Nov. 17, 1970 J. M. PORTER ET AL 3,540,231

TWO STAGE ABSORPTION REFRIGERATION MACHINE WITH FLASH GAS AND CARRYOVER CONTROL IN SECOND STAGE GENERATOR

Filed Dec. 20, 1968

2 Sheets-Sheet 1

FIG. 1

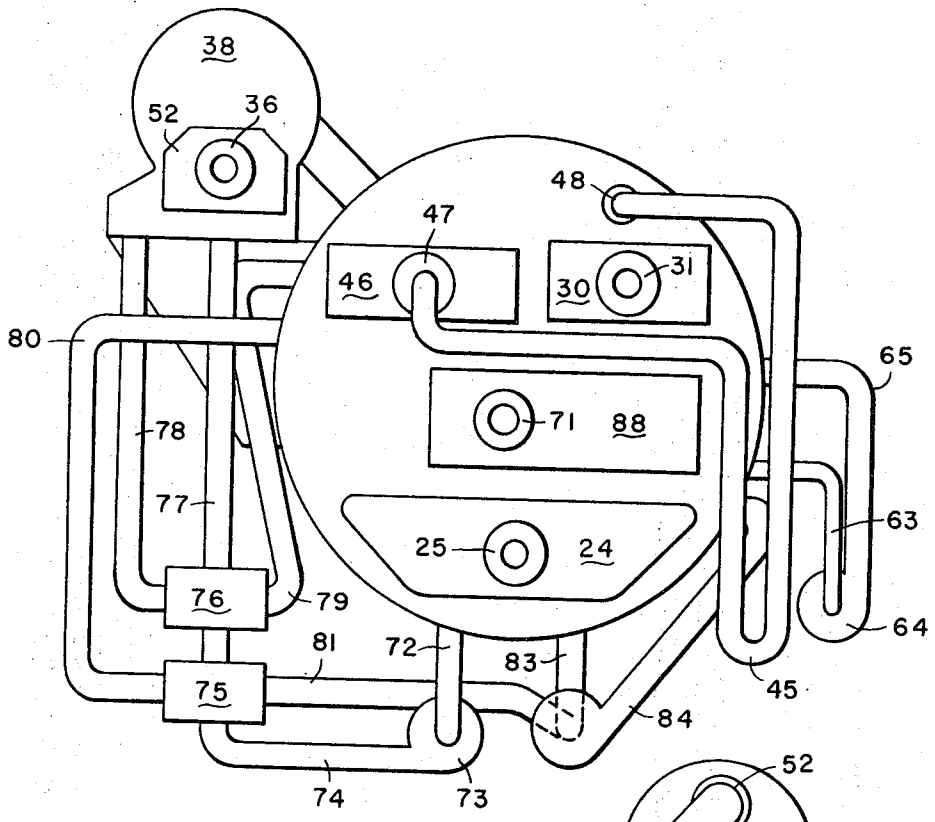
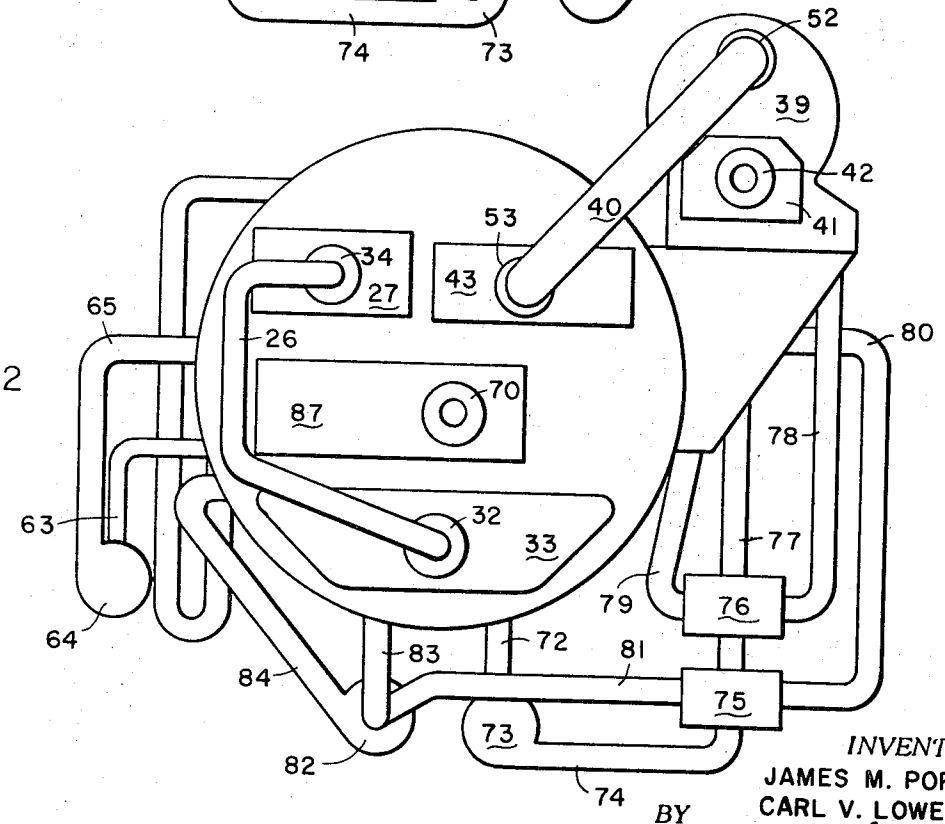


