

July 23, 1957

P. ARANT

2,800,196

STEAM ACCUMULATOR AND NOZZLE THEREFOR

Filed Feb. 18, 1952

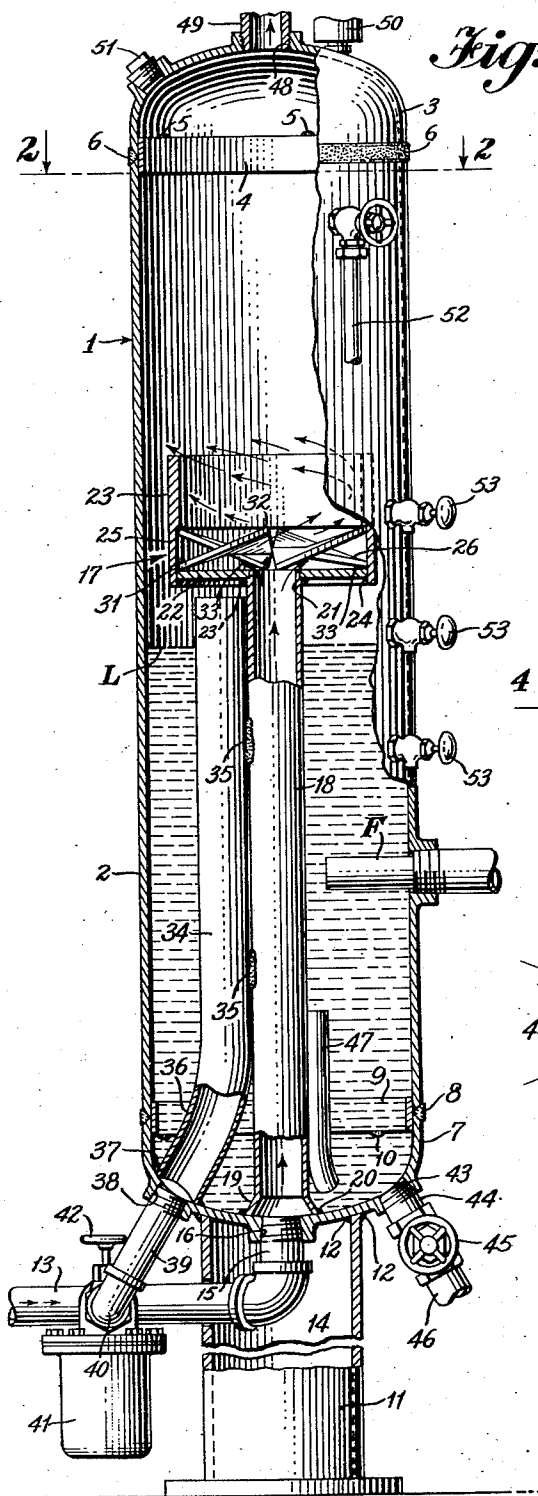


Fig. 1.

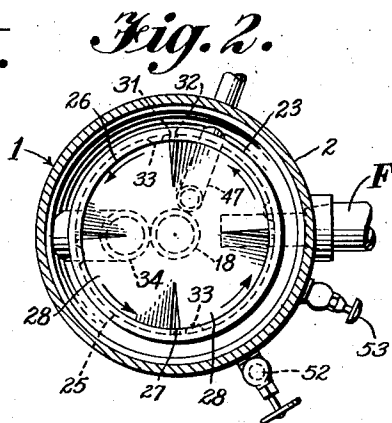


Fig. 2.

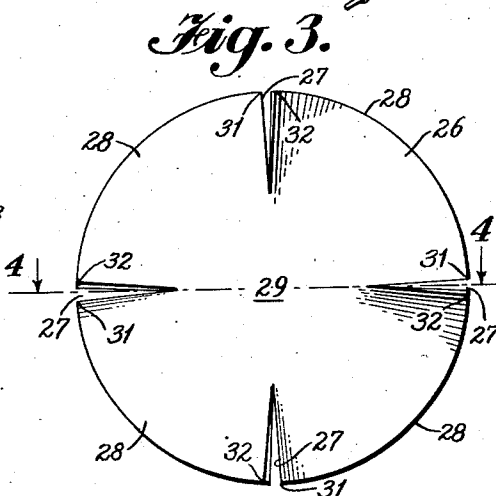


Fig. 3.

