March 25, 1941. H. A. BENNING 2,236,419

APPARATUS FOR TREATING SUGAR JUICES

Filed Sept. 16, 1939 5 Sheets-Sheet 1

FIG. 1.

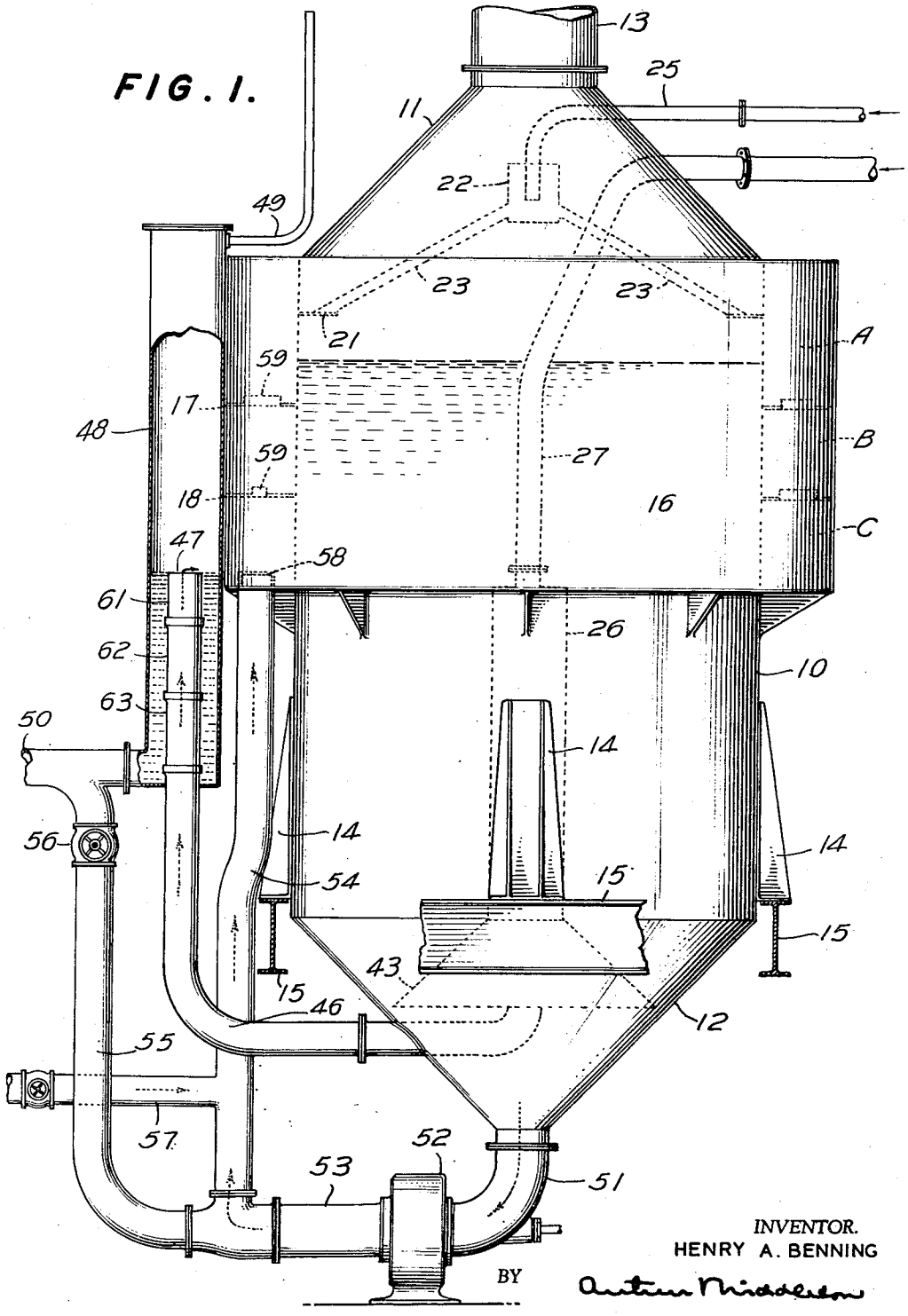

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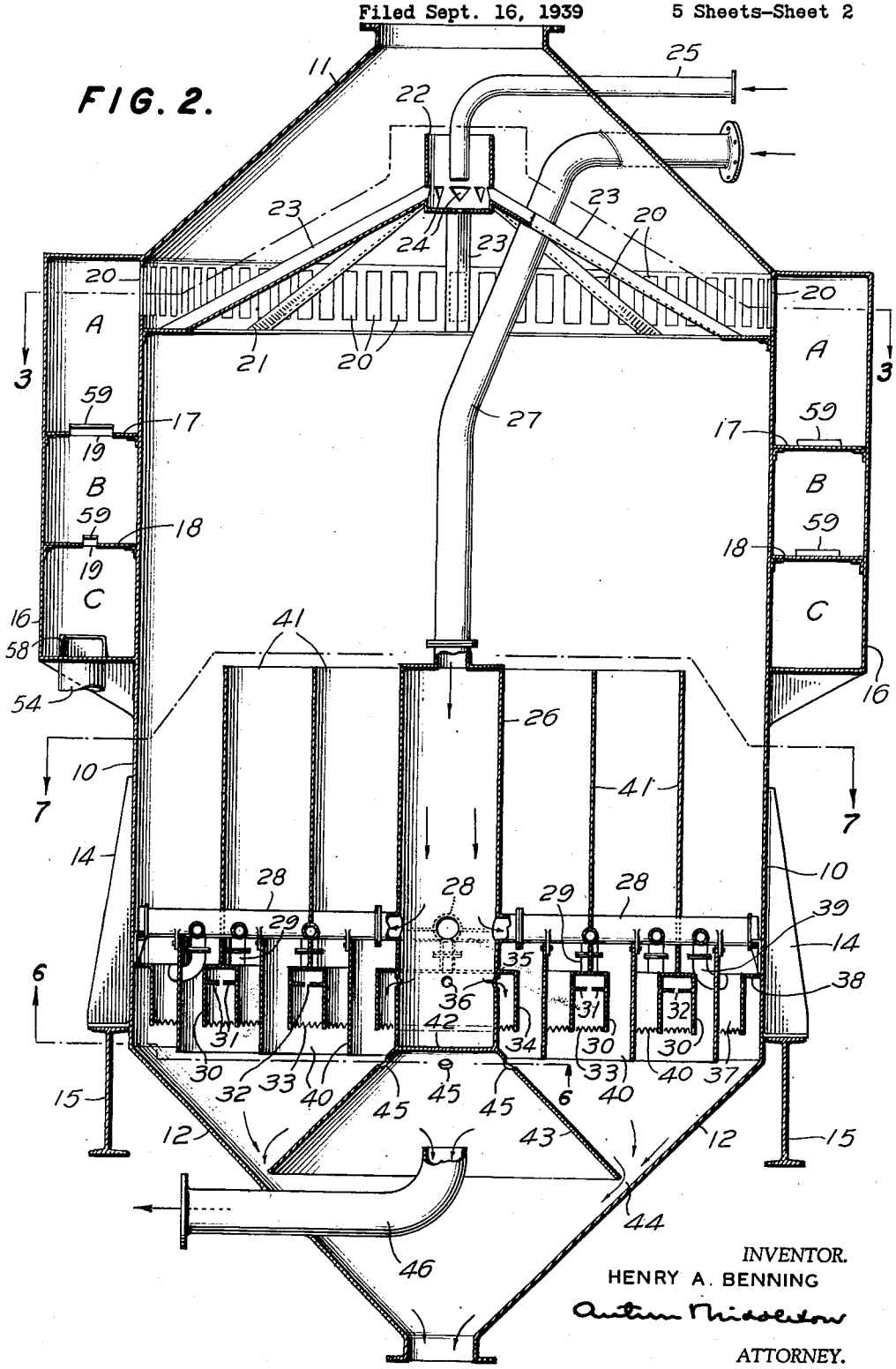
