

PATENT SPECIFICATION

(11) 1268 231

DRAWINGS ATTACHED

- (21) Application No. 30911/69 (22) Filed 18 June 1969
 (31) Convention Application No. 116 549 (32) Filed 28 June 1968 in
 (33) India (IN)
 (45) Complete Specification published 22 March 1972
 (51) International Classification A 23 f 3/00
 (52) Index at acceptance A2B A3D



(54) AN IMPROVED APPARATUS FOR CONTINUOUSLY FERMENTING PROCESSED TEA LEAF

(71) We, TEA RESEARCH ASSOCIATION, of Royal Exchange, 6, Netaji Subhas Road, Calcutta 1, West Bengal, India, a registered body under the West Bengal Societies Registration Act, 1961, do hereby declare the Invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

10 The present invention relates to an improved apparatus for continuously fermenting processed tea leaf.

15 The term fermentation used in connection with the processing of tea leaf, is in reality a process of oxidation, in which the polyphenols present in the cells of tea shoots are oxidised through the agency of the enzymes present in the tea shoots to produce a group of coloured chemical substances which are broadly called thearubigins and theaflavins and some other colourless compounds which provide the taste and aroma associated with the product black tea.

25 A number of devices and apparatus for the purpose are known. Normally, processed tea leaf is spread on clean cemented floors, tiles, metallic or plastics sheets for the duration of oxidation. The oxidised leaf which is normally copper-red colour is then lifted from these surfaces and collected in leaf containers or bowls to be spread again on the feeder trays of a drier to bring down its moisture content to within 3%.

35 There are other devices, where processed tea leaf is placed in a bowl or tray with a perforated bottom plate positioned on top of an air-duct with suitable air-flow arrangements to ensure a positive flow of air through the mass of leaf in the bowl or tray of the leaf container.

40 There is still another form of such devices in which trolleys are used which have with an additional intermediate perforated false bottom on which processed tea leaf is spread in thick layers to render the lowest section of the trolley a virtual air box with suitable nipples and hose connections to ensure a steady upward flow of air through the layer of pro-

cessed leaf when the air box is connected to suitable source of air supply.

There is yet another form of fermenting unit 50 where processed tea leaf is carried on the upper run of an endless open weave wire or plastics belt. The air supply to the mass of leaf spread on the upper surface is maintained by provision of suitable ducting means at the under- 55 side of the endless belt.

However, apparatus and mechanism used for the purpose in the first two instances suffer from discontinuity, while in the case of the endless belt, positive control over the air-flow distribution over the belt is hardly achievable. Further, it also suffers from the fact that complete discharge of fermented leaf from the top surface of the belt at the discharge end is hardly possible even with a good scraping arrangement at the discharge end because of the stickiness of fermented tea leaf, and secondly the surface of the belt cannot be kept clean without elaborate arrangement for the purpose. There are other draw backs also in its operation to which reference is made later in this specification. 70

The object of the present invention is to overcome the above difficulties and to ensure controlled temperature and humidity conditions of the air flow employed for the fermentation of the tea leaves. 75

Another object of the invention is to provide a closed air flow circuit for the continuous fermentation of tea leaves, so as to preserve as much as possible of the easily removable volatile compounds formed during fermentation in the air within such air circuit. 80

Accordingly, the present invention provides an apparatus for the continuous fermentation 85 of processed tea leaves comprising a travelling leaf-carrying surface with two side walls, made up of a plurality of abutting trays, each with a perforated bottom and two upstanding side plates, that when they abut define a continuous leaf-carrying surface, which extends in and travels in a generally straight upper path between two ends, means at each end for transferring the trays between the upper path and 90

a lower return path, an air chamber provided at opposite ends with means for preventing ingress or exit of air so as to constitute a closed air flow circuit, the chamber enclosing a substantial length of the upper path and the leaf-carrying surface formed thereon, the air flow arrangement in the air chamber being such that substantially half of the same is adapted to be kept under suction, while the other half is kept under compression and means inside the air chamber to ensure that the flow of air is positively directed upwards or downwards through the leaf-carrying surface enclosed by the air chamber.

In order to provide said air flow arrangement in a recirculatory air stream, preferably a single means for the air supply and air suction is connected through ducts to said closed air chamber. Such single means may be a fan and two ducts are connected at its two sides, one of said two ducts extending across substantially half the length of upper part of air chamber for the suction of air through the leaf-carrying surface enclosed by said length of the air chamber, and the other duct leading to the other half of the upper part of the air chamber for the supply of air under pressure on the leaf-carrying surface enclosed by said other half portion, the return air duct being constituted by the bottom half of the closed air chamber.

