



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11) **EP 1 128 393 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
29.08.2001 Bulletin 2001/35

(51) Int Cl.7: **G21F 9/36**

(21) Application number: **00308471.2**

(22) Date of filing: **27.09.2000**

(84) Designated Contracting States:
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE**
Designated Extension States:
AL LT LV MK RO SI

- **Kondo, Yoshikazu**
Hitachi-shi, Ibaraki 316-0021 (JP)
- **Kaneko, Shigezi**
Hitachi-shi, Ibaraki 316-0021 (JP)
- **Narita, Kenjiro**
Hitachinaka-shi, Ibaraki 316-0002 (JP)

(30) Priority: **21.02.2000 JP 2000042192**

(71) Applicant: **Hitachi, Ltd.**
Chiyoda-ku, Tokyo 101-8010 (JP)

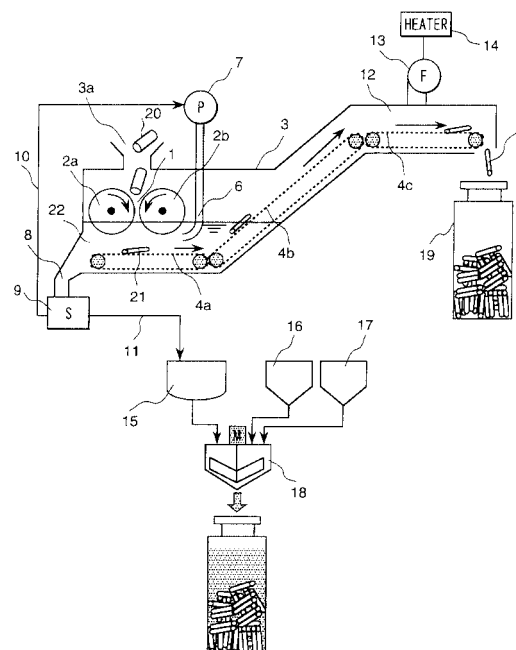
(72) Inventors:
• **Yoshida, Takuma**
Shinjuku-ku, Tokyo 160-0022 (JP)

(74) Representative: **Paget, Hugh Charles Edward et al**
MEWBURN ELLIS
York House
23 Kingsway
London WC2B 6HP (GB)

(54) **Hulls waste volume-reduction treatment equipment**

(57) Apparatus for volume-reduction of hulls waste (20), i.e. zircaloy and fuel cladding tube residues (hulls) generated during chemical reprocessing of a light-wafer reactor spent fuel, has at least two rotary cylindrical bodies (2a, 2b) having a clearance between them and rotating in mutually opposite directions are provided and compressive reduction in the volume of the hulls waste is accomplished by loading it into the clearance between said rotary cylindrical bodies. The rotary cylindrical bodies may be arranged in order for at least the clearance to be positioned in water or means may be provided for feeding or spraying water downward into the clearance and thus dust due to the occurrence of zircaloy powder during compressive volume-reduction treatment is prevented from exploding.

FIG. 1



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to hulls waste volume-reduction treatment equipment by which the zircaloy and fuel cladding tube residues arising from shearing and dissolving processes during chemical reprocessing of a light-water reactor spent fuel are reduced by compressive volume reduction; the invention relates more particularly to hulls waste volume-reduction treatment equipment that not only effectively prevents the likely explosion of dust particles due to the occurrence of powder zircaloy during compression, but also simplifies the compression equipment, reduces the quantity of secondary waste, removes moisture from the compressively volume-reduced waste, and thereby extending the subsequent period of waste storage in addition to improving the safety of the finally treated waste and the reliability of the final disposal

2. Description of the Prior Art

[0002] The hulls waste including the zircaloy that occurs in chemical reprocessing facilities usually undergoes compressive volume reduction using a large-size compressor. The zircaloy powder occurring during compression, however, easily reacts to the oxygen contained in the atmosphere and could cause dust particles to explode. It has been proposed, therefore, that hulls waste should be compressed in water or under an inert gas atmosphere.

