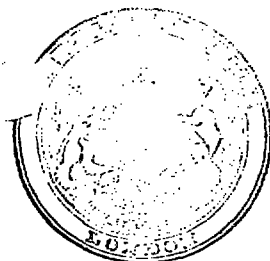


PATENT SPECIFICATION
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COMPLETE SPECIFICATION

A Continuous Process for the Production of "Beer".

We, DOMINION BREWERIES LIMITED, a Company duly incorporated under the laws of the Dominion of New Zealand, of Queens Arcade Building, Customs Street East, Auckland C.1., New Zealand, 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:—

This invention relates to a continuous process for the production of "beer".

The term "beer" as used herein both in the description and in the Claims is confined to beverages for direct consumption by which we mean ale, lager beer, stout and like beverages for direct consumption: as distinct from fermented liquors such as fermented molasses solutions intended for distillation, which are sometimes referred to as "beer" but are not prepared for direct consumption. With such liquors the problems of producing a "mature" and not a "worty" or a "yeasty" beverage do not arise. The present invention is directly concerned with these problems.

The invention consists in a continuous process for the production of "beer" comprising the steps of adding "fresh wort" to a, or to a first, fermenting and maturing zone containing wort which is being continuously fermented by means of yeast suspended therein; agitating the contents of the fermenting and maturing zone or zones sufficiently to maintain the suspension of yeast and wort in a substantially homogeneous state and at a substantially uniform temperature; withdrawing "beer" from the, or from the last, fermenting and maturing zone; maintaining in said zone or zones a concentration of suspended yeast which is sufficient to achieve by the fermentation of the wort in said zone or zones a desired reduction of the specific gravity of the added wort; and maintaining conditions of yeast

activity which are such that the "beer" produced is a "matured beer".

The invention also consists in apparatus for the continuous production of "beer" including at least one fermentation and maturing vessel which is provided with means for agitating the contents thereof, wherein conduit means are provided for the introduction of wort to be fermented and of yeast into the vessel, or into the first of the vessels, and for the withdrawal of "beer" from the vessel, or from the last of the vessels, and wherein means are provided for controlling the fermentation and maturing conditions in the fermentation and maturing vessel or vessels, including the temperature, the degree of agitation and the pH of the fermenting liquid so that the "beer" produced is a "matured beer."

The term "fresh wort" as used herein both in the description and in the Claims refers to wort in which substantial yeast activity has not as yet taken place. In general, we can use any unfermented brewery wort which is normally used in the production of beer and which has been processed to the point at which such wort is ready to be subjected to fermentation.

Furthermore, when we refer herein both in the description and in the Claims to the production of a "matured beer" by our fermentation process, we mean "beer" having the characteristic flavour which, in beer produced by conventional batch processing, is a result of a maturation period following the main fermentation. The "matured beer" of the invention has been found to need at most subsequent treatment of the kind suggested herein, e.g. cooling, holding for a period within the range of from six to forty-eight hours, inclusive, carbonation and final clarification, without the necessity for any subsequent storage period involving maturation of the "beer".

Our experiments suggest, however, that

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the "beer" may be stored for a period of up to three months before bottling or kegging without deterioration, but this does not improve the "beer" and is, therefore, unnecessary.

Furthermore, because production under the process of the invention is continuous and deliveries from most breweries cease during the week-end, finished "beer" stocks accumulate over this period, and breweries will normally find it necessary to carry a buffer stock of at least seven days supply. This should not, however, be confused with storage for maturation purposes.

According to one aspect, the present invention depends upon the observation that maturing may be accelerated, so that it becomes possible to produce a "matured beer" in the rapid continuous fermentation process of the invention, by controlled yeast activity in the wort, including the rate of yeast propagation. In contrast from any possible application of continuous fermentation to alcohol production in which yeast propagation must be minimised so far as practicable as representing a reduction in the yield of alcohol, the present invention employs in one of its aspects, rapid propagation of the yeast in the wort. This is our preferred method of securing the removal from the wort of the materials required by the yeast for yeast activity (especially amino-acids and other soluble nitrogenous matter), and of controlling the release into the wort of by-products of the enzymatic activity of the yeast both of which effects appear from our investigations to be essential to the production of a fully stable and "matured" "beer".

Our experiments suggest that "beer" made under the process of the invention contains desirable flavour-producing material not found in normal batch-fermented beer at the end of fermentation, and, according to these findings, this material results from the action of the active enzymes of the yeast being kept in suspension in the beer during the time in which the "beer" is held in the fermenting and maturing vessel or zone and maintained at near the finished specific gravity of the "beer".

Our experiments also suggest that "beer" made in accordance with the invention has a much cleaner flavour than beer produced by batch fermentation, and is not saturated with those volatile substances which are present in batch-fermented beer, and which are only removed by a period of storage involving maturation of the batch-fermented beer.

A controlled release of flavour-producing material is apparently effected by controlling the concentration of the by-products of the utilisation of wort material by the yeast in the liquid in which the main activity of the yeast

takes place.

According to a preferred aspect of the invention, a wort of higher specific gravity than that required for making the finished "beer" is employed and the liquid is thereafter diluted, so that a sufficient concentration of the by-products of the utilisation of wort material is maintained.

It will be understood that the "beer" produced in accordance with the invention can be produced by fermentation with either top or bottom fermentation yeasts and the system works equally well with either class of yeast.

Thus, although the invention is particularly concerned with the production of "beer" which is conventionally referred to as "matured beer", e.g. lager beer in bottles, the invention is also concerned with the production of draught beer which is obtained in a fraction of the time required for the production of draught beer by conventional batch processing.

In operation, the process and apparatus of the invention allow the flavour and specific gravity of the finished "beer" to be controlled and the "beer" to be obtained in a fraction of the time required for conventional "beer" processing, for example periods as low as 18 hours as compared with periods of 3 to 16 weeks generally required in conventional batch processes. In particular, the invention allows substantially continuous blending of the processed material during fermentation and maturing and this contributes to close control of flavour and specific gravity.

The invention also leads to a considerable economy in the labour, the capital and the refrigeration equipment required as compared with conventional processes, and allows control of processing losses. In particular, the necessity for the storage of "pitching yeast" as in batch fermentation is eliminated in most cases.

In general, we employ temperatures of from 38°F., but preferably above 48°F., up to a value below the "thermal death point" of the yeast, but when, in the description and Claims, we refer to "high" temperatures we mean temperatures in the ranges now specified, i.e. temperatures of at least 55°F., and preferably of from 55°F. to 75°F., but in any case below the "thermal death point" of the yeast.

According to a preferred process, the yeast is fed substantially continuously by the substantially continuous addition of "fresh wort", or of wort in which yeast has been caused to propagate, to a fermentation and maturing zone, or to the first of a series of fermentation and maturing zones.

We prefer that fermentation should take place in the presence of a "high" initial concentration of yeast.