The leaf carrying surface formed on the upper path has a feed end for the feeding of tea leaves thereon and a discharge end for the discharge of the fermented tea leaves therefrom. Preferably, that part of the air chamber which is adjacent the discharge end is kept under suction, while that part adjacent the feed end is kept under compression.

Preferably, such means for preventing ingress or exit of air is constituted by two swinging baffles fitted at the two ends of the chamber, the baffle plates resting on the upper surface of the leaves carried by the leaf-carrying surface during the operation. One or more swinging baffles may be located at the centre of the air chamber and rest on the upper surface of the leaves carried by the leaf-carrying surface, during the operation.

At the start of the fermentation, all the trays are empty. Hence, to prevent short circuiting of air flow through the empty trays, sealing means are provided below the leaf-carrying surface formed on the upper path in the air chamber. Such sealing means may be constituted by a pair of laterally spaced endless chains carrying a plurality of laths pivoting at one of their ends on the chains, the endless chains being located below the upper path in the air chamber, and the laths forming an overlapping air seal on their top run below the leaf-carrying surface formed on the upper path. The endless chains are thus mounted inside the return duct of the air chamber. The laths are generally narrow metallic or plastics

laths which are pivoted on pins attached to the chains on either sides. The laths effectively seal off all the trays at their bottom at the start of the fermentation operation. The endless chains are provided with the laths for half of their effective length only, while the other half of the chains is without any laths at all. Thus, at the beginning of the operation, the laths effectively seal all the trays within the air chamber. As the trays laden with leaf enter the chamber, the sealing laths are moved forward exposing the air duct below in a synchronous manner until the entire air duct is exposed to air flow when all the trays are full with leaf spread in thick layers; the laths are then at the bottom run of the endless chain circuit and are allowed to hang downwards on their pins to enable air flow to take place unhindered by their presence. Similarly at the end of the operation, as soon as the last tray with the load of processed tea leaf enters the air chamber, the empty trays following them are sealed off by synchronous running of the endless chain circuit with the laths.

The apparatus also includes vibration means for vibrating a feed hopper at the feed end and for vibrating the trays making up the leaf-carrying surface at the discharge end. Preferably, emptying of the abutting trays at the end of the upper path is effected by allowing the trays to drop on one or two vibrating bars or supports in between two pairs of return sprockets of endless tray haulage chains which constitute the means for transferring the trays between the upper path and the lower path, in such a manner that the trays are kept vibrating all the time until all the tea leaf particles spread on them are knocked out from the trays and the side plates mounted on them.

A series of jets or nozzles with a high velocity stream of water can be installed on the return run of the trays in the lower path to wash them off. Additionally, compressed air jets can also be used to dry off the washed trays before they reach the top feeding area.

Each of the trays is provided with rollers, which are supported on track means, and the track means follows the same course as that of the upper and lower paths.

The invention will now be described with reference to the accompanying drawings, by way of illustration, wherein:

Figure 1 shows in side elevation a general view of the apparatus according to the invention, partly in section;

Figure 2 shows a plan of some of the trays of the apparatus, and

Figure 3 shows sectional side elevation of two trays along with two centre baffle plates.

Referring to the drawings, the trays 1 are made of structural steel or metallic construction to which are fitted the upstanding side plates 2, one on each side. The bottom of the trays is perforated, as shown in the plan of Figure 2. The side plates of each tray are tied

70

75

80

85

90

95

100

105

110

115

120

125

130

5

10

15

20

25

30

35

40

45

50

55

60

65

with transverse tie rods R as shown in Figure 2. The perforated bottom of each of the trays is provided with fabric supports S, and woven wire mesh W are supported thereon. Thus, each tray is made accessible to gas passage through its bottom surface. Each of the trays are also provided with rollers 26 which are supported on tracks 27 at each side of the trays.

The trays are hauled by two endless chains 3 one on each side of the trays on the tracks at the top run and at the bottom run. A large sprocket 4 is fitted on the return side of the endless chains just ahead of the feed area 5. The horizontal edges of the bottom of each tray overlap the next bottom edges of the adjacent trays, and so do the side plates 2 of each tray with those of the adjacent tray. In view of this abutting relation, as shown clearly in Figures 2 and 3, a continuous leaf-carrying surface is formed on the upper run of the trays, which is adapted to be hauled by the endless chains 3.