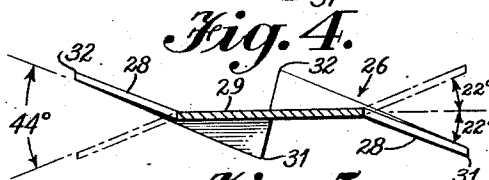


Fig. 4.

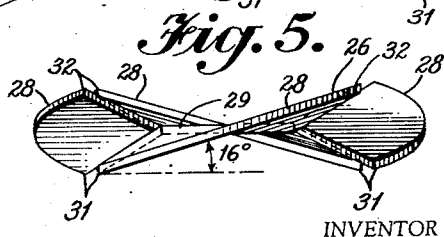


Fig. 5.

INVENTOR

Perry Arant

BY

Bacon + Thomas

ATTORNEYS

1

2,800,196

STEAM ACCUMULATOR AND NOZZLE THEREFOR

Perry Arant, San Gabriel, Calif., assignor to Clayton Manufacturing Company, El Monte, Calif., a corporation of California

Application February 18, 1952, Serial No. 272,059

8 Claims. (Cl. 183—95)

The present invention relates to steam separators, or accumulators, and more particularly to a novel discharge nozzle construction for use therein.

The principal object of the invention is to provide a discharge nozzle for an accumulator which will maintain the moisture carry-over in the steam leaving the accumulator at a minimum amount.

Another object of the invention is to provide a discharge nozzle for an accumulator which will provide a substantially uniform centrifugal discharge pattern and thereby eliminate the steam vortex and liquid disturbances which normally occur in accumulators having a tangentially directed discharge nozzle.

Another object of the invention is to provide a nozzle construction which will not deflect liquid into the path of the vapor leaving the accumulator.

Another object of the invention is to provide a nozzle for an accumulator which will function over a wide range of steam demand and over a substantial pressure range to keep the moisture content in the steam at a minimum.

Still another object of the invention is to provide a discharge nozzle for an accumulator that will maintain a substantially uniform separation of liquid and vapor when performing under increased velocities of the fluid, due to decreased operating pressure, at any given constant capacity.

A further object of the invention is to provide a nozzle for an accumulator which will produce a multi-direction discharge to substantially uniformly distribute that part of the heated fluid which does not flash into vapor as a liquid film on the inner surface of the accumulator wall.

A still further object of the invention is to provide a nozzle for an accumulator that will not disturb the liquid that has collected in the lower end of the accumulator, and which will provide an upper strata of liquid that has a temperature substantially equal to that of the fluid being discharged into the accumulator, to thereby avoid heat loss through condensation in the accumulator.

A more specific object of the invention is to provide a distributing plate for an accumulator nozzle constructed so that the fluid issuing from the nozzle is caused to flow at high velocity in a generally circular and upwardly inclined direction, whereby to permit the fluid in the central portion of the accumulator to flash into substantially dry vapor, and to cause the unvaporized liquid to impinge against the inner surface of the accumulator by the action of centrifugal force, and to flow downwardly by gravity to collect in the lower end of the accumulator.

Other objects and features of the invention will be apparent from the following description taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a vertical sectional view through an accumulator having incorporated therein a fluid discharge nozzle embodying the principles of the present invention;

Fig. 2 is a horizontal sectional view taken on the line of 2—2 of Fig. 1;

Fig. 3 is an enlarged plan view of the fluid distributing plate of the nozzle;

2

Fig. 4 is a sectional view taken on the line 4—4 of Fig. 3; and

Fig. 5 is a side elevational view of the fluid distributing plate, and particularly illustrating the angularity of the peripheral edges of the vanes with respect to the substantially flat central portion of said plate.

Referring now more particularly to Fig. 1, the accumulator is generally identified by the numeral 1 and comprises a tank including a cylindrical side wall section 2 having a dome-shaped head 3 at its upper end. The head 3 contains a ring 4 tack-welded thereto at 5 and received in the upper end of the side wall 2. The adjacent edges of the wall 2 and head 3 are permanently connected together by a continuous weld 6 backed by the ring 4.

A generally similar head 7 is secured to the lower end of the side wall 2 by a continuous weld 8 backed by a ring 9 within the accumulator and tack-welded to the head 7, as indicated at 10. A stand 11 is disposed below the accumulator 1 and is welded at 12 to the exterior of the head 7.