By a "high" initial concentration of yeast, we mean a concentration above that normally obtaining at the peak of a conventional batch fermentation process. This peak value is normally equivalent to 10 g of yeast (with an 80% by weight moisture content) per litre of wort. In general, we use a concentration of yeast which is equivalent to above 12 grams of yeast (with an 80% by weight moisture content) per litre of wort.

We may use an initial concentration of yeast up to a value equivalent to 100 grams of yeast (with an 80% by weight moisture content) per litre of wort. The preferred range is equivalent to between 25 grams and 35 grams of yeast (with an 80% by weight moisture content) per litre of wort.

Accelerated fermentation and maturing at "high" temperatures are achieved by the process of the invention without any substantial danger of autolysis of the yeast in suspension, which is normally inherent in batch fermentation. Autolysis is apparently avoided because the continuously added wort keeps substantially all the yeast in suspension in the maturing "beer" in an active fermenting state, thus maintaining the enzymatic activity of the maturing process and preventing the yeast from using up its own reserve of food which is stored within the yeast and thus from forming autolysates which impart undesirable flavours to the finished "beer".

The fermentation and maturing obtained in accordance with the invention also tend to a reduction in, or a substantial elimination of, "worty" and "yeasty" flavours in the finished "beer".

In order to protect the wort from any deleterious organisms which may be contained therein, "beer" may be withdrawn from the system and returned to the incoming unfermented wort before the unfermented wort is introduced into the liquid in the first fermentation zone. The "beer" is generally withdrawn in the ratio of at least one part of beer to each part of the unfermented wort.

This system brings about, because of the dilution of the incoming wort, an immediate drop in the pH so that fermentation takes place at this minimum pH value.

The invention provides for the use of intensive agitation which brings about greatly accelerated fermenting rates and a high yeast propagation without, or substantially without, the formation of foam. This intensive agitation not only achieves substantially immediate homogeneity of the added wort and of the fermenting liquid contained in the fermentation and maturing zone or zones but gives a close control of yeast activity within the "beer". This in turn controls the amino-acid content of the

finished "beer", the pH thereof, the flavour and the resistance to bacterial growth, and it is possible, for instance, to control the process at a substantially constant pH value which is determined by the nature of the desired finished "beer".

In order to obtain "beer" of good keeping quality, the yeast must be encouraged to reproduce itself and so to extract from the wort the necessary yeast growth material.

Both "rapid" extraction of yeast growth material and "rapid" propagation of the yeast should be encouraged. By "rapid" extraction of yeast growth material and "rapid" propagation of the yeast, we mean that the time required for the extraction of yeast growth material and for the yeast propagation which follows are short by comparison with the time required for normal batch fermentation and maturing of "beer"; we prefer (according to a further aspect of our process) that the extraction from the wort of yeast growth material should be largely completed during an initial stage followed by fermentation of the wort in a separate fermentation and maturing stage or in separate fermentation and maturing stages.

This action results in "beer" of better flavour and in the provision of less nutrient for harmful bacteria which normally cause so-called "off flavours" in the finished "beer." Yeast activity, which includes yeast propagation, is controlled by *inter alia* the degree of agitation, the fermenting temperature and the concentration of yeast and of nutrient suspended in the fermenting wort.

Should it not be possible to maintain the required yeast concentration in the fermenting wort by the propagation of the yeast therein, a proportion of yeast separated from the "beer" product may be returned to the fermenting wort.

A continuous flow of pure yeast obtained from a separate, substantially pure, culture-propagating plant may be added to the unfermented incoming wort.

In order to start the operation of the fermentation system, a predetermined quantity of wort and yeast which is equal to substantially 30 times the hourly flow of fermented wort required may be added to the fermentation and maturing zone or zones and allowed to ferment. As soon as the required specific gravity of the fermenting wort is reached, the continuous flow of wort to the, or to the first, zone and the withdrawal of the fermented wort from the, or from the last, zone are commenced. The continuous flow can be halved by reducing the level of the fermenting wort in the fermentation and maturing zone or zones accordingly and variations down to one-tenth of the total capacity are possible.

It will be understood that the wort may include the liquefied extract of fermentable

matter which is derived from fruit, vegetables, cereals or sugar cane.

The usual wort may also be replaced by two wort portions one of which provides the nutrients for yeast growth and also the necessary material for the production of body and alcohol in the finished "beer" and the other of which contains the flavour and aroma material, sugary matter and hop extracts.

We prefer, in many cases, to prepare in the brew-house a wort having a specific gravity in excess of that required for making the finished "beer", to treat the wort as described herein and to dilute the fermented wort at a later stage. In a system with two or more fermentation and maturing stages, the dilution may be effected between stages, and may be effected partly at one point in the system and partly at another. The wort entering the fermentation process may have a specific gravity which is such that dilution with up to six parts of dilutant is required for each part of entering wort. The diluent material may be water or water containing flavouring material of a fermentable or non-fermentable nature.

The outgoing "beer" may be cooled by the incoming cold wort with the use of a suitable heat-exchanger and by so doing the temperature of the cold incoming wort is increased.

If desired, the unfermented wort can be run directly to the, or to the first, fermentation and maturing zone and, in this case, the outgoing "beer" which runs through the heat-exchanger can be cooled by a conventional refrigerant.

The process of fermentation brings about the formation of carbon dioxide and in an open vessel this escapes to the atmosphere. When enclosed vessels are used, means for venting the carbon dioxide to the atmosphere, or to a compressor for storage and further use thereof, should be provided.

The invention will now be particularly described, by way of example, with reference to the accompanying drawings in which:—

figure 1 is a schematic diagram of one form of apparatus according to the invention for the continuous production of "beer";

figure 2 is a schematic diagram of a second form of apparatus according to the invention for the continuous production of "beer";

figure 3 is a schematic diagram of a third form of apparatus according to the invention for the continuous production of "beer";

figure 4 is a schematic diagram of a fourth form of apparatus according to the invention for the continuous production of "beer";

figure 5 is a schematic diagram of a

fifth form of apparatus according to the invention for the continuous production of "beer";

figure 6 is a schematic diagram of a sixth form of apparatus according to the invention for the continuous production of "beer"; and

figure 7 is a schematic diagram of one form of fermenting and maturing vessel in the apparatus of figures 1 to 6.

Referring firstly to Figure 1, a valve-controlled pipe-line 10, connected to a wort supply vessel (not shown), continuously introduces aerated "fresh wort" into a fermenting and maturing vessel A.

The valve in the pipe-line 10 controls the introduction of the "fresh wort" into the vessel A at a substantially constant rate. Yeast is generally kept in the vessel A at a predetermined "high" concentration and the liquid contents of the vessel A are generally kept at a "high" temperature. These contents, which include the added "fresh wort", are continuously maintained in a substantially homogeneous state by means of a mechanical agitator 11. All these factors combine to promote a high degree of yeast propagation and active fermentation.

The fermented wort is withdrawn from the vessel A by a valve-controlled pipe-line 12 at the rate at which the "fresh wort" is introduced into the vessel and is fed to a continuous yeast-separation vessel B. In this vessel, yeast is separated from the fermented wort by the rapid flocculation of the yeast and the settling of the yeast on the bottom of the vessel.