At the feed area 5 leaves are fed through a feed hopper 16 on the leaf-carrying surface defined by the upper run of the abutting trays. Leaves L are fed into the trays up to approximately 8" to 10" deep, and the feed hopper 16 has one or both of its sloping plates attached to a mechanical or electrical vibrating apparatus 15, to ensure correct filling of the trays to the desired depth. The trays are automatically hauled into an air chamber 6 in which air flow may be so arranged that air from the discharge side of a fan is forced downwards through the deep layer of tea leaves on the trays, while the suction side of the fan is so arranged that air is forced to come upwards through the deep layer of leaves on the other half of the trays run within the air chamber. The arrangement may be reversed depending on the drive arrangement.

As shown, the trays after crossing the feed area enter the air chamber 6 which is sealed off from the outside atmosphere by means of a swinging baffle 7 at the feed end and similar baffles 8 at the discharge end of the air chamber 6. The air chamber 6 has one or two cased fans 9 mounted on the top or side, as the case may be. The air chamber 6 extends below the trays and is boxed to form a return air duct 10. The delivery duct or ducts of the fan or fans are directed towards substantially a half of the number of trays inside the chamber while the suction side of the fan or fans has a ducting to induct air through the remaining trays in the air chamber. Thus the entire air ducting forms a closed circuit. In order to seal off delivery ducts of the fan(s) from the suction duct (s), over the top of the horizontal trays one or two intermediate swinging baffles 11 are fitted within the chamber. This is clearly shown in Figure 3. As shown, the fan 9 sucks the gases from the top of the leaf bed at the discharge end of

the chamber sealed by twin swinging baffles 11 and the baffle 8, which overlies a bed of leaf 'L'. The gases thus sucked into the fan are then discharged under pressure to the other half of the air chamber to the space above the bed of leaf sealed by the overlying baffles 7 and 11.

Inside the return air duct 10 a second endless chain circuit 12 is provided which is only brought into action at the start of the continuous fermentation process and at the close of the proceedings. The endless chains 12, on each side, have a number of narrow metallic or plastics laths 13, which overlap and can seal off air flow across any specified area of the leaf-carrying surface defined by the abutting trays. Normally these chains are provided with laths for half of their effective length only i.e. the laths are able to cover only the top run of this chain circuit. Thus, when freshly processed leaf is brought into the apparatus, this endless chain circuit 12 will be engaged by a clutch 14 to move forward progressively exposing the return air duct 10 as the freshly spread processed leaves enter the air chamber. When the chamber is full, the laths will remain on the chains at their return run, as shown in Figure 1, and thus will not interfere with the air flow. At the end of the proceedings these chains will again be brought into action with the help of the clutch 14 to progressively seal off the air flow through the empty trays.

One or a series of mechanically or electrically operated vibrating shafts 21 is or are provided at the discharge end for the trays to drop on to, so as to facilitate emptying of the trays on to a feed mechanism 20 or to conveyor belt of a subsequent processing machine e.g. driers.

Inside the air duct cooling coils and heating coils 17 and spraying nozzles with baffles 18 are provided to ensure controlled temperature and humidity conditions for fermentation, along with provision for injection of oxygen gas through an oxygen nozzle 19 from an oxygen source, when necessary.

The whole apparatus is supported in a frame structure 22. 23 denotes a drive source e.g. a motor for driving the sprockets 4; which may be of different sizes, but of the same pitch as for the tray haulage chains 3. Glass windows 24 are provided for inspecting the working from outside. A guide means 25 is provided at the feed end for guiding the trays to the feed area.

WHAT WE CLAIM IS:—

1. An apparatus for the continuous fermentation of processed tea leaves comprising a travelling leaf-carrying surface with two side walls, made up of a plurality of abutting trays, each with a perforated bottom and two up-standing side plates, that when they abut define a continuous leaf-carrying surface, which extends in and travels in a generally straight upper path between two ends, means at each



with transverse tie rods R as shown in Figure 2. The perforated bottom of each of the trays is provided with fabric supports S, and woven wire mesh W are supported thereon. Thus, each tray is made accessible to gas passage through its bottom surface. Each of the trays are also provided with rollers 26 which are supported on tracks 27 at each side of the trays.

