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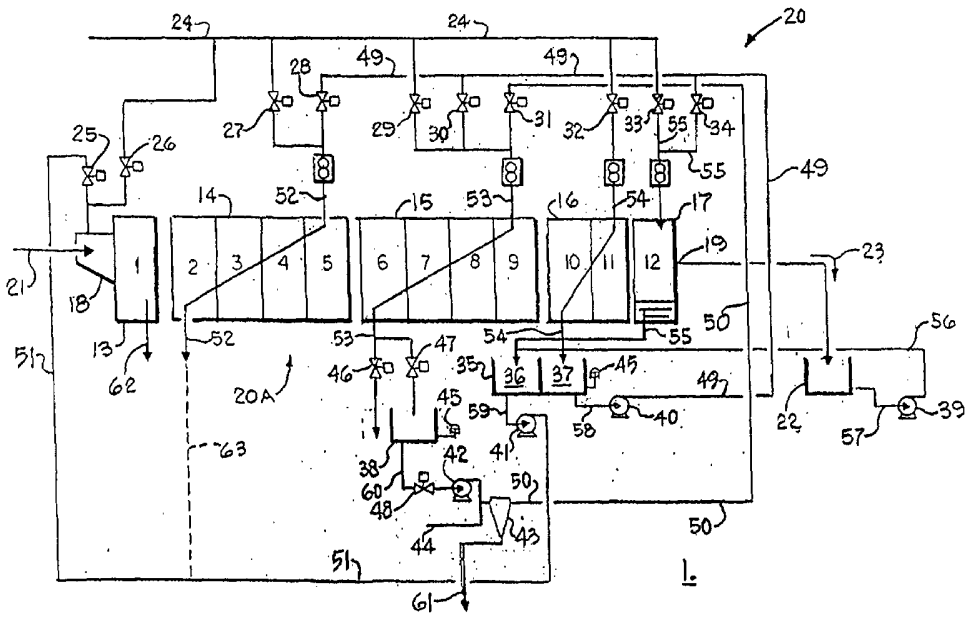
(54) Title: CONTINUOUS TUNNEL BATCH WASHER APPARATUS



(57) Abstract: An improved tunnel washer apparatus (20) is disclosed that includes a "ratio metric" water reuse system that features four water loops . The water loops include fresh water (24), reuse water (51), rinse water (49), and treated water (50). The tunnel washer (20) has five stages that include wet out (13), first wash zone (14), second wash zone (15), main rinse zone (16), and fine rinse/finishing zone (17). The water loops are designed to minimize the consumption of fresh water by blending the appropriate quantity of the four types of water. The blending formulation may vary based on the type of goods (for example linen) in the tunnel stage and the dynamic quality of each type of water.

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TITLE OF THE INVENTION

"CONTINUOUS TUNNEL BATCH WASHER APPARATUS"

INVENTOR(S): POY, Russell, a US citizen, of 601 Baronne No. 3B, New Orleans, Louisiana 70113, US.

CROSS-REFERENCE TO RELATED APPLICATIONS

Priority is hereby claimed to US Provisional Patent Application 60/313,101, filed 17 August 2001.

US Provisional Patent Application 60/313,101, filed 17 August 2001, is incorporated herein by reference.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not applicable

REFERENCE TO A "MICROFICHE APPENDIX"

Not applicable

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to continuous batch-type washing machines. More particularly, the present invention relates to an improvement in a continuous batch-type washing machine that features an improved multi-loop water reuse arrangement. Even more particularly, the present invention relates to an improved continuous batch-type washing machine apparatus wherein there are three water "loops" in addition to a fresh water loop. The additional "loops" include reuse water, rinse water, and treated water. The system of the present invention provides significant energy and water conservation thus reducing operating costs.

2. General Background of the Invention

In machines that are known in the industry as "tunnel washers", each of a succession of drums or baskets is mounted for rotation within a housing that includes a bath of liquor during each washing cycle. Each drum is contained within an individual compartment or cell of a succession of cells forming the tunnel. Goods to be cleaned

(such as cloth goods) are transferred sequentially from a drum into the next successive drum. Intermediate washing cycles are provided for causing liquor to circulate through each drum compartment and maintaining a desired level of liquor making up the bath during each washing cycle. Thus, successive batches of cloth goods may be fed via a hopper into the leading drum at the front end and removed from the trailing drum at the rear end of the passage and through intermediate drums.

Depending on the design and arrangement of the individual machines, water may be circulated through one or more drum compartments at the front portion of the machine for pre-wash and soap detergents and pH conditioning chemicals may be added to the water circulated through several of the following drum compartments in the main wash stage of the machine. The goods may then be bleached, unused, or conditioned rinsed with water circulated through one or more succeeding drum compartments. Water is circulated through the final drum compartments. In some cases, liquor may not pass entirely through the machine from one end to the other. For example, certain of the different types of liquor may be prevented from co-mingling.

Various patents have been issued for continuous tunnel washer batch-type washing machines and methods for operating them. The assignee of the present invention, Pellerin Milnor Corporation of Kenner, Louisiana is the assignee of several such "tunnel washer" patents that are listed in Table 1 below:

TABLE 1

PELLERIN MILNOR PATENTS

PATENT #	ISSUE DATE	TITLE
4,236,393	02 Dec.1980	Continuous Tunnel Batch Washer
4,363,090	07 Dec. 1982	Process Control method and Apparatus
4,485,509	04 Dec. 1984	Continuous Batch Type Washing Machine and Method for Operating Same
5,211,039	18 May 1993	Continuous Batch Type Washing Machine
5,454,237	03 Oct. 1995	Continuous Batch Type Washing

Machine

Other patents have issued that relate generally to the concept of a laundry machine or tunnel type commercial duty washing machine:

TABLE 2

WASHER PATENTS

PATENT #	ISSUE DATE	TITLE
3,103,802	17 Sept. 1963	Washing Machine
3,336,768	22 Aug. 1967	Washing Machines
3,406,543	22 Oct. 1968	Washing Machines, Notably Laundry Machines
3,509,744	5 May 1970	Washing Machines, and Especially Laundry Machines
3,550,406	29 Dec. 1970	Machine for Washing Laundry
3,693,639	26 Sept.1972	Apparatus for Treating Articles With Liquid Treatment Media
3,995,458	7 Dec. 1976	Laundry Machine
4,020,659	3 May 1977	Tunnel-Type Commercial-Duty Washing Machine
4,109,493	29 Aug. 1978	Drum-Type Machine for the Treatment of Textile Material

Tunnel washers are typically very large machines that are employed in commercial service. Users can include hotels and hospitals, for example.