[0003] For compression under an inert gas atmosphere, in addition to placing the entire equipment in the inert gas atmosphere, technology for encasing hulls waste in a sealed capsule charged with an inert gas and compressing the waste-containing capsule is proposed.

[0004] Japanese Application Patent Laid-Open Publication No. Hei-64588 (1999) proposes that a sealed capsule containing the hulls waste treated should be compressed in a cavity charged with an inert gas.

[0005] However, the prior art mentioned above has the following problems:

[0006] First, since conventional hulls waste volume-reduction treatment equipment uses a large compressor, it is basically impossible to avoid designing the equipment into large dimensions.

[0007] Also, since the zircaloy powder occurring during the compression of the hulls waste including the zircaloy that occurs in reprocessing facilities easily reacts to the oxygen contained in the atmosphere and could cause dust particles to explode, the hulls waste must be compressed in water or under an inert gas atmosphere.

[0008] Since compression under an inert gas atmosphere requires placement of the entire compressor in the inert gas atmosphere, such placement has the dis-

advantage that not only the dimensions of the equipment, but also the man-hours required for maintenance and check are increased.

[0009] To compress the hulls waste in capsule-sealed form together with the inert gas, a pretreatment unit, such as a capsulation unit, is required and this further increases the dimensions of the entire equipment. Also, there are problems associated with safety, because the capsule could be damaged during compression and because dust particles are most likely to explode in the event of capsule damage. In addition, since the avoidance of capsule damage requires highly accurate positioning for compression, working efficiency is difficult to improve.

[0010] After the cavity has been filled with an inert gas, to compress a sealed capsule that contains hulls, the process of preparing the capsule and the process of transferring the hulls to the capsule must be performed remotely and this makes it difficult to improve treatment efficiency. Also, the treatment equipment requires a large compressor and other components such as a capsulation unit and a capsule handling unit, and thus needs to be structured into very large dimensions as a whole.

[0011] Since it requires that the sheared pieces of hulls should be compressed underwater in great quantities using a large compressor, conventional underwater compression poses the problem that since the water is confined to the inside of the compressed body and resultingly generates hydrogen by radiolysis, it is difficult to store the waste for a long period of time or to evaluate the safety of the waste after its final disposal

SUMMARY OF THE INVENTION

[0012] The first objective of the present invention is to supply hulls waste volume-reduction treatment equipment capable of reducing the volume of hulls waste by compressing it with a simplified equipment configuration.

[0013] The second objective of the present invention is to supply hulls waste volume-reduction treatment equipment capable of reducing safely the volume of hulls waste by compressing it.

[0014] The third objective of the present invention is to supply hulls waste volume-reduction treatment equipment capable of reducing the quantity of secondary waste arising from compressive volume reduction of hulls waste.

[0015] The fourth objective of the present invention is to supply hulls waste volume-reduction treatment equipment that can create hulls waste containing no moisture after compression, and suitable for extended storage and final disposal

(1) According to the present invention, in order to achieve the first objective mentioned above, at least two rotary cylindrical bodies having the required

clearance between each other and rotating in mutually opposite directions are provided and compressive reduction in the volume of the zircaloy and fuel cladding tube residues (hulls) generated during chemical reprocessing of a light-water reactor spent fuel is accomplished by loading hulls into the clearances between the rotary cylindrical bodies.

This enables compressive volume reduction with simplified equipment, not requiring any pre-treatment units such as a large compressor or a capsulation unit.

(2) According to the present invention, in order to achieve the second objective mentioned above, the hulls waste volume-reduction treatment equipment set forth in item (1) above is provided with either said rotary cylindrical bodies so arranged as to position at least said clearances in water or a means for feeding or spraying water downward into said clearances, and thus prevents the explosion of dust particles due to the occurrence of zircaloy powder during compressive volume reduction.

This enables effective prevention of the explosion of dust particles due to the occurrence of zircaloy powder during compressive volume reduction.

