United States Patent [19]

Hubbard

[11] **4,322,447**

[45] **Mar. 30, 1982**

[54] **HIGH SPEED PROCESS FOR ROASTING COFFEE**

[75] Inventor: **Merton R. Hubbard,** Hillsborough, Calif.

[73] Assignee: **Hills Bros. Coffee, Inc.,** San Francisco, Calif.

[21] Appl. No.: **191,696**

[22] Filed: **Sep. 29, 1980**

[51] **Int. Cl.**[3] **A23F 5/04**

[52] **U.S. Cl.** **426/467;** 426/466

[58] **Field of Search** 426/466, 467; 99/470, 99/474, 477

[56] **References Cited**

U.S. PATENT DOCUMENTS

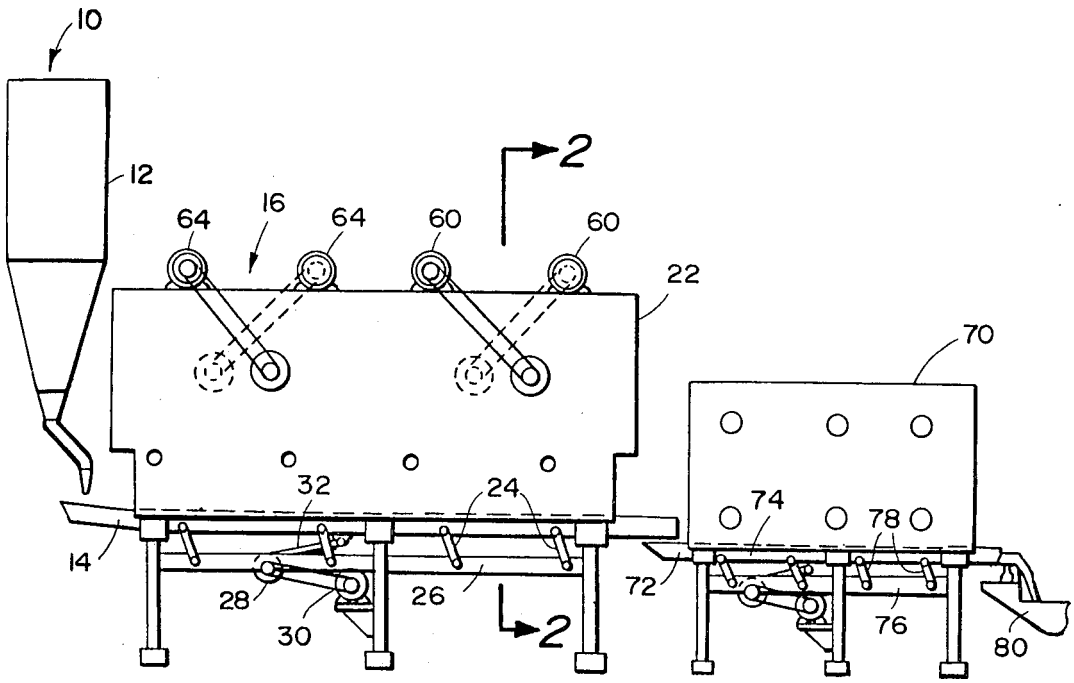
3,572,235	3/1971	Nutting et al.	99/477 X
3,595,668	7/1971	Nutting et al.	426/467
4,169,164	9/1979	Hubbard et al.	426/467

Primary Examiner—Joseph M. Golian
Attorney, Agent, or Firm—Flehr, Hohbach, Test, Albritton & Herbert

[57] **ABSTRACT**

A coffee roasting process for forming a low density roasted coffee having a yield of high soluble solids in which the green coffee beans are dry roasted by passage in a fluidized bed through a two-stage roaster. In the first stage, the beans are heated to a temperature of 550° F. to 570° F. by a roasting gas for partial roasting and expansion of their cellular structure. Then, in the second zone, the beans are contacted with an independent roasting gas stream at the same temperature and lower velocity to complete the roasting process.