FIG. 2.



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APPARATUS FOR TREATING SUGAR JUICES

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FIG. 3.

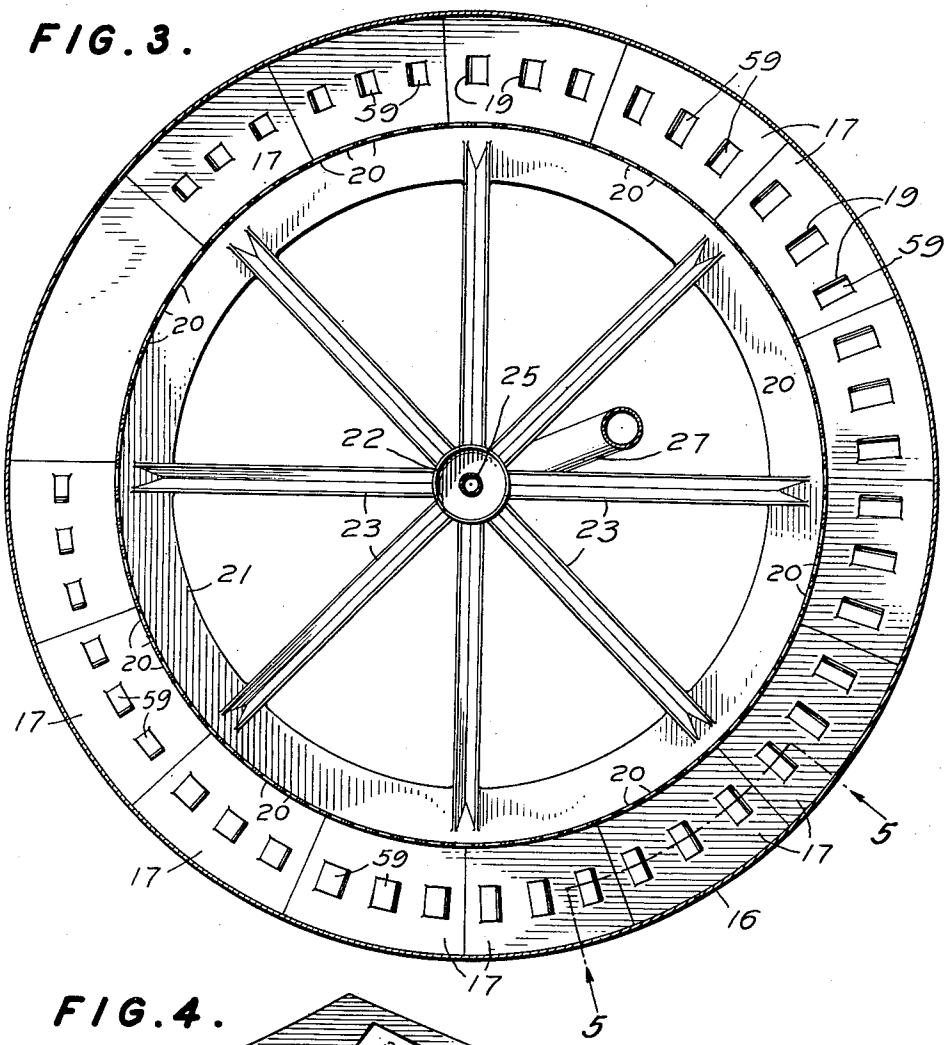


FIG. 4.

