METHOD AND APPARATUS FOR TREATING AND FILLING AMPOULES

Filed May 27, 1954 25 Sheets-Sheet 1

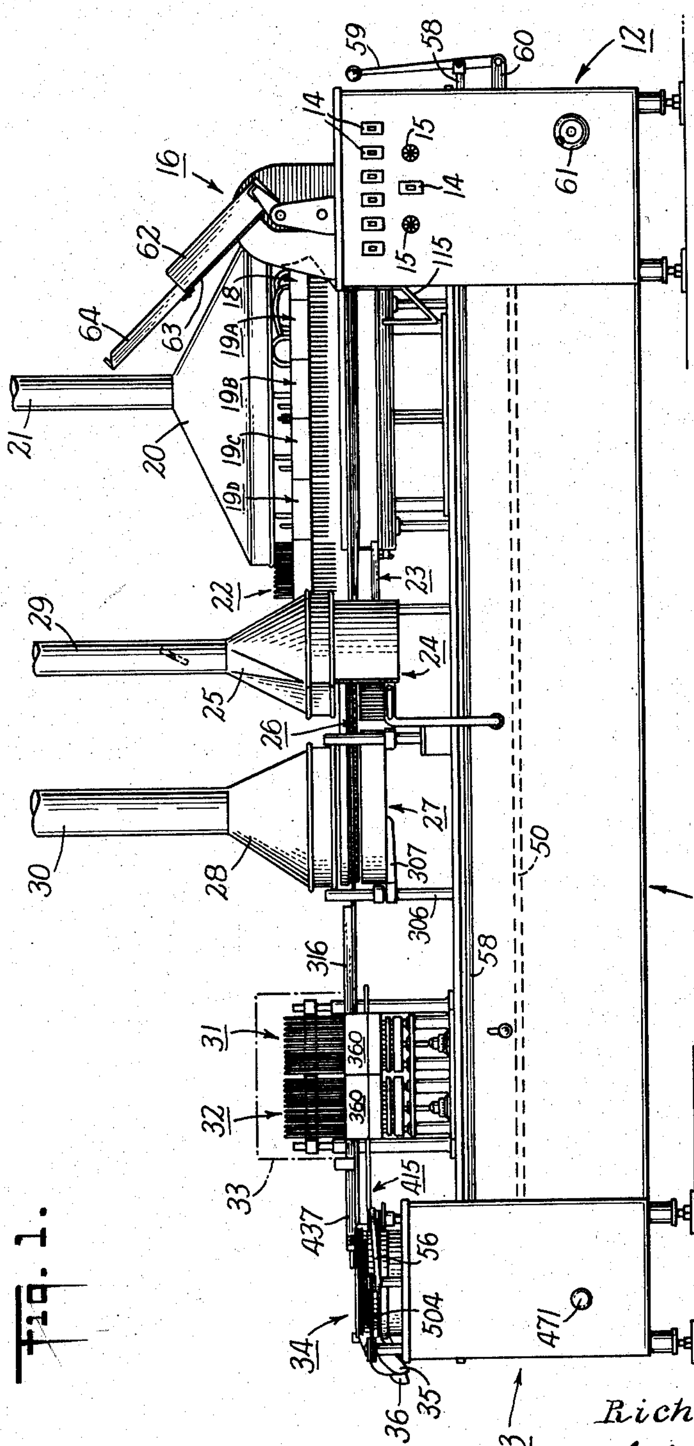


FIG. 1.

INVENTOR.

Richard Lange

BY *Frederick Greitenfeld*

ATTORNEY

July 28, 1959 R. LANGE 2,896,381

METHOD AND APPARATUS FOR TREATING AND FILLING AMPOULES

Filed May 27, 1954 25 Sheets-Sheet 2

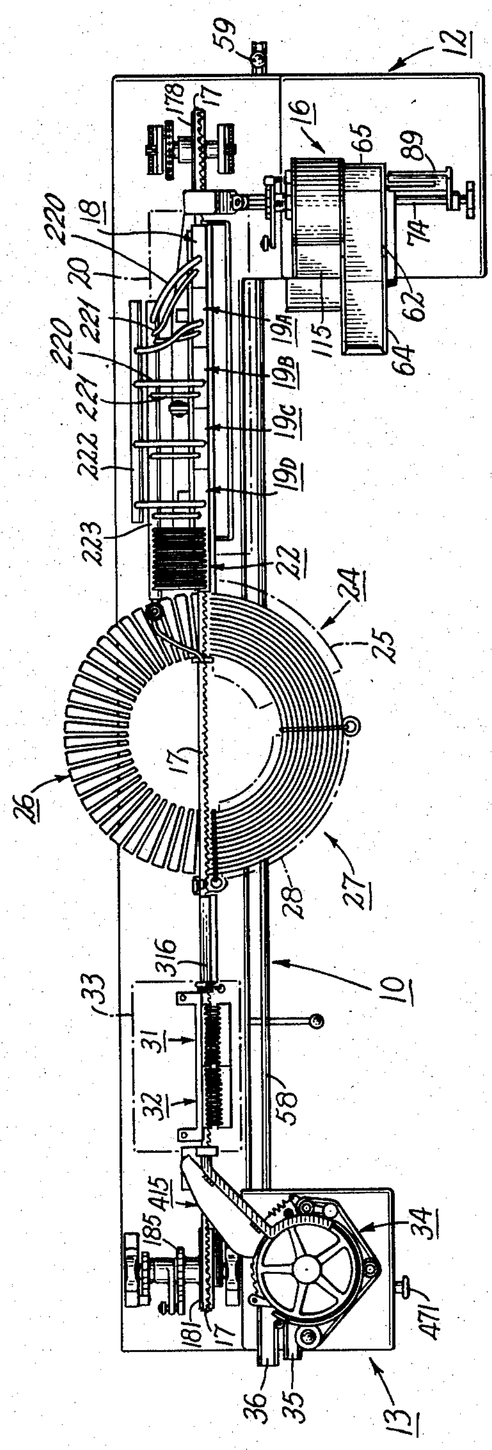


FIG. 2.

INVENTOR.

