This invention relates to apparatus for drying materials, wherein the materials are disintegrated in a stream of drying medium.

One known type of drying apparatus is a beater mill through which a stream of drying medium is conveyed during disintegration of the materials being treated, said drying medium acting simultaneously as conveying means for the materials. Such combined dryers and beater mills have heretofore only been constructed for the use in inorganic industries, wherein said mills are used in disintegrating and crushing clay, drying and disintegrating blast furnaces for manufacture of the bimolecular powder to be briquetted, and similar operations.

In connection with the application of such apparatus in an economically and technically satisfactory way to the art of drying organic protein matters, a number of difficulties are encountered, partly caused by the relatively small specific weight of such matters partly caused by the glutinous nature of such matter during certain phases of the process of reducing the moisture content, and partly by a tendency to agglomerate.

The invention has for an object the provision of apparatus which can be utilized in a satisfactory manner for organic materials, the invention contemplation the moving of the materials through a housing containing a rotatable dividing and dispersing means, the materials during their passage being retarded by particle-flow-retarding means prolonging the time of treatment and enabling a greater volume of charging of materials into the housing to obtain a convenient balance between disintegrating and drying effects.

In order to obtain the best balance possible, it is of great advantage to arrange for said retarding means to be adjustable. Preferably the retarding action is individual adjustable at different points.

Apparatus of the invention comprises a housing, disintegrating and dispersing means rotatably mounted within said housing, an inlet for materials and gaseous drying medium at one end of said housing, an outlet for materials and drying medium at the opposite end of said housing, and retarding means arranged in inwardly radially directed relationship on the interior walls of said housing.

By such means a greater speed of flow may be imparted to the drying medium through said housing than would otherwise be possible in view of the weight and particle size of the materials, further enabling particles in the higher particle size ranges—either by such particles being subjected to a lower degree of reduction, or by agglomerating a plurality of smaller particles during drying—to be subjected to a sufficiently long staying time so as to reach a sufficiently high degree of dryness. Simultaneously the average time of exposure of the particles to the drying treatment is considerably reduced.

The preferred embodiment of the invention is characterized in that the housing comprises a drum enclosing a shaft carrying radially directed impact arms. In said preferred embodiment, the retarding means may comprise substantially continuous plates. A further feature of the invention is that said plate-like rings are adjustable in their retarding action. Preferably, the plate rings are provided with one or more adjustable sections in order to enable adjustment of the retarding action as aforesaid.

In practice, for example in the production of herring meal, it has been found that said arrangement enables the manufacture of a very convenient combination of a mill and a drying apparatus, resulting in a meal which with respect to quality seems to exceed meals obtainable in the drying systems heretofore employed in the art.

For instance, it has appeared that herring meal and fish meal having a fibrous and pleasant appearance may be produced in a drying apparatus of the above-indicated kind, the unusual bright color of such meal indicating a quality improvement of the produced meal. It is believed that this result is partly caused by the unusually gentle drying procedure enabled by the extremely short staying time, in combination with the feature that regulation of the retarding effect may enable the drying effect to be raised or to be decreased as desired in any phase during the drying. The manner of the regulation of the retarding effect will of course, depend on the nature and characteristics of the moist material to be dried, and is not susceptible of precise definition. It will, however, be easily adaptable by one skilled in the art.

The invention will now be explained with reference to an embodiment shown in the accompanying drawings, wherefrom further objects, features and advantages may appear, and wherein:

FIG. 1 is a flow diagram illustrating the different steps in the processing of protein matters when employing the apparatus according to the present invention;

FIG. 2 is a perspective view, somewhat simplified, of the main parts of an apparatus according to the invention;

FIG. 2A is an axial sectional view of the apparatus shown in FIG. 2;

FIG. 3 is an axial sectional view of a modification of the apparatus shown in FIG. 2;

FIGS. 4 and 4A are views illustrating a detail of the rotor means which can be employed in the apparatus according to FIGS. 2 and 3;

FIG. 5 is a vertical sectional view of the apparatus according to the invention, as taken along the line V-V in FIG. 3; and

FIG. 6 is a lateral view of the regulating mechanism for the retarding segments in the apparatus of FIGS. 2 to 5.

