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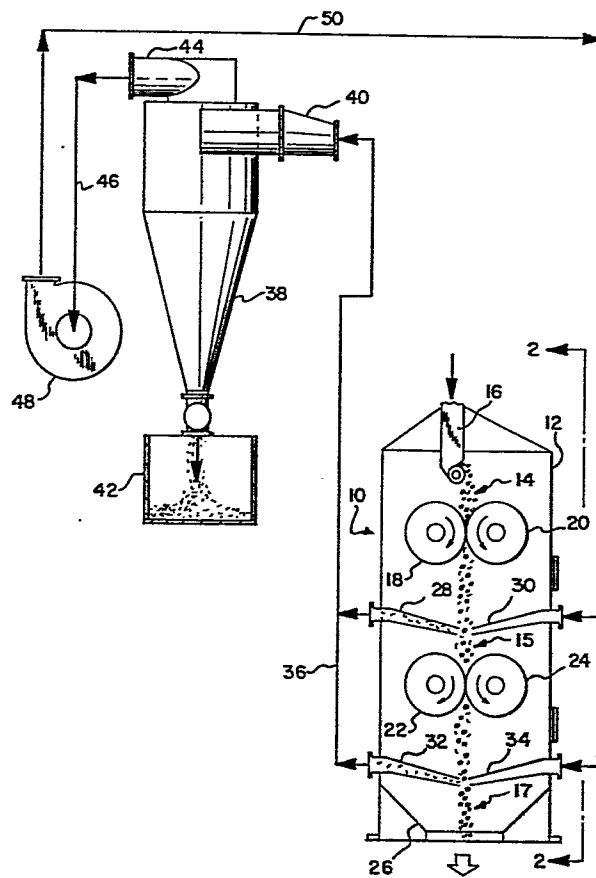
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Cracking mill and method of cracking hulled material.

A hulled material processing apparatus (10) is contained within a single housing (12) and includes a hulled material feeder (16) which introduces hulled material (14) into an upper portion of the housing. At least one pair of cracking rolls (18, 20) is mounted within the housing beneath the feeder for rotation in the housing with their axes of rotation disposed in parallel in a horizontal plane and with their circumferential surfaces disposed for forming a nip through which the hulled material (14) is passed to crush and release the hulls. The hulls and material from which they are separated then fall together from the nip of the cracking rolls through a hull separation zone in which air is passed through the path of travel of the hulls and other material to cause the hulls to be diverted from this path and caught in a duct (28) and removed from the housing while the remainder of the material continues along the path and is caught in a trough (26) in the bottom portion of the housing. The air used to divert the hulls from the normal path of movement from the cracking rolls can be recycled for energy conservation purposes.

FIG-1



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CRACKING MILL AND METHOD
OF CRACKING HULLED MATERIAL

The present invention relates to methods and devices for separating hulls from oil bearing seeds or nuts so that they can be more readily prepared for solvent extraction of oil therefrom.

5 In a conventional solvent extraction process, for example as that used in the processing of soybeans, it is desirable to separate the hulls from the beans for separate processing. Typically, such a system includes a plurality of cracking rolls through which the hulled
10 soybeans are initially passed through to cause the hulls to separate from the beans. Such cracking mills are generally constructed with at least one pair and typically two stacked pairs of adjacent cylindrical cracking rolls through which the hulled material is passed while the
15 cracking rolls are rotated. This action breaks the beans and causes some hulls to separate. Both the hulls and the beans are then removed through a conveying system at the discharge of the cracking mills to a screening section of the process.

20 In the screening section, a plurality of different meshes of screens, within vibrating screeners, are generally utilized to separate the beans from the hulls. A vacuum system is also generally associated with these screeners in order to draw off the lighter material,
25 containing hulls, for subsequent separation. After the beans have been separated from the hulls in at least one screening area, and typically in a secondary separation area similar to the first, the beans are then processed in the well-known conventional manner to prepare the soybeans
30 for removal of the oil therefrom.

The use of separate cracking mills and a plurality of screening steps consumes large amounts of energy, takes up a substantial amount of space and is relatively expensive due to the large amount of equipment and conveyors involved.

The present invention overcomes the above-described difficulties and disadvantages associated with prior art of oilseed preparation systems with respect to the separation of the hulls from the beans by essentially combining the cracking and hull separation steps into one apparatus.