The resulting "beer" flows, via a pipe-line 13, through a heat-exchanger D, which reduces the temperature of the "beer", and through a pipe-line 14 to a holding vessel E. The "beer" is held in the vessel E for a period within the range of from 6 to 48 hours, inclusive, and is thereafter withdrawn for carbonation, final clarification and bottling or kegging, as "matured beer".

The temperature of the fermenting wort in the vessel A can be maintained by heating and/or cooling means (not shown) at the desired "high" value.

Furthermore, the agitator 11 maintains substantial homogeneity of the contents of the vessel A as the added "fresh wort" is dispersed therein.

In general, the required specific gravity in the finished "beer" is obtained by adjusting the incoming flow of "fresh wort" so that the fermentable material replaces substantially exactly the material which is fermented, whereby the specific gravity in the vessel A remains substantially constant at a desired value.

Fermented wort is withdrawn through the pipe-line 12 at a rate which is substantially identical to the rate at which "fresh wort"

is added. This rate of addition of "fresh wort" (and of withdrawal of fermented wort) depends on the conditions in the vessel A and is increased for higher liquid levels, temperatures and yeast concentrations, or for intensive agitation, or for various combinations of these factors. With lower yeast concentrations and temperatures, and with gentle agitation, the hourly addition rate may be, for example, approximately one-sixtieth of the total contents of the vessel when a measured specific gravity drop of thirty-thousandths is required in a "fresh wort" having a specific gravity of 1.036. With intensive agitation, higher temperatures, for example 80°F., and higher yeast concentrations, for example equal to 70 grams of yeast (with an 80% moisture content) per litre of fermenting wort, the hourly throughput of wort may be, for example, as high as one-tenth of the total contents of the vessel. These conditions may be adjusted in accordance with the flavour required in the finished "beer".

The amount of yeast which is being produced may be controlled by adjusting the degree of agitation, the concentration of yeast in suspension and the temperature. Higher temperatures and higher agitation increase yeast propagation while higher yeast concentrations decrease the rate of yeast propagation. When approximately 5 grams of yeast are propagated per litre of wort, a fuller, sweeter "beer" is obtained, whilst, when approximately 15 grams of yeast per litre of wort are propagated, a drier, bitterer "beer" is obtained. These yeast concentrations are based on an incoming wort consisting of a malt extract with a specific gravity of 1.027. When the malt extract has a higher specific gravity, the rate of yeast propagation should be increased to obtain the same flavour.

The yeast which has settled to the bottom of the yeast-separation vessel B runs through a pipe-line 17, a pump P and a valve-controlled pipe-line 19 to surplus yeast tanks (not shown). Under some conditions, the outgoing flow through the pipe-line 12 may carry therewith more yeast cells than are being propagated in the vessel A; when this occurs, part of the surplus yeast from the yeast-separation vessel B may be returned to the fermenting and maturing vessel A through the valve-controlled pipe-line 18 in a sufficient quantity to maintain the required yeast concentration in the vessel A.

The yeast-separation vessel B may be replaced by a centrifugal clarifier of conventional construction.

The heat-exchanger D is employed for reducing the temperature of the "beer", while finings or absorbent material for clarification purposes may be injected into the "beer" by means of a pipe-line 20 and/or

a pipe-line 21, both of which are valve-controlled. A plurality of holding vessels such as the vessel E may be used, and the "beer" may remain in these vessels for a total period greater than 48 hours before being discharged for carbonation, final clarification and bottling or kegging. However, our experiments suggest that holding for a period above 48 hours does not lead to any noticeable improvement in the flavour and general quality of the final "beer" product.

When desired, a plurality of fermenting and maturing vessels may be substituted for the fermenting and maturing vessel A, in which case the output of the first vessel is at a desired intermediate specific gravity and the wort is further treated in the next vessel or vessels until a desired specific gravity and maturity are achieved, the agitation, yeast concentration and temperature in each vessel of the series being separately controlled.

The apparatus shown in Figure 2 is similar to that shown in Figure 1 except that a further fermenting and maturing vessel A', similar to the vessel A, is connected in series between the vessel A and the yeast-separation vessel B. The fermenting liquid contained in each vessel is maintained at a predetermined substantially constant level, and the wort is progressively fermented into "beer" by means of the two vessels A and A'.

Each of the vessels A and A' is maintained at its own individual temperature, degree of agitation and yeast concentration.

It is advantageous to run the vessel A so that substantially the total required amount of yeast production is obtained in this vessel, and to adjust the vessel A' so that practically no yeast production occurs therein and approximately one-fifth of the carbohydrate content of the wort is converted to alcohol and carbon dioxide in the vessel A'.

In order to produce substantially all the yeast in the first vessel, a higher rate of turbulence will be maintained therein so that the yeast will rapidly assimilate substantially all the oxygen in the incoming aerated wort and the second vessel will be run at a low degree of turbulence.

"Fresh wort" is introduced into the first vessel A via the line 10, in which the wort can be aerated, and fermenting wort passes from the vessel A through a pipeline 22 to the second fermenting and maturing vessel A', in which fermentation is completed (if desired, the vessel A' may be replaced by a plurality of vessels, which may be operated in series).

A valve-controlled pipe-line 23 feeds fermented wort from the vessel A' to the continuous yeast-separation vessel B. The yeast-depleted "beer" is passed by a pipe-line 24 to one or more holding vessels E (not shown) and thence to finishing vessels (not shown), as indicated with reference to Figure 1.

Yeast from the separation vessel B may be pumped through a pipe-line 26 to either or both of the fermenting and maturing vessels A and A' via valve-controlled inlet pipes 27 and 28, excess yeast being discharged through a valve-controlled discharge pipe 29. In order that all the conditions in the vessel A should be maintained favourable to yeast growth, the yeast concentration in this vessel should generally be kept as low as possible by keeping the valve in the inlet pipe 27 closed, and the temperature should be kept at substantially 10°F. above that in the vessel A', which is preferably controlled at substantially 60°F.

The apparatus shown in Figure 3 is similar to that of Figure 2 except that, in this case, aerated "fresh wort" is separately introduced to the vessel A' from a second wort supply tank (not shown) via a pipe-line 30. In this way, the wort is fermented in two separate parts, but still in a continuous flow as described in Figure 2.

The wort which is fermented in the vessel A may be characterised by a strong hop flavour and malt extract, while the sugary portion of the wort derived from the adjuncts and containing the choice, delicately flavoured hops is added to the vessel A'. The malt wort enters the vessel A as previously described with reference to Figure 1 and the agitation, temperature and yeast concentration are adjusted for the desired degree of yeast propagation and fermentation. The amount of carbohydrate material required to give the desired flavour is fermented, the fermenting wort then passing to the vessel A' in which the adjunct portion of the wort is added: from there, the wort is treated in a similar manner to that described with reference to Figure 2.