Tunnel washers consume a large amount of water on a yearly basis. They also require a substantial amount of energy for heating. On a yearly basis, water and energy costs can be hundreds of thousands of dollars for a large installation.

BRIEF SUMMARY OF THE INVENTION

The present invention provides an improved tunnel washer apparatus that can be energy and water saving. The system of the present invention can feature three water loops in addition to the fresh water loop. The additional loops include reuse water, rinse water, and treated water.

The improved tunnel washer of the present invention provides preferably five

stages or zones: wet out, first wash zone, second wash zone, main rinse, and fine rinse/finishing.

The water loops of the present invention help minimize the consumption of fresh water by blending a selected, appropriate quantity of the four types of water that are provided by the four loops. The blending formulation may be selected based upon the type of linen in the various tunnel stages and the dynamic quality of each type of water in the various loops.

The present invention thus provides an improved ratio metric flow arrangement and tunnel washer system.

Process water from a wash zone is treated in line and recirculated in both wash zones of the apparatus. The primary flow in the second wash zone is recirculated. The only makeup water can be used to replace the rejects from the filtration components.

The water treatment uses an oxidizer to breakdown organic material and a centrifugal separation unit to remove suspended solids.

By directly reusing this water, the water remains at the programed temperature, thereby dramatically reducing the heating energy required. Normally this water is sent to a sewer or to a centralized water treatment system, losing energy and adding significant cost to the installed system.

Conventional attempts to use central water treated water have not been successful because of the temperature and chemical incompatibility.

In the second wash zone, the dilution rate is increased over conventional designs because of the recirculated process liquor flowing at up to 300% of the conventional flow rate.

The purpose of increased flow rate is to improve the washing effect by increasing the dilution effect, as illustrated in the following Table 3.

TABLE 3

	% of Main Rinse Water						Main Rinse		Finish of Fine Rinse	
	Fresh Water	Total Water	Fresh Water	Total Water	Fresh Water	Total Water	Fresh Water	Total Water	Fresh Water	Total Water
Conventional	10	50	65	65	65	65	100	100	5	5
Ration	10	50	0	46-65	10	300	40-80	40-80	0	0-20

Sensors (e.g. turbidity sensors) are preferably used to measure the quality of the wash water zone. Upon reaching a selected limit, fresh water is increased to dilute the dissolved solids level. This water is then treated to improve its quality. Ozone, alone or in combination with other oxidizers, can be used directly in the pumped treated water stream to break down organic compounds. Alternative and/or replacement oxidizers can include chlorine dioxide or ultraviolet treatment. These can be used in place of or in addition to ozone. It is optional to filter this treated flow using an inline filter to further clarify the treated water. A cyclone separator or like filter can be used to remove suspended solids which can be reduced to preferably less than between about 50 to 500 parts per million, preferably about 100 parts per million.

The last "module" or cell is configured to primarily use water from the main rinse section as an overflow fine rinse. This water is recovered in a tank and used as reuse water for part of the flushing water in the wet out (inlet) zone.

For operating the present invention, fresh water is introduced into the last cell or module of the main rinse zone after start-up stabilization. The water counter flows to the first module in the rinse zone. The water is collected in a tank. The rate of flow in the rinse zone is selected based on the type of goods that are being washed. The rate of flow can be varied depending on the soil levels in different batches of goods. For example, when heavy soil follows light soil, the rinse zone water may be increased to address higher detergent and alkali levels. Additionally, the level of dissolved solids is measured in the tank. If the level exceeds a selected, programmed limit, the fresh water flow rate is increased. A computer can be used with the sensors to monitor water quality. A plurality of modulating valves can be computer controlled to automatically maintain water quality levels for water that is added to the apparatus at the various cells or at stages

that include multiple cells.

The first wash zone reuses the highest percentage of the rinse water when compared to the flow into the second wash zone and the final rinse zone. The first wash zone can be programmed to blend fresh water if required.

The second wash zone principally reuses its own treated water, blended with approximately 20% rinse water and 10% fresh water. These values can be programmable, generally about 0 to about 65% rinse and about 0 to about 65% fresh water.

The present invention thus provides an improved continuous tunnel batch washer apparatus that includes an elongated outer housing having opposed ends, an inlet at one of said ends and an outlet at the other of said ends, the housing having a water containing portion for washing goods.

A plurality of lateral walls divides at least a portion of the housing into a plurality of cells. The housing contains a plurality of drums, preferably one drum for each cell. Each of the drums is rotatably supported within the water containing portion of the frame. Each drum has an inlet for enabling goods to be washed to enter the drum and a drum outlet for enabling the goods to exit the drum.

A fresh water header is provided for supplying water to the water containing portion of the housing.

A rinse water flow line receives water that has been discharged from the water containing portion of the housing, for reuse.

A treated water flow line receives water that has been discharged from the water containing portion of the housing, for reuse.

Water treatment is provided for removing solid waste material from water that has been discharged from the water containing portion of the housing. Such treated water is transmitted to the treated water flow line.

