice-bran and embryos which have been separated from the grain proper during the grinding operation by the roll, the roll must be rotated at such a high peripheral speed that the rice-bran and embryos may be thrown away from the roll by centrifugal force. However, if the friction polishing roll is rotated at such a high peripheral speed at which the grinding roll in rotated on the same shaft, the raised portions, which are generally provided on the peripheral surface of the friction roll extending in the longitudinal direction of the roll, are apt to break the rice grains.

SUMMARY OF THE INVENTION

The present invention relates to an improved machine for processing cereals and especially unpolished rice grains, and more particularly to an improved combination grinding and friction-type rice polishing machine.

One object of the present invention is to provide an improved combination grinding and friction-type rice polishing machine which possesses the advantages inherent to both the prior art grinding-type and friction-type rice polishing machines while eliminating the disadvantages of these prior art rice polishing machines.

Another object of the present invention is to provide an improved combination grinding and friction-type rice polishing machine which is easier in adjustment, simpler in design and less expensive in manufacture and operation as compared with the prior art combination grinding and friction-type rice polishing machines.

A further object of the present invention is to uniformly and regularly polish unpolished rice grains with optimum grinding and friction polishing efficiencies and with a high yield rate.

It is still another object of the present invention to provide a single shaft combination grinding and friction-type rice polishing machine comprising a framework divided into a grinding operation chamber and a friction operation chamber by a partition plate; a rotary shaft journaled at the opposite ends adjacent to the opposite ends of the framework; a first cover member secured to one end of the framework and having a material inlet port in communication with the grinding operation chamber; a second cover member secured to the other end of the framework and having a product discharge port in communication with the friction operation chamber; a spiral material feed roll mounted on the shaft within the first cover member adjacent to the inlet port for receiving material from the inlet port; a grinding roll mounted on the shaft within the grinding operation chamber in end to end engaging relation to the spiral feed roll; a frustoconical spiral roll mounted on the shaft within the grinding operation chamber in end to end engaging relation to the grinding roll remote from the spiral feed roll and comprising a plain-surfaced frustoconical first portion and a spiral frustoconical second portion; a friction roll mounted on the shaft within the friction operation chamber in end to end engaging relation to the frustoconical spiral roll remote from the grinding roll; a stationary annular material feed rate adjusting member secured to the partition plate and disposed around the spiral frustoconical second portion of the spiral frustoconical roll in a peripherally spaced relation to the portion so as to form an annular space therebetween; an annular member having a threaded surface; and a movable annular material feed rate adjusting member disposed around the plain-surfaced frustoconical first portion of the spiral frustoconical roll in a peripherally spaced relation to the portion so as to form an annular space therebetween and in threaded engagement with the stationary annular member for relative movement with respect to the latter.

With these and other objects in view which will become apparent in the following detailed description, the present invention will be clearly understood in connection with the accompanying drawings, in which:

FIGURE 1 is a longitudinal sectional view of the principal parts of a preferred form of a rice polishing machine embodying the present invention showing the machine with some of the parts corresponding to those shown in FIG. 1 eliminated therefrom;

FIG. 2 is a fragmentary longitudinal sectional view of a modified form of rice polishing machine embodying the present invention showing the machine with some of the parts corresponding to those shown in FIG. 1 eliminated therefrom; and

FIG. 3 is a fragmentary longitudinal sectional view of a further modified form of rice polishing machine embodying the present invention showing the machine with some of the parts corresponding to those shown in FIG. 1 eliminated therefrom; and

FIG. 4 is a schematic longitudinal sectional view of a typical conventional grinding and friction-type rice polishing machine.