Under normal working conditions, the proportion of malt wort to sugary wort will be in approximately the ratio of 3 to 1 and approximately 75% of the total flow will, therefore, pass through the pipe-line 22 and the remaining 25% through the pipe-line 30, the total flow passing from the outlet of the vessel A' to the continuous yeast separator B. This system allows the retention in the finished beer of a part of the sweet, delicate portion of the extracts which would otherwise be lost during a normal batch fermentation. As described with reference to Figure 2, a plurality of vessels may be substituted for the vessel A'.

The returned yeast is conveyed separately to each of the vessels A and A' but generally the vessel A' should be maintained at a "high" concentration of yeast of approximately 40 grams per litre.

In the apparatus of Figure 4, the vessel A is preceded by the vessel F, and the vessel A' is omitted. Instead of the wort running continuously through the system, the wort

is fed continuously via the pipe-lines 10 and 31 to the vessel F. A valve-controlled pipe-line 32 controls the flow from the vessel F to the vessel A. The vessel F is yeasted with "yeasty beer" from the vessel A via a pipe-line 33, which contains a pump P, and a pipe-line 34, which feeds into the pipe-line 31. The fermented liquid from the vessel A is intermittently fed to the yeast-separating vessel B via a valve-controlled pipe-line 35 and a pipe-line 36.

The pump P in the pipe-line 33 continually circulates "yeasty beer" from the vessel A into the flow of wort in the pipe-line 10 at a flow rate equal to approximately one-fifth of the wort flow. A vigorous propagation of yeast takes place in the vessel F and this propagation can be aided by the introduction of air into the vessel F if it is found that the desired amount of yeast is not being propagated. Since the yeast in the vessel F, and the re-circulated "yeasty beer" in particular, rapidly absorb any necessary amounts of oxygen, conditions in the vessel F can still be kept "substantially oxygen-free" even if aeration is carried to the point of saturating the inflowing wort with air.

Stirring, heating and cooling means are adjusted to give the required amount of yeast propagation in the vessel F. The conditions in the vessel F are controlled in accordance with the flavour which is desired as described with reference to Figure 1. Near the end of the cycle, according to the flavour of the "beer" required, a batch of "yeasty beer" equal in amount to the wort fed to the vessel A, minus the recycle via the pipe-line 33, is caused to flow alternately to yeast-separation vessels B and B' via the pipe-line 35 and a change-over valve 35a.

The valve 35a is connected to the vessel B by the pipe-line 36 and to the vessel B' by a pipe-line 37, the vessels B and B' being interconnected by means of a valve-controlled pipe-line 38. The valve 38a in the pipe-line 38 is in turn connected to a discharge line 39 through which the fermented wort from which the yeast has been mainly separated is passed to one or more holding vessels and to finishing vessels as mentioned with reference to the previous Figures.

The timing of the change-over valve 35a is linked with that of the valve 38a in the pipe-line 38 in such manner that whilst one yeast-settling vessel is on a filling cycle, the flow rate being the same as that in the valve-controlled pipe-line 32 minus the recycle, the other yeast-settling vessel is on an emptying cycle, the flow rate being the same as that of the flow through the control valve in the pipe-line 10.

Discharge pipe-lines 40 and 41 lead from the yeast-separation vessels B and B' into a pipe-line 42 provided with a change-over valve 42a. The timing of the change-over

valve 42a is linked with that of the valve 35a in such manner that yeast is taken through the valve 42a from that vessel which is feeding fermented wort through the valve 38a. Yeast flows from the change-over valve 42a through the pipe-line 42 and a pipe-line 43, which controls amounts of the yeast into the fermenting vessel A when required so as to maintain the desired yeast concentration in the vessel A; surplus yeast is discharged in the opposite direction through the pipe-line 43 to an excess yeast collector (not shown).

The apparatus shown in Figure 5 is similar to that shown in Figure 4, except that, in the case of Figure 5, the wort from the malt and the wort from the adjunct are prepared separately in the brew-house, the adjunct wort containing the delicately flavoured hop material which is added by way of a vessel F'.

Thus, the system is similar to that of Figure 4 except that a second similar vessel F' is included in the system before the vessel A. The vessel F' is fed from a separate wort supply vessel (not shown) via valve-controlled pipe-lines 44 and 45. A further valve-controlled pipe-line 45a intermittently feeds, as required, wort in which yeast has been caused to propagate from the vessel F' to the vessel A.

"Yeasty beer" is fed to the vessels F and F' as required through the pipe-line 33, valve-controlled pipe-lines 34 and 46 and pipe-lines 31 and 45. The two different kinds of wort are fed to the fermenting and maturing vessel A from the vessels F and F'. The malt wort portion is added intermittently to the vessel A in a similar way to that described with reference to Figure 4. The sugary solution, which contains the delicate hop extracts, flows into the vessel F' continuously but is likewise intermittently added to the vessel A.

The proportion of sugary wort to malt wort is usually in the ratio of one part of sugary wort to three parts of malt wort but this ratio can be varied if desired. The sweetness of the finished "beer" may be varied by varying the time of addition of adjunct wort from the vessel F' to the vessel A in relation to the addition of the malt wort from the vessel F. Otherwise, as indicated above, the apparatus is closely similar to that shown in Figure 4.

In the apparatus shown in Figure 6 two portions of wort, namely malt wort for making the body and alcohol and sugary wort, which contains the flavour and bouquet material (as described with reference to Figure 3), are prepared in the brew-house and are introduced separately into a plurality of fermenting and maturing vessels, a series of four being illustrated. The first portion (the malt wort) is obtained from the corresponding supply vessel (not shown) by

the pipe-line 10, and may be fed to each of three fermenting and maturing vessels A, A¹ and A², either separately or in series (passing from one to the other by the interconnecting lines shown), and is finally fed by a pipe-line 47 to a fermenting and maturing vessel A³.

Although an apparatus employing four fermenting and maturing vessels is illustrated, it will be understood from the foregoing description that a larger or a smaller number may be used as desired. The second portion (the wort containing the flavour and bouquet material) is obtained from the corresponding supply vessel (not shown) via a pipe-line 50 and may be passed as required directly through pipe-lines 51, 52 and 53, or in series through the interconnecting lines, to the vessels A¹, A² and A³.

The first portion of the wort which is being fermented in the vessel A may not always contain all the material for making alcohol, whilst the flavour and bouquet material of the second portion added to the vessels A¹, A² and A³ would in most cases be of a fermentable nature. Therefore, as well as adding the desired bouquet and flavour to the finished "beer" this second portion also increases the alcoholic content thereof.

The first portion of the wort may be of a higher specific gravity than that required for making the finished "beer" to allow for the diluting effect of the flavouring material.