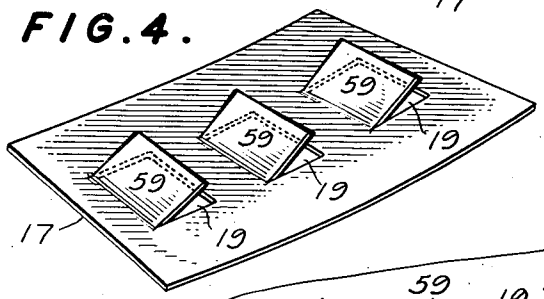
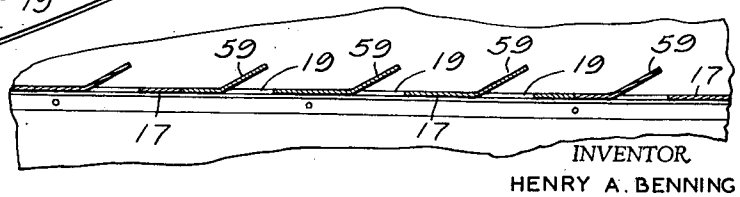


FIG. 5.



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APPARATUS FOR TREATING SUGAR JUICES

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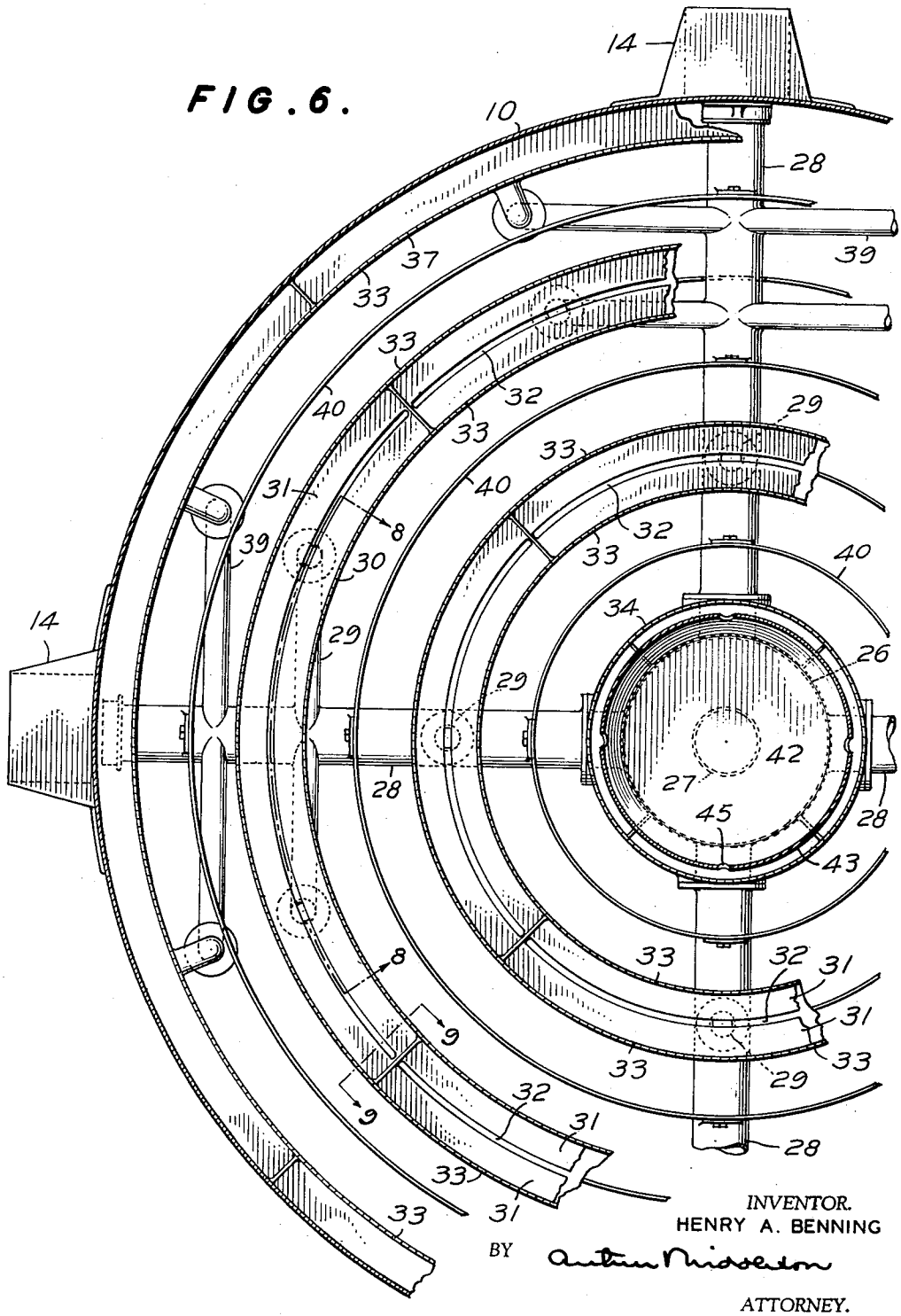
FIG. 6.



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APPARATUS FOR TREATING SUGAR JUICES

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FIG. 7.