6 Claims, 3 Drawing Figures



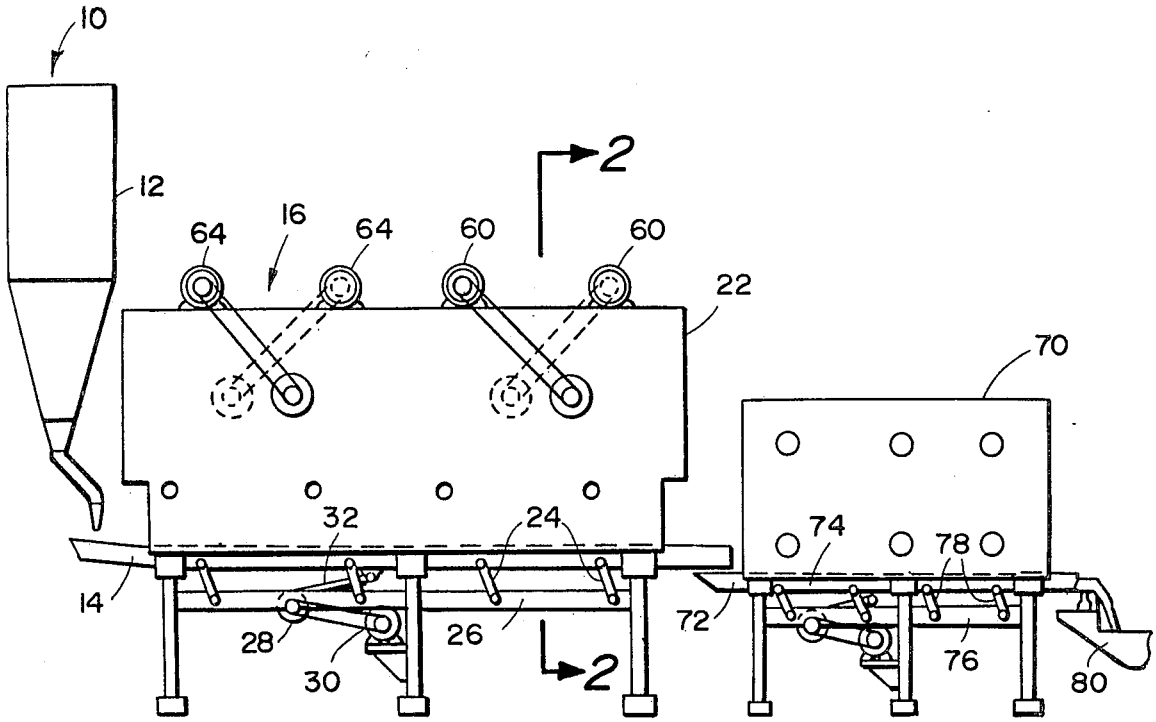

10
12
64
16
64
60
60
2
22
70
32
24
74
78
14
28
30
26
72
76
80
2

FIG. 1

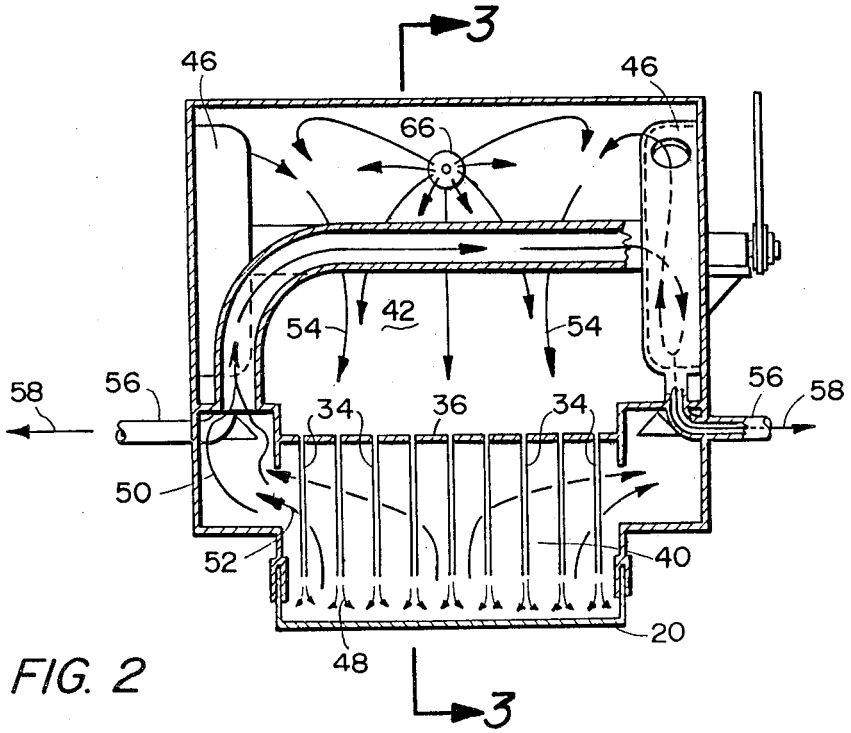

3
46
46
66
42
54
54
56
58
56
58
34
36
34
50
52
40
20
48
3

