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Gordon

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[54] **TANK WITH INTEGRAL REMOTELY CONTROLLED POWER ACTUATED BOTTOM VALVE**

[75] Inventor: **Robert E. Gordon,** Monson, Mass.

[73] Assignee: **Monsanto Company,** St. Louis, Mo.

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[52] **U.S. Cl.** **137/395,** 137/571, 251/144, 251/298, 251/305, 222/556

[51] **Int. Cl.** **F16k 31/02**

[58] **Field of Search** 137/173, 174, 255, 256, 137/259, 263, 264, 386, 391, 393, 395, 571–576; 251/144, 147, 298, 305; 222/21, 64, 183, 556

[56] **References Cited**

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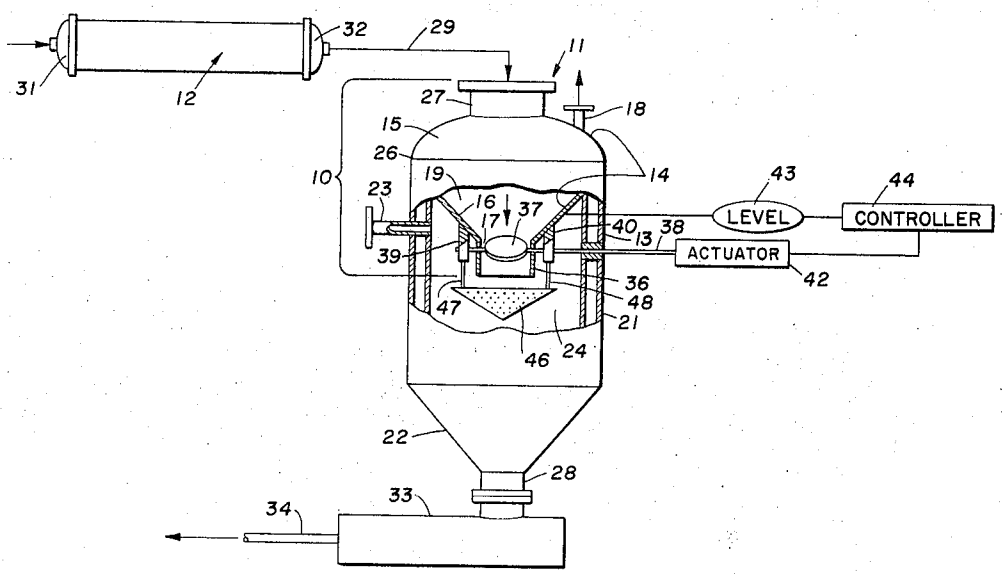
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Primary Examiner—William R. Cline
Assistant Examiner—David R. Matthews
Attorney, Agent, or Firm—Joseph S. Nelson; Edward P. Gratton; James C. Logomasini

[57] **ABSTRACT**

A tank and integral valve assembly suitable for storing and controlling the transfer of viscous fluids. The assembly utilizes a vessel in which is constructed a butterfly-type valve assembly located so as to regulate rate of egress of viscous fluid from the bottom of the vessel. An actuator assembly associated with a lateral side portion of the vessel controls rotary movements of a valve disc. The actuator is responsive to a level sensor coupled thereto through a controller assembly.