Referencing now to the accompanying drawings and especially to FIG. 1 thereof in which a preferred form of a single shaft combination rice polishing machine embodying the present invention is illustrated. A steel framework 1 of the rice polishing machine encircles or houses the principal parts of the machine and the interior of the upper portion of the framework is divided into a grinding operation chamber 3 and a friction operation chamber 4 by means of a transverse partition 2 which is integrally formed with the framework 1 and extends laterally of the upper portion of the interior of the framework at a midpoint between the front and rear end walls 5 and 6 of the framework. The front wall 5, rear wall 6 and partition wall 2 of the framework are provided with relatively large circular openings 7, 9 and 8, respectively. A relatively large diameter cylindrical cover member 10 partially fits in and is suitably secured to the circular opening 7 of the front wall 5 and has an upwardly projecting funnel-shaped material or unpolished rice grain receiving portion or inlet port for receiving rice grain from the open bottom of which is in communication with the interior of the body of the cover member. The cover member 10 is further provided with a reduced diameter
thicker portion 10’’ in which bearings 12 are received for the purpose which will be explained later. A relatively smaller diameter cover member 11 fits in and is suitably secured to the circular opening 9 of the rear wall 6 and has a product or processed rice grain discharge portion or outlet port 11’ which extends laterally and downwardly from the rear wall 6 at an angle with respect to the axis of the body of the cover member 11 and is in communication through the rear wall circular opening 9 with the interior of the friction operation chamber 4. The cover member 11 has a reduced diameter thicker portion 11’’ in which bearings 13 are received for the purpose which will be explained later. A main rotary shaft 14 extends longitudinally through the framework 1 and is journaled at the opposite ends by the above-mentioned bearings 12 and 13. The portion of the main shaft 14 which extends beyond the front wall 5 of the framework 1 has a grooved drive pulley P secured thereto and the pulley is connected through endless belts (not shown) which are trained thereabout to a suitable conventional drive mechanism (not shown). The main shaft 14 may be either in the form of a pipe or rod, but in the illustrated embodiment the shaft is preferably in the form of a pipe for the reason which will be explained hereinbelow. Therefore, in the illustrated embodiment, the main shaft 14 will be referred to hereafter as a pipe member as shown in FIG. 1. The pipe member 14 has a center bore 15 extending through the full length thereof. One end or the above-mentioned extension portion of the shaft (the right hand end as seen in FIG. 1) has one or arm of a smaller diameter connection pipe 18 of a substantially U-shape press fit therein. The other end or arm of the connection pipe 18 which extends parallel to and then downwardly at substantially right angles with respect to the first end or arm extends into the casing 17 of a fan 16 which is disposed outside of the framework 1 below the adjacent end of the main shaft 14 for supplying air into the friction operation chamber 4 and at the same time for inducing the generated rice-brown into a suitable rice-brown receiving bin (not shown) disposed outside of the machine. The fan 16 is fixedly mounted on a rotary shaft 14’ which is in turn journaled in the fan casing and has a grooved pulley P’ fixedly mounted at one end thereof. Thus, the fan 16 is driven from a separate drive mechanism (not shown) through an endless belt (not shown) trained thereabout. A larger relatively large diameter spiral feed roll 19, a relatively large diameter emery stone grinding roll 20 and a relatively large diameter spiral roll comprising a plain-surfaced frustoconical first portion 21 and a spiral frustoconical second portion 22 are fixedly mounted in end to end engaging relationship on the section of the main shaft 14 within the grinding chamber 3 in the order mentioned from right to left as seen in FIG. 1. Furthermore, a relatively small diameter and longer friction polishing roll 23 is fixedly mounted on the section of the main shaft 14 within the friction operation chamber 4 adjacent to and at one end engaging with the left end (as seen in FIG. 1) of the spiral roll 22. The friction polishing roll 23 is provided around its periphery with angularly spaced raised portions or bulging projections 23’ extending along a substantial length thereof. Each of the bulging projections has an elongated air blowing bore 23’’ which extends a substantially length of the projection. As will be understood, all the rolls mentioned above are adapted to be simultaneously rotated together with the main shaft 14 as the main members 10 and 11 are respectively partially inserted in the respectively associated openings 7 and 9 in the front and rear walls 5 and 6 so as to form annular projections which inwardly extend into the respectively associated openings 7 and 9 as indicated by projections 24 and 33 in FIG. 1 for the purpose which will be explained hereafter. For the same purpose, an annular plate 25 is secured to one side of the partition plate 2 (the left side as seen in FIG. 1) by means of suitable securing means such as set screws, for example, and has a pair of oppositely directing annular projections 25’ and 25’’ on the opposite sides thereof at different heights which correspond to the heights of the cooperating projections 24 and 33, respectively. The annular projection 24 of the cover member 19 and the annular projection 25’ of the annular plate 25 cooperate to mount a cylindrical wire mesh rice-brown discharge member or grate 31 around the emery stone roll 20 in a peripherally spaced relation to the latter. Similarly, the annular projection 33 of the cover member 11 and the other annular projection 25’’ of the annular plate 25 cooperate to mount a smaller diameter cylindrical wire mesh