(3) Also, according to the present invention, in order to achieve the second objective mentioned above, the hulls waste volume-reduction treatment equipment set forth in item (2) above is provided with a means for giving a constant stream of water in one specific direction at the bottom of the clearances between the rotary cylindrical bodies, and thus the movement of zircaloy powder is prevented from stopping and remaining near said rotary cylindrical bodies.

This makes it possible to prevent the movement of zircaloy powder from stopping and remaining near said rotary cylindrical bodies, and thus enables stable operation of the treatment equipment.

(4) According to the present invention, in order to achieve the third objective mentioned above, the hulls waste volume-reduction treatment equipment set forth in item (2) or (3) above is provided with a means by which processing water laden with the zircaloy powder resulting from compression is separated into treated water and either the zircaloy powder or sludge laden therewith, and a means for re-using said treated water to collect the zircaloy powder resulting from compression, and thus reduces the quantity of secondary waste occurring.

Thus, the quantity of secondary waste stemming from the treatment equipment, associated with compressive volume reduction of hulls waste, can be reduced.

(5) Also, according to the present invention, in order to achieve the third objective mentioned above, the hulls waste volume-reduction treatment equipment set forth in item (4) above is provided with a means

for preparing mortar by mixing said treated water and separated sludge with cement, and a container into which said mortar is to be poured, and thus creates a solidified cement body.

Thus, the solidification of the zircaloy powder stemming as secondary waste from the treatment equipment, associated with compressive volume reduction of hulls waste, can be suppressed.

(6) In addition, according to the present invention, in order to achieve the third objective mentioned above, said separating means in the hulls waste volume-reduction treatment equipment set forth in item (4) above has a metallic filter for separating said processing water into treated water and zircaloy powder, and a means for sintering said zircaloy powder and said metallic filter together into solid form, and thus minimizes increases in waste volume while at the same time obtaining a stable, solidified body.

Thus, the solidification of the zircaloy powder stemming as secondary waste from the treatment equipment, associated with compressive volume reduction of hulls waste, can be suppressed significantly.

(7) According to the present invention, in order to achieve the fourth objective mentioned above, the clearances between the rotary cylindrical bodies in the hulls waste volume-reduction treatment equipment set forth in item (2) or (3) above are set to a size at which no closed spaces are formed inside the compressed pieces of the hulls waste by controlling the degree of compression of the waste, then the residual moisture sticking to the compressed pieces is evaporated by the emission of the heat inherent in the hulls waste itself, and the compressed pieces of the hulls waste are dried immediately after its compressive volume reduction.

Thus, during extended storage or final disposal of the secondary waste existing after compressive volume reduction, a bottleneck associated with safety evaluation, namely, the occurrence of hydrogen due to the radiolysis of residual moisture can be avoided.

(8) Also, according to the present invention, in order to achieve the fourth objective mentioned above, the hulls waste volume-reduction treatment equipment set forth in item (7) above is provided with a drying chamber in which the hulls waste that has undergone compressive volume reduction is to be placed in a dry atmosphere before being released, and thus accelerates the drying of the residual moisture sticking to the compressed pieces of the waste.

Thus, during extended storage or final disposal of the secondary waste existing after compressive volume reduction, a bottleneck associated with safety evaluation, namely, the occurrence of hydrogen due to the radiolysis of residual moisture can

be avoided.

(9) Also, according to the present invention, in order to achieve the third objective mentioned above, said mortar container in the hulls waste volume-reduction treatment equipment set forth in item (5) above contains the compressed pieces of the hulls waste and said compressed pieces are solidified with said mortar to minimize increases in the volume of the compressively volume-reduced hulls waste.

Thus, increases in the volume of the compressively volume-reduced hulls waste can be minimized.

[0016] According to the present invention, the volume of hulls waste can be compressively reduced using simplified equipment.

[0017] According to the present invention, compressive volume reduction of hulls waste can be executed safely.

[0018] According to the present invention, the quantity of occurrence of secondary waste, associated with compressive volume reduction, can also be reduced.

[0019] In addition, according to the present invention, it is possible to create hulls waste containing no moisture after compression, and suitable for extended storage and final disposal.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] Figure 1 is a schematic block diagram of the hulls waste volume-reduction treatment equipment described as the first embodiment of the present invention.