3 Claims, 4 Drawing Figures



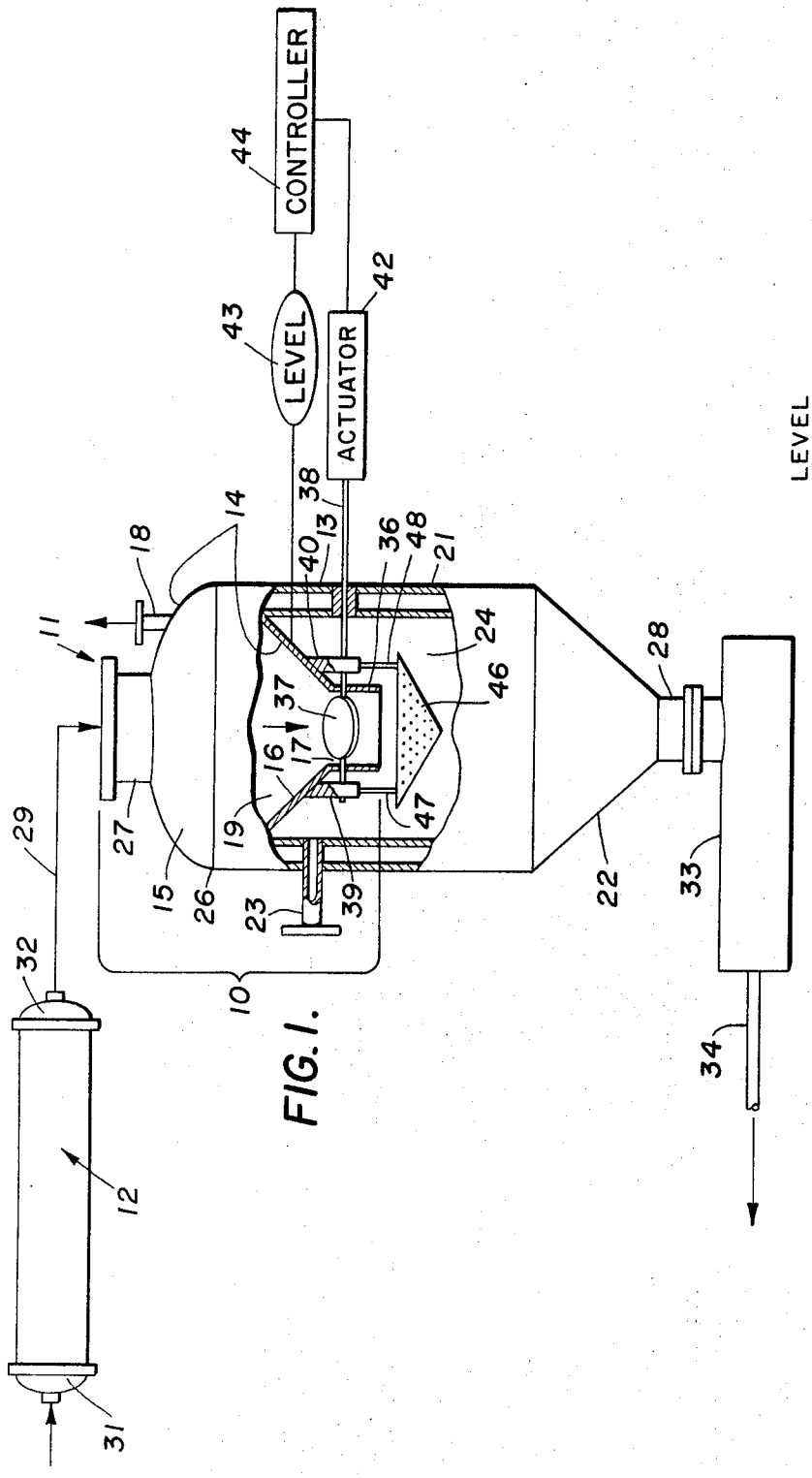

CONTROLLER
44
LEVEL
43
ACTUATOR
42
38
13
40
36
48
21
18
14
11
24
46
37
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FIG. 1.

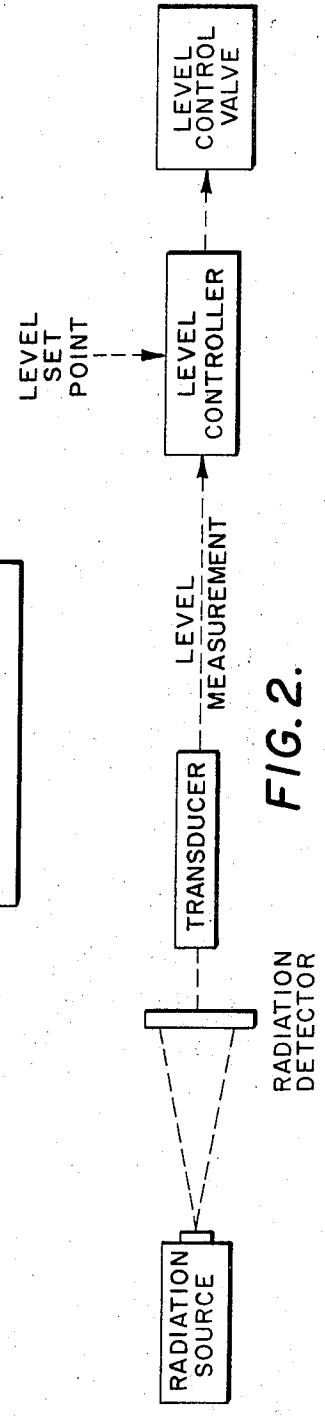

LEVEL CONTROL VALVE
LEVEL CONTROLLER
LEVEL SET POINT
LEVEL MEASUREMENT
TRANSDUCER
RADIATION DETECTOR
RADIATION SOURCE

FIG. 2.