According to one aspect of the present invention, a hulled material processing apparatus and method is provided, the apparatus including a housing, feed means for introducing hulled material into an upper portion of the housing, at least one pair of cracking rolls mounted for rotation in the housing beneath said feed means with their axes of rotation disposed parallel in a common substantially horizontal plane and with their circumferential surfaces disposed for forming a nip through which said hulled material is passed to release the hulls therefrom, hull separation means disposed in said housing beneath said cracking rolls in the path of movement of said material in the path of movement of said material passing through said nip for causing air movement across the path such that hulls released from said material by said cracking rolls will be diverted from said path and caught for removal from said housing while the remainder of said material continues along said path, means for collecting said remainder of material for subsequent processing, and means for removing the hulls to a remote location for subsequent processing.

The apparatus includes a housing in which are mounted at least one pair of cracking rolls which have their axes of rotation disposed in parallel in a common substantially horizontal plane with their circumferential surfaces disposed for forming a nip through which the hulled material to be processed is passed so as to release the hulls from the material. A feed device or hopper introduces the hulled material to the top of the housing directly above the cracking rolls so that the hulled material falls directly into the nip of the rolls.

The hull separation device is disposed in the housing beneath the cracking rolls and generally comprises duct work extending along substantially the width of the cracking rolls adjacent the flow path of the material passing through the nip of the rolls. A stream of air is passed through the ducts with either positive or negative pressure so as to cause the hulls to be drawn off or forced off generally horizontally into the ducts while the meat or heavier portion of the material continues to drop along the vertical flow path of material and is removed through a collection device in the lower portion of the housing.

The hulls are then removed through the duct work to a remote location where they are preferably introduced into a cyclone separation device wherein the hulls separate out from the air in which they are entrained. The air then leaving the cyclone device can be recirculated through an air pump and again introduced into the material processing apparatus for energy savings.

In order that the invention may be more readily understood, reference will now be made to the accompanying drawings in which:

Fig. 1 is a schematic illustration of the preferred embodiment of the hulled material processing apparatus of the present invention along with a cyclone separator and air pump; and

5 Fig. 2 is a side elevational view of the preferred embodiment of the hulled material processing apparatus of the present invention with the housing partially broken away to show the surface of a cracking roll, and also illustrates a portion of the external duct
10 work.

The hulled material processing apparatus 10 is illustrated schematically in Fig. 1 and includes an essentially closed rectangular cross sectioned housing 12 into which the hulled material 14 to be processed is
15 introduced. The hulled material 14 is introduced through a feeder 16 which opens into the upper portion of the housing 12. A first pair of cracking rolls 18 and 20 are mounted for rotation in the housing beneath the feeder 16 with their axes of rotation disposed in parallel in a
20 common, substantially horizontal plane and with their circumferential surfaces disposed for forming a nip through which the hulled material is passed from the hopper 16 to release the hulls from the beans or the like.

A second pair of cracking rolls 22 and 24 similar
25 to rolls 18 and 20 are positioned directly beneath the first pair of rolls in the path of movement of the hulled material 14 so as to receive the partially dehulled material 15 from the nip of the first pair of rolls. Although the preferred embodiment illustrates two pairs of
30 cracking rolls, a single pair or multiple pairs could be utilized, depending upon the requirements for the particular material being processed. The second pair of

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cracking rolls 22 and 24 have their axes of rotation mounted in a plane parallel to the first pair of rolls 18 and 20 and are mounted in identical manner for rotation so as to pass the partially dehulled material 15 through the nip area and thus release the hulls from the meat portion of the hulled material.

A collection trough 26 is formed in the lower region of housing 12 and receives the dehulled material 17 from the lower set of cracking rolls to pass the material for subsequent processing in a known manner. Usually a screw conveyor (not shown) or other conveying means is positioned below the collection trough 26 to remove the material to a remote location for subsequent processing.

Positioned beneath each pair of cracking rolls are pairs of contoured ducts 28, 30, 32 and 34. Each of the ducts extends across the apparatus for substantially the width of the cracking rolls and have their openings closely spaced adjacent the path of movement of the material 14 passing from the nip of each set of cracking rolls. Air is passed through adjacent pairs of ducts, for example 28 and 30, so that the path of movement of the air therebetween crosses the path of movement of the hulled material 14 and produces sufficient force on the hulls to be removed from the meat material to cause the hulls to be deflected into the ducts and is thus entrained in the air flow passing through the ducts and can be removed to a remote location as described below.

Contour of the ducts 28, 30, and 32, 34 is established by known principles depending upon the rate of air flow available and the weight of the hulls as well as the meat from the material being processed, in order to provide separation of the hulls from the material so that

the hulls can be removed through the ducts. The closeness of the open ends of the ducts to the flow path of the material is likewise important for accomplishing the proper change in trajectory of the hulls from the path of movement of the material in order to capture the hulls in the ducts.