[0021] Figure 2 (a) shows the shape of a sheared hulls piece existing before undergoing compressive volume reduction.

[0022] Figure 2 (b) shows the shape of the sheared hulls piece existing after undergoing compressive volume reduction.

[0023] Figure 3 is a schematic block diagram of the hulls waste volume-reduction treatment equipment described as the second embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0024] Embodiments of the present invention are described below using drawings.

[0025] Figure 1 is a schematic block diagram of the hulls waste volume-reduction treatment equipment described as the first embodiment of the present invention.

[0026] In Fig. 1, the hulls waste volume-reduction treatment equipment described as the first embodiment of the present invention comprises:

two rotary cylindrical bodies 2a and 2b having the required clearance 1 and necessary strength and rotating in mutually opposite directions;

casing 3 with pooled water 22 deep enough to permit the entire rotary cylindrical bodies 2a and 2b or at least the clearances thereof to be placed underwater;

hulls piece inlet 3a of casing 3, located directly above rotary cylindrical bodies 2a and 2b; compressed hulls piece outlet 5 provided at one end of casing 3;

conveyors 4a, 4b, and 4c, which carry compressed hulls from the bottom of the clearance between rotary cylindrical bodies 2a and 2b to compressed hulls piece outlet 5;

nozzle 6 and pump 7, which operate together to create the stream of water in the vicinity of rotary cylindrical bodies 2a and 2b, at the bottom thereof; zircaloy powder carrier waterstream receiving port 8 provided on the side of the casing, at the exit side of the stream;

solid-liquid separator 9, by which the processing water that accompanies zircaloy powder is separated into treated (filtered) water and sludge laden with zircaloy powder;

pipeline 10 for transferring to pump 7 the filtered water that has been created by solid-liquid separator 9; sludge reservoir 15 for storing the sludge laden with zircaloy powder that has been separated by solid-liquid separator 9;

sludge transfer pipeline 11 for transferring sludge from solid-liquid separator 9 to sludge reservoir 15; drying chamber 12 included as part of casing 3 to apply hot air from hear 14 and fan 13 to the hulls on conveyor 4c, in the vicinity of compressed hulls piece outlet 5, and generate a dry atmosphere, container 19 for accommodating the compressed hulls piece 21 discharged from compressed hulls piece outlet 5;

cement hopper 16 for solidifying zircaloy sludge; water adding tank 17 for adjusting the flow rate of cement, and;

cement mixer 18.

[0027] The sheared hulls piece 20 that has stemmed from shearing in chemical reprocessing facilities is loaded from hulls piece inlet 3a. The sheared hulls piece during loading has a cross-section circular cylindrical shape as shown in Fig. 2 (a). As the sheared hulls piece is being passed through clearance 1 between rotary cylindrical bodies 2a and 2b, the hulls piece is compressed into hulls piece 21 of a flat shape with the necessary and sufficient cavity 21a left for the internal moisture of the piece to evaporate, as shown in Fig. 2 (b). Since the zircaloy powder occurring during compression is released into pooled water 22, there is no danger of ignition or explosion.

[0028] Subsequently, compressed hulls piece 21 is carried from pooled water 22 to drying chamber 12 by conveyors 4a, 4b, and 4c installed at the bottom of casing 3. Since drying chamber 12 is always maintained in

a dry atmosphere by heater 14 and fan 13, the moisture on the surface and inner wall of compressed hulls piece 21 is sufficiently dried by the heat generated from the hulls itself, the dry atmosphere, and the effect of cavity 21a. The compressed hulls piece 21 that has been sufficiently dried is unloaded from compressed hulls piece outlet 5 into container 19.

[0029] Although the zircaloy powder that occurred during compression is released into pooled water 22, since the one-way water stream formed by pump 7 and nozzle 6 is present directly below rotary cylindrical bodies 2a and 2b, the zircaloy powder is conducted together with this stream into zircaloy powder carrier waterstream receiving port 8 by the stream. The zircaloy powder carrier water is separated into sludge laden with the zircaloy powder, and filtered water, by solid-liquid separator 9. The filtered water is carried to pump 7 via pipeline 10 and then reused as pooled water. The sludge laden with the zircaloy powder is sent to sludge reservoir 15 via sludge transfer pipeline 11.