Heated fluid at vapor forming temperatures and pressures is introduced into the accumulator 1 through a pipe 13 having one end thereof connected to an elbow 14, which, in turn, is connected by a conventional pipe nipple 15 to a threaded centrally located opening 16 in the head 7.

The discharge nozzle assembly is generally identified by the numeral 17 and comprises an inlet tube 18 flared at its lower end as indicated at 19 and welded or otherwise suitably secured at 20 in vertical alignment with inlet opening 16. The upper end of the tube 18 has a shoulder 21, which forms a seat for a centrally apertured disk 22 that is circumferentially welded, as indicated at 23', to the upper end of the tube 18. The disk 22 is received in the lower end of a cylindrical member 23 and is circumferentially welded at its outer periphery to said cylindrical member, as indicated at 24. The disk 22 and cylindrical member 23 are disposed concentrically in the accumulator tank and cooperate to form a cup member in which the disk 22 forms the bottom wall and the cylindrical member 23 the side wall. The inside diameter of cylindrical member 23 is substantially greater than that of the upper end of the tube 18 so as to provide a relatively large expansion zone where the heated fluid from tube 18 may flash into vapor. In the present example, as will be clearly seen in Figs. 1 and 2, the inside diameter of cylindrical member 23 is approximately four times as great as the inside diameter of tube 18.

A shoulder 25 is formed by an annular recess in the inner surface of the side member 23 and a fluid distributing member or plate 26 is disposed between said shoulder and the disk 22. The distributing plate 26 is circular in plan view, as best shown in Figs. 2 and 3, and is initially formed as a flat disk having a plurality of radial slots 27 extending inwardly from the outer periphery thereof for a distance equal to about one-fourth the diameter of the plate. Any suitable number of slots 27 of any suitable depth may be provided in the plate 26, but for illustrative purposes four such slots of the length specified have been shown herein. The portions of the plate between adjacent slots constitute a continuous series of vanes 28, which are bent or inclined relative to a flat central portion 29, so that one radial edge of each vane extends downwardly on an angle of about 22° (measured in a vertical plane) relative to the horizontal plane of the central portion 29 (see Fig. 4), and the other radial edge of each vane extends upwardly on an angle of about 22° (measured in a vertical plane) relative to the same horizontal plane. The bending of the vanes causes the slots 27 to assume the configuration of generally triangular-shaped orifices, with an apex

3

of about 44° (measured in a vertical plane) at the central portion 29. The outer peripheral edge of each vane 28 is disposed at an angle of about 16° to a plane parallel with the plane of the central portion 29, as best shown in Fig. 5. This provides for a low angle spiral travel of the fluid within the cup. The peripheral edge of each vane 28 is preferably shaved or ground so that it is truly vertical. Each vane has a lower corner 31 and an upper corner 32, and when the distributing plate 26 is positioned in the cup, the upper corners 32 of the vanes 28 engage the shoulder 25 and the lower corners 32 engage the disk 22. The periphery of the vanes 28 have a snug fit with the vertical inner face of the member 23 so that there is no fluid leakage at these regions. The distributing plate 26 is preferably secured to the member 23, prior to welding the disk 22 in place, by tack welding each of the vanes 28 thereto at a point adjacent the lower corner 31 as indicated at 33. Thereafter, the disk 22 is positioned in the member 23 and welded at 24 to maintain the disk 22, cylindrical member 23 and distribution plate 26 in permanently assembled relation. The tube 18 may be welded to the disk 22 either before or after said disk has been mounted in the member 23.

A stand pipe or overflow pipe 34 is tack-welded for convenience in assembly to the tube 18 at a plurality of points, as indicated at 35. The upper end of the overflow pipe 34 is spaced from the disk 22 and is located in the accumulator 1 at a height corresponding to the maximum desired liquid level and above a normal liquid level indicated at L. The lower end of the pipe 34 is bent outwardly as indicated at 36 and is welded at 37 in alignment with a threaded opening 38. One end of a pipe nipple 39 is threaded into the opening 38 and its other end is connected with an elbow 40 having connection with a conventional steam trap 41 for trapping excess liquid out of the accumulator should the liquid level in the accumulator rise above the upper end of the overflow pipe 34. A valve 42 is connected in the discharge line from the steam trap 41, in accordance with conventional practice.