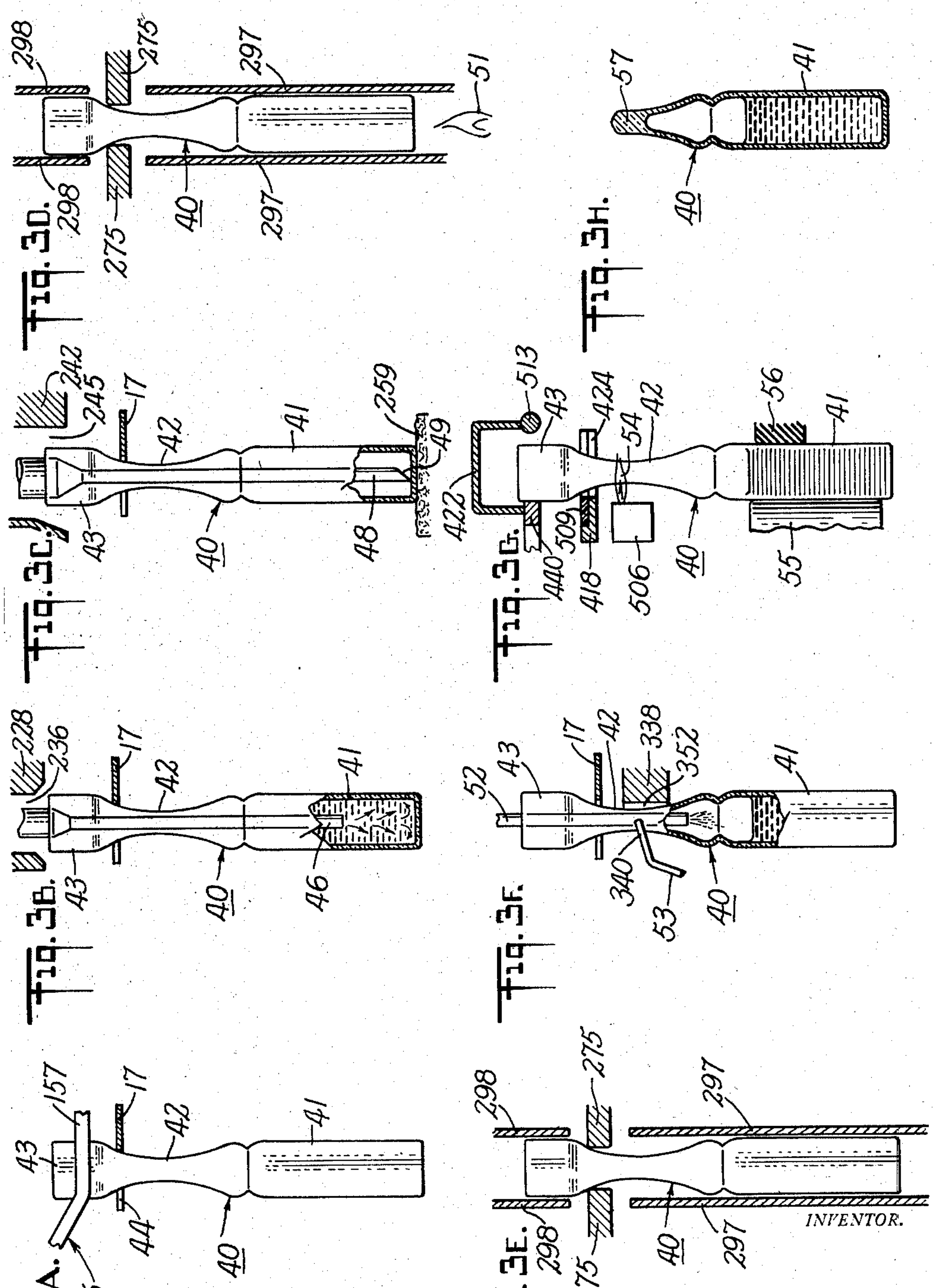
Richard Lange

BY Frederick Breitenfeld

ATTORNEY

METHOD AND APPARATUS FOR TREATING AND FILLING AMPOULES

Filed May 27, 1954 25 Sheets-Sheet 3

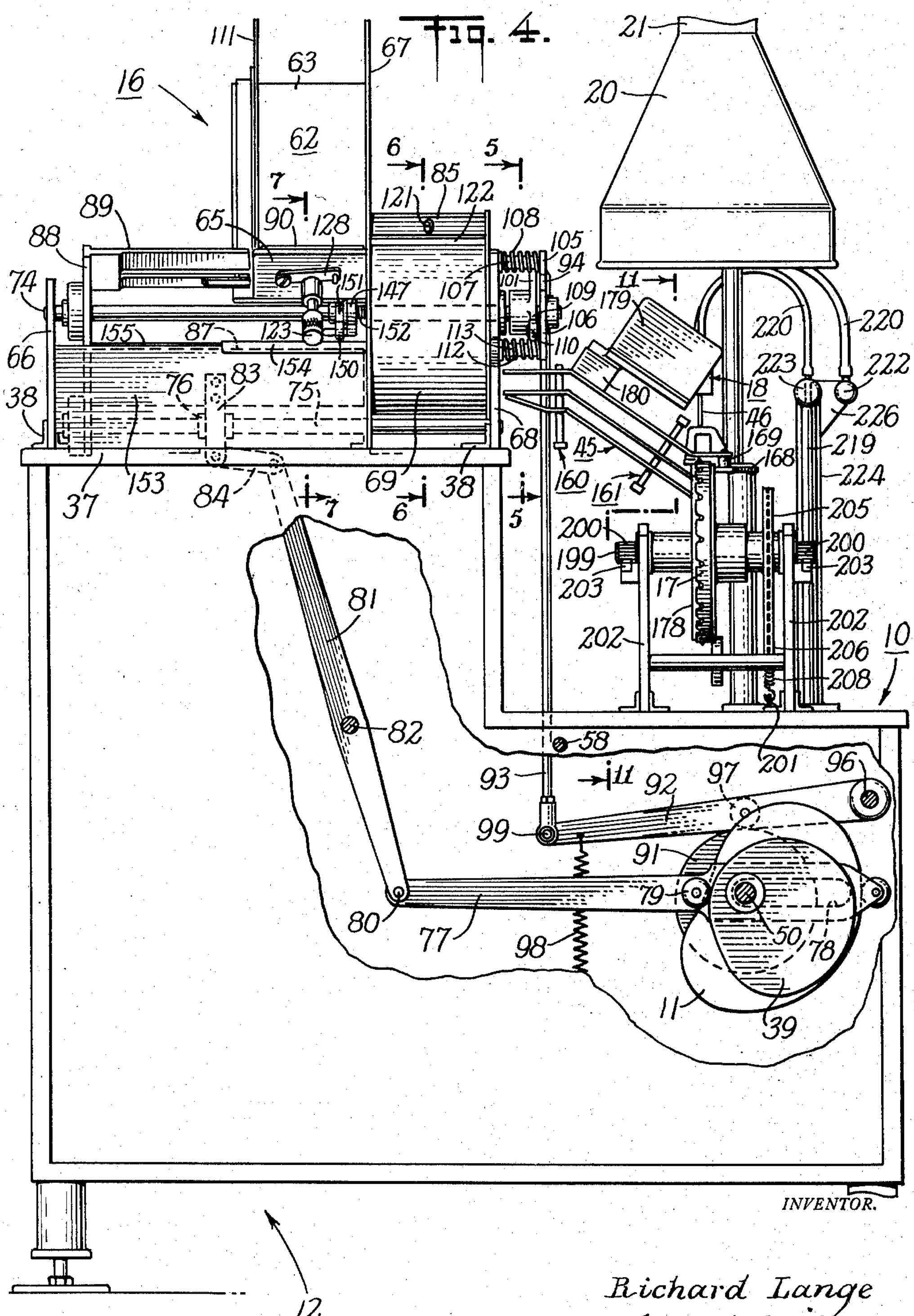


INVENTOR.
Richard Lange
BY Frederick Breitenfeld
ATTORNEY

METHOD AND APPARATUS FOR TREATING AND FILLING AMPOULES

Filed May 27, 1954 25 Sheets-Sheet 4

FIG. 4.



INVENTOR.