FIG. 2

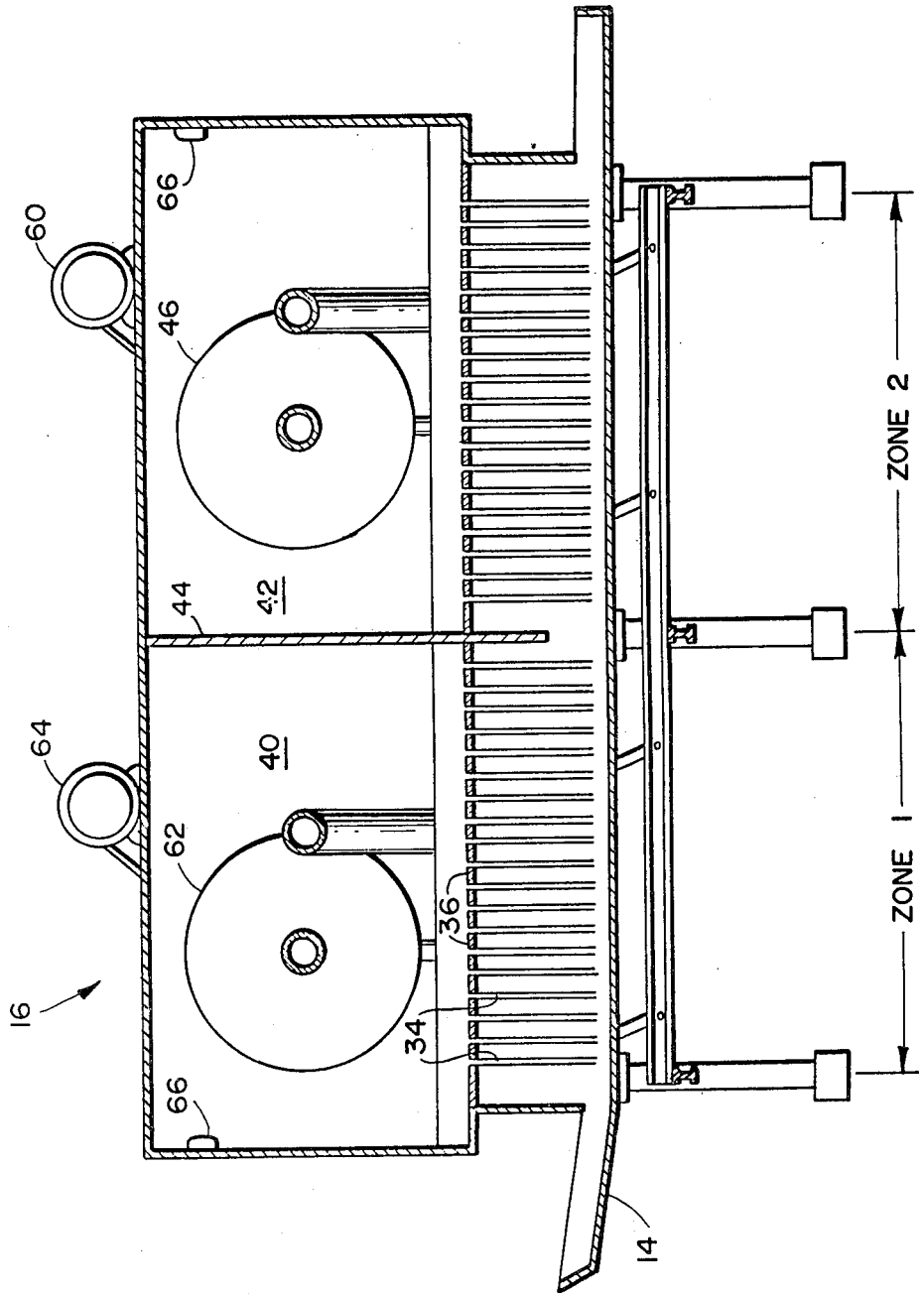


FIG. 3

HIGH SPEED PROCESS FOR ROASTING COFFEE

The invention relates to a two-stage continuous roasting process for coffee in which the roasted coffee product is of low density and high yield.