FIG. 2



INVENTORS
JAMES M. PORTER
CARL V. LOWETH

BY

ATTORNEY

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FIG. 3

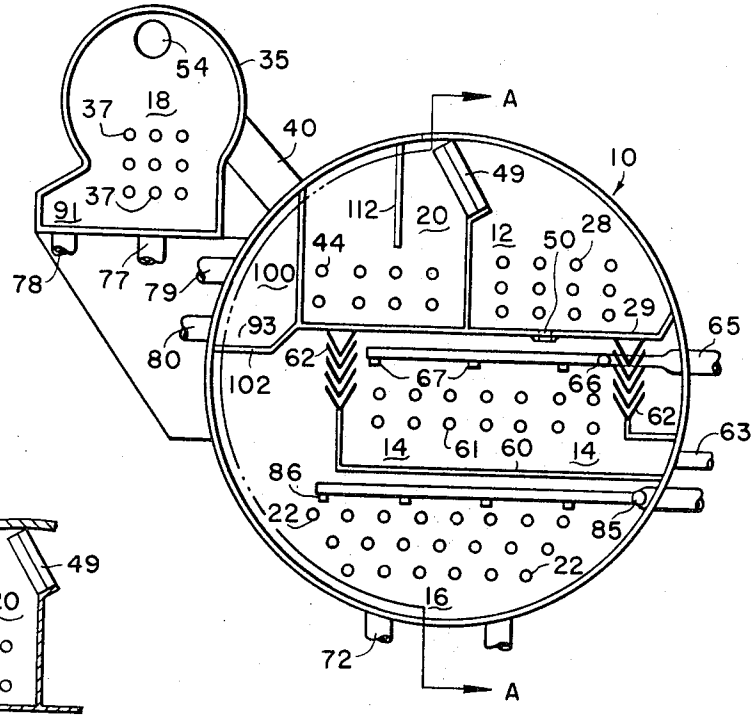


FIG. 5

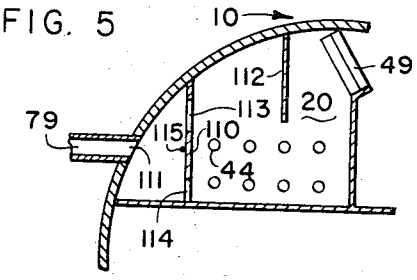
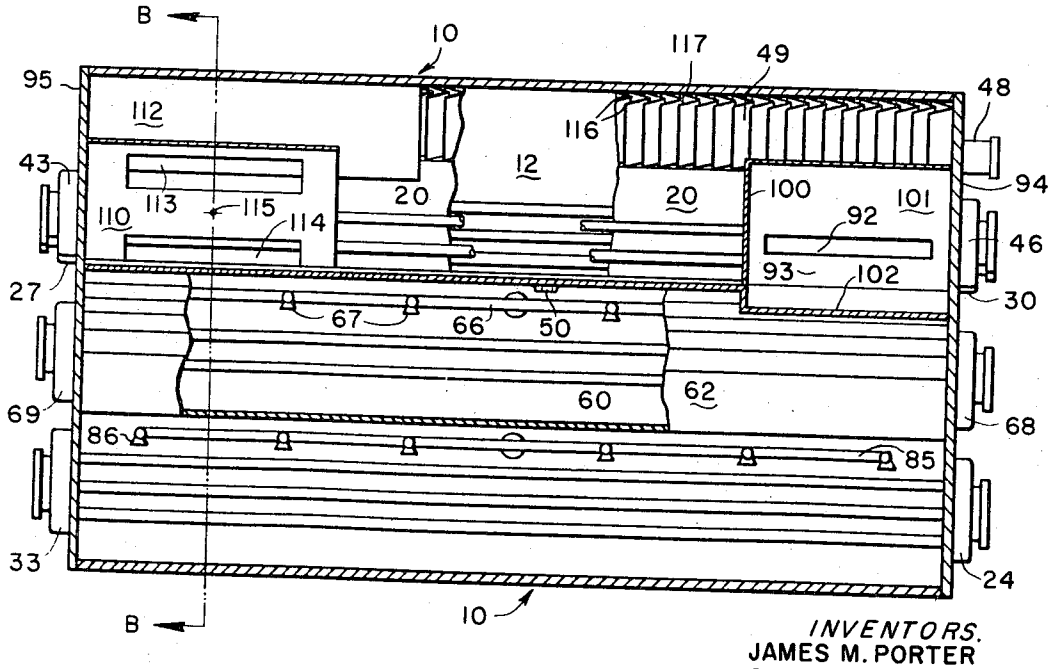


FIG. 4



INVENTORS.
JAMES M. PORTER
CARL V. LOWETH
BY
ATTORNEY

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3,540,231

TWO STAGE ABSORPTION REFRIGERATION MACHINE WITH FLASH GAS AND CARRY-OVER CONTROL IN SECOND STAGE GENERATOR

James M. Porter, La Crosse, and Carl V. Loweth, Onalaska, Wis., assignors to The Trane Company, a corporation of Wisconsin

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Int. Cl. F25b 15/06
U.S. Cl. 62—495 7 Claims

ABSTRACT OF THE DISCLOSURE

The structural relationship of a two stage generator absorption refrigeration machine is disclosed. A primary shell contains a low pressure generator, a condenser, an evaporator, and an absorber. A separate shell contains a high pressure generator. The low pressure generator includes flash gas and carryover control baffles.

BACKGROUND OF THE INVENTION

Field of the invention

This invention relates to a refrigeration machine, and more particularly, to a two stage generator absorption refrigeration machine containing an improved low pressure generator construction.

Description of the prior art

Two stage absorption refrigeration machines contain a first stage high pressure generator and a second stage low pressure generator for concentrating absorbent solution and liberating refrigerant in the form of vapor. This vapor is then condensed and reevaporated to chill a fluid which is circulated to a heat load. The evaporated refrigerant is absorbed by an absorbent solution. The diluted absorbent solution is circulated to the first stage generator for partial concentration. It is further concentrated in the second stage generator.

The first stage generator operates at a substantially higher pressure than does the second stage generator. The partially concentrated solution leaving the first stage generator has a tendency to flash or partially vaporize when it enters the lower pressure second stage generator. The vapor produced when the partially concentrated solution flashes entrains some liquid absorbent solution which is carried over into the condenser. This liquid, of course, contains absorbent, the presence of which is undesirable in the condenser.

SUMMARY OF THE INVENTION

This invention therefor provides an absorption refrigeration machine including an absorber section, an evaporator section, a condenser section, a first stage high pressure generator section, and a second stage low pressure generator section. The improvement in this refrigeration machine comprises: a conduit means for feeding intermediate strength absorbent solution to the low pressure generator section from the high pressure generator section, wall and floor means forming low pressure generator section, and a first baffle within the low pressure generator section spaced from the inlet of the conduit means. The wall means contains an eliminator means which places the condenser section and the low pressure generator section in vapor communication. The first baffle intersects the longitudinal axis of the inlet of the conduit means.

The first baffle preferably has a first opening above the longitudinal axis of the inlet to allow vapor to pass beyond the baffle and a second opening below the longitudinal axis to allow liquid to travel past the first baffle.