Referring first of all to the flow sheet of FIG. 1, it appears from said figure that during the processing of herrings, the materials are supplied at 10 in a fresh or preserved state to a continuous herring cooker 11, wherefrom cooked herring materials are conveyed to a screw press 12. Said press expresses the fluid content of the materials, the expressed fluid being removed through a conduit 13, leaving a press cake to be conveyed along by a conveyor 14. To said conveyor leads a conduit 15 partly supplying gaseous drying medium from a source 16, and partly supplying fresh air from a fresh air supply 17, in order to insure correct drying capacity and temperature of the drying medium.

The conveyor 14 leads to a drying apparatus, generally designated by reference numeral 18. In the path through said drying apparatus, the materials are retarded by three retarding flaps 19, 20 and 21. After passing through the drying apparatus 18, the dried material is conveyed by a fan 22 to a cyclone 23, in which cyclone dried matter is separated from the drying medium. The latter is removed through a conduit 24, whereas dried matter, that is herring meal, is conveyed through a conduit 25 to storage either for packing same direct into bags or for storing same in bulk. The construction of the drying apparatus 18 appears best from FIGURES 3, 4 and 5, reference now being had thereto. The apparatus comprises a drum-like stationary housing 26, having bearings 27 in which is rotatably mounted a rotor 28 carrying at its receiving end a first group of radially extending impact arms or blades 29. The blades are positioned adjacent the inlet 69,
through which material is supplied to the housing. The blades 29 are formed by a plurality of diametrically opposed sets of arms. It is preferred to arrange the arms in radial relationship to the axis of the drum, and the discharge end of the drum. The material is conveyed to the housing via the discharge end of the drum. The blades 29 are formed by a plurality of diametrically opposed sets of arms. In the disclosed embodiment, such pairs are employed, arranged in radial symmetry around the shaft (Figure 5) that the arm of the first pair being staggered (Figure 3). Each arm in said first group carries at its outer end a triangular knife blade 30, the shape of which has been described most clearly from Figure 4. It can be seen that each blade is mounted with its plane substantially parallel to the axis of rotation and has a cutting edge inclined to the plane of rotation of the arm. If desired, the blades, or some or them, could be mounted with their planes inclined to the axis of rotation for instance so as to be able to impart a backward movement to the solid particles. It appears further from said figure, that the blades are slightly curved, in order that they may run in close proximity to the interior wall of the drum, and bring material away therefrom. By this ac-
tion the blades will whirl up and disperse the material into a stream of drying medium which is passed through the drying apparatus hereinafter described.

At that portion of the drying apparatus 18 occupied by the group of impact arms 29, a part-annular stationary plate baffle 31 is arranged, said plate being interrupted at its outer end and carrying the rod 34, and substituted by a complementary radially movable arcuate plate or baffle section 32 extending through a slot 33 in the bottom of the drum. Said plate 32 is secured to the upper end of a vertically disposed axially movable rod 34 guided by bearings 35 during its axial displacement. In its raised position, the plate 32 substantially completes the annular shape of the plate 31. An elbow lever 36 is pivotally mounted at its apex on a pin 37 and engages with a slot 38 at the end of one of its two branches a pin on the rod 34, while a slot 39 at the end of the other branch of the elbow lever engages a pin on a nut piece 40. One end of an operating shaft 41 is threaded through said nut piece, while the opposite end of said operating shaft carries an operating spider 42 for rotating the shaft 41. The operating shaft is mounted for rotation and prevented from axial movement in a bearing 43 arranged in the wall of a housing 44 encasing the lower half of the drum.

In order to give an indication of the level of the plate 32 within the drum, a lever 45 is secured to the elbow lever 36, lever 45 extending diametrically opposed to the branch engaging the rod 34 and carrying at its outer end a dial plate 46, the position of which may be observed through an opening 47 in the wall of the housing 44.