[0030] The sludge laden with the zircaloy powder that has been stored into sludge reservoir 15 is conditioned into mortar of the required flow rate by undergoing mixing with premixed cement in cement hopper 16 and mixing in mixer 18. If the flow rate of the mortar is not sufficient, the flow rate can be adjusted by adding water from water adding tank 17 intended for cement flow rate adjustment. After the required mortar flow rate has thus been obtained, the mortar is poured into and solidified inside container 18a that already contains the required quantity of compressed hulls piece 21.

[0031] In this embodiment with the above-described equipment configuration, sheared hulls piece 20 undergoes compressive volume reduction by being loaded into the clearance between two rotary cylindrical bodies 2a and 2b. Therefore, no pretreatment unit, such as a large compressor or a capsulation unit, is required and compressive volume reduction with simplified equipment is possible.

[0032] Also, since compression occurs with rotary cylindrical bodies 2a and 2b so arranged as to position at least their clearance underwater, this arrangement enables effective prevention of the explosion of dust particles due to the occurrence of zircaloy powder during compression of sheared hulls piece 20.

[0033] In addition, since a one-way stream of water is given at the bottom of the clearance between rotary cylindrical bodies 2a and 2b, this stream prevents the movement of zircaloy powder from stopping and remaining near said rotary cylindrical bodies, and thus enables stable operation of the treatment equipment.

[0034] Since the processing water laden with the zircaloy powder resulting from compression with rotary cylindrical bodies 2a and 2b is separated into treated water and sludge laden with the zircaloy powder and the treated water is reused to collect the zircaloy powder resulting from compression, the quantity of secondary waste stemming from the treatment equipment during com-

pressive volume reduction of sheared hulls piece 20 can be reduced.

[0035] Since mortar is prepared by mixing with cement the sludge that has been separated from treated water to create a solidified cement body, the quantity of solidified zircaloy powder bodies stemming as secondary waste from the treatment equipment during compressive volume reduction of sheared hulls piece 20 can also be reduced.

[0036] In addition, after the clearance between rotary cylindrical bodies 2a and 2b has been set to a size at which a closed space is not formed inside compressed hulls piece 21 by controlling the degree of compression of the waste, since the residual moisture sticking to compressed hulls piece 21 is evaporated by the emission of the heat inherent in the hulls itself and compressed hulls piece 21 is dried immediately after its compressive volume reduction, a bottleneck associated with safety evaluation, namely, the occurrence of hydrogen due to the radiolysis of residual moisture can be avoided during extended storage or final disposal of the secondary waste existing after compressive volume reduction of sheared hulls piece 20.

[0037] Furthermore, since, prior to its release, compressed hulls piece 21 is placed in a dry atmosphere and the drying of the residual moisture sticking to compressed hulls piece 21 is accelerated, a bottleneck associated with safety evaluation, namely, the occurrence of hydrogen due to the radiolysis of residual moisture can also be avoided during extended storage or final disposal of the secondary waste existing after compressive volume reduction of sheared hulls piece 20.

[0038] After the mortar supplied from kneader 18 has been poured into container 19 that contains compressed hulls piece 21, since this compressed piece is solidified with the mortar, increases in the volume of the waste existing after compressive volume reduction of the compressed hulls piece can be minimized.

[0039] The second embodiment of the present invention is described below using Fig. 3. In this figure, the same equipment components as those shown in Fig. 1 are each assigned the same numeral as used in Fig. 1.