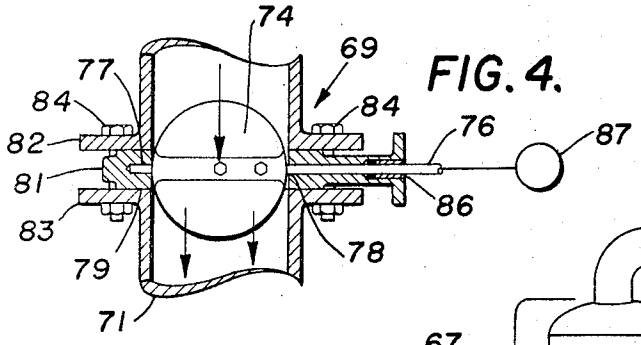

74
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77
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84
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71

FIG. 4.

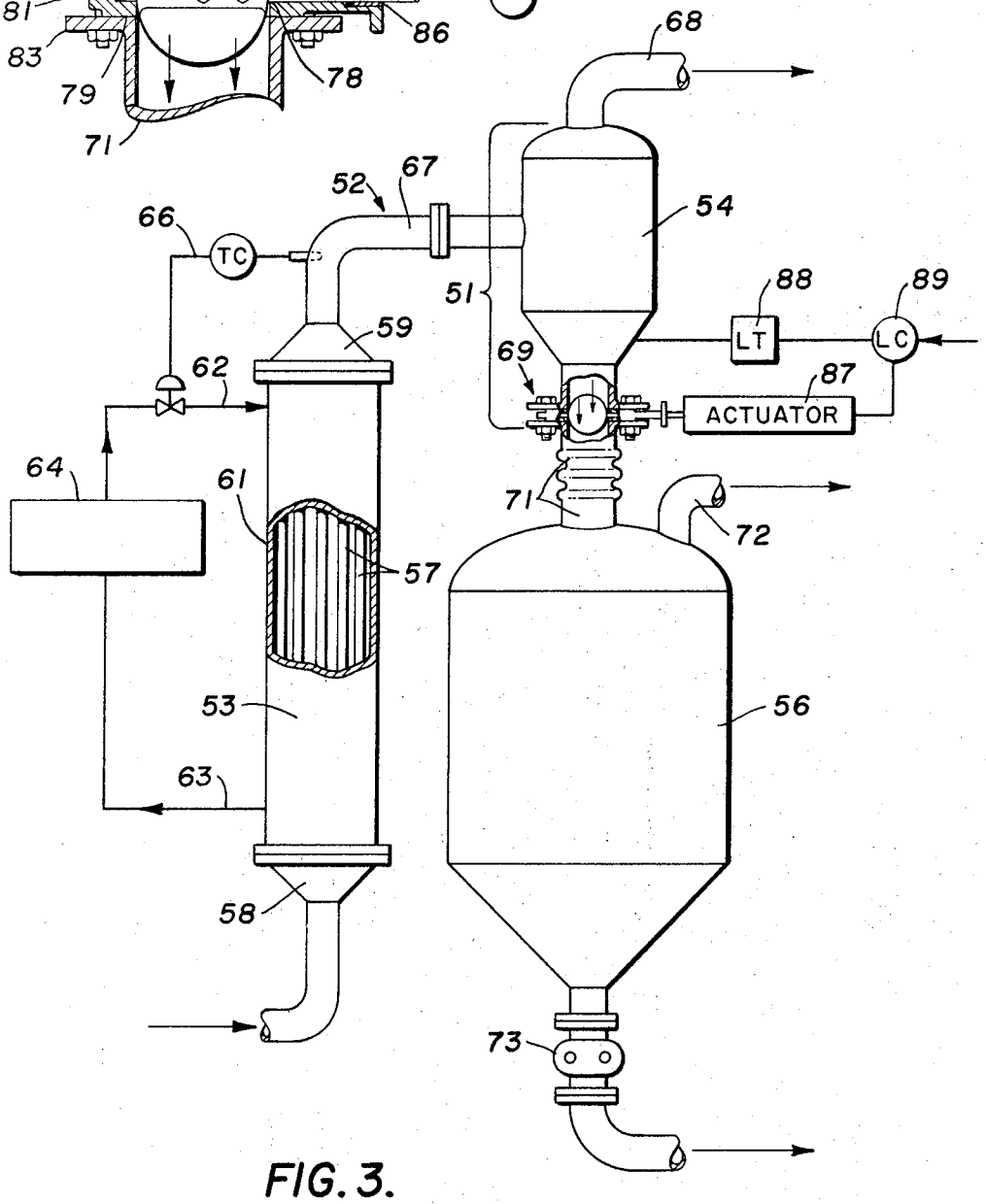

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66
TC
54
51
88
89
LT
LC
59
69
62
87
ACTUATOR
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61
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FIG. 3.