The lower head 7 may have any suitable number of threaded openings formed therein for the convenient connection of various pipes thereto. This arrangement avoids the necessity of making numerous pipe connections to the side wall 2. Thus, a threaded opening 43 has a pipe nipple 44 connected thereto, which, in turn, is connected with a manually operable blowdown valve 45 connected with a blowdown pipe 46, as is conventional practice. A pipe 47, through which liquid may be withdrawn from the accumulator 1 for recirculation through a heating coil (not shown), extends through the head 7 into the accumulator and is sealed by a conventional pipe gland (not shown). A feed water pipe F extends through the side wall 2 to a point adjacent the pipe 18 for introducing feed water at a level such that the upper strata of hot water in the accumulator is not disturbed, and in this way condensation losses which would otherwise result from adding relatively cool feed water to the accumulator are avoided. Similarly, the head 3 may have any desired number of threaded openings formed therein, and one such threaded opening 48 is centrally located in said head and has one end of a vapor or steam discharge pipe 49 mounted therein. A safety valve 50, for example, a portion only of which is shown, may be connected with another opening in the head 3. Any openings not used may be closed by a plug 51.

A conventional water gauge glass 52, the upper end only of which is shown in Fig. 1, may be connected with the accumulator 1, together with a plurality of test cocks 53 adapted to be opened to determine the water level in the accumulator, independently of the gauge glass. It will be understood, of course, that the accumulator 1 is covered with suitable lagging or heat insulating material (not shown) to prevent heat losses.

In the normal operation of the accumulator and dis-

4

charge nozzle shown in Fig. 1, fluid under sufficient temperature and pressure to flash into vapor upon reaching a zone of lower pressure is introduced through the pipe 13 and travels upwardly in the tube 18 and enters the lower zone of the relatively large cup below the distributing plate 26 where it expands and is deflected horizontally outwardly by the baffle effect of the central portion 29 of the distributing plate 26. The fluid is then angularly directed by the vanes 28, which cause the same to discharge through the V-shaped orifice between the vanes 28 and to travel helically upwardly in a generally circular path within the cup member 23. Most of the hot fluid flashes into substantially dry vapor upon expansion and rises in the central portion of the accumulator directly above the discharge nozzle 17. The fluid travels at high velocity, and centrifugal force causes the fluid which has not flashed into vapor to travel upwardly along the inner surface of the cup member 23 and to discharge outwardly over the rim of the cup against the inner surface of the wall 2. The distance or clearance between the outer periphery of the cup member 23 and the inner surface of the wall 2 is preferably quite small in order to quickly dissipate the rotating force imparted to the liquid. For example, in an accumulator having an internal diameter of about eight inches, the outside cup diameter is about 6 $\frac{3}{8}$ inches, so that the clearance space is only about $\frac{11}{16}$ of an inch. While the centrifugal force and velocity are quite high, the operation is smooth and the liquid thrown against the inner surface of the wall 2 never rises to a height where it is deflected inwardly by the head member 3 and, therefore, cannot fall back into the central stream of relatively dry vapor discharging from the accumulator through the pipe 49.

The multiple vane arrangement 28 assures a substantially uniform centrifugal pattern in which the unflashed liquid assumes a somewhat annular form as it flows over the rim of the cup member 23, wherefore, a substantially uniform film of liquid flows down the inside wall of the accumulator. Thus, the conventional steam vortex within the accumulator is eliminated, and the liquid which flows down the side wall 2 has its rotating force spent before it reaches the liquid already collected in the lower end of the accumulator. Hence, the unflashed liquid does not produce any turbulence in the collected liquid.

The accumulator and discharge nozzle disclosed herein may be made of any dimensions desired and constructed to meet various service requirements, as will be readily understood. However, the particular dimensions referred to hereinbefore by way of illustrating an operative example, and not by way of limitation, concern an accumulator adapted to operate over a pressure range of 50 to 150 pounds per square inch gauge. The relation of nozzle velocity to steam pressure is very close, and generally varies in accordance with the density of the steam. For example, the weight of steam at 150 pounds per square inch is more than double that of the weight of steam at 50 pounds per square inch. Discharge velocities determined from actual tests show that in a 50 H.P. steam generating unit operating at a constant full capacity, the nozzle discharge velocity at 150 pounds per square inch gauge was 94 feet per second, while at a pressure of 65 pounds per square inch gauge it was more than doubled, or about 192 feet per second.