[0040] In Fig. 3, the hulls waste volume-reduction treatment equipment described as the second embodiment of the present invention comprises:

two rotary cylindrical bodies 2a and 2b having the required clearance 1 and necessary strength and rotating in mutually opposite directions;

casing 31 in which rotary cylindrical bodies 2a and 2b are arranged;

hulls piece inlet 3a, compressed piece outlet 5, and zircaloy powder carrier waterstream receiving port 8, which are all provided in casing 31;

bottom 31a of casing 31, wherein the bottom has a downward slope directed from compressed piece outlet 5 toward zircaloy powder carrier waterstream receiving port 8;

conveyors 4 for carrying compressed hulls from the bottom of the clearance between rotary cylindrical bodies 2a and 2b to compressed hulls piece outlet 5;

nozzle 32 and pump 7, which create a dropwise stream of water 37 in the clearance between rotary cylindrical bodies 2a and 2b;

metallic filtered solid-liquid separator 33 by which the zircaloy powder carrier water from zircaloy powder carrier waterstream receiving port 8 located downstream at the bottom of casing 31a is separated into treated (filtered) water and zircaloy powder via the metallic filter 34;

pipeline 10 for transferring to pump 7 the filtered water that has been created by metallic filtered solid-liquid separator 33;

compression vessel 35 for sintering metallic filter 34 laden with the zircaloy powder that has been extracted from metallic filtered solid-liquid separator 33;

drying chamber 12 included as part of casing 31 to apply hot air from heater 14 and fan 13 to the hulls on conveyor 4, in the vicinity of compressed hulls piece outlet 5, and generate a dry atmosphere, and; container 19 for accommodating the compressed hulls piece 21 discharged from compressed hulls piece outlet 5.

[0041] The sheared hulls piece 20 that has stemmed from shearing in chemical reprocessing facilities is loaded from hulls piece inlet 3a. As the sheared hulls piece is being passed through clearance 1 between rotary cylindrical bodies 2a and 2b, the hulls piece is compressed into hulls piece 21 having a flat shape with the necessary and sufficient cavity 21a left for the internal moisture of the piece to evaporate, as shown in Fig. 2 (b). Since the zircaloy powder occurring during compression is accompanied by the water flowing down from nozzle 32, there is no danger of ignition or explosion.

[0042] Subsequently, compressed hulls piece 21 is carried to drying chamber 12 by conveyor 4 installed at the bottom of casing 31. Since drying chamber 12 is always maintained in a dry atmosphere by heater 14 and fan 13, the moisture on the surface and inner wall of compressed hulls piece 21 is sufficiently dried by the heat generated from the hulls itself, the dry atmosphere, and the effect of cavity 21a. The compressed hulls piece 21 that has been sufficiently dried is unloaded from compressed hulls piece outlet 5 into container 19.

[0043] The zircaloy powder that occurred during the compression of hulls is accompanied by the water flowing down from nozzle 32, then passed to sloped bottom 31a of casing 31, and released into zircaloy powder carrier waterstream receiving port 8. The treated water in the zircaloy powder carrier water is separated from the zircaloy powder by metallic filtered solid-liquid separator 33, and the zircaloy powder is retained in metallic filter 34. The filtered water that has been passed through me-

tallic filtered solid-liquid separator 33 is carried to pump 7 via pipeline 10 and then reused as the water that flows downward. After the required period of test use of the metallic filter laden with the separated zircaloy powder, this filter is removed with the zircaloy powder retained.

[0044] The metallic filter 34 that has been removed with the zircaloy powder retained is stored into compression vessel 35 for sintering use, where the filter then undergoes high-pressure high-temperature treatment to create sintered body 36. The sintered body 36 that has thus been obtained is stored together with compressed hulls piece 21 into container 19.

[0045] This embodiment with the above-described equipment configuration also produces the same effects as those obtained in the first embodiment.

[0046] Since solid-liquid separator 33 separates treated water and zircaloy powder via metallic filter 34 and the zircaloy powder is sintered together with metallic filter 34 into solid form, increases in the volume of the waste are significantly reduced and a stable, solidified body can be obtained, which in turn enables significant reduction of the quantity of solidified zircaloy powder bodies stemming as secondary waste from the treatment equipment during compressive volume reduction of sheared hulls piece 20.