Richard Lange

BY Frederick Breitenfeld

ATTORNEY

METHOD AND APPARATUS FOR TREATING AND FILLING AMPOULES

Filed May 27, 1954 25 Sheets-Sheet 5

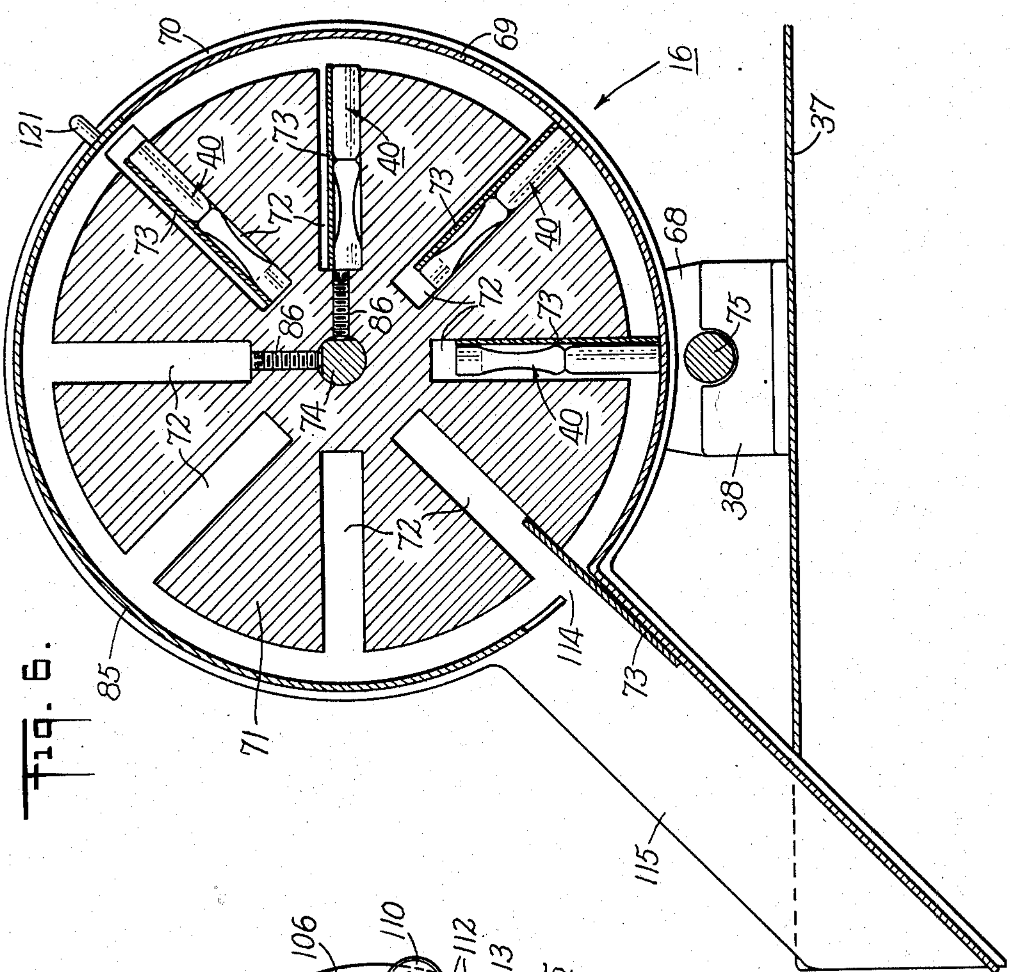


Fig. 6.

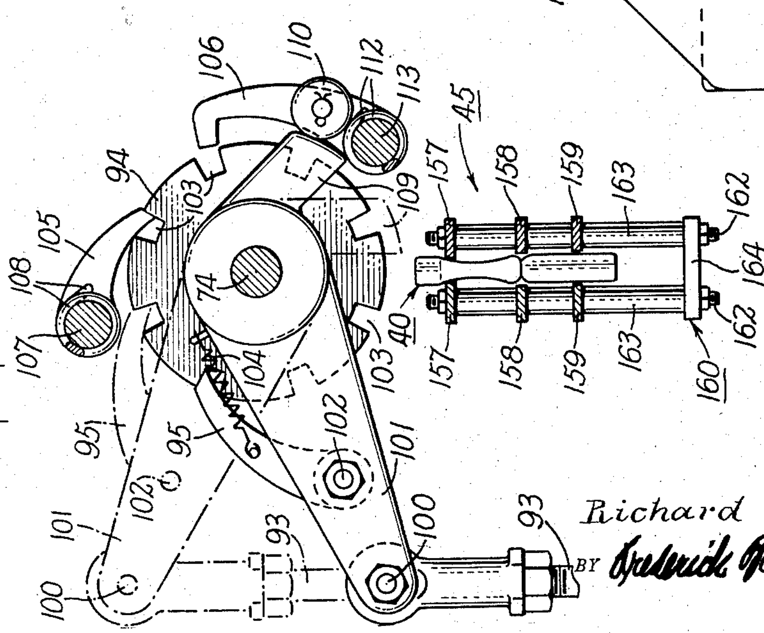


Fig. 5.