The trays are hauled by two endless chains 3 one on each side of the trays on the tracks at the top run and at the bottom run. A large sprocket 4 is fitted on the return side of the endless chains just ahead of the feed area 5. The horizontal edges of the bottom of each tray overlap the next bottom edges of the adjacent trays, and so do the side plates 2 of each tray with those of the adjacent tray. In view of this abutting relation, as shown clearly in Figures 2 and 3, a continuous leaf-carrying surface is formed on the upper run of the trays, which is adapted to be hauled by the endless chains 3.

At the feed area 5 leaves are fed through a feed hopper 16 on the leaf-carrying surface defined by the upper run of the abutting trays. Leaves L are fed into the trays up to approximately 8" to 10" deep, and the feed hopper 16 has one or both of its sloping plates attached to a mechanical or electrical vibrating apparatus 15, to ensure correct filling of the trays to the desired depth. The trays are automatically hauled into an air chamber 6 in which air flow may be so arranged that air from the discharge side of a fan is forced downwards through the deep layer of tea leaves on the trays, while the suction side of the fan is so arranged that air is forced to come upwards through the deep layer of leaves on the other half of the trays run within the air chamber. The arrangement may be reversed depending on the drive arrangement.

As shown, the trays after crossing the feed area enter the air chamber 6 which is sealed off from the outside atmosphere by means of a swinging baffle 7 at the feed end and similar baffles 8 at the discharge end of the air chamber 6. The air chamber 6 has one or two cased fans 9 mounted on the top or side, as the case may be. The air chamber 6 extends below the trays and is boxed to form a return air duct 10. The delivery duct or ducts of the fan or fans are directed towards substantially a half of the number of trays inside the chamber while the suction side of the fan or fans has a ducting to induct air through the remaining trays in the air chamber. Thus the entire air ducting forms a closed circuit. In order to seal off delivery ducts of the fan(s) from the suction duct (s), over the top of the horizontal trays one or two intermediate swinging baffles 11 are fitted within the chamber. This is clearly shown in Figure 3. As shown, the fan 9 sucks the gases from the top of the leaf bed at the discharge end of

the chamber sealed by twin swinging baffles 11 and the baffle 8, which overlies a bed of leaf 'L'. The gases thus sucked into the fan are then discharged under pressure to the other half of the air chamber to the space above the bed of leaf sealed by the overlying baffles 7 and 11.

Inside the return air duct 10 a second endless chain circuit 12 is provided which is only brought into action at the start of the continuous fermentation process and at the close of the proceedings. The endless chains 12, on each side, have a number of narrow metallic or plastics laths 13, which overlap and can seal off air flow across any specified area of the leaf-carrying surface defined by the abutting trays. Normally these chains are provided with laths for half of their effective length only i.e. the laths are able to cover only the top run of this chain circuit. Thus, when freshly processed leaf is brought into the apparatus, this endless chain circuit 12 will be engaged by a clutch 14 to move forward progressively exposing the return air duct 10 as the freshly spread processed leaves enter the air chamber. When the chamber is full, the laths will remain on the chains at their return run, as shown in Figure 1, and thus will not interfere with the air flow. At the end of the proceedings these chains will again be brought into action with the help of the clutch 14 to progressively seal off the air flow through the empty trays.

One or a series of mechanically or electrically operated vibrating shafts 21 is or are provided at the discharge end for the trays to drop on to, so as to facilitate emptying of the trays on to a feed mechanism 20 or to conveyor belt of a subsequent processing machine e.g. driers.

Inside the air duct cooling coils and heating coils 17 and spraying nozzles with baffles 18 are provided to ensure controlled temperature and humidity conditions for fermentation, along with provision for injection of oxygen gas through an oxygen nozzle 19 from an oxygen source, when necessary.

The whole apparatus is supported in a frame structure 22. 23 denotes a drive source e.g. a motor for driving the sprockets 4; which may be of different sizes, but of the same pitch as for the tray haulage chains 3. Glass windows 24 are provided for inspecting the working from outside. A guide means 25 is provided at the feed end for guiding the trays to the feed area.