Water flowing in the treated water flow line is supplied to the second wash zone. Water flowing in the rinse zone is supplied to the first and/or second wash zones, and optionally the fine rinse and finish zone. Water flowing in the reuse flow line is used in the "wet out" or intake zone. The fresh water header can optionally supply water to the wet out (intake) zone, the first and second wash zones, the main rinse zone and the fine rinse and finish zone.

BRIEF DESCRIPTION OF THE DRAWINGS

For a further understanding of the nature, objects, and advantages of the present invention, reference should be had to the following detailed description, read in conjunction with the following drawings, wherein like reference numerals denote like elements and wherein:

Figure 1 is a schematic flow diagram of the preferred embodiment of the apparatus of the present invention.

Figure 2 includes some preferred ranges for water.

DETAILED DESCRIPTION OF THE INVENTION

In Figure 1, the tunnel batch washer apparatus of the present invention is designated generally by the numeral 20. Tunnel batch washer 20 has an inlet end portion 18 (e.g. hopper) and an outlet end portion 19. A housing 20A is defined by a plurality of cells 1-12. There can be more cells. The maximum number is preferably (but not limited to) 32. The cells 1-12 can be defined by lateral dividing walls of the housing 20A. The housing 20A provides a water containing portion. One or more of the cells 1-12 can provide drums that are rotatable. Chutes on each drum transfer goods from one drum to the next drum. Thus, each drum has an inlet and an outlet so that goods to be washed can enter and exit each drum.

One or more of the above listed Pellerin Milnor patents in Table 1 discloses the general concept of a tunnel batch washer that includes a housing, a water containing portion, a plurality of cells, drums contained within the cells, and chutes associated with each of the drums for transferring clothes or other goods to be cleaned from one drum to the next drum. Each of the above listed patents contained in the Tables 1 and 2 is hereby incorporated herein by reference.

The housing 20A has five (5) zones or stages: wet out first wash, second wash, main rinse, and fine rinse/finish. Next to inlet 18 there is provided a wet out zone 13. The wet out zone 13 provides a hopper or chute that allows clothing, linens, cloth goods or other articles to be washed to be added to the housing 20A. Thus cell number 1 defines the "wet out" or inlet zone 13. Cells 2, 3, 4 and 5 define a first wash zone 14. Cells 6, 7, 8 and 9 define a second wash zone 15. A main rinse zone 16 is defined by cells 10 and 11. A fine rinse and finish zone 17 is defined by the cell 12.

During operation, the goods to be cleaned move in the direction of arrow 21, entering the housing 20A at inlet 18 and exiting the housing 20A at outlet 19. In general,

water flow in housing 20A is in the opposite direction of arrow 21. The goods that exit outlet 19 can be transported to a press, the details of which are known in the art and therefore not disclosed herein. Pressed water from the press or other extracting device is contained in a tank 22. The arrow 23 schematically illustrates the transfer of goods from housing 20A to a known press so that water can be removed from the linens or other washed goods and collected at press water return tank 22.

The apparatus 20 of the present invention provides four different main headers or flow lines. These include fresh water header 24, rinse water flow line 49, treated water flow line 50 and reuse water flow line 51.

The various headers and flow lines 24, 49, 50, 51 supply water to different stages or zones of the housing 20A. For example, treated water flowing in the flow line 50 is reused in the second wash zone 15. Rinse water flowing in the flow line 49 is optionally used in the first wash zone 14, second wash zone 15, main rinse zone 16, and fine rinse and finish zone 17. Reuse water flowing in line 51 is the water collected from the press water return tank 22, main rinse 16 and fine rinse and finish 17. This reuse water flows in line 51 to the wet out or inlet stage 13. Fresh water is optionally supplied to the wet out zone 13 using fresh water header 24, first and second wash zones 14, 15, main rinse zone 16, and fine rinse and finish zone 17.

A plurality of modulating valves 25-34 are provided for enabling selected control of the percentage of water from the various headers or flow lines 24, 49, 50, 51 that are added to selected stages. For example, at the wet out stage 13, reuse water and fresh water are supplied through the respective headers 51 and 24. Modulating valve 25 controls the flow of reuse water in line 51. Valve 26 controls fresh water in line 24 that is added to the wet out zone 13. Modulating valve 27 controls the flow of fresh water in header 24 while valve 28 controls rinse water in flow line 49 that is to be added via lines 24, 49 to the first wash zone 14. Modulating valves 29, 30 and 31 control the flow of water that is added to the second wash zone 15. The valve 29 controls the flow of fresh water from header 24 that is added to the second wash zone 15. The valve 30 controls the flow of rinse water from flow line 49 that is added to the second wash zone and the valve 30 controls the flow of treated water from flow line 50 that is added to the second wash zone. A computer can be used to control the valves 25-34, and pumps that drive flow in the lines 24, 49, 50 and 51. Modulating valves 25-34 can be models commercially

available.

The main rinse zone 16 can be supplied by fresh water received from header 24 as controlled by modulating valve 32. The fine rinse and finish zone 17 is supplied with a combination of fresh water from header 24 as controlled by valve 33 and rinse water supplied by flow line 49 as controlled by valve 34.

A tank 35 is provided for receiving water as it exits housing 28 from main rinse zone 16 and fine rinse and finish zone 17. The tank 35 has tank sections 36, 37. A tank 38 is provided for receiving flow from the second wash zone via second wash zone flow line 53. Flow line 54 is provided for transferring water from the main rinse 16 and to tank 35. Flow line 55 is provided for transferring water from the fine rinse and finish 17 stages to tank 35. Downstream of second wash zone 15, flow line 53 has a branch portion that includes two valves 46 and 47. These valves 46 and 47 control the flow of water to tank 38, or to be discharged for example, to a sewer. The tank 38 communicates with flow line 60 for supplying water through valve 48 to pump 42. The water flowing in line 60 is water that is to be treated and then reused. Treatment can include centrifugal separator combination cleaner 43, ozone injection 44, carbon filtration, ultraviolet treatment, and/or reverse osmosis filtration. Flow line 61 schematically indicates the discharge of reject solids from separator 43 to a suitable discharge site.