After the aforementioned first group of impact arms 29 in the housing 18 a second group of impact arms 47 is arranged, said second group of arms being tapered at their outer ends. Two further stationary part-annular plates or baffles 48, 49 are arranged between said second groups of impact arms, with complementary radially movable arcuate plates or baffle sections 50, and 51, respectively. The movable plates are adjustable by mechanisms 52, 53 respectively, of a construction similar to that of the mechanisms described above, operating spiders 54 and 55 respectively, being arranged to operate said latter mechanisms. Thus, it appears clearly from Figure 6, that the movable plates aforesaid, are individually adjustable.

A set of arms 56 are arranged at the discharge end of the drying chamber beyond the plate 49, each of said arms carrying at their outer ends a plate 57. The function of said plates 57 is to whirl up the finely divided, dried solid material as discharged (in the modified form of FIGS. 3-5 through perforations 58 in the discharge end of the drum. The material then enters into an annular chamber 59, from which it is exhausted) by a fan not shown through a duct 60a and blown off to a cyclone also not shown.

The function of the apparatus is that the material to be disintegrated is conveyed in a stream of drying medium. The material, partly disintegrated and dispersed into the stream of air, partly thrown against the drum wall, where a certain accumulation is obtained due to the annular plates 31, a feature enabling better conditions of treatment, disintegration and dispersion, all of said movements and of the apparatus being conveyed through a stream of drying medium during said procedure, the position of the movable arcuate plates are adjusted to give optimum staying time in the different zones of the apparatus.

In the arrangement shown in FIG. 2, the perforated walls and the annular chamber 59 are not emporved; instead, the materials are conveyed directly into the duct 60 leading to the fan 22 and the cyclone 23. Material is supplied via inlet 69.

As can be seen further from FIG. 2 the shaft of the rotor is driven by means of a belt 62 and electric motor 63. The speed to be chosen depends on the characteristics of the materials.

FIG. 2A shows in axial section the apparatus of FIG. 2 clearly illustrating the manner in which the annular chamber of the embodiment of FIG. 3 has been dispensed with.

It is preferred to employ a mixture of hot furnace gases, preferably having a temperature of about 200–400 °C, as the drying medium. It should be understood that this feature only represents a preferred embodiment, and that it is possible as well to employ an indirectly heated gas, for instance air heated by conveying it through a suitable heat exchanger. The temperature to be used, depends of course, on the special materials to be processed.

The preferred staying time may run from about a few seconds up to about half a minute or more, according to the requirements. Said feature is a remarkable improvement compared with the drum dryers heretofore employed in the herring oil industry, wherein the drying medium has a staying time amounting to only a few seconds, whereas with the aforesaid apparatus the staying time for the materials to be dried, amounts to between 3 and 5 minutes, and even more.

What is claimed is:

1. A drying apparatus comprising a drum-shaped housing, an inlet in one end of said housing, an outlet in the opposite end of said housing, a rotor comprising a shaft, axially spaced arms on said shaft, means for mounting said shaft within said housing so as to be rotatable about an axis extending from said inlet end to said outlet end, said arms being arranged in groups on said shaft, the groups being sequentially disposed from said inlet to outlet, knife means on the group closest to said inlet for disintegrating particles engaged thereby, a second group of said arms positioned adjacent the first said group imparting to particles engaged thereby a whirling movement while simultaneously disintegrating such particles, a third group being positioned closest to said outlet and imparting to particles engaged thereby a whirling movement, a first individually adjustable baffle in said housing and arranged to retard particle flow from said first group of arms to the second said group, a second individually adjustable baffle in said housing and arranged to retard particle flow from said second group to the third said group, means in said housing for introducing moist solid material and gaseous drying medium through said inlet, means in said housing for discharging particles of said material in a dried state dispersed in said gaseous drying medium from said outlet, and means coupled to said outlet for separating said solid particles from said gaseous medium.

2. Drying apparatus according to claim 1, wherein said baffles are radially intertuned rings at the inner pe-
riphery of said housing, said baffles each including a radially adjustable section.

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