The outer ends of ducts 28 and 32 are connected to a conduit 36 which transports the hulls to a cyclone separator 38 where they are introduced into its upper region through the duct 40. The cyclone operates in conventional manner to cause the hulls to be deposited by gravity into a container 42 for collection, or for further processing. The air introduced into the cyclone separator 38 and from which the hulls are removed is then passed out through a duct 44 in the upper region of the cyclone separator 38 and is subsequently passed through conduit 46 into the intake of an air pump 48. The pump then forces the air through its outlet into conduit 50 which at its opposite end introduces the air into the openings in ducts 30 and 34. Thus, it can be seen that, in the preferred embodiment, the operation utilizes a closed system with respect to the air transfer in order to produce an increased energy efficiency.

The direction of air flow between the pairs of conduits 28, 30 and 32, 34 does not matter within the processing apparatus 10 itself, but obviously, must direct the hulls towards the cyclone separator 38. Likewise, entrainment of the hulls can occur through either positive or negative air pressure, whichever is desired, although in the preferred embodiment a suction arrangement is preferably utilized.

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Also, it is not essential that the air flow path be a closed loop within the system, although as stated above, this is preferable to enhance the energy efficiency of the system. Likewise, the type of air moving equipment does not have to be a pump such as pump 48 in the preferred embodiment, but can be any form of apparatus which produces a positive or negative air flow within the ducts 28, 30 and 32, 34. Further, a single duct, such as duct 28 or duct 32, can be positioned beneath each pair of cracking rolls and be provided with a negative air flow which will cause the hulls to be drawn into the duct. This can be accomplished so long as there is adequate air supply within the housing 12, either through the hopper 16 or provided through ventilation (not shown) elsewhere within the housing 12.

CLAIMS

1. A hulled material processing apparatus characterized by:

a housing (12);

5 feed means (16) for introducing hulled material (14) into an upper portion of said housing;

at least one pair of cracking rolls (18, 20) mounted for rotation in said housing (12) beneath said feed means (16) with their axes of rotation disposed in parallel in a common substantially horizontal plane and
10 with their circumferential surfaces disposed for forming a nip through which said hulled material is passed to release the hulls therefrom;

hull separation means (28, 30) disposed in said housing beneath said cracking rolls in the path of
15 movement of said material in the path of movement of said material passing through said nip for causing air movement across said path such that hulls released from said material by said cracking rolls will be diverted from said path and caught for removal from said housing while the
20 remainder of said material continues along said path;

means for collecting said remainder of material for subsequent processing (26); and

means (36) for removing said hulls to a remote location for subsequent processing.

2. A hulled material processing apparatus as claimed in claim 1 wherein said hull separation means includes:

means (30, 48) producing a positive air pressure across said material path to divert said hulls; and

5 duct means (28) extending adjacent and transverse to said path for substantially the width thereof and opposite said means for producing positive air pressure, for receiving said hulls diverted from said path.

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3. A hulled material processing apparatus as claimed in claim 1 wherein said hull separation means includes:

means (38, 40) producing a reduced air pressure across said material path to divert said hulls; and

5 duct means (28) extending adjacent and transverse to said path for receiving said hulls diverted from said path.

4. A hulled material processing apparatus as claimed in claim 1 wherein said hull separation means and said means for removing said hulls define a closed loop such that the air used to divert said hulls is contained

5 therein and reprocessed therethrough.

5. A hulled material processing apparatus as claimed in claim 1 or 4 wherein:

said means for removing said hulls includes a cyclone separation device (38);

5 said hull separation means includes an air pump (48) connected to said means for removing said hulls and duct means (28) extending adjacent and transverse to said path for receiving said hulls diverted from said path; and

10 said cyclone separation device (38) is disposed between said pump (48) and said duct means (28).

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6. A method of processing hulled material characterized by the steps of:

feeding hulled material (14) into an upper portion of a substantially enclosed housing (12);

5 passing the hulled material introduced into the housing (12) through at least one pair of cracking rolls (18, 20) mounted for rotation in said housing with their axes of rotation disposed in parallel in a common substantially horizontal plane and with their
10 circumferential surfaces disposed for forming a nip through which the hulled material is passed to release the hulls therefrom;

separating the hulls from the remaining material by means of an air flow induced across the path of
15 movement of the material coming from the nip between the above set of cracking rolls such that the hulls released from the material by the cracking rolls will be diverted from the path and caught for removal from the housing while the remainder of the material is allowed to continue
20 along the path of movement;

collecting the remainder of material for subsequent processing; and

removing the hulls to a remote location for subsequent processing.