Tank 35 also receives the press water return from tank 22 via flow line 56. The press water return flow line 56 receives flow from pump 39 and pump suction line 57. Water that is received in tank 35 can be tested for quality using a sensor such as turbidity sensor 45. Water quality can also be tested for total suspended solids being preferably less than 100 parts per million. Suction line 58 receives flow from tank 35 and communicates with pump 40 for pumping water in flow line 49. Some of the water in tank 35 can also be received by suction line 59 for transfer to pump 41 to be pumped as reuse water in line 51 for transfer to the wet out zone 13.

A turbidity sensor 45 can determine the quality of water in tanks 35 and 38. Water quality can also be tested for total suspended solids being preferably less than 100 parts per million. A determination is made of whether to transfer that water to the rinse flow line 49 or to the reuse flow line 51. If the turbidity sensor 45 at tank 35 indicates that the water in tank 35 is too dirty for use as rinse water, the pump 41 will be activated and the pump 40 will be deactivated so that only reuse flow line 51 receives water from tank

35. If the turbidity sensor 45 indicates that the water quality in tank 35 is good enough, pump 41 is deactivated and pump 40 is activated so that the water contained in tank 35 is used in flow line 49 for rinse water.

Flow lines are provided for supplying fluid to the various zones 13-17 after the modulating valves have controlled the percentage of water that flows from various of the different headers or flow lines. For example, the first wash zone flow line 52 receives flow through valves 27 and 28 from either fresh water header 24 or rinse water flow line 49. The second wash zone flow line 53 receives water that passes through valves 29, 30 and 31. The valve 29 controls the flow of fresh water, the valve 30 controls the flow of rinse water and the valve 31 controls the flow of treated water. Main rinse flow line 54 receives water directly from header 24 as controlled by valve 32. Fine rinse flow line 55 receives water from valves 33, 34 that includes a selective amount of fresh water from header 34 and rinse water from flow line 49.

Computer controls can be programmed to set the ratio of flow for each water loop into each of the 5 zones. These formulas are assigned to a wash classification. When different goods are in adjacent modules, the computer controls can set the water flow and ratios to the program that uses the most fresh water. Additionally, the computer controls can be programmed according to chemical and water loop compatibility setting the formula to the safest chemical formula highest fresh water settings.

Water that exits the wet out zone 13 via flow line 62 is typically waste water that is discarded to a suitable discharge site. Water exiting first wash zone 52 can either be discarded to a suitable discharge site or used as reuse water and added via flow line 63 to reuse flow line 51.

Figure 2 includes some preferred ranges for water for reusing water in various zones. The ranges are about zero to about the amount shown.

PARTS LIST

The following is a list of suitable parts and materials for the various elements of the preferred embodiment of the present invention.

PARTS LIST

PART NO.	DESCRIPTION
1	cell
2	cell

3	cell
4	cell
5	cell
6	cell
7	cell
8	cell
9	cell
10	cell
11	cell
12	cell
13	wet out zone
14	first wash zone
15	second wash zone
16	main rinse zone
17	fine rinse and finish zone
18	inlet
19	outlet
20	tunnel batch washer
20A	housing
21	arrow
22	press water return tank
23	arrow
24	fresh water header
25	modulating valve
26	modulating valve
27	modulating valve
28	modulating valve
29	modulating valve
30	modulating valve
31	modulating valve
32	modulating valve
33	modulating valve

34	modulating valve
35	tank
36	tank section
37	tank section
38	tank
39	pump
40	pump
41	pump
42	pump
43	centrifugal separator
44	ozone injector
45	turbidity sensor
46	valve
47	valve
48	valve
49	rinse water flow line
50	treated water flow line
51	reuse water flow line
52	first wash zone flow line
53	second wash zone flow line
54	main rinse flow line
55	fine rinse flow line
56	press water return flow line
57	pump suction line
58	pump suction line
59	pump suction line
60	pump suction line
61	reject solids flow line
62	reject flow line
63	reuse flow line

The foregoing embodiments are presented by way of example only; the scope of the present invention is to be limited only by the following claims.

CLAIMS

1. A continuous tunnel batch washer apparatus, comprising:

a) an elongated outer housing having opposing ends, an inlet at one of said ends and an outlet at the other of said ends, the housing having a water containing portion;

b) a plurality of lateral walls dividing at least a portion of the housing into a plurality of cells;

c) the housing containing a plurality of drums, each being rotatably supported within the water containing portion of the frame, each having a drum inlet for enabling goods to be washed to enter the drum and a drum outlet for enabling the goods to exit the drum, and at least some of the cells having drums therein;

d) a fresh water header for supplying water to the water containing portion of the housing;

e) a rinse water flow line that receives water that has been discharged from the water containing portion of the housing;

f) a treated water flow line that receives water that has been discharged from the water containing portion of the housing;

g) means for removing solid waste material from water flowing in at least one of the flow lines that receives water that has been discharged from the water containing portion of the housing and for transmitting such treated water to the treated water flow line; and

h) wherein water flowing in the treated water flow line supplies water to the wash zone.

2. The continuous tunnel batch washer apparatus of claim 1 wherein water flowing in the rinse water flow line supplies water to the wash zone.

3. The continuous tunnel batch washer apparatus of claim 1 wherein the water flowing in the treated water flow line is flowing a high flow rate that is higher than the flow rate of water flowing in the fresh water header.

4. The continuous tunnel batch washer apparatus of claim 1 wherein the water flowing in the treated water flow line is flowing a high flow rate that is higher than the flow rate of water flowing in the rinse flow line.