Preferably, the improvement includes a second baffle positioned in a path between first opening in the first baffle and the eliminator means.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front view of the absorption refrigeration machine of the present invention.

FIG. 2 is a rear view of the absorption refrigeration machine of FIG. 1.

FIG. 3 is a front view of the absorption refrigeration machine of FIG. 1 in which the front tube sheets of the primary and first stage generator shells have been omitted. The external piping has also been deleted for simplicity.

FIG. 4 is a side view of the primary shell taken along section A—A of FIG. 3.

FIG. 5 is a partial cross sectional front elevation view of the primary shell taken along section B—B of FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring jointly to FIGS. 1, 2, and 3, the absorption refrigeration machine comprises a first fluid tight shell **10** which encloses a condenser section **12**, an evaporator **14**, an absorber **16**, and a second stage generator, low pressure **20**. A second fluid tight shell **35** encloses the first stage, high pressure generator **18**.

The absorber **16** has a heat exchanger, comprising longitudinally extending tubes **22**, which is supplied with cooling fluid from a source not shown through header **24**. Connection with the conduit from the cooling fluid source is made with flange **25**. Header **24** supplies all of tubes **22**. The cooling fluid, which can be water which is evaporatively cooled by air, is conducted from header **33** by conduit **26** from the rear of the heat exchange tubes **22** to a header **27** which supplies heat exchange tubes **28** in condenser **12**. Connection of conduit **26** with headers **33** and **27** is made by means of flanges **32** and **34**, respectively. A wall **29** substantially encloses the condenser section. The cooling fluid leaves the condenser through header **30** and returns to the cooling fluid source via a conduit (not shown) connected to flange **31**. It is understood, of course, that any of a variety of connections may be made with the heat exchangers of this machine without departing from the inventive concept; for example, heat exchangers **22** and **28** can be independently connected to a source of cooling fluid, and each can be altered to produce a two-pass effect.

High pressure steam, or other heating medium, flows from a source, such as a boiler (not shown), into header **52** by connection with flange **36**. The steam flows from header **52** into heat exchange tubes **37** in high pressure generator **18**. End plate **38** has a dual function; it serves not only as the end plate which seals the ends of shell **35**, but also is the tube sheet for heat exchange tubes **37**. End plate **39** serves the same purpose at the opposite end of the generator **18** and additionally provides connection with conduit **40**. Heat exchange tubes **37** terminate within end plate **39** and in fluid communication with header **41**. A restrictor means is normally attached to flange **42** to prevent escape of steam from the heat exchange tubes **37** until it has condensed, allowing essentially only condensate to leave the heat exchange tubes **37** through connection **42**. This restrictor means can be any suitable steam flow restrictor such as an orifice or a float valve. Alternatively, the restrictor can be mounted within the generator **12**.

Heat from condensing steam in the heat exchange tubes **37** causes dilute absorbent solution present in the first stage generator to boil. The steam condensate from the aforementioned restrictor means flows back to the steam generating source. It is to be understood, of course, that

any other suitable heat source can be substituted for the first stage generator heat exchanger without substantially modifying the principals of construction of this invention.

Various types of refrigerants and absorbents may be used in the present machine. A solution of lithium bromide absorbent in a refrigerant such as water is satisfactory. Other suitable absorbents and refrigerants may be used if desired. The term "concentrated solution" as used herein means a solution which is concentrated in an absorbent. A "weak solution" is a solution dilute in absorbent. A solution having a concentration between that of a concentrated solution and a weak solution is termed as "intermediate strength solution."

The refrigerant vapor generated in the first stage generator **18** flows through conduit **40** and into the second stage low pressure generator **20**. Conduit **40** is connected to flanges **52** and **53**, the latter of which allows access to header **43**. The refrigerant vapor flows from header **43** into heat exchange tubes **44**. The refrigerant vapor condenses and releases heat to further concentrate intermediate strength solution present in the second stage generator **20**. A flow regulating device in the form of an orifice or a trap **45** regulates the flow of refrigerant from the heat exchange tubes **44** into the condenser **12**.