In general, a wort which is substantially higher in specific gravity than that normally required for making the finished "beer" may be employed. Thus, the wort may have a specific gravity of up to 1.300 and may be diluted with up to six parts of water for each part of wort as the fermenting wort flows through the system, so that the finished "beer" will have the same measured specific gravity and alcoholic content as that made from a brewers' wort with a specific gravity of 1.050. The wort of substantially higher specific gravity is diluted with water, or water containing flavouring material of a fermentable or unfermentable nature, as the fermenting wort flows through the system, until the desired specific gravity, alcoholic content and flavour are achieved.

From the fermenting and maturing vessel A³, the fermented wort is passed by way of a valve-controlled pipe-line 48 to the yeast-separation vessel B from which the yeast is pumped via a pipe-line 49 and is introduced into any of the vessels A to A³ when necessary to maintain the required yeast concentration, control being provided by the valves indicated. In order to ensure that the flow of partly clarified fermented wort from the yeast-separation vessel B should be equal to the "yeasty beer" flow into this vessel, the top of the vessel B is vented and is connected by a pipe-line 48a to the top of the vessel A³.

Fermented wort leaving the vessel B is fed via pipe-lines 54 and 55 to a second yeast-separation vessel B². The resulting "beer", which leaves the vessel B² is passed by way of pipe-line 56 to holding and finishing vessels as mentioned with reference to Figure 1.

The yeast which has settled in the vessel B² may be discharged via a pipe-line 57 to an excess yeast collector. It will be noted that when the yeast taken from the bottom of the yeast-separation vessel B is not required for maintaining a required yeast concentration in any fermenting and maturing vessel, the yeast is pumped through the pipe-line 49 and a pipe-line 58 into the pipe-line 55 in which the yeast is mixed with partly clarified fermented wort from the outlet of the separation vessel B, the complete flow going through the pipe-line 55 into the second continuous yeast-separation vessel B².

The flow of sugary wort into the series-connected vessels can be adjusted to give large variations in flavour to the finished "beer" but, of course, the other controls of flavour, for example the control of yeast propagation which is described with reference to the apparatus illustrated in Figure 1 may also be used in this case.

The malt wort addition can be adjusted so that the vessel A is maintained at the lowest possible specific gravity, and under these conditions acts as a yeast-propagating or yeast-growth vessel, the yeast slurry being fed to the vessel A¹. It is apparent from the illustration of this system and the various valve controls provided therein that a varied combination of treatments may be employed selectively as desired, so that the rapidly fermenting and maturing wort may be subjected to variations in treatment as the wort passes through the system.

It will also be apparent from the foregoing that the principles of the invention described herein may be applied in a number of ways to suit particular requirements, for example by varying the number of fermenting and maturing zones, the manner of adding wort and the yeasting thereof.

The fermenting and maturing vessel illustrated in Figure 7 is provided with a propeller 122 mounted on a drive shaft 121. The drive 120 lies outside the vessel and the drive shaft 121 passes through a gas-tight gland 113 in the domed top 112 of the vessel, which is vented at 114.

The vessel is provided with a wort inlet 117, an inlet 118 for yeast or "yeasty beer" and an outlet 119 for fermented wort. The propeller 122 is surrounded by a cylindrical shroud 123.

The clearance 124 between the shroud 123 and the conical bottom 116 of the vessel is adjustable between predetermined limits as required.

The vessel briefly described above may be used as follows, the use of a single vessel being described for simplicity:—

Aerated "fresh wort" to be fermented is continuously added to the vessel through the inlet 117 and the rotating propeller 122 rapidly mixes this added material with the material already in the vessel so that the contents of the vessel are maintained in a homogeneous condition. The clearance 124 and the speed of the propeller 122 can be adjusted so as to provide various low pressure conditions under the propeller which assist in drawing the carbon dioxide out of the liquid.

In general, the diameter of the shroud 123 should be approximately one-sixth of the diameter of the vessel. The rise of the carbon dioxide bubbles through the shroud 123 (as indicated by the arrows) takes place at a faster rate than the natural upward movement of the bubbles if the liquid were quiescent.

This arrangement allows the use of intensive agitation without the formation of any substantial head of foam on the agitated liquid, and average running conditions for the agitating mechanism cause a substantially complete circulation of the contents of the vessel every minute.

The heat of fermentation in the fermenting and maturing liquid is controlled by cooling and/or heating means (not shown) and the fermenting and maturing wort in the vessel is kept in a steady state by adjusting the throughput, the temperature, the yeast concentration and the degree of agitation, e.g. the propeller speed.

At the same time, fermented wort is continuously withdrawn through the outlet 119 and separated yeast may be introduced as required through the yeast inlet 113.

It will be understood that the connections to and from the vessels are varied as required by the systems shown in Figures 1 to 6.

The Specification of Application No. 7381/61 (Serial No. 872395) which has been divided from the present Application, claims a process for the production of "beer" by continuous fermentation, wherein substantially unfermented wort is subjected to the action of a "high" initial concentration of yeast under conditions leading to "rapid" extraction of yeast growth materials from the wort and to a "high" degree of yeast activity; and apparatus for producing "matured beer" by continuous fermentation including a first and a second treatment vessel; means for feeding wort to said first vessel; means for transferring partially-fermented wort from said first to said second vessel; means for agitating the contents of each said vessel; means for introducing diluent water at a point in the flow later than said first vessel; and means for returning separated yeast, and/or yeasty "beer" taken

from a point in the flow later than said second vessel, to said first vessel.

The Specification of Application No. 7386/61 (Serial No. 872,400), which has been divided from the present Application, claims a process for the production of "beer" by continuous fermentation, wherein unfermented or partially fermented wort is added to and dispersed in at least one body of continuously fermenting wort with yeast homogeneously suspended therein and the reduction of the specific gravity of the added wort by fermentation is carried substantially to completion in said body, such addition and dispersal taking place either continuously or at such frequent intervals as to prevent the starvation of the suspended yeast: whereby accelerated maturing of the "beer" is achieved without any substantial autolysis of the yeast.

The Specification of Application No. 7380/61 (Serial No. 872,394), which has been divided from the present Application, claims a process for the production of "beer", by continuous fermentation, in which there are fed to a plurality of vessels connected in series a main flow, of wort containing yeast growth materials, and a supplementary flow, relatively free from yeast growth materials; and in which all or part of the supplementary flow is mixed with the main flow only after yeast propagation in said main flow is largely completed.

The Specification of Application No. 7385/61 (Serial No. 872,399), which has been divided from the present Application, claims a process for the production of "beer" by continuous fermentation, in which the pH of the inflowing wort is adjusted, before substantial fermentation or yeast propagation is allowed to take place therein, by mixing with said wort liquid recirculated from a later stage of the fermentation process; and apparatus for producing beer by continuous fermentation including a first treatment vessel (or vessels), a second treatment vessel (or vessels), means for supplying substantially unfermented wort continuously to said first vessel, means for transferring wort from said first to said second vessel, means for withdrawing fermented wort from said second vessel, means for the continuous recirculation to said first vessel of fermented wort which has passed through said second vessel, and means for mixing the inflowing wort and the recirculated liquid together before they enter said first vessel.