[0047] The present invention is not limited to the embodiments described above and permits these embodiments to be modified into various form. For example, although in the above embodiments, two rotary cylindrical bodies 2a and 2b, are used to reduce the volume of sheared hulls piece 20 compressively, four or more such cylindrical bodies can be used. Also, although in the second embodiment, water 37 is supplied dropwise to the clearance between the two rotary cylindrical bodies 2a and 2b, the water can be injected using a spray means.

Claims

1. Hulls waste volume-reduction treatment equipment characterized in that: at least two rotary cylindrical bodies having the required clearance between each other and rotating in mutually opposite directions are provided and compressive reduction in the volume of the zircaloy and fuel cladding tube residues (hulls) generated during chemical reprocessing of a light-water reactor spent fuel is accomplished by loading hulls into the clearances between said rotary cylindrical bodies.
2. Hulls waste volume-reduction treatment equipment set forth in Claim 1 above, wherein said equipment is characterized in that said rotary cylindrical bodies are arranged in order for at least said clearances to be positioned in water or a means for feeding or spraying water downward into said clearances is provided and thus dust particles due to the occurrence of zircaloy powder during compressive vol-

ume-reduction treatment is prevented from exploding.

3. Hulls waste volume-reduction treatment equipment set forth in Claim 2 above, wherein said equipment is characterized in that a means for giving a constant stream of water in one specific direction at the bottom of the clearances between the rotary cylindrical bodies and thus the movement of zircaloy powder is prevented from stopping and remaining near said rotary cylindrical bodies. 5
10
4. Hulls waste volume-reduction treatment equipment set forth in Claim 2 or 3 above, wherein said equipment is characterized in that: a means by which processing water laden with the zircaloy powder resulting from compression is separated into treated water and either the zircaloy powder or sludge laden therewith, and a means for reusing said treated water to collect the zircaloy powder resulting from compression are provided and thus the quantity of secondary waste which occurs is reduced. 15
20
5. Hulls waste volume-reduction treatment equipment set forth in Claim 4 above, wherein said equipment is characterized in that: a means for preparing mortar by mixing said treated water and separated sludge with cement, and a container into which said mortar is to be poured are provided and thus a solidified cement body is created. 25
30
6. Hulls waste volume-reduction treatment equipment set forth in Claim 4 above, wherein said equipment is characterized in that: said separating means has a metallic filter for separating said processing water into treated water and zircaloy powder, and a means for sintering said zircaloy powder and said metallic filter together into solid form, and thus minimizes increases in waste volume while at the same time obtaining a stable, solidified body. 35
40
7. Hulls waste volume-reduction treatment equipment set forth in Claim 2 or 3 above, wherein said equipment is characterized in that: the clearances between said rotary cylindrical bodies are set to a size at which no closed spaces are formed inside the compressed pieces of the hulls waste by controlling the degree of compression of the waste, then the residual moisture sticking to the compressed pieces is evaporated by the emission of the heat inherent in the hulls waste itself, and the compressed pieces of the hulls waste are dried immediately after its compressive volume reduction. 45
50
8. Hulls waste volume-reduction treatment equipment set forth in Claim 7 above, wherein said equipment is characterized in that: a drying chamber in which the hulls waste that has undergone compressive 55

volume reduction is to be placed in a dry atmosphere before being released, is provided and thus the drying of the residual moisture sticking to the compressed pieces of the waste is accelerated.

9. Hulls waste volume-reduction treatment equipment set forth in Claim 5 above, wherein said equipment is characterized in that: the container into which aforementioned mortar is to be poured contains the compressed pieces of said hulls waste, and said compressed pieces are solidified with said mortar to minimize increases in the volume of the compressively volume-reduced hulls waste.