5. The continuous tunnel batch washer apparatus of claim 1 further

comprising a turbidity meter for monitoring the turbidity of water that has been discharged from the water containing portion of the housing.

6. The continuous tunnel batch washer apparatus of claim 1 further comprising a plurality of valves that automatically meter the flow of water from the treated water and rinse water to the cells.

7. The continuous tunnel batch washer apparatus of claim 1 further comprising a plurality of valves that automatically meter the flow of water from the treated water and fresh water to the cells.

8. The continuous tunnel batch washer apparatus of claim 1 further comprising a plurality of valves that automatically meter the flow of water from the rinse water and fresh water to the cells.

9. The continuous tunnel batch washer apparatus of claim 1 wherein the means for removing solid waste includes a centrifugal separator.

10. The continuous tunnel batch washer apparatus of claim 1 further comprising means for injecting ozone into the treated water flow line.

11. A continuous tunnel batch washer apparatus, comprising:

a) an elongated outer housing having opposing ends, a hopper inlet at one of said ends and an outlet at the other of said ends, the housing having a water containing portion;

b) a plurality of lateral walls dividing at least a portion of the housing into a plurality of cells;

c) the housing containing a plurality of drums, each being rotatably supported within the water containing portion of the frame, each having a drum inlet for enabling goods to be washed to enter the drum and a drum outlet for enabling the goods to exit the drum, and at least some of the cells having drums therein;

d) at least a plurality of the drums having inclined chutes that transfer goods to be washed from one cell to another adjacent cell when the drums are rotated a selected angular amount;

e) a fresh water header for supplying water to the water containing portion of the housing;

f) a rinse water flow line that receives water that has been discharged from the water containing portion of the housing;

g) a treated water flow line that receives water that has been discharged from the water containing portion of the housing;

h) means for removing solid waste material from water flowing in at least one of the flow lines that receives water that has been discharged from the water containing portion of the housing and for transmitting such treated water to the treated water flow line; and

i) wherein water flowing in the treated water flow line supplies water to the wash zone.

12. A continuous tunnel batch washer apparatus, comprising:

a) an elongated outer housing having opposing ends, an inlet at one of said ends and an outlet at the other of said ends, the housing having a water containing portion;

b) a plurality of lateral walls dividing at least a portion of the housing into a plurality of cells;

c) the housing containing a plurality of drums, each being rotatably supported within the water containing portion of the frame, each having a drum inlet for enabling goods to be washed to enter the drum and a drum outlet for enabling the goods to exit the drum, and at least some of the cells having drums therein;

d) a fresh water header for supplying water to the water containing portion of the housing;

e) a rinse water flow line that receives water that has been discharged from the water containing portion of the housing;

f) a treated water flow line that receives water that has been discharged from the water containing portion of the housing, the treated water flow line having a flow rate that is greater than the flow rates in the fresh water header or rinse water flow line;

g) a separator that enables solid waste material to be removed from water flowing in at least one of the flow lines that receives water that has been discharged from the water containing portion of the housing and for transmitting such treated water to the treated water flow line; and

h) wherein water flowing in the treated water flow line supplies at least part of the water to the wash zone.

13. The continuous tunnel batch washer apparatus of claim 12 wherein water

flowing in the rinse water flow line supplies water to the wash zone.

14. The continuous tunnel batch washer apparatus of claim 12 wherein the water flowing in the treated water flow line is flowing a much higher flow rate than the flow rate of water flowing in the fresh water header.

15. The continuous tunnel batch washer apparatus of claim 12 wherein the water flowing in the treated water flow line is flowing a much higher flow rate than the flow rate of water flowing in the rinse flow line.

16. The continuous tunnel batch washer apparatus of claim 12 further comprising a turbidity meter for monitoring the turbidity of water that has been discharged from the water containing portion of the housing.

17. The continuous tunnel batch washer apparatus of claim 12 further comprising a plurality of valves that automatically meter the flow of water from the treated water and rinse water to the cells.

18. The continuous tunnel batch washer apparatus of claim 12 further comprising a plurality of valves that automatically meter the flow of water from the treated water and fresh water to the cells.

19. The continuous tunnel batch washer apparatus of claim 12 further comprising a plurality of valves that automatically meter the flow of water from the rinse water and fresh water to the cells.

20. The continuous tunnel batch washer apparatus of claim 12 wherein the means for removing solid waste includes a centrifugal separator.

21. The continuous tunnel batch washer apparatus of claim 12 further comprising means for injecting ozone into the treated water flow line.

22. A continuous tunnel batch washer apparatus, comprising:

a) an elongated outer housing having opposing ends, a hopper inlet at one of said ends and an outlet at the other of said ends, the housing having a water containing portion;

b) a plurality of lateral walls dividing at least a portion of the housing into a plurality of cells;

c) the housing containing a plurality of drums, each being rotatably supported within the water containing portion of the frame, each having a drum inlet for enabling goods to be washed to enter the drum and a drum outlet for enabling the goods to exit the

drum, and at least some of the cells having drums therein;

d) at least a plurality of the drums having inclined chutes that transfer goods to be washed from one cell to another adjacent cell when the drums are rotated a selected angular amount;

e) a fresh water header for supplying water to the water containing portion of the housing;

f) a rinse water flow line that receives water that has been discharged from the water containing portion of the housing;

g) a treated water flow line that receives water that has been discharged from the water containing portion of the housing;

h) means for removing solid waste material from water flowing in at least one of the flow lines that receives water that has been discharged from the water containing portion of the housing and for transmitting such treated water to the treated water flow line; and

i) wherein water flowing in the treated water flow line flows at a rate that is at least twice as high as the flow rate of one of the other flow lines.