The Specification of Application No. 7382/61 (Serial No. 872,396), which has been divided from the present Application, claims a process for the manufacture of "beer", which comprises continuously fermenting wort in at least one fermenting vessel and maintaining a desired yeast concentration in said vessel; adding wort to the fermenting

wort at a desired rate; agitating the resulting body of liquid to cause substantially immediate homogeneity of the added wort and the fermenting wort, and to maintain said body of liquid at a substantially uniform temperature; and withdrawing fermented wort from said vessel.

The Specification of Application No. 7383/61 (Serial No. 872,397), which has been divided from the present Application, claims a continuous "beer" fermentation process in which yeast suspended in a body of continuously fermenting wort, to which wort to be fermented is continuously or intermittently added, continuously utilises material in the fermenting wort, the conditions being adjusted to control the utilisation of said material in such manner as correspondingly to control the release into the fermenting wort of various by-products of said utilisation.

The Specification of Application No. 7378/61 (Serial No. 872,392), which has been divided from the present Application, claims a continuous "beer" fermentation process, wherein a body of continuously fermenting wort, to which wort to be fermented is added, and containing yeast for the fermentation thereof, is sufficiently agitated to ensure substantially continuous homogeneity of said body, the rate of yeast propagation in said body being controlled in relation to the temperature and to the degree of agitation thereof and to the yeast concentration therein, in such manner as to obtain a desired pH in the finished beer.

The Specification of Application No. 7379/61 (Serial No. 872,393), which has been divided from the present Application, claims a continuous "beer" fermentation process, wherein a body of continuously fermenting wort, to which wort to be fermented is added, and containing yeast for the fermentation thereof, is sufficiently agitated to ensure substantially continuous homogeneity of said body, the fermentation and the rate of yeast propagation in said body being controlled in relation to the temperature and to the degree of agitation thereof, and to the yeast concentration therein, in such manner as to obtain a desired reduction in the amino-acid content of the added wort by yeast utilisation.

The Specification of Application No. 7384/61 (Serial No. 872,398), which has been divided from the present Application, claims a continuous "beer" fermentation process, wherein a body of continuously fermenting wort, to which wort to be fermented is added, and containing yeast for the fermentation thereof, is sufficiently agitated to ensure substantially continuous homogeneity of said body, the rate of yeast propagation in said body being controlled in relation to the temperature and to the degree of agitation thereof and to the yeast concentration therein,

in such manner as to obtain a desired resistance to bacterial growth in the finished "beer".

WHAT WE CLAIM IS:—

1. A continuous process for the production of "beer" comprising the steps of adding "fresh wort" to a, or to a first, fermenting and maturing zone containing wort which is being continuously fermented by means of yeast suspended therein; agitating the contents of the fermenting and maturing zone or zones sufficiently to maintain the suspension of yeast and wort in a substantially homogeneous state and at a substantially uniform temperature; withdrawing "beer" from the, or from the last, fermenting and maturing zone; maintaining in said zone or zones a concentration of suspended yeast which is sufficient to achieve by the fermentation of the wort in said zone or zones a desired reduction of the specific gravity of the added wort; and maintaining conditions of yeast activity which are such that the "beer" produced is a "matured beer".
2. A process as claimed in Claim 1, in which both the addition of "fresh wort" and the withdrawal of "beer" are continuous.
3. A process as claimed in Claim 1 or 2, in which the "beer" which is withdrawn is thereafter substantially separated from the yeast contained therein.
4. A process as claimed in any of Claims 1 to 3, in which yeast is recycled to the, or to at least one, fermenting and maturing zone.
5. A process as claimed in any of Claims 1 to 4, in which "beer" is recycled to the, or to at least one, fermenting and maturing zone.
6. A process as claimed in any one of the preceding Claims, in which the added wort has a specific gravity exceeding that required for making the finished "beer", and is diluted after fermentation, or after one or more stages of fermentation.
7. A process as claimed in any of Claims 1 to 6, in which carbon dioxide is withdrawn from the, or each, fermenting and maturing zone.
8. A process as claimed in any of Claims 1 to 7, in which the added wort is dispersed in the, or each, zone by agitation which is such as to maintain the fermenting wort in the form of a substantially homogeneous suspension without the formation of a substantial head of foam thereon.
9. A process as claimed in any of Claims 1 to 8, wherein a substantially unvarying volume of liquid is maintained in the, or each, fermenting and maturing zone.
10. In a process as claimed in any of the preceding Claims, controlling the rate of yeast activity, by adjustment of the conditions of fermentation and maturing, so as to maintain said rate substantially steady, at a

level determined by the nature of the added wort and the character required in the final "beer".

11. In a process as claimed in any of Claims 1 to 10, adjusting the conditions of fermentation and maturing, and the rate of any recirculation of yeast or yeasty "beer," so as to maintain the yeast concentration in the, or each, fermenting and maturing zone, at a level determined by the nature of the added wort and the character required in the final "beer".

12. In a process as claimed in any of Claims 1 to 11, controlling the rate of yeast activity in such manner as to give a desired pH to the final "beer".

13. A process as claimed in any of Claims 1 to 12, in which the pH at which fermentation begins is controlled by controlling the nature of the added wort and the proportions in which the added wort is mixed with the continuously fermenting wort, and the pH of the final "beer" is controlled by controlling the rate of yeast activity.

14. A process as claimed in any one of the preceding Claims, in which fermentation and maturing of the wort take place in two or more stages and/or in two or more parts, in a series or set of zones in each of which continuous fermentation and maturing are maintained.

15. A process as claimed in any of Claims 1 to 14, in which fermentation and maturing are carried out in a series of zones, in each of which, except the first, partially fermented wort from a preceding zone is dispersed.

16. A process as claimed in any of Claims 1 to 15, wherein a plurality of fermenting and maturing zones are employed, and the concentration of yeast in each zone is determined by controlling the amount of suspended yeast in the flow from one zone to the next in the direction of flow.

17. A process as claimed in any of Claims 1 to 16, wherein yeast is separated from the "beer" product by passing the "beer" into a settling vessel and by overflowing the "beer" in a condition substantially free from yeast from an upper part of the vessel, the settled yeast being extracted from a lower part of the vessel.

18. A process as claimed in any of Claims 1 to 16, wherein yeast is separated from the "beer" product by means of a centrifugal clarifier.

19. A process as claimed in any of Claims 1 to 18, wherein the yeast concentration in the, or each, fermenting and maturing zone is controlled to a value above 12 grams per litre of wort and up to a value of 100 grams per litre of wort.

20. A process as claimed in any of Claims 1 to 19, wherein the temperature in the, or each, fermenting and maturing zone is controlled to a value of at least 38°F. and



in such manner as to obtain a desired resistance to bacterial growth in the finished "beer".