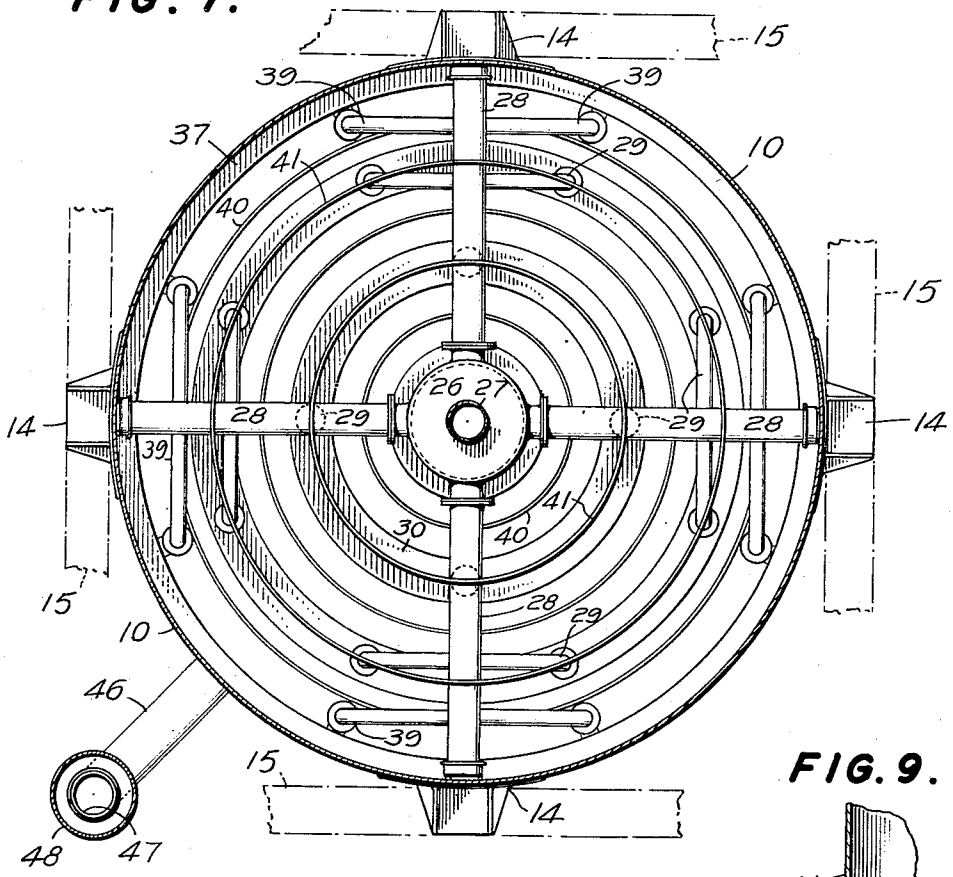


FIG. 9.

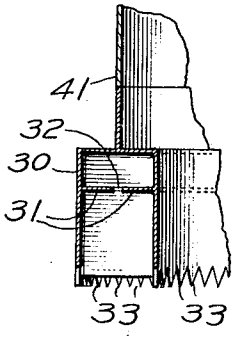
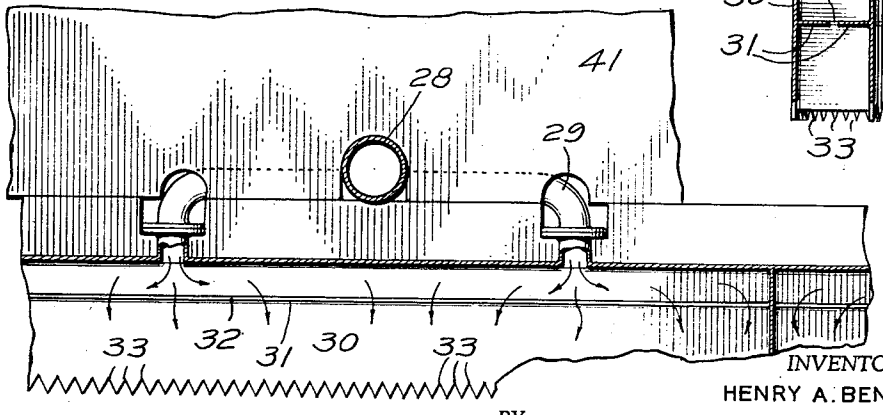


FIG. 8.



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Patented Mar. 25, 1941

2,236,419

UNITED STATES PATENT OFFICE

2,236,419

APPARATUS FOR TREATING SUGAR JUICES

Henry A. Benning, Ogden, Utah

Application September 16, 1939, Serial No. 295,177

11 Claims. (Cl. 127—12)

This invention relates to the manufacture of sugar from beet juices and, more particularly, to that phase of the sugar making process known as carbonation wherein the raw beet juices are subjected to treatment with lime and a carbon dioxide bearing gas for the precipitation into insoluble form of various impurities contained in the raw juices, which are then subsequently separated from the carbonated juices.

Specifically, the invention embraces a novel apparatus wherein the carbonation operation may be conveniently carried out, and which is of particular utility and advantage in the practice of the widely used continuous carbonation process as exemplified in the United States Patent to Arthur W. Bull, No. 1,755,165.

In the normal commercial application of that process some six to eight parts of unseparated carbonation reaction products are recirculated to be mixed with one part of raw beet juice being introduced into the system. The resulting mixture, after thorough mixing, is subjected to the chemical action of milk-of-lime and a carbon dioxide containing gas. Manifestly, two zones of action are involved, the first of which comprises a mixing zone, while the second may be designated as a gassing or primary reaction zone. Heretofore it has always been customary to employ separate tanks or apparatus for each of these zones, thus requiring considerable space for positioning of the apparatus and involving relatively large expense for initial installation.

It is a prime object of the present invention to provide a novel apparatus for the continuous carbonation of beet juices wherein both of the above mentioned zone actions are effected within a single unit, thus effecting material savings in apparatus expense, space required for installation, and loss of heat from radiating surfaces.