INVENTOR.
Richard Lange
BY Frederick Breitenfeld
ATTORNEY

METHOD AND APPARATUS FOR TREATING AND FILLING AMPOULES

Filed May 27, 1954 25 Sheets-Sheet 6

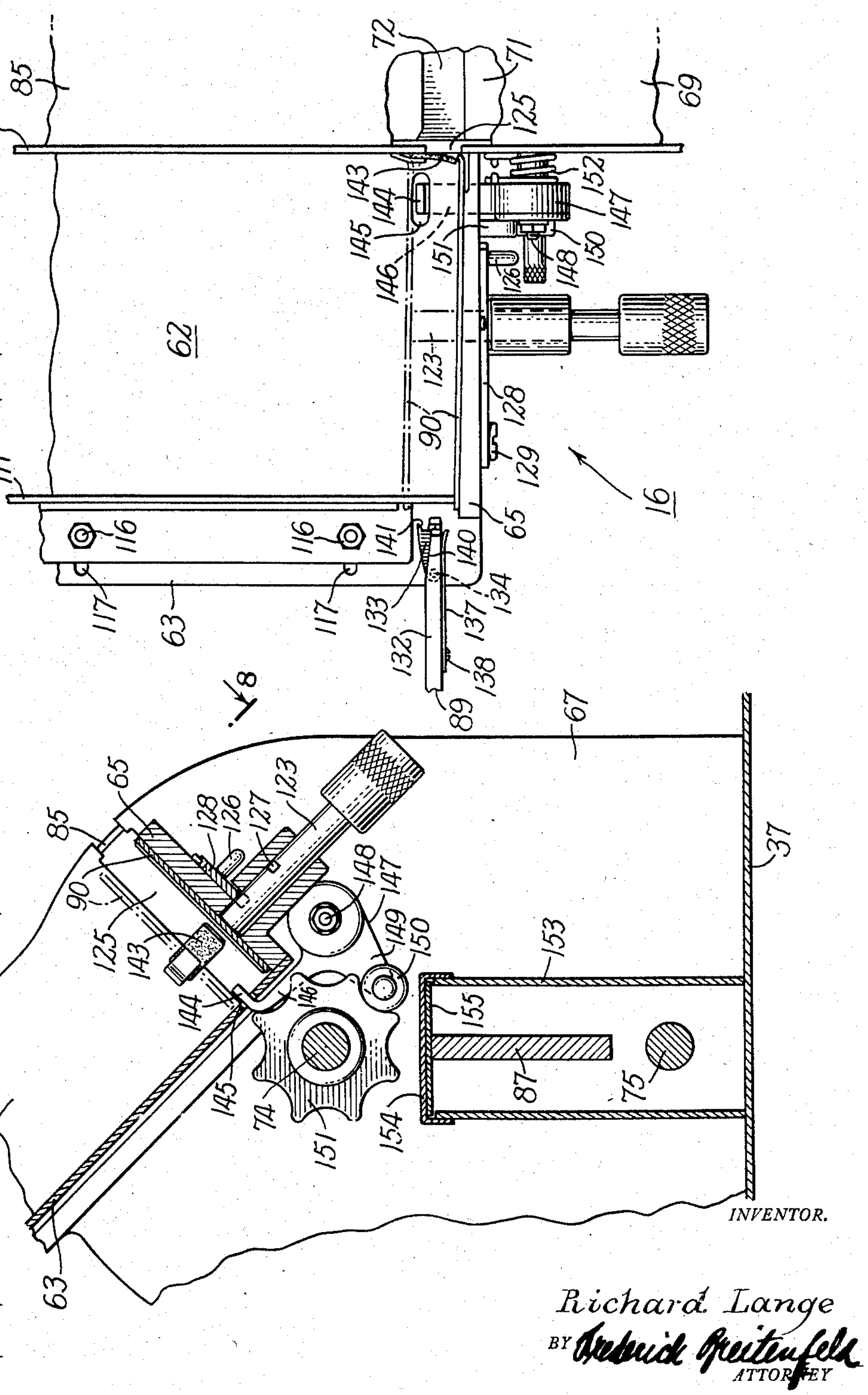


FIG. 8.

FIG. 7.

INVENTOR.

Richard Lange

BY

ATTORNEY

Fig. 9.

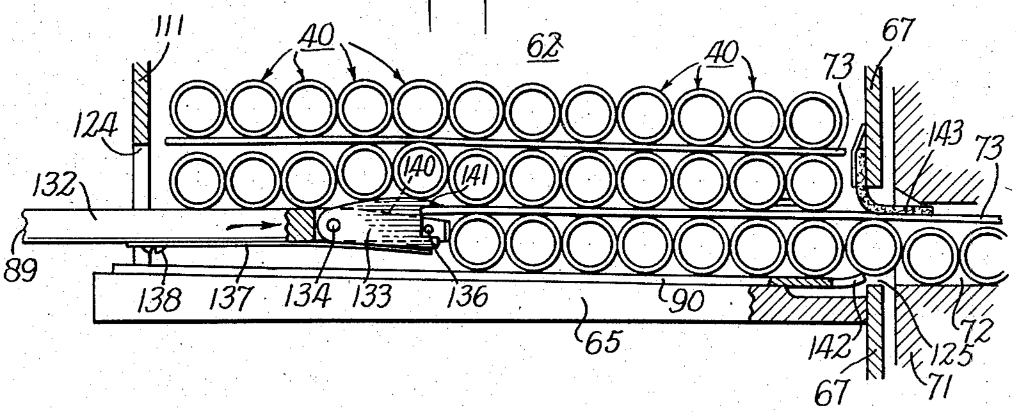
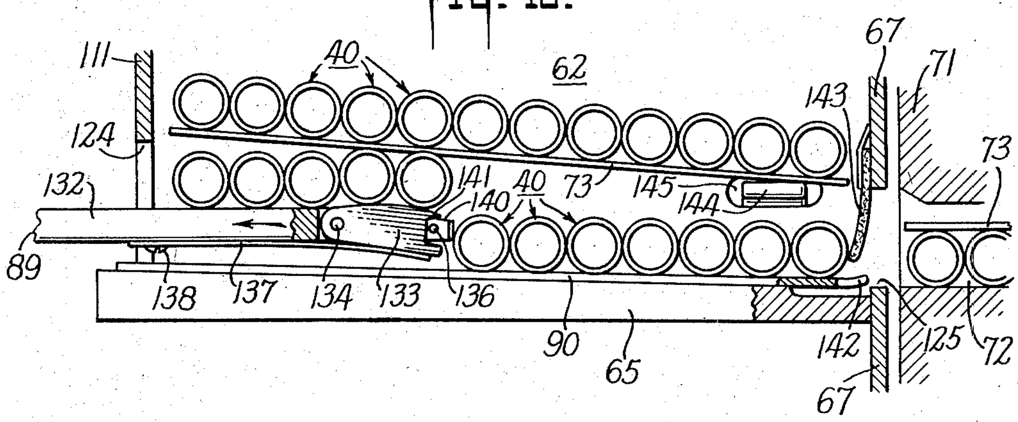


Fig. 10.



INVENTOR.

Richard Lange

BY Frederick Breitenfeld

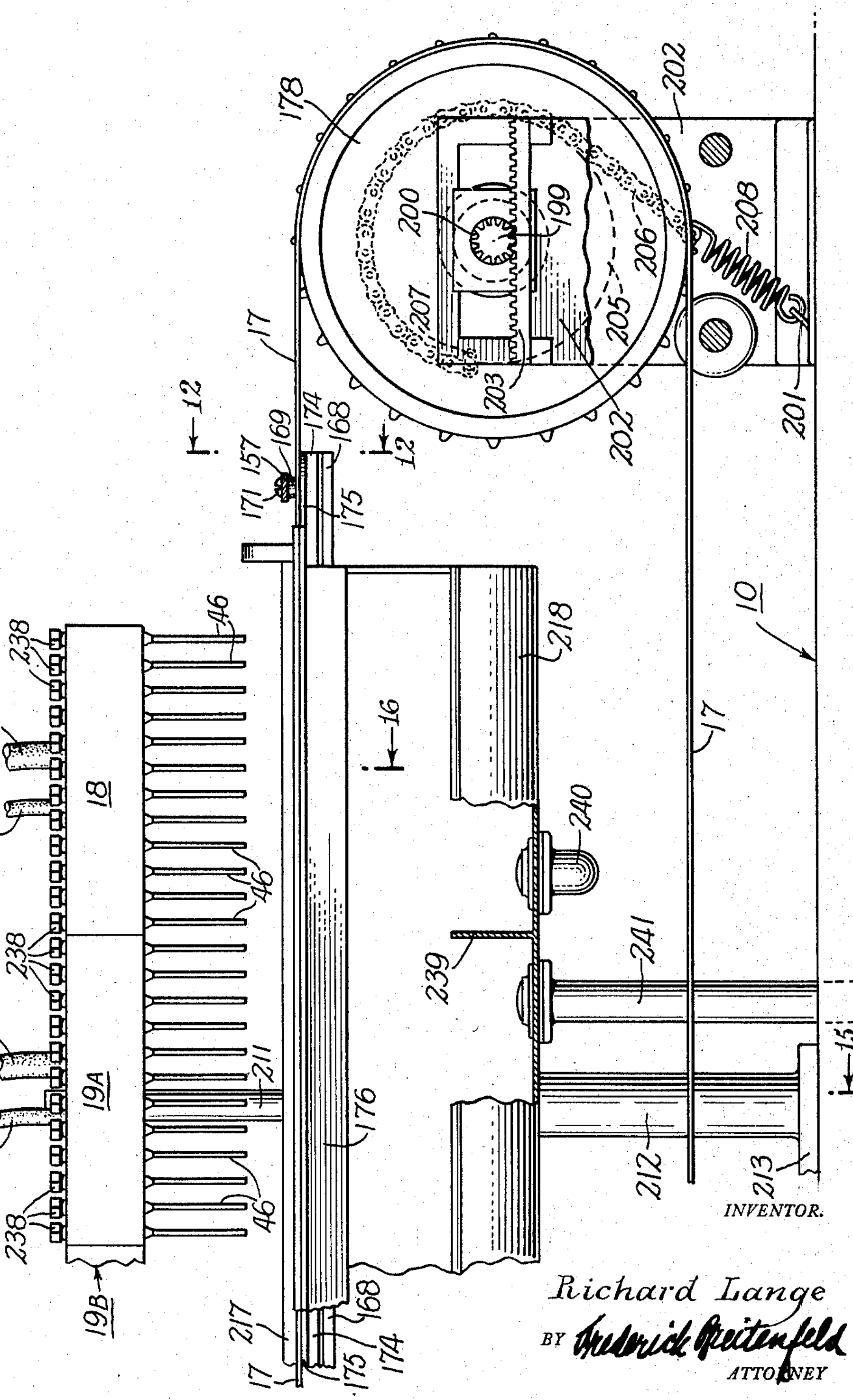
ATTORNEY

July 28, 1959 R. LANGE 2,896,381

METHOD AND APPARATUS FOR TREATING AND FILLING AMPOULES

Filed May 27, 1954 25 Sheets-Sheet 8

Fig. 11.