rice-brown discharge member or grate 34 around the smaller diameter friction polishing roll 23 in a peripherally spaced relationship to the latter. The above-mentioned plain-surfaced frustoconical first portion 21 and spiral frustoconical second portion 22 are provided for the purpose that the transfer or feed rate of partially polished or ground grains from the grinding operation chamber 3 to the next or friction operation chamber 4 may be adjusted in accordance with the feed rate of the material grains to the machine and the grinding efficiency of the emery stone grinding roll 20. However, in order to assist or facilitate the functions of these feed rate adjusting portions 21 and 22, according to the embodiment illustrated in FIG. 1, a stationary annular member 27 having a sloped inner peripheral surface 27’ corresponding to the sloped configuration of the feed rate adjusting spiral portion 22 is secured to one side of the annular plate 25 (the right side as seen in FIG. 1) by means of suitable securing means such as set screws, for example, in a peripherally spaced surrounding relation to the portion 22, and the annular member is provided at its outer peripheral surface with a threaded portion. Another movable annular member 29 having a sloped inner peripheral surface 30 corresponding to the sloped configuration of the roll 21 is provided in threaded engagement with the first stationary annular member 27 in a peripherally spaced surrounding relationship to the portion 21. The second annular member 29 may be turned by any suitable tool (not shown) so as to extend or shorten its threaded engaging distance with respect to the mating first stationary annular member 27 whereby the annular space between the plain-surfaced feed rate adjusting portion 21 and the opposing second annular member 29 may be widened or narrowed as desired or if necessary. Thus, the transfer rate of partially polished or ground grains from the grinding operation chamber 3 to the friction operation chamber 4 may be optionally adjusted in accordance with the feed rate of the material rice grains to the polishing machine and the grinding efficiency of the grinding roll 20. For the purpose, of displacing the movable member 29 relative to the stationary member 27 the annular projection 25’ of the annular plate 25 is provided at opposite aligned points with a pair of access openings 25’’ through which the tool can be inserted. A rice-brown receiving and guiding chamber 35 is adapted to receive the rice-brown which has been generated by the grinding operation by the grinding roll 20 and separated from the individual rice grain strips which were ground by the grinding roll. The separated rice-brown falls down from the grinding operation chamber 3 through the annular wire mesh rice-brown discharge member 31 into the chamber 35. Another rice-brown receiving and guiding chamber 36 is adapted to receive the rice-brown which has been generated by the friction polishing roll and rubbing among the rice grains in the friction polishing chamber 4 by the rotation of the friction polishing roll 23 and separated from the completely polished rice grain proper. The separated rice-brown falls down from the friction polishing operation chamber 4 through the annular discharge member or grate 34 into the chamber 36. Similar triangular guide members or baffles 37 are suitably secured to the front and rear walls 5 and 6 on the inner surfaces of these walls within the rice-brown
receiving and guiding chambers 35 and 36, respectively. Another triangular guide member 37 is also suitably secured to the annular plate 25 with its opposite sides outwardly extending into the chambers 35 and 36, respectively. Thus, it will be understood that the rice-bran flour will be forced through the spiral roll 20 preventing from dispersing by the opposing sloped sides of the guide member 37 on the front wall 5 and the guide member 37' while the rice-bran from the friction operation chamber 4 will be prevented from dispersing by the opposing sloped sides of the other guide member 37 on the rear wall 6 and the union member 37'. The rice-bran then passes through a discharge port 38 provided in the front wall 5 just below the triangular guide member 37 and a connection pipe 39 into a conventional cyclone collector (not shown) by the action of the rotating fan 16. The construction and operation of the fan and its drive mechanism are conventional and do not form part of the present invention and detailed explanation thereof is not given herein. The completely polished rice grains are discharged through the discharge port 11' provided in the rear wall cover member 11 adjacent to the rear wall 6 into a conventional receiving container (not shown) for shipping. In order to adjust the frictional hulling pressure within the friction polishing operation chamber 4, a conventional hulling pressure adjusting device C generally shown with reference character is provided adjacent to the discharge port 11' and operatively connected to the cover member 11, and the hulling pressure adjusting device 40 which is mounted at the end of a pivotal arm for moving toward and away from the discharge port 11' so as to vary the magnitude of the hulling pressure within the friction polishing operation chamber 4. The hulling pressure adjusting device C has a counterweight adjustable mounted on a scale beam and the weight is adapted to be adjusted to a position on the scale beam in accordance with a predetermined setting value which maintains the disc 40 in abutment against the discharge port 11' and maintains the adjusted position thereby to prevent the completely polished rice grains from flowing out of the port 11' until a cycle of the rice polishing operation is completed. When the rice polishing operation cycle has been completed and the polished rice grains have accumulated in the friction polishing chamber 4 in an amount the load of which is sufficient enough to exceed the setting value of the weight so as to force the disc 40 away from the discharge port 11' the polished rice grains may flow out of the machine via the port. In