Another object is to provide a carbonation apparatus having improved means for effecting a thorough and complete mixing of the recirculated carbonated juice and the raw juice, all without the use of moving parts.

Another object is to provide, in a carbonation apparatus, an improved arrangement of gas suppling means for insuring a more thorough distribution of gas throughout the contents of the gassing zone, thus eliminating or minimizing localized over-carbonation of the juices.

A further object of the invention is to provide for a more uniform distribution of the previously mixed raw juice and recirculated carbonated juice into the carbonation zone, thus insuring against isolated, stagnant areas in the carbonating zone.

Still another object is to provide, in a carbonation apparatus, an improved means for distributing a continuous feed of milk-of-lime, or its equivalent saccharate milk, into the feed of mixed juices entering the carbonation zone.

With these and other objects in view, the invention consists in the construction and novel combination and arrangement of parts hereinafter fully described, illustrated in the accompanying drawings, and set forth in the claims hereto appended, it being understood that various changes in the form, proportion and minor details of construction, within the scope of the claims, may be resorted to without departing from the spirit of the invention or sacrificing any of the advantages thereof.

In the drawings:

Figure 1 is a side elevation, partly in section, of an apparatus for the continuous liming and carbonation of beet juices embodying the features of the present invention.

Figure 2 is a vertical section through the apparatus of Figure 1, somewhat enlarged.

Figure 3 is a horizontal sectional view of the apparatus taken approximately on the line 3—3 of Figure 2.

Figure 4 is an enlarged fragmentary perspective view illustrating a detail of the invention.

Figure 5 is a detailed sectional view taken on the line 5—5 of Figure 3.

Figure 6 is an enlarged fragmentary sectional view of the apparatus taken approximately on the line 6—6 of Figure 2.

Figure 7 is a hoizontal section taken on the line 7—7 of Figure 2.

Figure 8 is a detailed section taken on the 8—8 of Figure 6, and

Figure 9 is a detailed section taken on the line 9—9 of Figure 6.

In the manufacture of sugar from beets, as hereinbefore indicated, one of the primary operations is that known as carbonation, wherein the raw juices extracted from the beets are treated with lime and carbon dioxide for the precipitation of impurities. This operation is most efficiently performed by a continuous procedure, such as described in the Bull Patent No. 1,755,165, wherein quantities of previously limed and carbonated juices, bearing insoluble precipitate, are returned to be mixed with raw untreated juices entering the system, the resulting mixture thereafter being limed and carbonated.

Apparatus embodying the features of the pres-

ent invention, as hereinbefore mentioned, is aimed at performing the separate acts of mixing the recirculated reaction product with the raw juices and liming and carbonating in a single compact unit. The apparatus also possesses other features of novelty which materially enhance and improve the efficiency of this particular stage of sugar making process.

In general the apparatus is embodied in a single unit wherein the mixing zone and the carbonating zone are concentrically arranged. Specifically the carbonating zone comprises a vertical tank surrounded by an integral annular section which provides the mixing zone. Suitable means are provided in the mixing zone for assuring a thorough and homogeneous mixing of the raw juices and the recirculated reaction product, and suitable means are provided in the carbonation zone for introducing milk-of-lime or saccharate milk as well as a continuous supply of a carbon dioxide bearing gas, which latter is thoroughly and evenly distributed to the contents of this zone. Means are also provided for effecting a recirculation to the mixing zone of reaction products from the carbonation zone as well as means for permitting a continuous discharge from the carbonation zone of a suitable quantity of the reaction product for further processing in a known manner.

Referring to the drawings in detail, and particularly Figures 1 and 2 thereof, reference numeral **10** designates a cylindrical upright tank forming the liming and carbonation zone, the tank being provided with a top **11** in the form of a truncated cone as well as a similarly shaped bottom **12**. The top **11** is preferably provided with a stack or vent pipe **13** for the venting of spent gases which have passed through the contents of the tank **10**. Tank **10** may be provided with a number of brackets **14** spaced about its periphery for supporting the apparatus upon a suitable foundation such as the beams **15**.

The mixing zone of the device is embodied in an annular chamber or bustle **16** surrounding the tank **10** and preferably extending from adjacent its top a distance approximately half-way to the bottom of the tank. For a purpose to be presently described the mixing chamber **16** is divided into a plurality of superposed sections, herein shown as three, by annular partitions **17** and **18**, thus forming separate annular sections A, B and C within the mixing zone. These sections are in communication with one another through apertures **19** in the partitions **17** and **18**, the form, arrangement and effect of which will be dwelt upon hereinafter.

The upper section A of the mixing zone acts as a manifold and supplies the liquid mixture to the interior of the carbonation tank **10** through the annularly arranged ports or openings **20**. Around the inner periphery of the tank **10** and positioned a short distance below the ports **20** is an annular shelf **21** upon which the liquid entering through the ports flows to thence cascade into the tank **10**.

For supplying milk-of-lime or saccharate milk to the contents of tank **10** there is provided a lime feedwell in the form of a cylindrical cup **22** which is supported as shown by suitable rigid troughs or launders herein exemplified by angle irons **23** which are welded or otherwise attached to the shelf **21** and which are similarly attached to the feedwell **22** but in communication with the interior thereof as indicated by the ports **24**. A pipe **25** is arranged to conduct the lime into the feedwell **22** from whence it can flow by means of the launders **23** to the shelf **21** and thus mix with the liquid splashing upon the shelf through the ports **20**.

For supplying and distributing a CO_2 bearing gas to the contents of the tank **10**, there is provided an assembly comprising a vertical central tube or core **26** of relatively large diameter connected with a supply pipe **27** which furnishes a continuous supply of gas to the core **26**. Extending radially from the core are a plurality, preferably four, of distributor pipes **28** which communicate, by means of suitable elbows **29**, with gas distributors generally indicated at **30**.