23. A continuous tunnel batch washer apparatus, comprising:

a) an elongated outer housing having opposing ends, an inlet at one of said ends and an outlet at the other of said ends, the housing having a water containing portion;

b) a plurality of lateral walls dividing at least a portion of the housing into a plurality of cells, the cells being grouped into a first wash zone group of one or more cells, a second wash zone of one or more cells, a main rinse zone of one or more cells and a fine rinse zone of one or more cells;

c) the housing containing a plurality of drums, each being rotatably supported within the water containing portion of the frame, each having a drum inlet for enabling goods to be washed to enter the drum and a drum outlet for enabling the goods to exit the drum, and at least some of the cells having drums therein;

d) a fresh water header for supplying water to the water containing portion of the housing;

e) a rinse water flow line that receives water that has been discharged from the water containing portion of the housing the rinse water flow line transmitting at lest

some water back to the housing;

f) a treated water flow line that receives water that has been discharged from the water containing portion of the housing;

g) a separator for removing solid waste material from water flowing in at least one of the flow lines that receives water that has been discharged from the water containing portion of the housing and for transmitting such treated water to the treated water flow line; and

h) wherein water flowing in the treated water flow line supplies water to the wash zone;

i) a sensor that determines whether or not all or part of the rinse water is either discarded or transmitted to the reuse flow line.

24. The continuous tunnel batch washer apparatus of claim 23 wherein water flowing in the rinse water flow line supplies water to one of the wash zones.

25. The continuous tunnel batch washer apparatus of claim 23 wherein the water flowing in the treated water flow line is flowing a high flow rate that is higher than the flow rate of water flowing in the fresh water header.

26. The continuous tunnel batch washer apparatus of claim 23 wherein the water flowing in the treated water flow line is flowing a high flow rate that is higher than the flow rate of water flowing in the rinse flow line.

27. The continuous tunnel batch washer apparatus of claim 23 wherein the sensor is a turbidity meter that monitors the turbidity of water that has been discharged from the water containing portion of the housing.

28. The continuous tunnel batch washer apparatus of claim 23 further comprising a plurality of valves that meter the flow of water from the treated water and rinse water to the cells.

29. The continuous tunnel batch washer apparatus of claim 23 further comprising a plurality of valves that automatically meter the flow of water from the treated water and fresh water to the cells.

30. The continuous tunnel batch washer apparatus of claim 1 further comprising a plurality of valves that automatically meter the flow of water from the rinse water and fresh water to the cells.

31. The continuous tunnel batch washer apparatus of claim 23 wherein the

separator is a centrifugal separator.

32. The continuous tunnel batch washer apparatus of claim 23 further comprising means for injecting ozone into the treated water flow line.

33. A continuous tunnel batch washer apparatus, comprising:

a) an elongated outer housing having opposing ends, a hopper inlet at one of said ends and an outlet at the other of said ends, the housing having a water containing portion;

b) a plurality of lateral walls dividing at least a portion of the housing into a plurality of cells;

c) the housing containing a plurality of drums, each being rotatably supported within the water containing portion of the frame, each having a drum inlet for enabling goods to be washed to enter the drum and a drum outlet for enabling the goods to exit the drum, and at least some of the cells having drums therein;

d) at least a plurality of the drums having inclined chutes that transfer goods to be washed from one cell to another adjacent cell when the drums are rotated a selected angular amount;

e) a fresh water header for supplying water to the water containing portion of the housing;

f) a rinse water flow line that receives water that has been discharged from the water containing portion of the housing;

g) a treated water flow line that receives water that has been discharged from the water containing portion of the housing;

h) a separator for removing solid waste material from water flowing in at least one of the flow lines that receives water that has been discharged from the water containing portion of the housing and for transmitting such treated water to the treated water flow line;

i) wherein water flowing in the treated water flow line supplies water to the wash zone; and

j) a sensor that determines whether or not all or part of the rinse water is either discarded or transmitted to the reuse flow line.

34. A continuous tunnel batch washer apparatus, comprising:

a) an elongated outer housing having opposing ends, an inlet at one of said

ends and an outlet at the other of said ends, the housing having a water containing portion;

b) a plurality of lateral walls dividing at least a portion of the housing into a plurality of cells;

c) the housing containing a plurality of drums, each being rotatably supported within the water containing portion of the frame, each having a drum inlet for enabling goods to be washed to enter the drum, a drum outlet for enabling the goods to exit the drum, and at least some of the cells having drums therein, the housing having one or more water discharge outlets for enabling water to be discharged from the housing;

d) a fresh water header for supplying water to the water containing portion of the housing;

e) a tank that receives discharged water via an outlet;

f) a rinse water flow line that is receptive of water that has been discharged from the tank;

g) a treated water flow line that is receptive of water that has been discharged from the tank;

h) a separator that enables solid waste material to be removed from water flowing in treated water flow line;

i) wherein water flowing in the treated water flow line supplies at least part of the water to the wash zone; and

j) a sensor that determines whether or not all or part of the rinse water is either discarded or transmitted to the reuse flow line.

35. The continuous tunnel batch washer apparatus of claim 34 wherein water flowing in the rinse water flow line supplies water to the wash zone.

36. The continuous tunnel batch washer apparatus of claim 35 wherein the water flowing in the treated water flow line is flowing a much higher flow rate than the flow rate of water flowing in the fresh water header.

37. The continuous tunnel batch washer apparatus of claim 35 wherein the water flowing in the treated water flow line is flowing a much higher flow rate than the flow rate of water flowing in the rinse flow line.

38. The continuous tunnel batch washer apparatus of claim 35 wherein the sensor includes a turbidity meter for monitoring the turbidity of water that has been

discharged from the water containing portion of the housing.

39. The continuous tunnel batch washer apparatus of claim 35 further comprising a plurality of valves that meter the flow of water from the treated water and rinse water to the cells.

40. The continuous tunnel batch washer apparatus of claim 35 further comprising a plurality of valves that automatically meter the flow of water from the treated water and fresh water to the cells.