shaft 14, the main shaft 24 is rotationally driven by the conventional drive mechanism (not shown) through the conventional transmission gearing, and the rotational movement of the main shaft causes the various rolls 19, 20, 21, 22 and 23 mounted thereon to rotate simultaneously. At the same time, material to be processed or unpolished rice grains are fed at a predetermined constant rate via the inlet port 10' into the rice polishing machine. The thus fed rice grains are forceably and forwardly conveyed by the rotating spiral feed roll 19 to the adjacent rotating emery stone grinding roll 20. As the rice grains are advancing along the peripheral surface of the grinding roll 20, the surfaces of the grains are gradually slowed and substantially the entire grain surfaces will become evenly flayed until the grains reach the adjacent and succeeding plain-surfaced frustoconical portion 21 which is also rotating. The thus flayed or ground rice grains are then forceably conveyed from the portion 21 through the spiral portion 22 onto the smaller diameter friction polishing roll 23 in the friction polishing chamber 4 to be finally processed therein. The pressure within the grinding operation chamber 3 for partially polishing or grinding the material rice grains is preferably maintained in the order of 50 g./cm.² and in order to adjust the grinding pressure. As mentioned above the movable annular member 29 is turned by a suitable tool to extend or shorten its threaded engagement distance relative to the mating stationary annular member 27 thereby to widen or narrow the annular space between the inner peripheral surface of the member 29 and the outer peripheral surface of the opposed member 28. The surfaced portion 21 of the frustoconical spiral roll since the emery stone grinding roll 20 has a relatively large diameter, a high peripheral speed can be obtained for the grinding roll and there will be no possibility for the pores in its peripheral surface to be clogged with the generated rice-bran. The initially polished rice grains which have been fed into the friction polishing chamber 4 is then subject to the final polishing process by the rotating friction operation roll 23. The friction polishing pressure within the friction polishing chamber 4 for causing the individual grains to frictionally rub against themselves should be maintained at least at 500 b./cm.² because if the pressure is below the above-mentioned value the rice-bran which still adheres to the surface of the finally polished rice grains will not be completely separated from the grain proper by only the mutual frictional rubbing among the grains. In order to eliminate this disadvantage, according to the present invention the frustoconical spiral roll portion 22 is adapted to forcibly convey the initially ground rice grains from the grinding operation chamber 3 into the friction polishing chamber 4 with great force. The friction polishing pressure within the friction operation chamber 4 may be easily adjusted by the manipulation of the respective adjusting device C so as to move the disc 40 toward and away from the discharge port 11'. In order to increase the friction polishing pressure, the disc 40 is maintained against the discharge port 11' and on the other hand when it is desired to reduce the pressure to zero, the disc is caused to pivot away from the discharge port. In the illustrated rice polishing machine, since the rice grains are subjected to the friction polishing operation immediately thereafter they have been subject to the grinding operation (i.e., the grinding operation and friction polishing operation are successively carried out) it seems to be difficult to determine to what degree the rice grains have been ground in the grinding operation chamber. However, according to the present invention, the grinding degree of the rice grains can be easily determined in a quite simple manner. For the purpose, the pressure adjusting device C is manipulated with a finger tip so as to move the disc 40 away from the discharge port 11' thereby to reduce the pressure within the friction operation chamber 4 to zero. Therefore, the friction polishing roll 23 in the chamber 4 will no longer cause the rice grains to frictionally rub among themselves and the rice grains are allowed to flow out of the machine through the discharge port 11'. The thus discharged rice grains comprise only those which have been subject to only the grinding process and do not include completely polished rice grains. Thus, when the operator checks the conditions of some of the thus discharged rice grains, he can easily determine to what degree the grains, including the other ones, have been ground in the grinding operation chamber 3. Thereafter, the operator adjusts the position of the counter-weight of the pressure adjusting device C depending upon the ground conditions of the grains and sets the weight in the adjusted position and then pivots the disc 40 toward the discharge port 11' whereby the friction operation pressure within the friction chamber 4 may be adjusted for proper polishing operation is ready to be resumed. Thus, it will be understood that the rice grains which have been subject to both the grinding and friction polishing operations and discharged via the discharge port 11' are of a completely and properly polished, acceptable quality. The rice polishing machine according to the present invention illustrated and described hereinabove have various features, and some of the important features will be described hereinafter.
One feature is that since two operation chambers with functions different from each other are provided on a single shaft and since these chambers are designed to perform grinding and friction polishing operations on the material rice grains at optimum different magnitudes of pressure, respectively, as compared with the conventional rice polishing machine in which the grinding and friction polishing chambers have their own separate shafts provided therein, the novel rice polishing machine can be constructed with a relatively simpler design and at a greatly reduced cost.