Green coffee is roasted to produce the desired dark brown color and to alter the natural elements present in the green beans to provide the aromatic qualities and taste or flavor values desired in a freshly brewed coffee beverage. One known technique for the continuous roasting of coffee is disclosed in Nutting et al U.S. Pat. No. 3,572,235. There, the coffee beans are first subjected to steam in a pre-heating zone and thereafter progressively moved as a fluidized bed through a roasting zone in which the pre-heated beans are contacted with a hot roasting gas at a temperature in the range of 450° F.-575° F. Then, the beans are dried by contact with an ambient air stream.

It is well known that the price of coffee has increased significantly in recent years. For economy, it is desirable to increase the yield per volume of green coffee beans assuming that the quality of coffee could be maintained.

In Hubbard et al U.S. Pat. No. 4,169,164, a two-stage fluidized bed roasting process is disclosed to form an excellent roasted product of low density and high soluble solids content. In the disclosed preferred process, the coffee beans are roasted in the first stage at a temperature of 450° F. to 470° F., while in the second stage they are roasted at about 540° F., with a fluidized bed depth of about 2 inches.

It is an object of the invention to provide a high-speed continuous roasting process in which the desired flavor and aroma characteristics are developed from the green coffee beans to produce low density roasted coffee product with a high yield of soluble solids.

Additional objects and features of the invention will appear from the following detailed description taken in conjunction with the accompanying drawings.

FIG. **1** is a schematic representation of apparatus suitable for performing the continuous roasting process of the present invention.

FIG. **2** is an enlarged view in transverse section of the roaster of FIG. **1**, taken along the line **2—2**.

FIG. **3** is an enlarged view of the roasting apparatus of FIG. **2** taken along the line **3—3** of FIG. **2**.

In general, the present process is directed toward a high-speed, two-stage roasting process carried out under conditions to form low density roasted coffee product of high soluble solids yield. The beans are progressively and continuously moved and agitated through the two roasting stages in a fluidized bed and thereafter cooled and ground to form the final product.

Referring specifically to the first stage or zone of the two-stage roasting process, green coffee beans are subjected to a high velocity heated roasting gas to effect at least a partial roasting of the coffee beans. It has been found that by controlling the conditions in this first zone, the cellular structure of the coffee beans is expanded. The roasting gases are passed into the coffee beans as high velocity streams of roasting gas which pass through the bed of beans at a sufficient rate to induce fluidization of the beans into a bed to provide uniform heating of the beans.

As set forth above, the heating conditions in the first zone are maintained to provide an expansion of the cellular structure of the coffee beans. This, in turn, produces a disrupted or slightly puffed condition to the beans which forms porous openings or passageways from the surface of the beans to the interior of the same. This expanded structure permits a highly efficient penetration or entry of roasting gases into the coffee beans during roasting and also provides more ready access to the soluble solids content of the beans by the action of heated water during brewing of the coffee beverage. In this manner, the yield of the product is increased.

A major advancement of the present process over that of U.S. Pat. No. 4,169,164 is a significant reduction in the total residence time in the first and second roasting chambers to about 3 to 4 minutes. This results in a significant increase in coffee output from the same roaster. Unexpectedly, this result is accomplished by simultaneous modification of the temperature and bed depth of fluidized coffee bean during the roasting process. A bed depth suitable to accomplish the desired amount of heating in the first and second stages in a high-speed process is from about 0.25 in. to about 1.0 in., and preferably on the order of 0.5 in.

The temperature of the roasting gas is adjusted to accommodate the shallower depth and thus higher speed. Suitable gas temperatures for both zones are on the order of 550° F. to 570° F., preferably about 560° F., with a temperature variance between the first and second zones no greater than about 5° F.

The flow rate of the roasting gas at this temperature for a given residence time and bed depth determines the heat input to the beans. A suitable air flow in this stage is on the order of from about 19,000 to 21,000 standard cubic feet per minute.