Trap **45** is connected with heat exchange tubes **44** via header **46** onto which it is attached at flange **47**. Refrigerant condensed in heat exchange tubes **44** enters the condenser **12** at a connection **48** above header **30**. The difference in pressure between the condenser and heat exchange tubes **44** forces the condensed refrigerant from the tubes **44** into the condenser. Trap **45** functions to prevent flow of any refrigerant vapor from heat exchange tubes **44** into the condenser **12**. The vapor produced from the boiling intermediate strength solution in the second stage generator **20** passes through liquid eliminator **49** where it is condensed into a liquid in condenser **12**. The total liquid refrigerant flows from the condenser through opening or orifice **50** into evaporator **14**.

The liquid refrigerant is evaporated in evaporator **14**, thus removing heat from the fluid in heat exchange tubes **61**. The refrigerant vapor produced passes through liquid eliminators **62** and into the absorber section **16**. Unevaporated liquid refrigerant is collected in pan **60** from which it enters conduit **63** and is recirculated by pump means **64** through conduit **65** into spray header **66**. From header **66** the liquid refrigerant is sprayed over heat exchange tubes **61** through spray nozzles **67**. Fluid from a heat load is circulated through heat exchange tubes **61** by connection with flanges **70** and **71** on headers **87** and **88**. The fluid circulated through heat exchange tubes **61** is cooled by the evaporating refrigerant. It is thereafter returned to the heat load.

Absorbent solution present in absorber **16** absorbs refrigerant vapor produced in evaporator **14**. The solution from the absorber **16** flows through a conduit **72** in the bottom of the absorber section. The absorbent solution from conduit **72** is circulated by pump **73** through conduit **74**, a low temperature heat exchanger **75**, a high temperature heat exchanger **76**, and conduit **77** from which it enters high temperature generator **18**. The absorbent solution flowing into generator **18** is partially concentrated therein.

The partially concentrated solution from high temperature generator **18** flows through conduit **78** to high temperature heat exchanger **76** in which it gives up heat to weak solution flowing into conduit **77**. It then flows through conduit **79** into low temperature generator **20**, in which it is further concentrated. The concentrated solution from the second stage generator **20** flows through conduit **80**, through low temperature heat exchanger **75** into conduit **81** which is connected to the inlet of pump **82**. Dilute solution flowing from absorber **16** through conduit **83** also enters the inlet of pump **82** where it is mixed with the concentrated solution flowing from conduit **81**. The weak and concentrated solutions are mixed in pump **82** and are forced through conduit **84** to spray header **85**, from which it is distributed over heat exchange tubes **22** by spray nozzles **86**.

It will be understood by one skilled in the absorption refrigeration art that motive power is necessray to drive pumps **64**, **73**, and **82**. The preferred power source is, of course, an electric motor. Each pump can be driven by a separate motor, or a single motor can be employed to drive all pumps with a single shaft.

Referring now to FIGS. 3, 4, and 5, the internal arrangement of the component sections of the absorption machine will be further described. The repetitive numerals used in FIGS. 4 and 5 correspond to those utilized in the preceding figures. High temperature generator **18** can have a length equal to that of main shell **10**. In this embodiment generator shell **35** has an upper circular section and a lower liquid tank section **91**. Partially concentrated absorbent solution is collected in tank **91** before it flows into conduit **78**. Refrigerant vapor produced in high pressure generator **18** flows through opening **54** into conduit **40**. Intermediate strength solution flows into low pressure generator **20** through conduit **79**.

Concentrated solution flows out of low pressure generator **20** through weir **92** in wall **101** into compartment **93**. From this compartment the concentrated absorbent solution flows into conduit **80**. Compartment **93** is enclosed by walls **100** and **101** and by bottom plate **102**. The liquid eliminators **49** are a series of spaced V-shaped plates positioned as shown in FIGS. 3 and 4 so that the edges **116** of one plate overlap the V-intersection **117** of the next adjacent plate. This construction provides a tortuous path for refrigerant vapor to enter the condenser facilitating removal of entrained liquid refrigerant.

It will be noted that all of the heat exchange tubes are longitudinally extending relative to the main shell **10** and generator shell **35**. End plates **94** and **95** attached at the ends of shell **10** serve a dual function. They seal and form the end portions of the various compartments within the shell. Furthermore, the heat exchange tubes extend through to the outside of end plates **94** and **95**. Thus the end plates form the tube sheets for all of the heat exchangers in primary shell **10**. The headers **24**, **27**, **30**, **33**, **43**, **46**, **68** and **69** are mechanically attached to the end plates for distributing the various fluids through the heat exchange tubes.