7. A method as claimed in claim 6 wherein said step of separating the hulls includes producing a positive air pressure across the material path to divert the hulls and receiving the hulls thus diverted in duct means (28)

5 extending adjacent to and transverse to the path of movement of the material for substantially the width thereof.

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8. A method as claimed in claim 6 wherein said step of separating the hulls includes producing a reduced air pressure across the material flow path to divert said hulls and receiving said diverted hulls in duct means (28) disposed adjacent to and transverse to the path of movement of the material.
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FIG-1

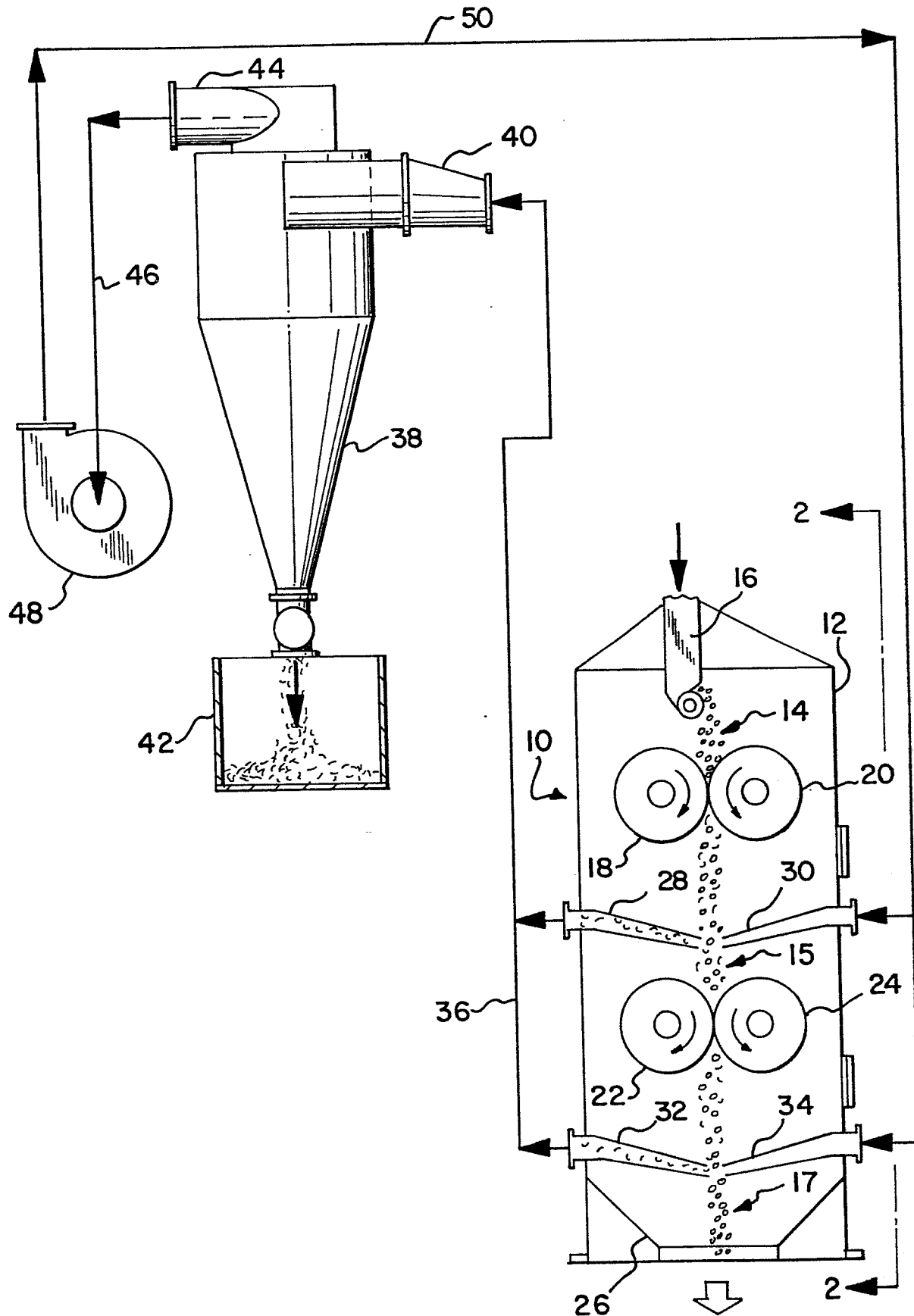


FIG-2