It will be appreciated that it is difficult to maintain a substantially uniform moisture content in the steam issuing from the accumulator 1 under varying steam pressures, for example, from about 50 to 150 pounds per square inch gauge. This difficulty is increased where the demand on the steam generator varies over a substantial range of the capacity of the unit. It is not uncommon for a unit to be required to operate from anywhere between 50 percent to 100 percent of its rated capacity. Changes in either the steam demand, or the operating pressure, create a corresponding change in the velocity of the discharge

5

nozzle. Moreover, and contrary to the performance of certain previous nozzle designs, the increased discharge velocity of the nozzle disclosed herein does not create disturbances in the liquid in the separation as ordinarily occurs with high velocities so that the uniform separation of moisture from liquid when operating at increased velocities creates no undesirable operating characteristics.

A steam generating unit is considered to be satisfactory, from the standpoint of moisture content, if the maximum moisture content is not in excess of 1 percent at an operating pressure of about 150 pounds per square inch. However, actual tests have shown that the present nozzle will provide steam at a pressure of 150 pounds per square inch with a moisture content as low as .5 percent. At a much lower pressure and higher nozzle discharge velocity, the moisture content is even less. Specifically, tests have shown that with a pressure of 50 pounds per square inch, the moisture content in the steam leaving the accumulator was as low as .25 percent, which is substantially dry steam.

The principal advantage of providing substantially dry steam is quite apparent, namely, that with dry steam, the total heat content is greater than that of steam containing moisture. Heat losses are proportionate to the percentage of moisture contained within the steam. Other economies result from the production of dry steam, in that there is no moisture content to cause interferences in the steam consuming equipment, and there are no undue feedwater losses due to moisture carry-over. Also, less trapping out of hot liquid from the accumulator itself is required by maintaining the liquid level in the accumulator below the upper end of the overflow pipe 34.

It will be understood that various changes may be made in the details of construction, size, and arrangement of the parts of the accumulator and discharge nozzle disclosed herein, without departing from the principles of the invention or the scope of the annexed claims.

I claim:

1. An accumulator, comprising: a generally cylindrical tank having a head at each end thereof, one of said heads having an inlet for heated fluid and the other of said heads having an outlet for vapor; a nozzle pipe disposed in said tank and having one end thereof communicating with said inlet; a fluid discharge nozzle at the opposite end of said nozzle pipe including an expansion zone for said fluid to facilitate the flashing of said fluid into vapor; and an overflow pipe in said tank for unvaporized fluid having its upper end disposed below said discharge nozzle with one end thereof at a predetermined height to provide a desired maximum liquid level in said tank and having its opposite end connected with an outlet opening in said one head for discharging excess liquid from said tank.

2. An accumulator, comprising: a tank; a head member at one end of said tank having an inlet opening for heated fluid; a tube for heated fluid in said tank having its lower end connected with said head and communicating with said opening; a discharge nozzle mounted upon the opposite end of said tube and comprising a cup-shaped member of substantially larger diameter than said tube to facilitate flashing of said fluid into vapor and having a central inlet opening and a vaned fluid distributing member in said cup above said opening arranged to direct the flow of fluid circumferentially and angularly upwardly within said cup; and an overflow tube in said tank for unvaporized fluid having its upper end located at a predetermined height to provide a desired maximum liquid level in said tank and having its lower end secured to said head member and communicating with an outlet opening in said head member.

3. An accumulator, comprising: a generally cylindrical tank having a head at each end thereof, one of said heads having an inlet for heated fluid located centrally thereof and the other of said heads having an outlet for vapor;

6

a nozzle pipe disposed substantially concentrically in said tank and having one end thereof communicating with said inlet; a fluid discharge nozzle at the opposite end of said nozzle pipe including an expansion zone for flashing said fluid into vapor; and an overflow pipe in said tank for unvaporized fluid secured to said nozzle pipe and having its upper end disposed below said discharge nozzle and at a predetermined height to provide a desired maximum liquid level in said tank and having its opposite end connected with an outlet opening in said one head for discharging excess liquid from said tank.

4. In an accumulator, a tubular member for heated fluid; and a discharge nozzle mounted upon one end of said tubular member and comprising a cup having a bottom provided with a relatively small central inlet opening communicating with said tubular member, and a fluid distributing member disposed horizontally within said cup including a flat imperforate central portion larger than said inlet opening spaced axially relative to said inlet opening and including vanes slightly inclined from the horizontal disposed about said central portion, whereby the flow of fluid at high velocity is directed outwardly by said central portion and tangentially upwardly within said cup by said vanes.