As seen in detail in Figs. 8 and 9, these gas distributors are annularly disposed and are in the form of inverted U's or channels open at the bottom. Internally thereof the distributors are provided with transverse horizontal partitions **31** for the purpose of forming the annular manifold spaces **31***a*. Each partition **31** is provided with a series of aligned slots **32**, whereby the gas supplied via the distributing pipes **28** and elbows **29** may escape from the manifold portion **31***a* of the distributors **30** and thence downwardly and outwardly into the contents of the tank. By this arrangement it is assured that a proper gas pressure will be maintained in the distributing system and the liquid contents of the tank prevented from backing up into the gas supply system. In addition, a plurality of vertical partitions or baffles **32***a* may be utilized in the distributors **30** to divide the same into sectors. By this expedient gas is prevented from surging to a high point in the annular distributor should the same be not absolutely level. The lower edge of each downwardly projecting side of the distributors **30** is serrated or toothed as indicated at **33**. These serrations, past which the gas must flow on its course into the contents of the tank, tend to promote the separation of the gas into bubbles of a desirable small size and assist in the uniform distribution or influx of the gas into the contents of the tank.

While two of the annular distributors **30** have been shown in the drawings, it is obvious that any desired number may be used. In addition it is convenient to provide a somewhat similar distributor adjacent to and attached to the central tube **26**, this distributor taking the form of a cylindrical baffle **34** closed at the top and attached to the central tube as at **35**. Suitable ports or openings **36** in the wall of the central tube provide means for the flow of gas into the annular space provided by the baffle **34**, whence it passes downwardly and around the lower serrated edge of the baffle. A similar downwardly depending baffle **37** may be provided adjacent the inside wall of the tank **10**, this baffle being closed at the top and joined to the tank wall as indicated at **38**. Gas may be supplied into the space between the baffle **37** and the side wall of the tank through means of a suitable elbow or connecting pipe **39** leading from a distributing pipe **28** and communicating through the baffle **37**. The lower edge of this baffle may, of course, be serrated for the purpose hereinbefore mentioned. Obviously each of these gassing means may be provided with vertical partitions for dividing them into sectors in the manner previously described.

It is generally preferable to provide downwardly extending annular baffles **40** between each of the gas distributors just described. These baffles prevent coalescing of the gas and prevent its spreading horizontally.

There are also provided the upwardly extend-

ing annular baffles 41 which extend upwardly for a considerable distance from approximately the central portion of each of the distributors 30. These baffles 41 perform at least two desirable functions. They prevent the coalescence of gas bubbles, which action causes the formation of large bubbles and a lack of uniformity of conditions in the zone. They also prevent, to an appreciable degree, swirling or rolling of the entire content of the gassing zone, which action likewise results in lack of uniformity and homogeneity in the zone.

The central supply tube 26 is, of course, closed at the bottom as at 42. This tube may conveniently support a conical shroud and hood 43, which flares outwardly or downwardly to a point sufficiently near the conical bottom 12 of the tank to provide a narrow annular space 44 through which the carbonated juice must pass before being withdrawn from the tank. This affords a throttling feature which tends to produce a uniform flow downwardly through the gassing zone. Furthermore, it assures the prevalence of relatively quiescent conditions in the liquid beneath the hood 43 which allows and promotes the separation of entrained gas bubbles, which will rise and return upwardly to the gassing zone through the ports 45 provided for that purpose.

The end product or effluent of the apparatus, comprising carbonated juice for further processing in known manner, is allowed to continuously pass from the zone beneath the hood 43 by means of the effluent pipe 46 which rises outside of the tank and terminates in a barometric leg 47 within a cylinder or effluent receiving receptacle 48 which may be supported upon the outside of the mixing chamber 16. The overflow cylinder 48 may be provided with a vent 49 for venting any gas that may have been carried over into the effluent cylinder and is also provided with a discharge pipe 50 through which the product may pass to a further processing station.

The material for recirculation to the mixing zone 16 is withdrawn from the tank at the very lowermost part thereof, through an appropriate opening in the conical bottom 12. For this purpose an elbow 51 connects the conical bottom with an appropriate pump 52 whose discharge is connected by means of a pipe section 53 with a standpipe or riser 54. A branch pipe 55 may lead from the pipe 53 and communicate through valve 56 with the effluent discharge pipe 50. The valve 56 is normally maintained closed so that the material acted upon by the pump 52 is forced upwardly through the riser 54. If, however, it is desired at any time to entirely empty the tank 10, valve 56 may be opened, permitting the entire tank contents to be pumped out through the effluent discharge 50.

Communicating with the riser 54 is the new feed supply pipe 57 through which the new feed or raw beet juice is supplied to the apparatus. As previously indicated, the proportion of the new feed entering through the pipe 57 to the carbonated juice being recirculated by the pump 52, is of the order of about 1 to 8. The raw juice, of course, begins to mingle with the juice being pumped upwardly through the riser 54 and the mixing of the two is initiated within the riser. The latter communicates with the annular mixing chamber 16 through the bottom thereof and terminates in an elbow or bent portion at 58, so that the mixture is discharged into the mixing zone in a relatively horizontal direction so as to impart a swirling or helical flow path to the liquid within the mixing zone. The liquid mixture flowing around and upwardly through the mixing chamber passes through the openings 19 in the partitions 17 and 18 and eventually reaches the upper compartment A as a thorough and homogeneous mixture from whence it passes into the liming and carbonation zone through the ports 20 as previously mentioned.