WHAT WE CLAIM IS:—

1. A continuous process for the production of "beer" comprising the steps of adding "fresh wort" to a, or to a first, fermenting and maturing zone containing wort which is being continuously fermented by means of yeast suspended therein; agitating the contents of the fermenting and maturing zone or zones sufficiently to maintain the suspension of yeast and wort in a substantially homogeneous state and at a substantially uniform temperature; withdrawing "beer" from the, or from the last, fermenting and maturing zone; maintaining in said zone or zones a concentration of suspended yeast which is sufficient to achieve by the fermentation of the wort in said zone or zones a desired reduction of the specific gravity of the added wort; and maintaining conditions of yeast activity which are such that the "beer" produced is a "matured beer".
2. A process as claimed in Claim 1, in which both the addition of "fresh wort" and the withdrawal of "beer" are continuous.
3. A process as claimed in Claim 1 or 2, in which the "beer" which is withdrawn is thereafter substantially separated from the yeast contained therein.
4. A process as claimed in any of Claims 1 to 3, in which yeast is recycled to the, or to at least one, fermenting and maturing zone.
5. A process as claimed in any of Claims 1 to 4, in which "beer" is recycled to the, or to at least one, fermenting and maturing zone.
6. A process as claimed in any one of the preceding Claims, in which the added wort has a specific gravity exceeding that required for making the finished "beer", and is diluted after fermentation, or after one or more stages of fermentation.
7. A process as claimed in any of Claims 1 to 6, in which carbon dioxide is withdrawn from the, or each, fermenting and maturing zone.
8. A process as claimed in any of Claims 1 to 7, in which the added wort is dispersed in the, or each, zone by agitation which is such as to maintain the fermenting wort in the form of a substantially homogeneous suspension without the formation of a substantial head of foam thereon.
9. A process as claimed in any of Claims 1 to 8, wherein a substantially unvarying volume of liquid is maintained in the, or each, fermenting and maturing zone.
10. In a process as claimed in any of the preceding Claims, controlling the rate of yeast activity, by adjustment of the conditions of fermentation and maturing, so as to maintain said rate substantially steady, at a

level determined by the nature of the added wort and the character required in the final "beer".

11. In a process as claimed in any of Claims 1 to 10, adjusting the conditions of fermentation and maturing, and the rate of any recirculation of yeast or yeasty "beer," so as to maintain the yeast concentration in the, or each, fermenting and maturing zone, at a level determined by the nature of the added wort and the character required in the final "beer".

12. In a process as claimed in any of Claims 1 to 11, controlling the rate of yeast activity in such manner as to give a desired pH to the final "beer".

13. A process as claimed in any of Claims 1 to 12, in which the pH at which fermentation begins is controlled by controlling the nature of the added wort and the proportions in which the added wort is mixed with the continuously fermenting wort, and the pH of the final "beer" is controlled by controlling the rate of yeast activity.

14. A process as claimed in any one of the preceding Claims, in which fermentation and maturing of the wort take place in two or more stages and/or in two or more parts, in a series or set of zones in each of which continuous fermentation and maturing are maintained.

15. A process as claimed in any of Claims 1 to 14, in which fermentation and maturing are carried out in a series of zones, in each of which, except the first, partially fermented wort from a preceding zone is dispersed.

16. A process as claimed in any of Claims 1 to 15, wherein a plurality of fermenting and maturing zones are employed, and the concentration of yeast in each zone is determined by controlling the amount of suspended yeast in the flow from one zone to the next in the direction of flow.

17. A process as claimed in any of Claims 1 to 16, wherein yeast is separated from the "beer" product by passing the "beer" into a settling vessel and by overflowing the "beer" in a condition substantially free from yeast from an upper part of the vessel, the settled yeast being extracted from a lower part of the vessel.

18. A process as claimed in any of Claims 1 to 16, wherein yeast is separated from the "beer" product by means of a centrifugal clarifier.

19. A process as claimed in any of Claims 1 to 18, wherein the yeast concentration in the, or each, fermenting and maturing zone is controlled to a value above 12 grams per litre of wort and up to a value of 100 grams per litre of wort.

20. A process as claimed in any of Claims 1 to 19, wherein the temperature in the, or each, fermenting and maturing zone is controlled to a value of at least 38°F. and



below the "thermal death point" of the yeast.

21. A process as claimed in Claim 20, wherein the temperature is above 48°F.

5 22. A process as claimed in any of Claims 1 to 21, wherein the hourly rate of addition of wort is approximately one-sixtieth of the contents of the fermentation and maturing zone, or of all the fermenting and maturing zones, for a measured specific gravity drop of

10 thirty-thousandths.
23. A process as claimed in any of Claims 1 to 21, wherein the hourly rate of addition of wort is approximately one-tenth of the

15 contents of the fermentation and maturing zone, or of all the fermenting and maturing zones, for a measured specific gravity drop of thirty-thousandths.
24. A process as claimed in Claim 23,

20 wherein the yeast concentration is approximately 70 grams per litre of wort.
25. A process as claimed in any of Claims 1 to 24, wherein the rate of inflow of wort is controlled in such manner that the fermentable material of the incoming wort

25 substantially exactly replaces the material fermented.
26. A process as claimed in any of Claims 1 to 25, wherein the fermentation and maturing

30 are effected in a plurality of interconnected zones and a stream of diluent mixes with partially fermented wort from the first and/or a following fermenting and maturing zone which passes to the second, or next, fermenting and maturing zone.

35 27. A process as claimed in Claim 26, wherein a further stream of diluent enters the system of interconnected zones at a point at which fermentation is substantially

40 complete.
28. A process as claimed in Claim 26 or 27, wherein said diluent is water or water which contains a flavouring material of a fermentable or non-fermentable nature.
45 29. A process as claimed in any of the preceding Claims, wherein a plurality of fermenting and maturing zones are employed, and wherein the conditions in the first, or at least the first, zone are controlled

50 in such manner that substantially all the required yeast production takes place in the first fermenting and maturing zone or zones, and wherein the conditions in the later fermentation zone or zones are controlled in such manner that substantially no yeast production occurs therein.
55 30. A process as claimed in any of the preceding Claims, wherein a series of interconnected zones is employed, and a substantially continuous inflow of wort and outflow of "beer" is maintained with respect to said series whilst intermittent flow takes place between two or more zones of said series.

60 31. A process as claimed in any of Claims

1 to 30, wherein, during the continuous running, the fermentation and maturing conditions are maintained in a substantially equilibrium state in the, or each, fermenting and maturing zone.

32. A process as claimed in Claim 31, wherein the temperature of the, or each, fermenting and maturing zone is maintained substantially unvarying.

33. A process as claimed in Claim 31 or 32, wherein the yeast concentration in the, or each, fermenting and maturing zone is maintained substantially unvarying.

34. A process as claimed in any of Claims 31 to 33, wherein the degree of agitation in the, or each, zone is maintained substantially unvarying.

35. A process as claimed in any of Claims 31 to 34, wherein a plurality of fermenting and maturing zones are employed, and the fermenting and maturing conditions are maintained substantially identical from one zone to the second or next.