After passage through the first stage or zone, the fluidized bed of coffee beans move into the second zone in a bed of constant depth. In the second zone, the roasting conditions are substantially altered. There, roasting is completed under conditions to stabilize the open porous structure of the beans and to darken them into the desired dark brown color without burning. In addition, the conditions are adjusted to form low density roasted coffee product of high soluble solids yield. It is desirable to reduce the roasting gas velocity so that the total heat input to the coffee beans in the second stage is insufficient to cause burning. A suitable roasting gas velocity is less than about 18,000 cubic feet per minute and preferably on the order of 17,000 cubic feet per minute or less.

After completion of roasting in the second zone, a continuous stream of the roasted coffee beans is cooled rapidly by a suitable cooling technique to arrest the roasting operation and maintain the open cellular porous structure of the coffee beans. A suitable technique for such rapid cooling is by directing (e.g., by flowing or drawing), an ambient air stream through a fluidized bed of the roasted coffee product. Cooling is typically completed in a relatively short period of time, ranging from 0.5 to 10 minutes and generally from 0.5 to 2 minutes. Such cooling is preferably performed by employing streams of high velocity ambient air which pass through the roasted beans at a rate sufficient to fluidize the same in a manner similar to that of the fluidized roasting process on the first and second zones. Cooling in this manner is performed in less than about 2 minutes.

FIG. **1** schematically illustrates apparatus for carrying out the continuous roasting process of the present invention. Green coffee beans are introduced to the system at **10** to a suitable feed hopper **12** and are directed onto an inclined chute or ramp **14** with the result

that the beans are force fed by gravity into the two-stage roaster unit **16**.

Roaster **16** operates to provide a controlled oxidizing heat treatment of the green coffee beans. High velocity streams of heated roasting gas function to fluidize the beans within the roasting unit **16** and thereby to provide a uniform, even heat treatment. The roaster apparatus includes a gas impervious bed forming plate **20** mounted for sliding vibratory movements with respect to the main housing **22** by means of parallelogram links **24** pivotally connected to the support frame **26**. The plate **20** is vibrated in a conventional manner by a rotary eccentric **28** driven by motor **30** connected to the plate by means of a connector link **32**. The apparatus is of the type illustrated in the aforementioned U.S. Pat. No. 3,572,235. It includes a pattern of nozzles or tubes **34** which are suspended from a partition **36** which separates an upper plenum within the roaster housing from an exhaust chamber **40**. Referring specifically to FIG. **3**, the plenum is divided into a first roasting zone **40** and a second roasting zone **42** by an impermeable partition **44** which extends from the top to the bottom of the roasting chamber in a vertical direction to provide a barrier against air flowing between zones **40** and **42**. The two zones are so designated in FIG. **3**.

Referring to the second roasting zone **42**, fans or blowers **46** are provided on opposite sides of the zone to control the flow of air into the upper plenum chamber and through tubes **34** to achieve a high velocity jet action below each tube, illustrated at **48**, which serves to suspend the coffee beans in a fluidized state as they progress through the roaster. As described in the foregoing patent, the fluidizing effect is achieved by jetting of the roasting gases downwardly onto the gas impermeable plate **20** simultaneously with a rapid withdrawal of the gases upwardly through the blower units, for example, as illustrated by the arrows **50** and **52**. Major portions of the recirculated gases is returned to the tubes **34** as indicated by the arrows **54**, while a portion of the gases is simultaneously removed from the roaster through exhaust ducts **56** as indicated by the arrows **58**. As illustrated in FIG. **1**, the blower units are suitably driven by motors or like drive units **60** which can be controlled to provide the desired gas velocities within tubes **34**. Referring to FIG. **3**, independent fans or blower units **62** are provided at opposite sides of the first stage plenum chamber **40** driven by motor **64** of a similar type to fans or blowers **46**.

Referring again to the first zone, the circulating gases are heated to effect the desired heat treatment for the roast. Heating of the roasting gases may be accomplished by any suitable means. As illustrated in FIGS. **2** and **3**, the roasting gases are directly heated by injection and burning of a fuel gas within the plenum space of roaster unit **16**. Apparatus for this purpose is illustrated in the form of injection nozzles **66** on opposite sides of partition **44**. Burning of the fuel gas (i.e., natural gas, propane or the like) within the plenum is accomplished by introduction of combustible mixtures of the gas with combustion air through each of nozzles **66**. The combustion gas is being distributed in separate independent streams in the first and second plenum roasting zones **40** and **42**, respectively, separated by partition **44**. In this manner, different roasting gas velocities are maintained in each of the two roasting zones.