INVENTOR.

Richard Lange

BY Frederick Breitenfeld

ATTORNEY

METHOD AND APPARATUS FOR TREATING AND FILLING AMPOULES

Filed May 27, 1954 25 Sheets-Sheet 9

FIG. 12.

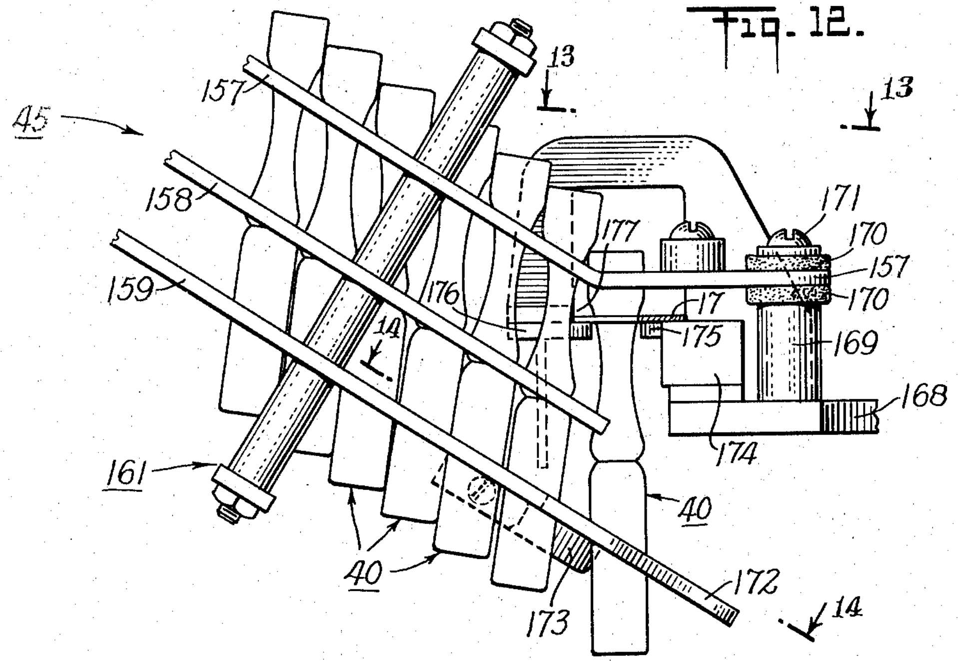


FIG. 13.

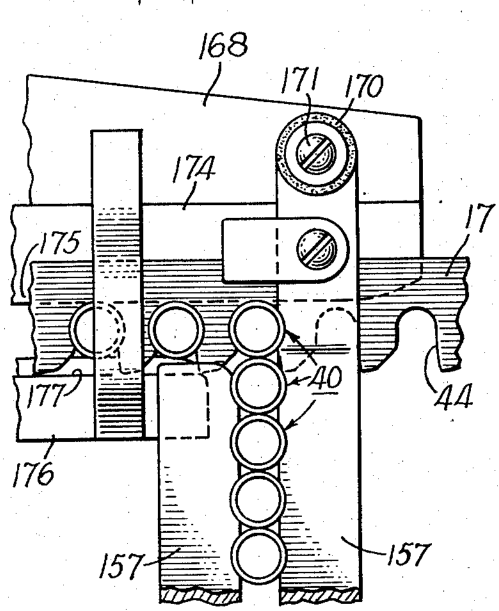
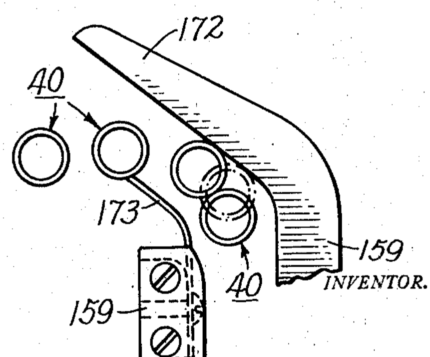


FIG. 14.



INVENTOR.
Richard Lange
BY Frederick Breitenfeld
ATTORNEY

METHOD AND APPARATUS FOR TREATING AND FILLING AMPOULES

Filed May 27, 1954 25 Sheets-Sheet 10

FIG. 15.