TANK WITH INTEGRAL REMOTELY CONTROLLED POWER ACTUATED BOTTOM VALVE

BACKGROUND

In the chemical industry, it is sometimes necessary to discharge fluid material from one tank into a second tank located below the first tank for temporary storage or holding on a batch or continuous basis in a controlled manner and at a controlled rate. When the fluid material is heated and viscous, the problem of controlled material transfer from one tank to the second can become very severe, particularly when gravitational forces are to be used at least in part to provide the power causng such material to flow from the one to the second tank.

For example, in the falling strand devolatilization of a polymer syrup such as a polystyrene/styrene monomer mixture, it has heretofore been relatively common practice to preheat such syrup, as in a shell and tube preheater, from an already melted condition to a higher temperature and then to discharge the so-heated syrup into a flash chamber (or flash tank) wherein the temperature/pressure relationship is above the boiling point of the styrene monomer but below that of the homopolystyrene polymer so that the monomer is separated from the polymer and removed from the flash chamber as a vapor. Separated monomer vapor is commonly removed from a location near the top of the flash chamber while the polymer, which is in the form of a hot, viscous melt, is pumped or drained from a bottom region of the flash chamber for further processing.

In order to remove as much of the monomer as possible from the polymer, it was and is commonly to subject the polymer hot melt recovered from a first flash chamber to another sequence of (second) preheater heating followed by passage through a (second) flash chamber, the second preheater generally being at a higher temperature, and the second flash chamber being at a higher temperature and lower pressure than the preceding first-stage of heating/flashing. Recently, an improvement in this falling strand devolatilization procedure has been discovered by which the need for the second preheater has been eliminated and hot melt from a first flash chamber is passed directly into a second flash chamber. Such improved procedure requires control of hot melt transfer from first into second flash chamber not only to regulate flow rate, but also to permit maintenance of a pressure differential between the two chambers. Specifically it is necessary to maintain the hot melt level in the bottom of a first flash tank at some predetermined level and to meter such hot melt from this flash tank into a second flash tank continuously and at a controlled rate.

Such a level maintenance and metering can be accomplished by a pump or valve means. However, owing to the combination of elevated temperatures, pressure differential between the first flash tank and the second flash tank, viscosity of the hot melt fluids involved, rate of hot melt flow from first flash tank into second flash tank, and the like, I have found that a major problem exists in accomplishing hot melt transfer directly from such a first into such a second flash tank. This problem is particularly important in the type of continuous process operation involved in the continuous falling strand devolatilization of a polymer syrup such as a polystyrene/styrene monomer mixture where long periods of continuous, trouble-free operation with a high degree of reliability are contemplated. Furthermore, such an operation should be conducted with relatively simple, relatively low cost, controlled, hot melt transfer means.

SUMMARY

I have now discovered a new and very useful apparatus to store and control the transfer of viscous fluid from a process tank to a subsequent processing operation. This invention is further adapted for use in transferring a hot, viscous fluid from the bottom region of a process tank to a spatially lower process station under conditions partly dependent upon gravitational forces, and this invention is particularly well adapted for transferring such a fluid from such a tank to a second tank which is normally maintained during equipment operation at a pressure lower than that of the (first) process tank.

The invention utilizes relatively simple, easy to maintain components, and provides the capability of operation continuously for extended periods of time with a high degree of reliability.

The invention may be used more or less as a separate system in practicing some chemical or physical operation upon fluid materials, or it may be used in combination with other elements as a sub-combination of a greater system. For example, in this last connection, the invention may be used as part of a falling-strand devolatilizer which employs a preheater preceding two subsequent flash chambers wherein the present invention is utilized as the fluid transfer arrangement. Those skilled in the art of chemical process industry techniques, however, will readily appreciate that the present invention is useful in many applications.

Briefly, the present invention employs as one element a generally enclosed vessel having adjacent one end region thereof a generally funnel shaped or tapered configuration, the vessel being adapted to be oriented spatially with such tapered end region downwardly extending. The vessel has a port defined in the apex portion of this tapered end section. The vessel may have additional ports depending on the end use application contemplated, as desired by a particular end user.