5. An accumulator discharge nozzle, comprising: a tube for heated fluid; a cup member having a cylindrical side wall and a substantially flat bottom wall with said bottom wall mounted upon one end of said discharge tube and having a relatively small central opening compared to the diameter of said side wall communicating with said tube, whereby said cup serves as an expansion chamber for heated fluid; and baffle means in said cup including a flat central portion spaced from said opening and a series of radial vanes adjacent said bottom wall of said cup and spaced a substantial distance below the rim of said cup, said vanes having portions disposed above and below the plane of said flat central portion with their outer margins inclined on a slight angle to the plane of said bottom wall for directing fluid flow upwardly and in a circumferential direction within said cup for discharge laterally outwardly by centrifugal force over the rim of said cup.

6. An accumulator nozzle, comprising: a cup having a side wall and a flat bottom wall having a relatively small fluid inlet opening, whereby said cup serves as an expansion chamber for heated fluid; and a circular vaned fluid distributing member in said cup, said fluid distributing member being provided with a plurality of radial slots extending inwardly from the outer edge thereof, the outer marginal portions of said distributing member between said slots being in contact with said side wall and bent on an angle of about 16° relative to the plane of said bottom wall to provide a plurality of inclined vanes with the uppermost edge of each vane disposed at a point about midway of the depth of said cup, whereby the fluid is directed circumferentially within the cup on a low angle of spiral for discharge laterally over the rim of said cup.

7. An accumulator nozzle, comprising: a cup having a cylindrical side wall, said side wall having a shoulder formed on the inner surface thereof and spaced a substantial distance from the rim of said cup; a bottom wall spaced from said shoulder and provided with a relatively small inlet opening, whereby said cup serves as an expansion chamber for heated fluid; and a vaned fluid distributing member in said cup between said shoulder and bottom wall, said fluid distributing member being substantially circular and provided with a plurality of uniformly spaced radial slots extending inwardly from the outer edge thereof, the outer marginal portions of said distributing member between said slots engaging said side wall and being bent on an angle of about 16° relative to the plane of said bottom wall to provide a plurality of inclined vanes with the uppermost edge of each vane

7

engaged with said shoulder and the lowermost edge of each vane engaged with said bottom wall.

8. An accumulator, comprising: a vertical tank having a side wall and a head at each end thereof, one of said heads having an inlet for heated fluid and the other of said heads having an outlet for vapor; a vertical nozzle pipe disposed substantially centrally in said cylindrical tank and having its lower end communicating with said inlet; a fluid discharge nozzle mounted upon the upper end of said nozzle pipe and comprising a generally cup-shaped member having a cylindrical side wall and a substantially flat bottom wall provided with a central opening communicating with said pipe, said cup-shaped member being of considerably greater diameter than said nozzle pipe and having its cylindrical side wall in close proximity to but spaced from the inner surface of said tank; and baffle means at the bottom of said cup cooperating therewith to provide an expansion zone for said fluid and arranged to direct the fluid, introduced into said cup through said central opening, in a generally upward, tangential direction in said cup, whereby said fluid may readily flash into vapor directly above the bottom of said cup, the rim of said cup being sufficiently close to the inner surface of said tank so that any unvaporized fluid

8

is thrown solely by centrifugal force laterally outwardly over the rim of said cup into contact with said side wall and thus prevented from being carried upwardly into the tank by the vaporized fluid.

References Cited in the file of this patent

UNITED STATES PATENTS

1,017,275	Walker	Feb. 13, 1912
1,279,758	Putnam	Sept. 24, 1918
1,534,833	Binks	Apr. 21, 1925
1,693,849	Lorranine	Dec. 4, 1928
1,751,324	Green	Mar. 18, 1930
1,806,543	Kamrath	May 19, 1931
1,930,476	Hawley	Oct. 17, 1933
1,931,194	Hawley	Oct. 17, 1933
1,934,674	Lichtenthaeler	Nov. 7, 1933
1,981,549	Hawley	Nov. 20, 1934
2,250,226	Juelson	July 22, 1941
2,299,332	Marshall	Oct. 20, 1942
2,557,332	Wright	June 19, 1951
2,565,902	Wright et al.	Aug. 28, 1951
2,648,397	Ravese et al.	Aug. 11, 1953