FIG. 1

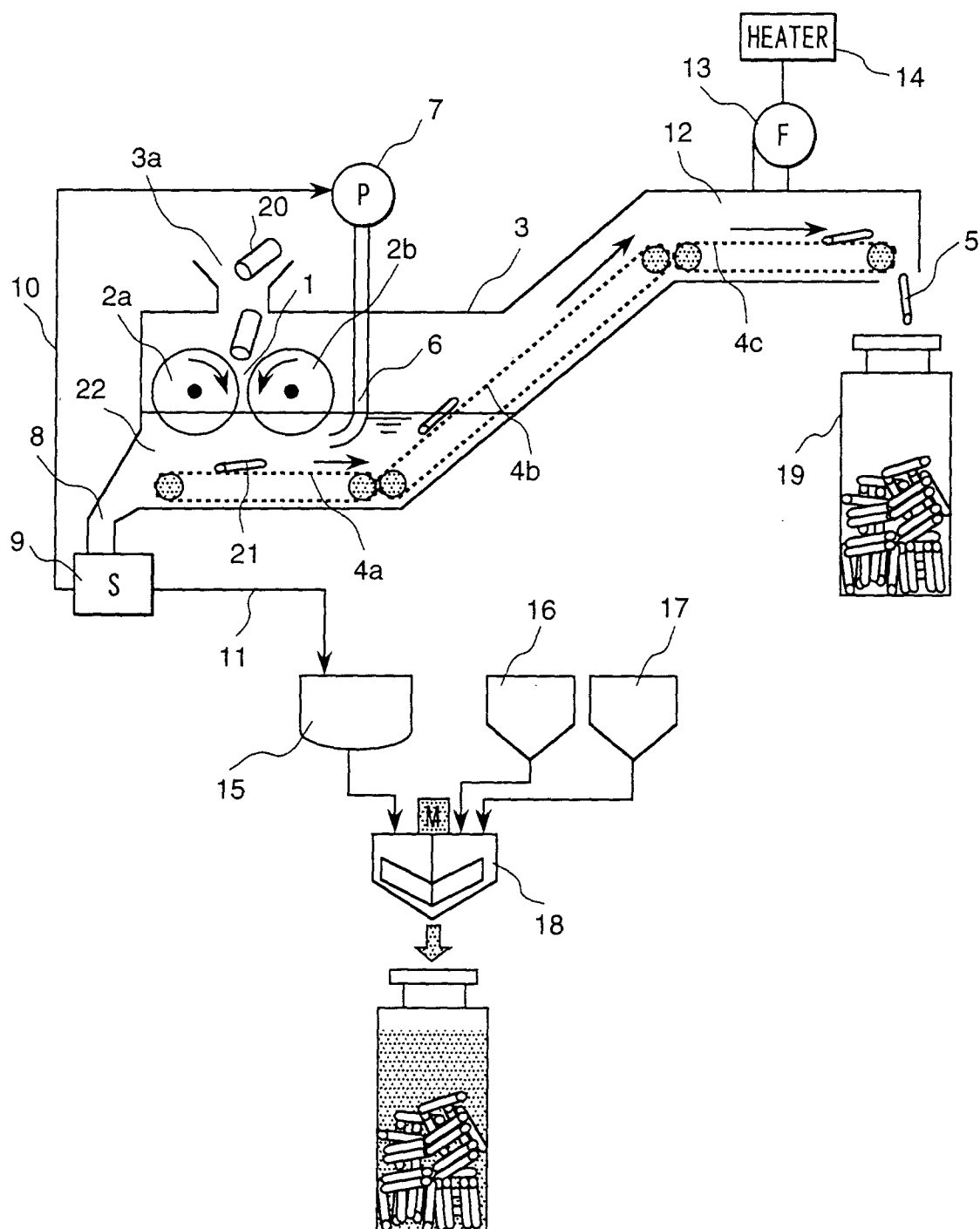


FIG. 2(a)

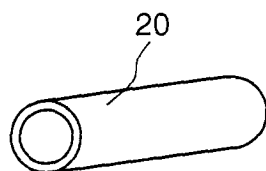


FIG. 2(b)

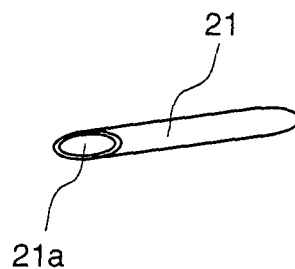


FIG. 3