Another feature is that since a rice feed rate adjusting spiral roll is mounted on a shaft between a grinding operation roll and a friction polishing operation roll which are also mounted on the same shaft and a cooperating annular member is provided opposite to and spaced from the spiral roll for movement relative to the latter, the grinding operation by the grinding roll and the friction polishing operation by the friction polishing roll can be easily performed at optimum adjusted pressures by moving the cooperating annular member relative to the spiral roll. Furthermore, the grinding pressure within the grinding chamber can be adjusted independently of the friction pressure within the friction polishing chamber regardless of the value of the friction pressure within the friction operation chamber.

A third feature is that the above-mentioned rice feed rate adjusting roll which is provided between the larger diameter emery stone or grinding roll and the smaller diameter friction polishing roll comprises a plain-surfaced frustoconical first portion and a frustoconical spiral second portion and the above-mentioned adjustment of the rice grain feed rate is performed only at the location of the first roll portion by moving the cooperating annular member relative to the spiral feed rate adjusting roll.

Referring now to FIG. 2 of the accompanying drawings in which the principal parts of a modified embodiment of the present invention are shown in longitudinal section with some of the parts corresponding to those of the first embodiment omitted therefrom for clarification, since the construction, arrangement and operation of the omitted parts of this modified embodiment which correspond to those of the first embodiment are identical with those of the preceding embodiment, description thereof will be omitted herein. The modified embodiment is different from the preceding embodiment in that the grinding roll and friction roll are coaxial, but fixedly mounted on separate rotary shafts which are disposed in one-around-another relationship whereby the grinding roll may be rotated independently of and faster than the friction roll. As shown, the rotary shaft 14' for the friction roll 23' extends longitudinally through the framework of the rice polishing machine (not shown) and the rotary shaft 14" since the grinding roll 20' is formed of a hollow cylindrical sleeve member and is rotatably mounted on the shaft 14' by means of conventional bearings 12' extending along a short section of the friction roll shaft. The rice grain feed rate adjusting roll 21' comprises only a frustoconical spiral member instead of the two portion construction of the feed rate adjusting roll in the preceding embodiment. However, it should be understood that the two portion construction feed rate adjusting roll described hereinabove in connection with FIG. 1 may be equally employed in this embodiment within the scope of the present invention. One end of the friction roll sleeve shaft 14" has a separate pulley 39 secured to one end so that these shafts may be individually rotated from separate drive mechanisms (not shown) and accordingly, the grinding roll 20' and friction roll 23' which are fixedly mounted on the respective shafts may be individually rotated. As compared with the preceding embodiment, the feature of this modified embodiment is the fact that the grinding roll 20' can be rotated faster than the friction roll 23'. Although the friction roll 23' is shown as a roll having a rather short length, other friction rolls having longer lengths may be also employed in the modified embodiment as desired and the length of the friction roll is not important in the present invention.