A valve disc means is positioned generally across said valve plate means. This valve disc means is adapted for rotational movements about a generally horizontally extending axis in a generally cylindrical opening. This opening may be part of the tank assembly or part of a separate attached valve body or valve plate means. This valve disc means is further adapted to substantially shut the opening within which such disc rotates when such disc is generally in a horizontal position in an operating embodiment.

A valve plate means if used is mounted in and about the opening within which the valve disc means rotates. The valve plate may be integral with and form a part of the construction material used to make the vessel, or otherwise, as those skilled in the art will appreciate.

A valve stem means extends generally coaxially with the aforeindicated horizontal axis, and the valve stem means projects beyond opposed side edges of the valve disc means through adjacent openings defined in the aforesaid valve plate means. Such valve stem means can be considered to include bearing means and this valve stem means is adapted to rotatably move the

valve disc means about the indicated horizontal axis between shut and open positions relative to the apparatus in the valve plate means. One end portion of the valve stem means project laterally outwardly to a terminal location exteriorly located with respect to the vessel.

A variable actuator means is exteriorly located with respect to the vessel and is functionally engaged with the aforeindicated exposed terminal end region of the valve stem means. This actuator means is adapted in response to signal means applied thereto to move revolvably the valve stem means relative to the vessel.

Level sensing means is associated with the vessel. Such level sensing means is adapted both to measure a fluid level in the vessel and to generate a signal means in response thereto when the vessel is functioning with the valve equipped port downwardly oriented spatially.

A controller means functionally interconnects the level sensing means and the actuator means. The controller means is adapted in response to signals from the level sensing means to generate control signals for the actuator means to control rotational movements of the valve stem means, and the valve disc means associated therewith, in a predetermined manner so that a predetermined variable aperture is maintainable between the valve disc means and the valve plate means, thereby to regulate the flow of fluid material moving therebetween when the vessel is functioning with a port downwardly positioned.

FIGURE DESCRIPTION

The invention is better understood by reference to the attached drawing wherein:

FIG. **1** is a side elevational view of one falling strand devolatilization apparatus incorporating an embodiment of the present invention, some parts thereof broken away and some parts thereof shown in section;

FIG. **2** is a block diagrammatic view of a level control system suitable for use with the apparatus of FIG. **1**;

FIG. **3** is a side elevational view of another falling strand devolatilizer apparatus incorporating another embodiment of the present invention, some parts thereof broken away and some parts thereof shown in section; and

FIG. **4** is a vertical sectional view illustrating details of the valve assembly used in the apparatus of FIG. **3**, some parts thereof broken away and some parts thereof shown in section.

DETAILED DESCRIPTION

Turning to FIG. **1**, there is seen illustrated a first embodiment of this invention herein designated in its entirely by the numeral **10**. As shown in FIG. **1**, embodiment **10** is incorporated into a falling strand devolatilizer apparatus herein designated in its entirety by the numeral **11**. Devolatilizer **11** can be considered to comprise a shell and tube heat exchanger assembly **12**, a vessel **14** or first flash tank which comprises part of the embodiment **10** of the present invention, and a second flash tank **13**.

The shell and tube heat exchanger assembly **12** is adapted for the input, passage through, and discharge from the tubes thereof (not shown) of process fluid (not shown). Heat exchanger assembly **12** is further adapted for the receipt of, passage through, and discharge from, the shell interior thereof (not shown) heat exchange fluid for heat transfer from the heat exchange fluid to the process fluid.

Vessel **14** has a tapered lower region **16** which terminates in a discharge port **17**. Vessel **14** also has a vapor take-off port formed by pipe and flange assembly **18**. The assembly **18** communicates with the interior space **19** of vessel **14**.

Vessel **14** has a double walled, jacketed construction in its upper portion **15** for purposes of controlling the interior temperatures of vessel **14** during operation of the devolatilizer **11**.

Vessel **14** is integral with tank **13**; thus, the wall of tapered lower portion **16** of vessel **14** forms the top wall of tank **13**. The side walls **21** and tapered lower region **22** of tank **13** are of double walled jacketed construction for purposes of controlling the interior temperatures of the vessel **13** during operation of the devolatilizer **11**. A vapor take-off port for tank **13** is provided by the pipe and flange assembly **23** which communicates with the interior space **24** of tank **13**.