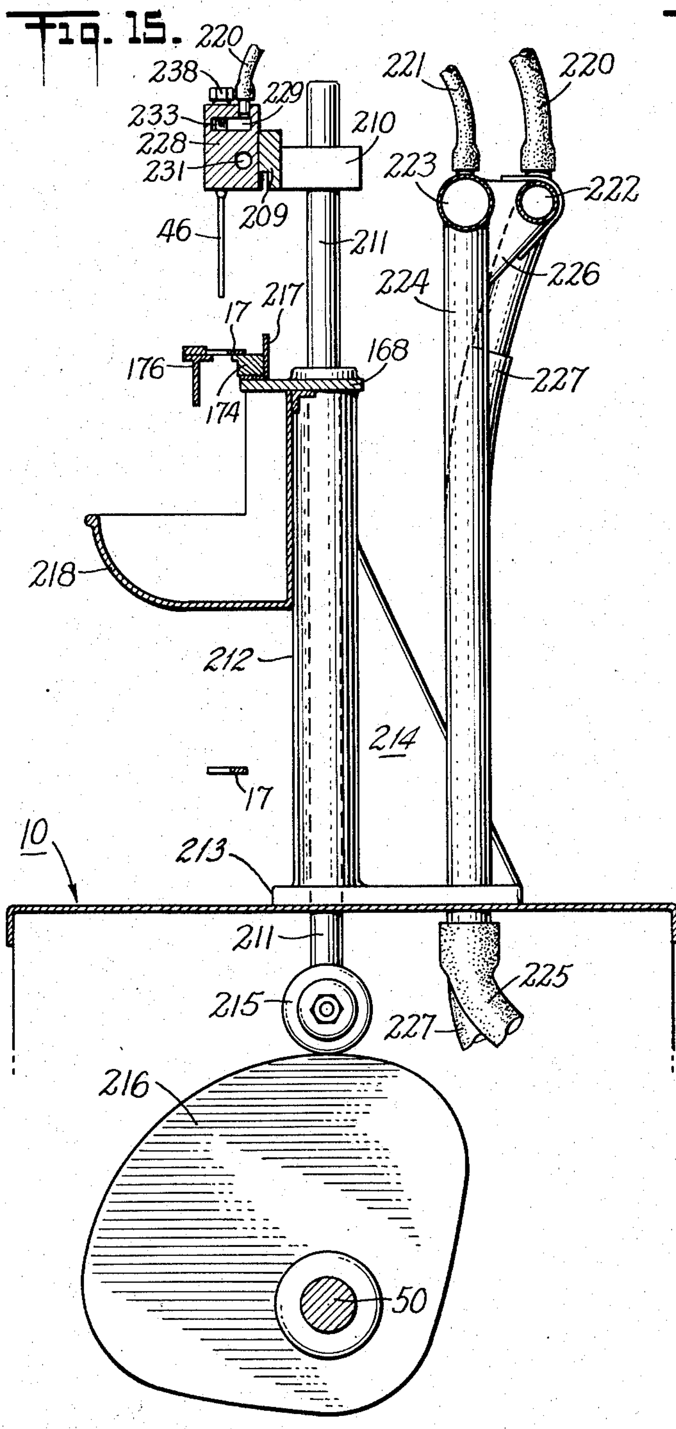
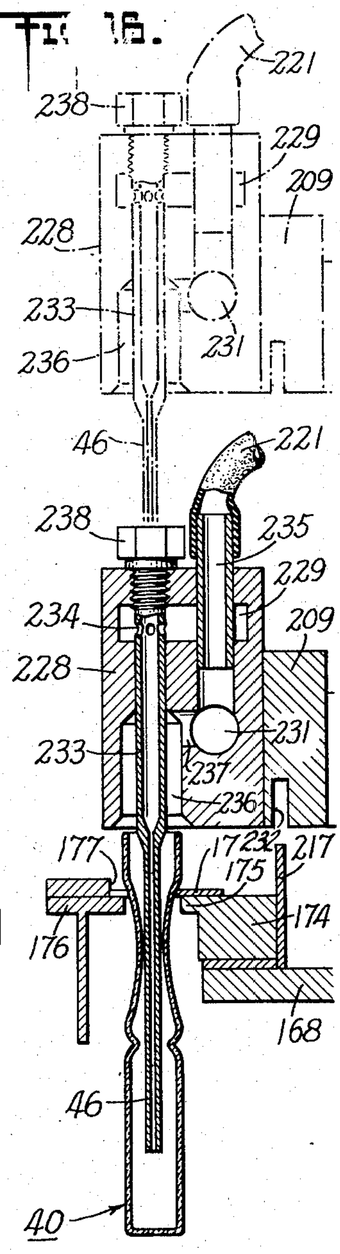


FIG. 16.



INVENTOR.

Richard Lange

BY Frederick Breitenfeld

ATTORNEY

Fig. 18.

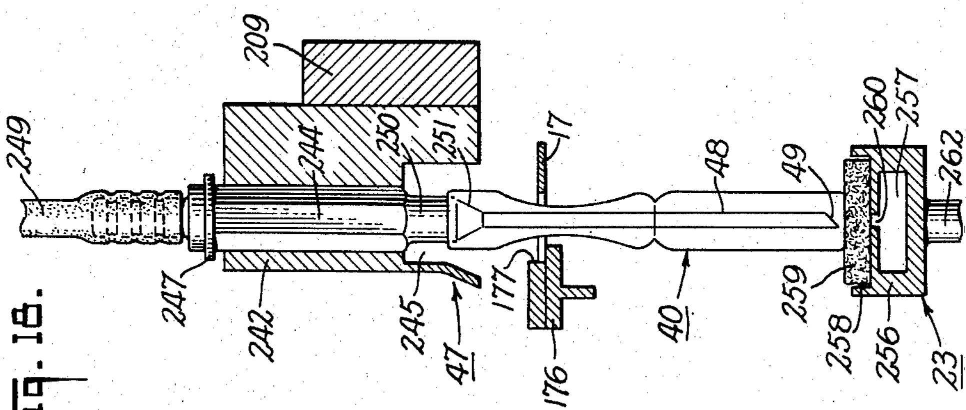
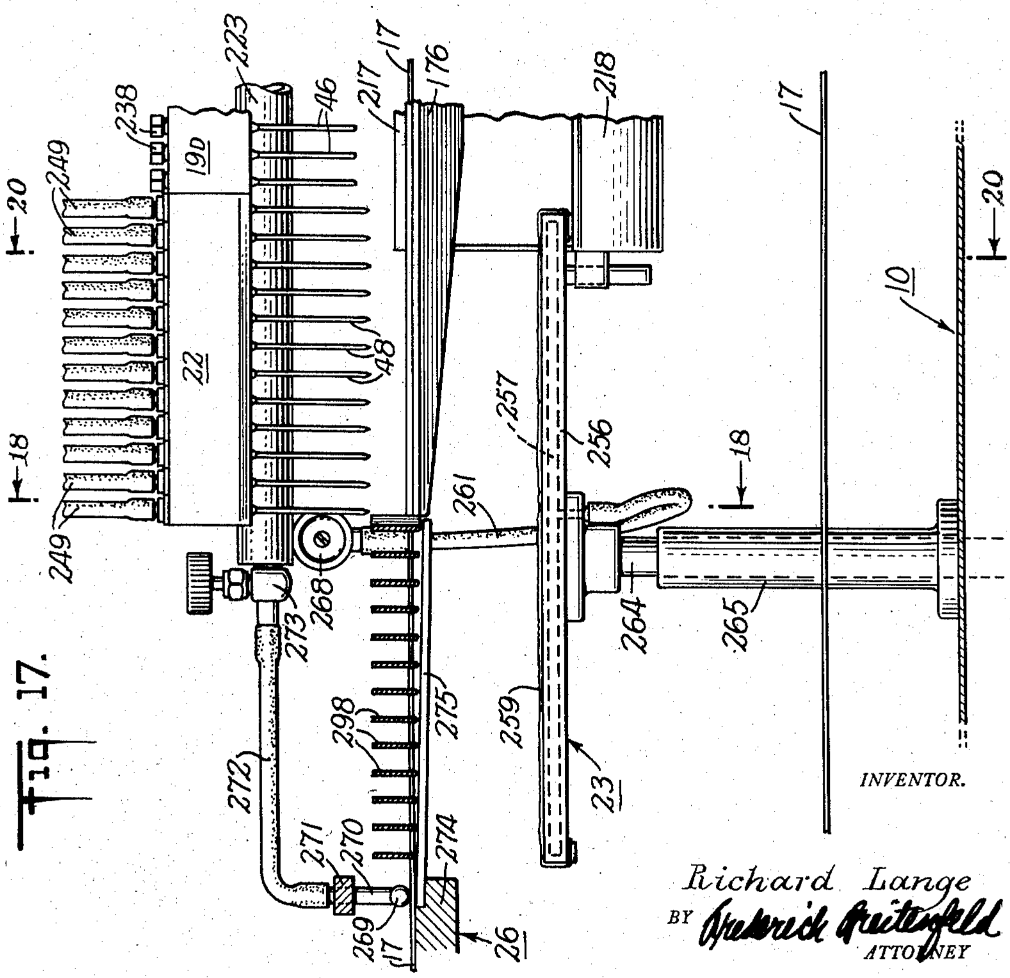


Fig. 17.



INVENTOR.
Richard Lange
BY Frederick Breitenfeld
ATTORNEY

METHOD AND APPARATUS FOR TREATING AND FILLING AMPOULES

Filed May 27, 1954 25 Sheets-Sheet 12

Fig. 20.