41. The continuous tunnel batch washer apparatus of claim 35 further comprising a plurality of valves that meter the flow of water from the rinse water and fresh water to the cells.

42. The continuous tunnel batch washer apparatus of claim 34 wherein the means for removing solid waste includes a centrifugal separator.

43. The continuous tunnel batch washer apparatus of claim 35 further comprising means for injecting ozone into the treated water flow line.

44. A continuous tunnel batch washer apparatus, comprising:

a) an elongated outer housing having opposing ends, a hopper inlet at one of said ends and an outlet at the other of said ends, the housing having a water containing portion;

b) a plurality of lateral walls dividing at least a portion of the housing into a plurality of cells, the cells being grouped into a first wash zone group of one or more cells, a second wash zone of one or more cells, a main rinse zone of one or more cells and a fine rinse zone of one or more cells;

c) the housing containing a plurality of drums, each being rotatably supported within the water containing portion of the frame, each having a drum inlet for enabling goods to be washed to enter the drum and a drum outlet for enabling the goods to exit the drum, and at least some of the cells having drums therein;

d) at least a plurality of the drums having inclined chutes that transfer goods to be washed from one cell to another adjacent cell when the drums are rotated a selected angular amount;

e) a fresh water header for supplying water to the water containing portion of the housing;

f) a rinse water flow line that receives water that has been discharged from

the water containing portion of the housing;

g) a treated water flow line that receives water that has been discharged from the water containing portion of the housing;

h) means for removing solid waste material from water flowing in at least one of the flow lines that receives water that has been discharged from the water containing portion of the housing and for transmitting such treated water to the treated water flow line; and

i) wherein water flowing in the treated water flow line flows at a rate that is at least twice as high as the flow rate of one of the other flow lines.