In falling strand devolatilizer **11**, the vessel **14** is thus positioned spatially above tank **13** and is generally coaxial therewith. The top portion **15** of vessel **14** conveniently meets at its rim or edge portion **26** with the upper end of the side walls **21** of tank **13**, the vessel **14** being secured to the tank **13** by any convenient means such as welding or the like so that the vessel **14** is sealingly engaged with the tank **13** at rim portion **26**. A material input port for vessel **14** is provided by pipe and flange assembly **27** which communicates with the interior space **19** of vessel **14**. The tapered lower region **22** of tank **13** ends in a discharge port (not shown) which interconnects with pipe and flange assembly **28**, the pipe and flange assembly **28** communicating with the interior space **24** of the vessel **13** (the tube input and output means for circulating heat exchange fluid in the respective double walls of vessel **14** and tank **13** are not shown, nor are the pipe means for inputting and outputting heat exchange fluid for the heat exchanger assembly **12**).

The heat exchanger assembly **12** has its tube portions (not shown) interconnect by suitable pipe means **29** with the pipe and flange assembly **27** of vessel **14**. As those skilled in the art will appreciate, the heat exchanger assembly **12** is itself composed of two main subassemblies, a shell portion and a tube core, all of conventional construction. Into header **31** of the shell and tube heat exchanger **12** is input a process fluid (not shown) for heating, while from header **32**, the thus heated process fluid exits from the tubes within the heat exchanger assembly **12** and enters the pipe **29**.

Process fluid leaving tank **13** through pipe and flange assembly **28** enters a pumping screw assembly **33** from which the process fluid is pumped as through a pipe **34** for subsequent processing.

The discharge port **17** of vessel **14** forms the input port for the vessel or tank **13**. The tapered lower region **16** of vessel **14** interconnects with a pipe **36** at port **17**. Pipe **36** serves as a valve plate means extending generally circumferentially about port **17**.

A valve disc **37** is positioned generally across port **17** but within the neck of pipe **36**. Valve disc **37** is positioned and adapted for rotational movements about a generally horizontal axis. When the valve disc **37** is generally in a horizontal position across port **17**, the valve disc **37** substantially shuts port **17**. Particularly when the apparatus of this invention is to be used for

the processing of viscous fluids using elevated temperatures, it is preferred that the circumferential edge region of the valve disc **37** not engage the pipe **36** but rather be in slighly spaced relationship thereto, the spacing between the edge of the valve disc **37** and the adjacent inner wall of pipe **36** being sufficiently small as to substantially prevent any passage therethrough of viscous fluid during operation of an assembly of the invention.

A valve stem **38** extends generally coaxially along the indicated horizontal turning axis of the valve disc **37**. The valve stem **38** projects beyond opposed side edges of the valve disc **37** through appropriate port means defined in the pipe **36**. The portions of valve stem **38** thus adjacent to pipe **36** are journaled in bearing means (not shown) positioned in supports **39** and **40** which depend from the wall of tapered lower region **16** of vessel **14**. These bearings in respective supports **39** and **40** permit revolvable movement of the valve disc **37** on the valve stem **38**.

One end portion of the valve stem **38** projects laterally outwardly to a terminal location which is exteriorly located with respect to the vessel **14** and which is also exteriorly located with respect to the tank **13** in this embodiment **10**. In the region where the valve stem **38** extends through the side wall **21** of tank **13**, sealing means between such side wall **21** and valve stem **38** is provided (not shown). When embodiment **11** is in operation, the level of fluid material in the bottom of vessel **14** over valve stem **38** is such as to act as a sealing means between valve stem **38** and pipe **36** thereby permitting maintenance of a differential pressure between the respective spaces **19** and **24**.

An actuator means, herein designated in its entirety by the numeral **42**, is provided to move the valve stem **38** rotationally in response to signal means applied to actuator means **42**. Actuator means **42** is conveniently mounted by some sort of bracket means (not shown) in fixed relationship to tank **13**. The rotatable shaft of actuator **42** conveniently interconnects with the valve stem **38** by means of a collar assembly or the like (not shown). Any convenient conventional type of actuator can be employed. The falling strand devolatilizer **11** illustrates a preferred embodiment of the present invention where the actuator means **42** is completely outside of the process zones (here, the interior space **19** of vessel **14** and the interior space **24** of tank **13**.)