36. A process as claimed in any of Claims 31 to 34, wherein a plurality of fermenting and maturing zones are employed, and the fermenting and maturing conditions differ from one zone to the second or next.

37. A process for the manufacture of "beer" comprising adding "fresh wort", or wort in which yeast propagation has been caused to take place, to a fermenting and maturing vessel; continuously fermenting wort in said vessel; agitating the contents of said vessel to cause rapid circulation thereof (whereby yeast in said vessel is maintained in suspension and the liquid in said vessel is kept substantially homogeneous and substantially uniform in temperature); and drawing off fermented wort from said vessel: the propagation of yeast in the fermenting wort being such as to maintain in said vessel a concentration of suspended yeast sufficient to achieve by the fermentation a desired reduction of specific gravity of the wort; and the conditions of fermentation and yeast propagation being such that the "beer" produced is a "matured beer".

38. A process according to Claim 37 in which both addition and withdrawal of wort are continuous.

39. A process according to Claim 37 or 38, in which the wort added to said vessel results from the mixing of "fresh wort" with recirculated yeasty "beer".

40. A modification of the process according to any of Claims 37 to 39, in which fermentation and maturing of the wort takes place in two or more stages and/or in two or more parts, in a series or set of vessels in each of which continuous fermentation is maintained.

41. A process according to any preceding Claim, in which the wort is prepared with a specific gravity exceeding that required for

making the finished "beer", and is diluted after fermentation or after one or more stages of fermentation.

42. In a process according to any preceding
5 Claim, controlling the rate of yeast propagation, by adjustment of conditions of fermentation and maturing, so as to maintain said rate substantially steady, at a level determined by the nature of the "fresh wort" and the
10 character required in the final "beer".

43. In a process according to any of Claims 37 to 41, adjusting conditions of fermentation and maturing, and the rate of any recirculation of yeast or yeasty liquid, so as to maintain the yeast concentration used at each stage of fermentation and maturing at a level determined by the nature of the "fresh wort" and the character required in the
15 final "beer".

44. In a process according to any of Claims 37 to 41, so controlling the rate of yeast propagation as to give a desired pH to the final "beer".

45. A process according to any of Claims 37 to 44, in which the pH at which fermentation begins is controlled by controlling the proportions in which "fresh wort" is mixed with material already subject to fermentation, and the pH of the final beer is controlled by
30 controlling the rate of yeast propagation.

46. A continuous process for the production of "beer" substantially as hereinbefore particularly described with reference to Figure 1 of the accompanying drawings.

47. A continuous process for the production of "beer" substantially as hereinbefore particularly described with reference to Figure 2 of the accompanying drawings.

48. A continuous process for the production of "beer" substantially as hereinbefore particularly described with reference to Figure 3 of the accompanying drawings.

49. A continuous process for the production of "beer" substantially as hereinbefore particularly described with reference to Figure 4 of the accompanying drawings.

50. A continuous process for the production of "beer" substantially as hereinbefore particularly described with reference to Figure 5 of the accompanying drawings.

51. A continuous process for the production of "beer" substantially as hereinbefore particularly described with reference to Figure 6 of the accompanying drawings.

52. A continuous process for the production of "beer" substantially as hereinbefore particularly described with reference to Figure 7, together with any one of Figures 1 to 6, of the accompanying drawings.

53. Apparatus for the continuous production of "beer" including at least one fermentation and maturing vessel which is provided with means for agitating the contents thereof, wherein conduit means are
65 provided for the introduction of wort to be

fermented and of yeast into the vessel, or into the first of the vessels, and for the withdrawal of "beer" from the vessel, or from the last of the vessels, and wherein means are provided for controlling the fermentation and maturing conditions in the fermentation and maturing vessel or vessels, including the temperature, the degree of agitation and the pH of the fermenting liquid so that the "beer" produced is a "matured beer".

54. Apparatus as claimed in Claim 53, wherein at least one other treatment vessel is adapted to separate the yeast from the "beer".

55. Apparatus as claimed in Claim 54, wherein conduit means are provided for recycling at least part of the separated yeast to the fermentation and maturing vessel, or to at least one of the fermentation and maturing vessels.

56. Apparatus as claimed in any of Claims 53 to 55, wherein two or more fermentation and maturing vessels are connected to one another in such manner that the fermenting wort flows continuously through succeeding fermentation and maturing vessels.

57. Apparatus as claimed in Claim 56, wherein at least one yeast separation vessel is connected to the second or last fermentation and maturing vessel.

58. Apparatus as claimed in any of Claims 53 to 57, wherein the, or each, fermentation and maturing vessel is provided with a mechanical stirrer.

59. Apparatus as claimed in Claim 58, wherein said stirrer is constituted by a propeller which is surrounded by an upright shroud the gap between the bottom of the shroud and the bottom of the vessel being adjustable to throttle the flow of liquid which enters the shroud at the bottom thereof, and to cause the liquid to flow out of the shroud at the upper end thereof.

60. Apparatus as claimed in any of Claims 53 to 54, wherein the, or each, fermentation and maturing vessel is provided with gas-venting means.

61. Apparatus as claimed in any of Claims 53 to 60, wherein the conduit means for introducing wort to be fermented and yeast into the vessel, or into the first of the vessels, and for the withdrawal of "beer" from said vessel, or from the last of the vessels, are provided with valve means for controlling the rate of introduction of wort and of yeast and the rate of withdrawal of "beer", thereby to control the conditions in the fermentation and maturing vessel or vessels.

62. Apparatus as claimed in any of Claims 53 to 61, wherein a plurality of interconnected treatment vessels are employed and heat-exchange means are provided in the flow circuit between the, or at least one, pair of interconnected treatment vessels to control the temperature of the liquid flowing between



aid vessels.

- 5 63. Apparatus for the continuous production of "beer" substantially as hereinbefore particularly described with reference to Figure 1 of the accompanying drawings.

64. Apparatus for the continuous production of "beer" substantially as hereinbefore particularly described with reference to Figure 2 of the accompanying drawings.

- 10 65. Apparatus for the continuous production of "beer" substantially as hereinbefore particularly described with reference to Figure 3 of the accompanying drawings.

- 15 66. Apparatus for the continuous production of "beer" substantially as hereinbefore particularly described with reference to Figure 4 of the accompanying drawings.

- 20 67. Apparatus for the continuous production of "beer" substantially as hereinbefore particularly described with reference to Figure 5 of the accompanying drawings.

68. Apparatus for the continuous production of "beer" substantially as hereinbefore particularly described with reference to Figure 6 of the accompanying drawings.

25

69. Apparatus for the continuous production of "beer" substantially as hereinbefore particularly described with reference to Figure 7, together with any of Figures 1 to 6, of the accompanying drawings.

30

70. "Matured beer" when prepared by a process as claimed in any of Claims 1 to 52 or by an apparatus as claimed in any of Claims 53 to 69.

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ERRATUM

SPECIFICATION NO. 872,391

Page 1, line 90, for "th" read "that"

THE PATENT OFFICE,
14th August, 1961.

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