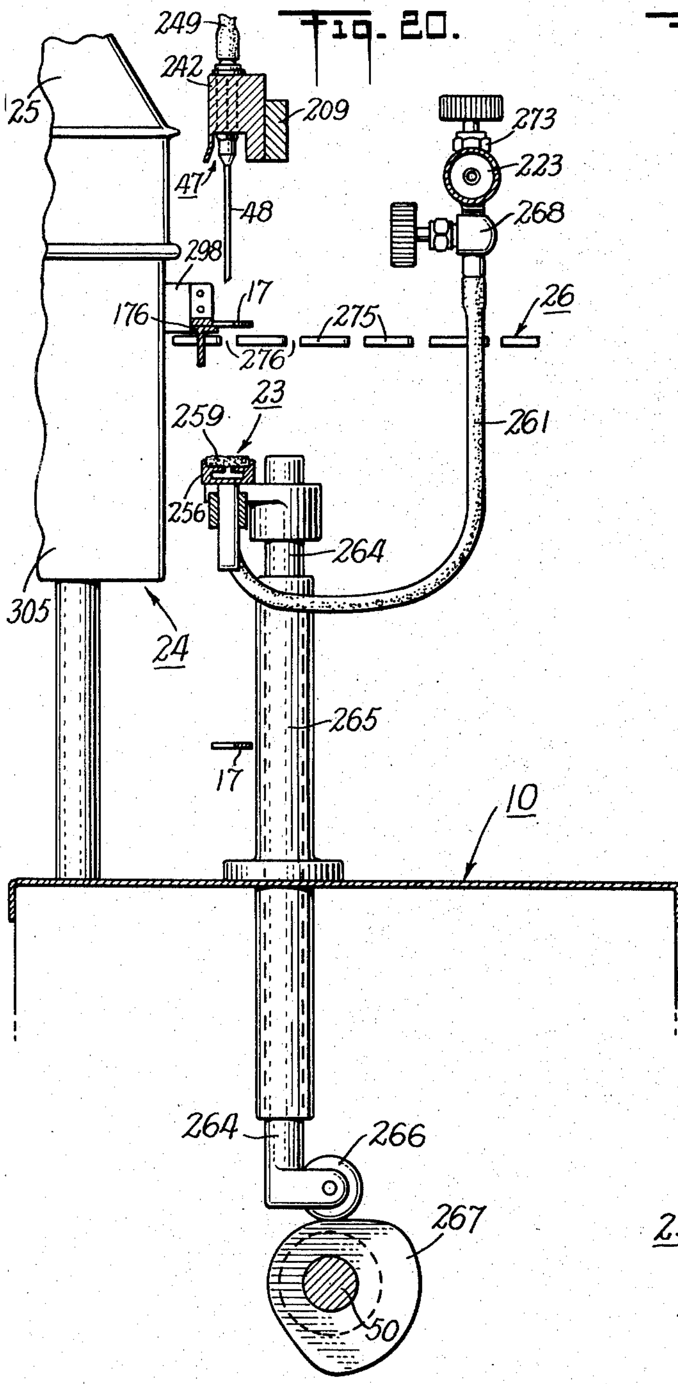
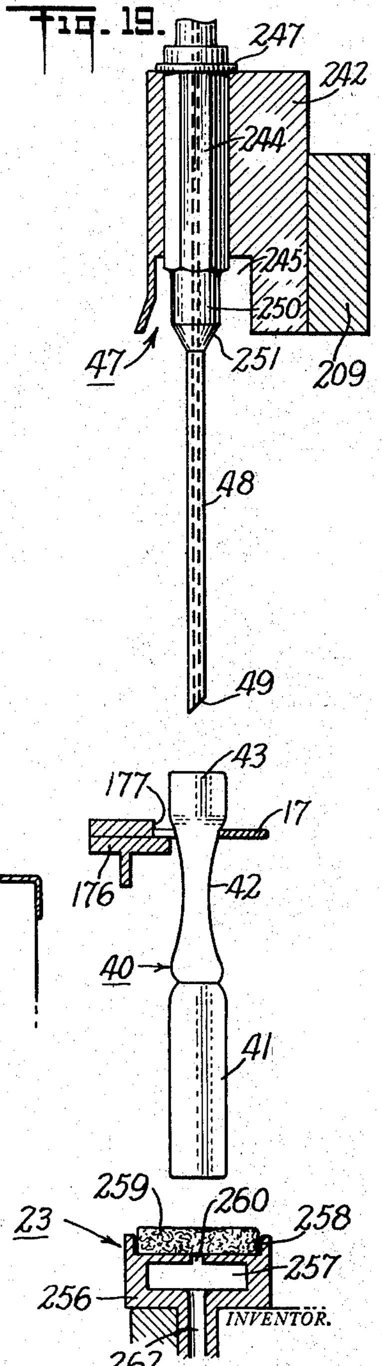
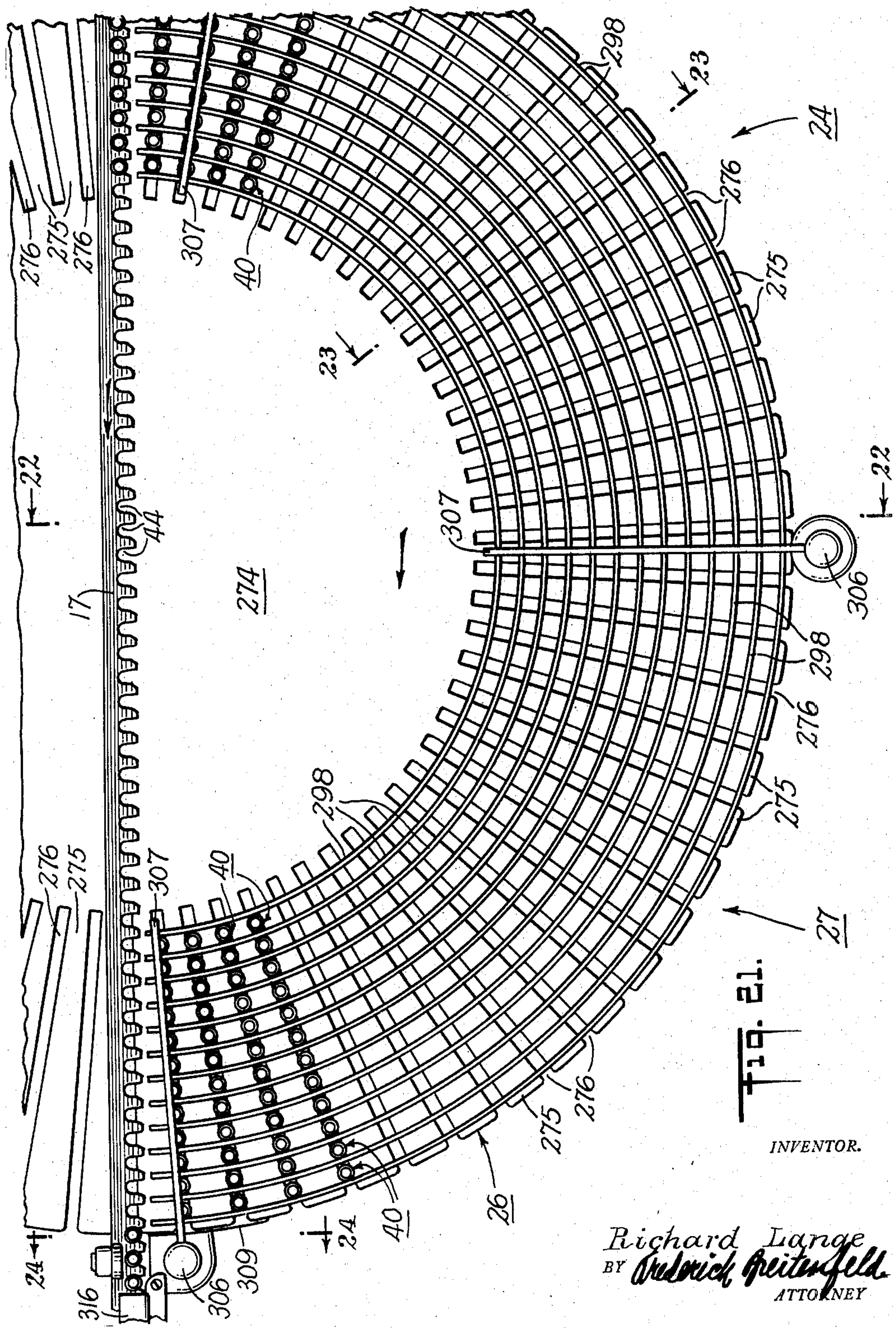