In order to measure process fluid level in the vessel **14**, preferably in the lower most region thereof, a level sensor as shown in FIG. **2** is employed. Level sensed by the level sensing means is converted to a signal output as by a transmitter **43** or the like, the signal being generated by transmitter **43** being representative of the fluid level measured inside the vessel **14** in an operating devolatilizer **11**. In the embodiment **10**, the level sensing means preferably comprises a radiation source and a radiation detector, although any convenient level sensing means, as those skilled in the art will appreciate, may be used to measure level in the vessel **14** in the practice of the present invention.

A controller **44** functionally interconnects the level sensing means and the actuator means **42**. Controller **44** is adapted, in response to signals from the level sensing means, to generate control signals for the actuator means **42**. Thus, rotational movements of the valve stem **38** are controlled and the valve disc **37** engaged therewith is open or closed to a predetermined extent in relation to the pipe **36**. Thus, a predetermined variable aperture is maintainable between the pipe **36** and the valve disc **37**.

In space **24** is shown positioned an optional perforated basin-like structure **46** which is here suspended in fixed relationship to port **17** by means of rods **47** and **48** which interconnect in turn with the supports **39** and **40**, respectively. While this assembly does not constitute part of the present invention, when during apparatus operation process fluid leaving pipe **36** falls into basin-like structure **46**, the perforations in basin-like structure **46** permit a viscous process fluid to be stranded into a plurality of high surface area components in the interior space **24** of vessel **13**. When such a structure **46** is employed, independent suspending means therefor are preferably used.

The interrelationship between the level sensing means, the actuator means **42**, and the controller **44**, is depicted in block diagrammatic form in FIG. **2**. Thus, gamma radiation emitted from radiation source is detected by a radiation detector. A signal from the detector is fed to a transducer where a signal output is generated which is representative of variations in fluid level in the vessel **14**, thereby to complete level measurement. The output from the transducer is fed to a level controller where the level measurement signal is compared to a predetermined level set point and an output signal is generated which is fed to the actuator means associated with the valve stem **38**, the whole being reference in FIG. **3** as the level control valve.

Turning to FIGS. **3** and **4**, there is seen another embodiment of the present invention. This embodiment is generally designated in its entirety by the numeral **51** and it is incorporated into a falling strand devolatilizer assembly which is herein referred to in its entirety by the numeral **52**. Devolatilizer **52** can be considered to comprise a shell and tube heat exchanger assembly **53**, and vessel **54** or first flash tank (which comprises part of the embodiment **51**, and a second flash tank **56**). In the shell and tube heat exchanger assembly **53**, process fluid (not shown) is input to the tubes **57** of exchanger assembly **53** through header **58** and exits from the heat exchanger assembly **53** through header **59**. The shell portion **61** of heat exchanger assembly **53** is used for circulation of a heat exchange fluid (not shown) which enters the shell **61** as through a pipe **62**, circulates within the shell **61** about tubes **57** and exits from the shell **61** as through a pipe **63**. The heat exchange fluid is conveniently heated in a heater assembly **64**. The temperature of the heat exchange fluid entering the shell **61** through pipe **62** is conveniently regulated by means of a temperature control means **66** which is conventional in construction. From the header **59**, the process fluid is conducted into the vessel **54** via pipe means **67** where vapor separated from the process fluid is removed by means of the pipe **68**, the pipe **68** being interconnected with a vapor recovery means (not shown) and vacuum pump means (not shown). A valve assembly, herein designated in its entirety by the numeral **69** at the lower end of the tank or vessel **54** meters process fluid at a controlled rate from the vessel **54** into the vessel **56** through the longitudinally expandable pipe **71**. In the tank **56**, process fluid has further volatiles separated therefrom which are removed through a pipe **72**, the pipe **72** being connected to a vapor recovery means (not shown) and vacuum pump means, (not shown).

Process fluid is removed from the second flash tank **56** bottom portion through a melt pump **73.**

Constructional details of the valve assembly **69** are illustrated in FIG. **4.** Across an upper section of pipe **71** extends a valve disc **74** being adapted for rotational movements about a generally horizontal axis, the valve disc **74** is adapted to substantially shut the pipe **71** when the valve disc **74** is in a relatively horizontal position thereto. Associated with valve disc **74** are valve stems **76** and **77** which protrude in diametrically opposed fashion from valve disc **74** on opposite side edges thereof. Stem **76** is journaled for rotational movements in the bearing assembly **78,** while stem **77** is journaled for rotational movements in bearing assembly **79.** Stems **76** and **77** adapt the valve disc **74** for rotational movements. Bearings **78** and **79** are mounted in a ring **81.** Ring **81** is adapted to be mounted across pipe **71** between a pair of flanges **82** and **83** as by means of nut and bolt assemblies **84** or the like. The valve assembly **69** is an unlined, all metal assembly suitable for utilization in the characteristically strenuous operating environments associated with, for example, wiped film devolatilizers used for devolatilizing polystyrene. Stem **76** extends through the ring **81** radially to a terminal location exteriorly positioned with respect to the ring **81.** A seal **86** between the stem **76** and the ring **81** is provided to prevent ingress of air to the evacuated process space. Gaskets (not shown) on opposed faces of ring **81** seal the ring **81** between the adjacent faces of flanges **82** and **83.** In the valve assembly **69,** the ring **81** may be regarded as a valve plate.