FIG. 3 shows the optional parts of a further modified embodiment of the present invention in longitudinal section with some of the parts corresponding to those of the preceding embodiments omitted therefrom for clarification. Since the construction, arrangement and operation of these omitted parts are identical with those of the corresponding parts of the preceding embodiments, description thereof will be omitted herein.

This second modified embodiment is featured by the fact that the stationary annular feed rate adjusting member 27 and movable annular feed rate adjusting member 29 as employed in the first embodiment shown in FIG. 1 are not employed, but instead a single movably annular feed rate adjusting member is employed. As shown, a frustoconical movably annular feed rate adjusting member 29' is disposed around the frustoconical feed rate adjusting roll 21" disposed between the grinding and friction rolls 20" and 23" in a peripherally in step with the opposing roll 21" so as to form an annular space therebetween. Although the fore and rear horizon ends 29" and 29'" of the annular member 29' are shown as being spaced from the opposing annular projections which support the annular rice-grain discharge members, in fact, the annular member 29" is normally tightly fit at its ends 29" and 29"" on the annular projections and held in position, and is adapted to be axially moved relative to the opposing spiral 21" by suitable conventional means (not shown) only when adjustment of rice grain feed rate is desired or necessary depending upon the ground conditions of the rice grains thereby to widen or narrow the annular space between the annular member and spiral roll.

FIG. 4 schematically shows a typical conventional combination of grinding and friction-type rice polishing machine in longitudinal section for the purpose of illustrating the advantages of the present invention over the conventional machine. In the machine shown in this figure, the grinding roll A and the friction roll B are fixedly mounted on separate rotary shafts suitably journalized on the framework and individually rotated from different drive mechanisms (not shown). The framework is divided into the grinding operation section in which the grinding roll is disposed and the friction operation section in which the friction roll is disposed. The grinding section is provided with the inlet port C for receiving material rice grains and the friction section is provided with the product or polished rice grain discharge port E. The two sections communicate with each other by means of the communication passage D through which the partially polished or ground rice grains from the grinding section are introduced into the friction section to be subjected to further processing therein. However, in the conventional rice polishing machine, the rice grains often accumulate at the point shown with the circle at one corner of the grinding section resulting in uneven polishing of the rice grains. The cause for such a difficulty is believed to be due to the location and configuration of the discharge port. However, according to the present invention, the grinding chamber 3 and friction chamber 4 communicate with each other by means of the communication passage, and the difficulty as experienced in the conventional machine is effectively eliminated and a perfect uniform polishing of the rice grains is attained.

While I have disclosed several embodiments of the present invention, it is to be understood that these embodiments are given by example only and not in a limiting sense.

I claim:

1. A single shaft combination grinding and friction-type rice polishing machine comprising a framework di-
vided into a grinding operation chamber and a friction operation chamber by a partition plate; a rotary shaft journaled at the opposite ends adjacent to the opposite ends of said framework; a first cover member secured to one end of said framework in communication with said grinding operation chamber and having a material inlet port; a second cover member secured to the other end of said framework in communication with said friction operation chamber and having a product discharge port; a spiral material feed roll mounted on said shaft within said first cover member adjacent to said inlet port for receiving material from the inlet port; a grinding roll mounted on said shaft within said grinding operation chamber in end to end engagement relation to said spiral roll; a frustoconical spiral material feed rate adjusting roll mounted on said shaft within said grinding operation chamber in end to end engagement relation to said grinding roll remote from said spiral feed roll and comprising a plain-surfaced frustoconical first portion and a frustoconical spiral second portion; a friction roll mounted on said shaft within said friction operation chamber in end to end engagement relation to said frustoconical spiral material feed rate adjusting roll remote from said grinding roll; and cooperating material feed material feed rate adjusting member secured to said partition plate and disposed around said frustoconical spiral second portion of the frustoconical feed rate adjusting spiral roll in a peripherally spaced relation to the portion so as to form an annular space therebetween, said annular member having a threaded surface and a movable annular material feed rate adjusting member disposed around said plain-surfaced frustoconical first portion of the frustoconical spiral feed rate adjusting roll in a peripherally spaced relation to the portion so as to form an annular space therebetween and in threaded engagement with said stationary annular member for relative movement with respect to the latter.

2. A single shaft combination grinding and friction-type rice polishing machine as set forth in claim 1 in which the diameter of said grinding roll is larger than that of said friction roll.

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