The partitions 17 and 18 and the manner in which the openings 19 are provided and arranged constitute novel and important features of the invention. Preferably the openings 19 are provided by punching out portions of the respective partitions while leaving the punched out sections joined to the partitions at one edge so as to form the flaps or lips 59. These flaps are adjusted at an acute angle to the upper faces of the partitions so as to deflect the liquid rising upwardly through the openings 19 and continue the guidance of the flow of the liquid in a relatively horizontal and circular direction. In order to maintain the pressure relatively constant and the liquid flow as even as possible, suitable arrangement is made for having the openings 19 progressively increase in size in each direction from adjacent the point of discharge of the terminus 58 of the riser. As shown in Fig. 3, the area of the punched out sections 59 progressively increases in size in two directions around the periphery. It would also be feasible to make the flaps 59 and openings 19 all of the same size and adjust the flaps at progressively increasing angles with respect to the partitions, thus achieving the same effect of varying the size of the openings through which the liquid passes. The continuous helical swirl maintained in the mixture passing through the mixing compartment 16, and the relatively small openings 19 through which the material passes, and the baffling and intercepting effect of the flaps 59 all cooperate to achieve a thorough and complete mixing of the recirculated reaction product and the raw juice fed in through the pipe 57. Thus there is delivered to the liming and carbonation zone 10, through the ports 20, a thorough and homogeneous mixture, all effected without the use of any mechanical agitation or moving parts.

In operation, raw beet juice is introduced into the recirculation line or riser 54 and passes with the recirculated unseparated reaction products, pumped from the bottom of the tank 10 by the pump 52, into the mixing zone 16. As previously indicated, the risers should be arranged to introduce the mixture into the annular section "C" in a tangential manner so as to induce a circular motion in the contents thereof. Obviously the flow of juice mixture is generally upward through the mixing chamber 16 through the baffled ports 19 provided in the partitions 17 and 18 for maintaining the coincidental circulatory motion. The juice passes from the mixing zone through the ports 20, which are arranged to provide a uniform distribution of the mixed products around the peripheral wall bounding the carbonation zone 10. As the juice appears through these ports it falls upon the annular plate 21, flows across this plate and drops from the edge of the same into the carbonation zone. Milk of lime or its equivalent, saccharate milk, continuously flows from the supply well 22 through the launders 23 and is thoroughly dispersed in and mixed with the mixture entering the carbonation zone as it flows across the shelf 21 in a relatively thin film.

Gas is introduced through the gas supply pipe

27 into the central core 26 and thus escapes into the contents of the tank via the serrated distributors 30, 34 and 37, and rises through the contents of the tank, the unabsorbed products escaping through the vent 13 at the top of the tank. The rate of gas introduction, as well as that of milk of lime introduction, may be controlled through manually operated valves or any other suitable means. The function of the serrated gas distributors is to separate the so introduced gas into bubbles of desirable size, the CO_2 from which will be adsorbed as they rise through the liquid within the tank. As previously mentioned, the upstanding cylindrical baffles 41 prevent coalescence of gas bubbles and minimize swirling or rolling of the entire content of the gassing zone, both of which actions result in lack of uniformity and homogeneity in the gassing zone, which in turn yields effluent with undesirable characteristics.

These details found in and surrounding the carbonation zone are all directed toward one end—the maintenance of a high degree of uniformity and homogeneity within said zone—which condition avoids, to a large degree, localized over-carbonation, the incidental by-passing through and from the zone of quantities of untreated, admixed juices, and by so doing produces a reaction product of more uniform characteristics than has heretofore been available. This latter especially manifests itself in terms of reduced lime-salts content and uniform alkalinity of said reaction products.

The flow of the liquid mixture in the tank is, of course, generally downward, while that of the gas upward through the downwardly flowing liquid. As previously mentioned, the downward flow is throttled at the passage 44 so that relatively quiescent conditions prevail under and beneath the hood 43. It is within the space confined by this hood that the final effluent of the apparatus is withdrawn. There is thus provided the effluent pipe 46 through which the carbonated liquid, containing but little unabsorbed gas, is allowed to pass, by virtue of the hydraulic pressure existing within the tank 10. The pipe 46 constitutes a barometric leg and terminates in an open upper end within the level control box or cylinder 48. The hydraulic leg is, of course, adjustable by being formed of a plurality of readily detachable and removable sections 61, 62 and 63.

Thus the height of the upper end of the leg, at which point the liquid discharges, may be adjusted at any desired level. This hydraulic leg is utilized to balance the contents of the tank 10 and thus maintain a relatively constant liquid level therein. Since the liquid within the tank 10 and above the gas distributors is thoroughly saturated with a light gas, whereas the liquid rising through the barometric leg and overflowing into the cylinder 48 contains practically no gas, the latter liquid is considerably higher in specific gravity than the contents of the tank 10. Thus, the discharge level of the barometic leg will balance the contents of the tank 10 at a relatively higher level as clearly indicated in Fig. 1. For best operation it is desired to maintain the liquid level in the tank 10 at a point somewhat below the shelf 21 in order that the liquid entering the carbonation zone may cascade thereinto from the said shelf. If the ports 20 were submerged the influx of liquid from the mixing zone would be less constant and less evenly distributed, which would result in localized over-carbonation. Thus, knowing the respective specific gravities of the two liquids, it is manifestly a relatively simple matter to adjust the upper end of the barometric leg at a discharge level that will balance the contents of the tank 10 at a desired level below the shelf 21. With this adjustment made, and the rate of recirculation and of new feed maintained fairly constant, the apparatus will remain in balance and operate practically automatically with a minimum of operative attention and regulation. In most instances it is practicable to adjust the barometric leg so that it balances the contents of the tank 10 by visual observation. Likewise the said adjustment may be varied from time to time as changes in operating conditions or characteristics of the feed of liquid or gas cause substantial fluctuations of the specific gravity in the gassing zone.