The stem **76** is connected at its exterior end region with a variable actuator means **87,** the actuator **87** being exteriorly located in a fixed position relative to the vessel **54** and functionally adapted to rotatably move the valve stem **76** in response to signal means applied thereto.

Level sensing means associated with the vessel **54** (preferably the lower regions thereof) is provided. Level sensing means **88** is adapted both to measure a fluid level in the vessel **54** and to generate a signal means in response thereto when the vessel **54** is functioning in the falling strand devolatilizer **52** with the valve assembly **69** at the downwardly extending end of the vessel **54.**

A level controller **89** functionally interconnects the level sensing means **88** and the actuator means **87.** The level controller means **89** is adapted, in response to signals from the level sensing means **88,** to generate control signals for the actuator means **87,** thereby to control rotational movements of the valve stem **76** and **77** in a predetermined manner. Thus, a predetermined variable aperture is maintainable between the valve assembly ring **81** and the valve disc **74.**

Other and further embodiments of the present invention will be apparent to those skilled in the art from a reading of the present specification and drawings.

What is claimed is:

1. A flash tank and integral valve assembly adapted for the devolatilization, storage and continuously controlled transfer therefrom of viscous fluid and comprising in combination:

A. a generally enclosed vessel having adjacent one end region thereof a generally funnel-shaped configuration terminating in a discharge port means at said one end region said vessel being adapted to be oriented spatially with said one end region downwardly when said vessel is operating, said vessel having defined therein at least two additional ports in an upper wall region thereof, one port being adapted as a fluid input port, a second port being adapted as a vapor removal port, said vapor removal port interconnecting with a vacuum pump means adapted to remove volatiles from said viscous fluid and said vessel,

B. valve disc means positioned generally across said discharge port means and adapted for rotational movements therein about a generally horizontal axis when said vessel is operating, said valve disc means further being adapted to substantially shut said port means when in a generally horizontal position relative thereto when said vessel is operating,

C. valve stem means extending generally coaxially with said horizontal axis and projecting beyond opposed side edges of said valve disc means into generally mating openings defined in a valve plate means, said valve stem means including bearing means, one end portion of said valve stem means projecting laterally outwardly to a terminal location exteriorly located with respect to said vessel, said valve stem means being adapted to rotatably move said valve disc means about said horizontal axis between shut and open positions relative to said port means, said bearing means having a seal between said valve stem means and said valve plate means, thereby preventing the ingress of air to the evacuated process space,

D. variable actuator means exteriorly located with respect to said vessel and functionally engaged with said exposed terminal end portion of said valve stem means, said actuator means being adapted in response to signal means applied thereto to move revolvably said valve stem means,

E. level sensing means associated with said vessel and adapted both to measure a fluid level in said vessel and to generate a signal means in response thereto when said vessel is functioning with said one end region downwardly oriented spatially, wherein said level sensing means comprises a gamma ray emitter located adjacent said one end region of said vessel exteriorly thereof, a gamma ray sensor located adjacent said one end region of said vessel exteriorly thereof but on an opposite side of said vessel relative to said emitter, and correlator means adapted to make said sensor and said emitter adapted to detect variations in said fluid level and to generate a signal means responsive thereto, and

F. controller means functionally interconnecting said level sensing means and said actuator means and adapted in response to signals from said level sensing means to generate control signals for said actuator means to control rotational movements of said valve stem means and said valve disc means engaged therewith in a predetermined manner whereby a predetermined variable aperture is maintainable between said discharge port means and said valve disc means.

2. The assembly of claim **1** wherein said vessel interconnects with another vessel at said one end region below said discharge port means.

3. The assembly of claim **2** wherein said vessel interconnects with another vessel at said one end region below said valve plate means and said other vessel has defined therein at least two additional ports, one of which is connected with a source of pressure lower than that maintained by said pump means in said vessel.

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