WHAT WE CLAIM IS:—

1. An apparatus for the continuous fermentation of processed tea leaves comprising a travelling leaf-carrying surface with two side walls, made up of a plurality of abutting trays, each with a perforated bottom and two up-standing side plates, that when they abut define a continuous leaf-carrying surface, which extends in and travels in a generally straight upper path between two ends, means at each

- end for transferring the trays between the upper path and a lower return path, an air chamber provided at opposite ends with means for preventing ingress or exit of air so as to constitute a closed air flow circuit, the chamber enclosing a substantial length of the upper path and the leaf-carrying surface formed thereon, the air flow arrangement in the air chamber being such that substantially half of the same is adapted to be kept under suction, while the other half is kept under compression and means inside the air chamber to ensure that the flow of air is positively directed upwards or downwards through the leaf-carrying surface enclosed by the air chamber.
2. An apparatus as claimed in Claim 1, in which a single means for the air supply and air suction is connected through ducts to the closed air chamber, in order to provide the air flow arrangement in a recirculatory air stream.
3. An apparatus as claimed in claim 2, in which the single means is a fan and two ducts are connected at its two sides, one of the two ducts extending across substantially half the length of upper part of the air chamber for the suction of air through the leaf-carrying surface enclosed by the length of the air chamber, and the other duct leading to the other half of the upper part of the air chamber for the supply of air under pressure on the leaf-carrying surface enclosed by the other half portion, the return air duct being constituted by the bottom half of the closed air chamber.
4. An apparatus as claimed in any of the preceding claims, in which the leaf-carrying surface formed on the upper path has a feed end for the feeding of tea-leaves thereon, and a discharge end for the discharge of the fermented tea-leaves therefrom.
5. An apparatus as claimed in Claim 4, in which the path of the air chamber adjacent the discharge end is kept under suction, while that adjacent the feed end is kept under compression.
6. An apparatus as claimed in Claim 1, in which the means for preventing ingress or exit of air is constituted by two swinging baffles fitted at the two ends of the chamber, the baffle plates resting on the upper surface of the leaves carried by said leaf-carrying surface, during the operation.
7. An apparatus as claimed in Claim 1, in which one or more swinging baffles are located at the centre of the air chamber, and rest on the upper surface of the leaves carried by said leaf-carrying surface during operation.
8. An apparatus as claimed in any one of the preceding claims, in which means are provided below the leaf-carrying surface formed on the upper path in the air chamber, to prevent short circuiting of air flow through the surface having no leaves thereon.
9. An apparatus as claimed in Claim 8, in which the means for preventing short circuiting of air flow is constituted by a pair of laterally spaced endless chains carrying a plurality of laths, pivoting at one of their ends on the chains, the endless chains being located below the upper path in the air chamber and the laths forming an over-lapping air seal on their top run below the leaf-carrying surface formed on the upper path.
10. An apparatus as claimed in Claim 9, in which the endless chains are provided with laths for half of their effective length.
11. An apparatus as claimed in Claim 8 or 9, in which a clutch is provided for engaging the endless chains.
12. An apparatus as claimed in Claim 4, and those dependent thereon, in which vibrating means are provided for vibrating a feed hopper at the feed end, and for vibrating the trays making up the leaf-carrying surface at the discharge end.
13. An apparatus as claimed in any one of the preceding claims, in which means are provided for controlling the temperature and humidity conditions of the air flow in the air chamber.
14. An apparatus as claimed in Claim 13, in which the means for controlling the temperature and humidity of the air flow are constituted by cooling and heating coils, and water spray nozzles with baffles respectively, located in the air flow duct of the air chamber.
15. An apparatus as claimed in any one of the preceding claims, in which means are provided for supplying additional oxygen to the air chamber, when desired.
16. An apparatus as claimed in any one of the preceding claims, which includes means to wash and dry off the trays at their return lower path.
17. An apparatus as claimed in any one of the preceding claims, in which each of the trays is provided with rollers, the rollers being supported on track means which follows the same course as that of the upper and lower paths.
18. An apparatus for continuous fermentation of processed tea-leaves substantially as hereinbefore described with particular reference to and as illustrated in the accompanying drawings.

In
Cc
SeRe
Ac
TH
4

* C L M S *

Agents for the Applicants,
STANLEY, POPPLEWELL, FRANCIS &
ROSS,
Chartered Patent Agents,
20/21 Tooks Court,
Cursiter Street,
London, E.C.4.A 1LB.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1972.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from
which copies may be obtained.

PATENTS ACT 1949

SPECIFICATION NO 1268231

In accordance with the Decision of the Superintending Examiner, acting for the
Comptroller-General, dated 13 June 1974 this Specification has been amended under
Section 14 in the following manner:-

Page 2, line 6, page 4, line 8, *after* thereon *insert* but not enclosing any
portion of the lower return path,

Reference has been directed in pursuance of Section 9 subsection (1) of the Patents
Act 1949, to Patent No 1085525.

THE PATENT OFFICE
4 October 1974

R 77216/6



* C L M S *