I claim:

1. Apparatus for the continuous liming and carbonation of sugar juices comprising a tank for holding a mixture of raw juices and previously carbonated juice, means for supplying lime and means for supplying a CO_2 bearing gas to said tank, an annular chamber surrounding said tank and constituting a mixing chamber, means for transferring previously carbonated juice from said tank to said chamber, means for introducing raw juice into said chamber, and means to permit material to pass from said chamber into said tank.

2. Apparatus for the continuous liming and carbonation of sugar juices comprising a tank for holding a mixture of raw juices and previously carbonated juice, means for supplying lime and means for supplying a CO_2 bearing gas to said tank, an annular chamber surrounding said tank and constituting a mixing chamber, means for transferring previously carbonated juice from said tank to said chamber, means for introducing raw juice into said chamber, means in said chamber for assisting the mixing of said juices, means to permit the mixed juices to pass from said chamber into said tank, and means for discharging carbonated juice from the apparatus.

3. Apparatus for the continuous liming and carbonation of sugar juices comprising a tank for holding a mixture of raw juices and previously carbonated juice, means for supplying lime and means for supplying a CO_2 bearing gas to said tank, an annular chamber surrounding said tank and constituting a mixing chamber, a substantially horizontal perforate partition in said chamber dividing the same into a plurality of superposed sections, means for transferring previously carbonated juice from said tank to said chamber, means for introducing raw juice into said chamber, said chamber being in communication with said tank whereby material may pass from the former into the latter, and means for discharging carbonated juice from the apparatus.

4. Apparatus for the continuous carbonation of sugar juices comprising a tank for holding a mixture of raw juices and previously carbonated juice, means for supplying a CO_2 bearing gas to said tank, an annular chamber surrounding said tank and in communication therewith through an annularly arranged series of ports in an upper portion of said chamber and adapted to permit juices to pass from said chamber into said tank, means for introducing raw juice into a lower portion of said chamber, means for transferring previously carbonated juice from said tank to

said chamber, and means for discharging carbonated juice from the apparatus.

5. Apparatus for the continuous liming and carbonation of sugar juices comprising a tank for holding a mixture of raw juices and previously carbonated juice, means for supplying a CO_2 bearing gas to said tank, an annular chamber surrounding said tank and constituting a mixing chamber, a substantially horizontal perforate partition dividing said chamber into a plurality of superposed sections, an upper one of said sections being in communication with said tank through an annularly arranged series of ports, a conduit leading from the lower portion of said tank and terminating in a substantially horizontal discharge portion in a lower one of said sections whereby previously carbonated juice is conducted to said chamber and introduced thereinto in a substantially circumferential flow, means associated with the perforations in said partition for assisting in maintaining the circumferential flow as material from a lower of said sections passes through said perforations to an upper of said sections, means for adding raw juice to previously carbonated juice conducted to said chamber from said tank, means to introduce lime into the resulting mixture of said juices, and means for discharging carbonated juice from the apparatus.

6. Apparatus according to claim 5 wherein an annular shelf is provided around the inner periphery of said tank a short distance below said annularly arranged series of ports to cause the juices to cascade therefrom into said tank.

7. Apparatus according to claim 5 wherein an annular shelf is provided around the inner periphery of said tank a short distance below said annularly arranged series of ports, and wherein means is provided for adding lime to the juices as they flow over said shelf.

8. Apparatus for the continuous liming and carbonation of sugar juices comprising a tank for holding a mixture of raw juices and previously carbonated juice, means for supplying lime and means for supplying a CO_2 bearing gas to said tank, an annular chamber surrounding said tank and constituting a mixing chamber and in communication with said tank at the upper portion thereof through an annularly arranged series of ports adapted to permit juices to pass from said chamber into said tank, a conduit leading from a lower portion of said tank and communicating with said chamber for conducting previously carbonated juice from the tank to the chamber, means for introducing raw juice into said chamber, and means for discharging carbonated juice from the apparatus.

9. Apparatus for the continuous carbonation of sugar juices comprising a tank for holding a mixture of raw juices and previously carbonated juice, means for supplying lime and means for supplying a CO_2 bearing gas to said tank, an annular chamber surrounding said tank and constituting a mixing zone, means for transferring previously carbonated juice from a lower portion of said tank to said chamber, means for introducing raw juices into said chamber, said chamber being in communication with said tank whereby the resultant mixture of juices may pass from the former into the latter, an effluent receiving receptacle, an effluent conduit leading from a lower portion of said tank and terminating within said receptacle in upstanding manner, and a conduit leading from said receptacle for conducting away effluent for further processing.

10. Apparatus according to claim 9 in which the upstanding end of the conduit leading from the tank to the effluent receiving receptacle is adjustable as to length, thereby constituting a barometric leg to maintain a predetermined liquid level within the tank.

11. Apparatus for continuous liming and carbonation of sugar juices comprising a tank having a mixing section and a carbonation section, said sections being concentrically arranged with respect to one another, means for introducing raw sugar juice into a lower portion of said mixing section, said sections being in communication with one another whereby material may pass from said mixing section into an upper portion of said carbonation section, means for supplying lime to an upper portion of said carbonation section, means for supplying a CO_2 bearing gas to a lower portion of said carbonation section, means for withdrawing a quantity of reaction products from a lower portion of said carbonation section and discharging the same from the apparatus, and means for returning another quantity of reaction products from said carbonation section to said mixing section.

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