After the roasting operation in roaster **16**, the hot roasted beans are discharged from the end of bed forming plate **20** into cooling unit **70** as illustrated in FIG. **1**. Beans are received on a chute or ramp **72** which is similar in construction to feed ramp **14** for the roaster unit **16**. The entire cooling unit may be similar in construction to the roaster unit, with the ramp **72** forming a part of a vibrated gas-impervious plate **74** within the cooler. The plate **74** is supported on frame work **76** connected by similar parallelogram linkage including links **78**. After cooling in unit **70**, the beans are collected in a suitable basin **80** for subsequent unit operations including grinding and packaging. Cooling gases (i.e., ambient air) may be circulated within the cooling unit by a fan or blower which functions to direct cooling air downwardly through tubes in the same manner as in the roaster.

In a typical operation, the beans are advanced onto ramp **14** at a rate so that the progress of the beans through both stages of the roaster is accomplished in a period of about 3 to 4 minutes, with equal residence times in each stage. The beans are progressively moved at a constant state of fluidization induced by the circulating roasting gases to provide a fluidized bed at a depth on the order of 0.5 inches. A suitable feed rate may be on the order of 10,000 pounds of coffee per hour. In the first roasting zone, a typical temperature is on the order of 560° F., at a roasting gas flow velocity induced by the fan of about 20,000 cubic feet per minute. Here, the initial heating of the beans to the roasting temperature is accomplished while the cellular structure of the beans is expanded to provide a network of interconnecting pores.

In the second zone of roasting below plenum **42**, the temperature of the roasting gas remains substantially constant at about 560° F., with a reduced flow velocity of on the order of 17,000 standard cubic feet per minute. The roasted beans continue to develop the desired darker brown color without burning and without losing the expanded porous cellular structure formed in the first zone. Thereafter, the coffee is passed through the cooling unit **70** in a fluidized bed of the same depth. There, the beans are subjected to a gas stream at a flow rate similar to that in the roaster unit to provide rapid cooling. A typical residence time for adequate cooling is on the order of 0.5 to 2 minutes. Such rapid cooling is believed to assist in maintaining the open cellular porous structure of the coffee beans.

The roasted coffee product produced by the foregoing process is of low bulk density (about 0.36 to 0.37 gm/cc), comparable to the product produced by the process described in U.S. Pat. No. 4,169,164. The technique employed for measurement is to tap a 250 cc graduated cylinder containing 50 grams of sample for 250 strokes. The density of the tapped volume is determined by dividing the 50 grams by the volume left in the graduated cylinder. The product of the present process also has a high soluble solids yield comparable to the 4,169,164 patent.

The present process produces a comparable product to that of U.S. Pat. No. 4,169,164, but at a significantly increased roaster rate (10,000 lb./hr. compared to 7,200 lb./hr.) and lower residence (3 to 4 minutes compared to 5 to 10 minutes).

What is claimed is:

1. A continuous high speed process for dry roasting green coffee beans comprising the steps of progressively and continuously moving and agitating dry green coffee beans in a fluidized bed successively through first and second separate roasting chambers, said bed depth in both chambers being maintained below about one

inch, the beans being uniformly contacted in the first chamber with a dry roasting gas stream which fluidizes said beans, said gas being at a temperature from about 550° F. to 570° F., and the gas effecting at least a partial roasting of the beans and expansion of the cellular structure of the beans, then passing the beans through a second chamber in which the beans are uniformly contacted with an independent dry roasting gas stream, which fluidizes said beans to complete the roasting process, said independent gas stream being at substantially the same temperature as the gas stream in the first chamber, and then cooling the beans to form a low density roasted coffee product having a yield of high soluble solids.

2. The process of claim **1** in which the temperature of the gas streams in said first and second chambers vary by no greater than about 5° F.

3. The process of claim **1** in which the temperature of the gas streams in said first and second chambers is on the order of 560° F.

4. The process of claim **1** in which the bed depth in said first and second chambers is approximately 0.5 inch.

5. The process of claim **1** in which the total residence time in said first and second chambers is from about 3 to 4 minutes.

6. The process of claim **5** in which there is approximately equal residence time in the first and second chambers.

* * * * *