The second stage generator receives partially concentrated solution from the first stage high pressure generator through conduit **79**. FIG. 5 illustrates the rear portion of low pressure generator **20** taken along section B—B of FIG. 4. Baffle **110** is positioned in spaced relationship to the inlet **111** of conduit **79**. As the partially concentrated, intermediate strength absorbent solution enters the low pressure generator from the high pressure generator, the pressure reduction will cause it to flash, producing a vapor in which liquid absorbent solution is entrained. Baffle **110** intersecting the longitudinal axis (indicated on baffle **110** by point **115**) of the inlet **111** prevents the flashing absorbent solution from carrying across low pressure generator **20** and inhibits the flow of entrained liquid through eliminators **49**. Baffle **110** has an opening **113** in its upper portion which allows vapor and some entrained liquid to pass beyond baffle **110**. An additional opening **114** is included in the lower portion of baffle **110** to allow free flow of absorbent solution from the inlet **111** to the area of low pressure generator **20** occupied by heat exchange tubes **44**. An additional baffle **112** is placed in the path between eliminators **49** and opening **113** of baffle **110**. Vapor and entrained liquid passing through opening **113** will impinge upon baffle **112**. Since baffle **112** is attached to the roof (primary shell **10**) of the low pressure generator **20**, this vapor must pass below baffle **112** to enter eliminators **49**. Substantially all of the liquid absorbent solution entrained in the flash vapor is removed by baffle **112**. It will be noted that baffles **110** and **112** do not extend

the full length of evaporator **20** as the area near inlet **111** is the only portion of evaporator **20** effected by the flash problem.

The absorber section **18** is in vapor communication with the evaporator section **14**. Condenser **12** is in liquid communication with the evaporator section **14** through the orifice **50**. The condenser **12** receives refrigerant liquid from heat exchange tubes **44** via connection **48** and is also in vapor communication with the low pressure generator **20** through liquid eliminators **49**. The relative arrangement of the sections as shown in FIG. 3 are preferred, that is, the low pressure generator and condenser substantially horizontally contiguous in the upper portion of the main shell, the absorber in the lower portion of the main shell, and the evaporator above the absorber. The high pressure generator is preferably located to provide a liquid level therein above any liquid level existing in the main shell. However, other arrangements of the low pressure generator, the condenser, the evaporator, and the absorber within the main shell **10** can be made without departing from the present invention. Of course, the shells **10** and **35** need not be of the cylindrical cross section as shown. They may be of any desired cross section; however, the cylindrical shape is most desirable.

Flow, pressure, safety, and miscellaneous control is necessary for proper operation of the absorption refrigeration machine disclosed above. For an example of an appropriate control mechanism for the instant machine, refer to the copending application, Ser. No. 785,512, filed Dec. 20, 1968, the disclosure of which is incorporated herein by reference.

The utility and need for the generator construction of this invention are apparent from the foregoing description. Therefore, what is claimed is:

1. An absorption refrigeration machine including an absorber section, an evaporator section, a condenser section, a high pressure generator section, and a low pressure generator section, the improvement therein comprising:

(a) conduit means for feeding intermediate strength absorbent solution to said low pressure generator section from said high pressure generator section,

(b) wall and floor means forming said low pressure generator section, said wall means containing eliminator means placing said contenser section and said low pressure generator section in vapor communication,

(c) a first baffle within said low pressure generator section spaced from the inlet of said conduit means, said baffle intersecting the longitudinal axis of the inlet of said conduit means.

2. The machine of claim **1** wherein said baffle has a first opening above said axis for passage of vapor.

3. The machine of claim **2** wherein said baffle has a second opening below said axis for passage of liquid.

4. The machine of claim **2** additionally comprising a second baffle positioned in a path between said first opening and said eliminator means.

5. The machine of claim **3** wherein said inlet of said conduit means is positioned so that its said axis is substantially in a horizontal plane.

6. The machine of claim **5** wherein said first baffle is positioned substantially in a vertical plane.

7. The machine of claim **6** wherein said second baffle is positioned substantially in a vertical plane.

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U.S. Cl. X.R.

62—497; 202—197