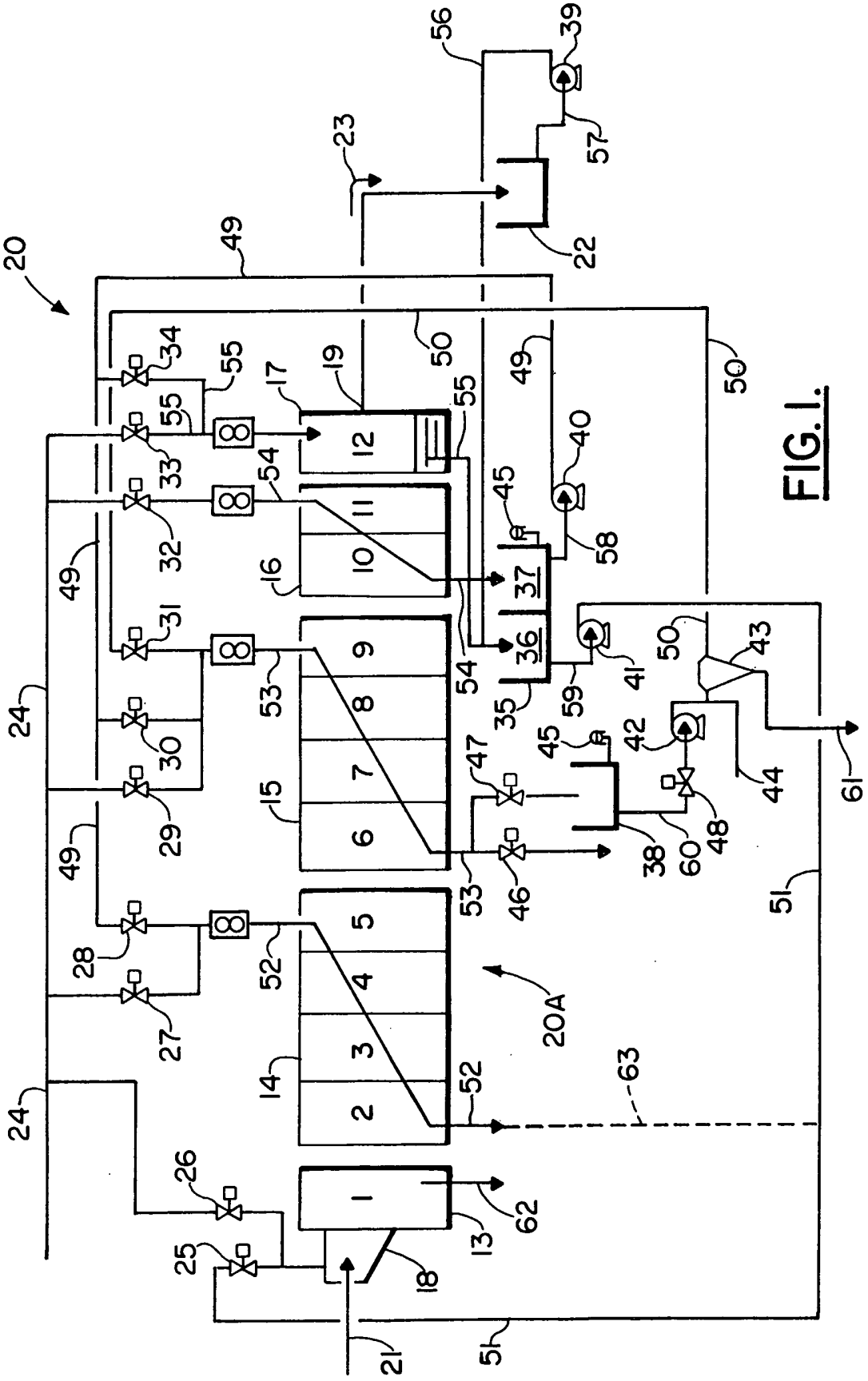
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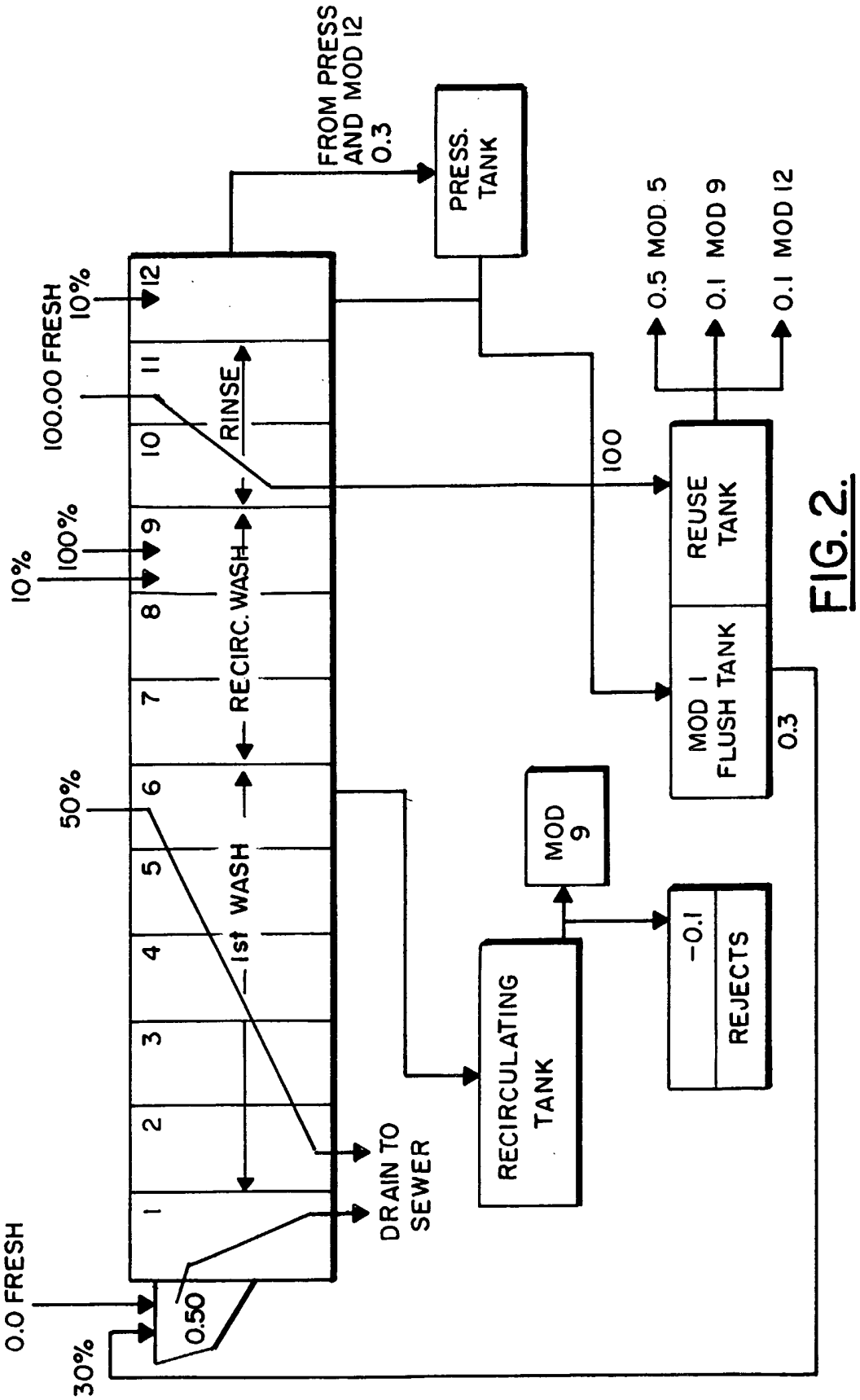
FIG. I.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PRESS. TANK
0.5 MOD 5
0.1 MOD 9
0.1 MOD 12
100
REUSE TANK
MOD 1 FLUSH TANK
0.3
MOD 9
-0.1
REJECTS
RECIRCULATING TANK
DRAIN TO SEWER
10%
100.00 FRESH
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10%
50%
0.0 FRESH
30%
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FIG. 2.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US02/26416

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : D06F 31/00
US CL : 68/27,58,139,140,142,143,147,147,173,210

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 68/27,58,139,140,142,143,147,147,173,210

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- A	US 5,203,359 A (FESMIRE et al) 20 April 1993 (20.04.1993), abstract; column 11, line 33-column 16, line 4; column 17, line 33-column 20, line 39.	1-4, 6-8, 11-15, 17-19, 22, 44 --- 5, 9-10, 16, 20-21, 23-43
A	US 5,454,237 (PELLERIN) 03 October 1995 (03.10.1995), entire reference.	1-44
A	US 5,211,039 (PELLERIN) 18 May 1993 (18.05.1993), entire reference.	1-44
A	US 4,519,224 (SEIFERT et al) 28 May 1985 (28.05.1985), entire reference.	1-44
A	US 4,485,509 (PELLERIN et al) 04 December 1984 (04.12.1984), entire reference.	1-44
A	US 4,236,393 (KATZFEY) 02 December 1980 (01.12.1980), entire reference.	1-44
A	US 4,020,659 (BHAVSAR) 03 May 1977 (03.05.1977), entire reference.	1-44

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"E" earlier application or patent published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 December 2002 (12.12.2002)	30 DEC 2002
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230	Authorized officer Randy Gulakowski Telephone No. (703)308-0661

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PCT/US02/26416

INTERNATIONAL SEARCH REPORT

C. (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3,693,639 (CORBETT) 26 September 1972 (26.09.1972), entire reference.	1-44
A	US 3,550,406 (JACK, JR et al) 29 December 1970 (29.12.1970), entire reference.	1-44
A	US 3,336,768 (KLEEFISCH) 22 August 1967 (22.08.1967), entire reference.	1-44