Fig. 19.



INVENTOR.
Richard Lange
BY Frederick Breitenfeld
ATTORNEY



INVENTOR.

Richard Lange

BY Frederick Breitenfeld

ATTORNEY

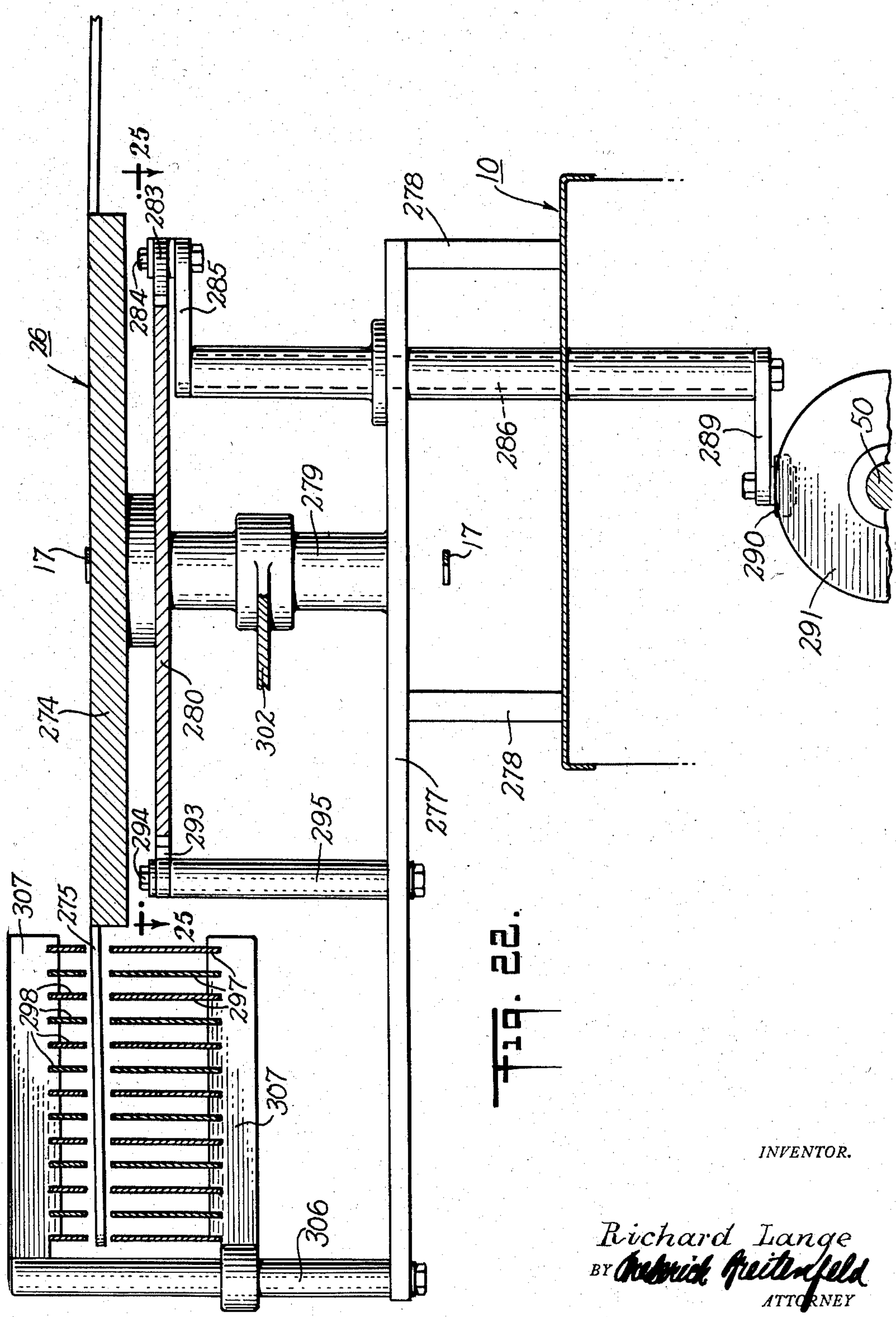


Fig. 22.

INVENTOR.

Richard Lange

BY

ATTORNEY

July 28, 1959 R. LANGE 2,896,381

METHOD AND APPARATUS FOR TREATING AND FILLING AMPOULES

Filed May 27, 1954 25 Sheets-Sheet 15

Fig. 23.

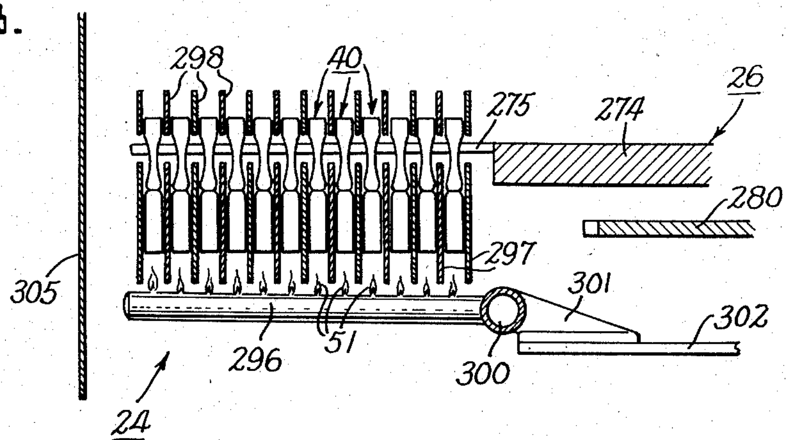


Fig. 24.

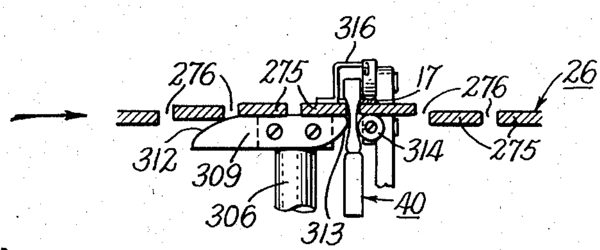
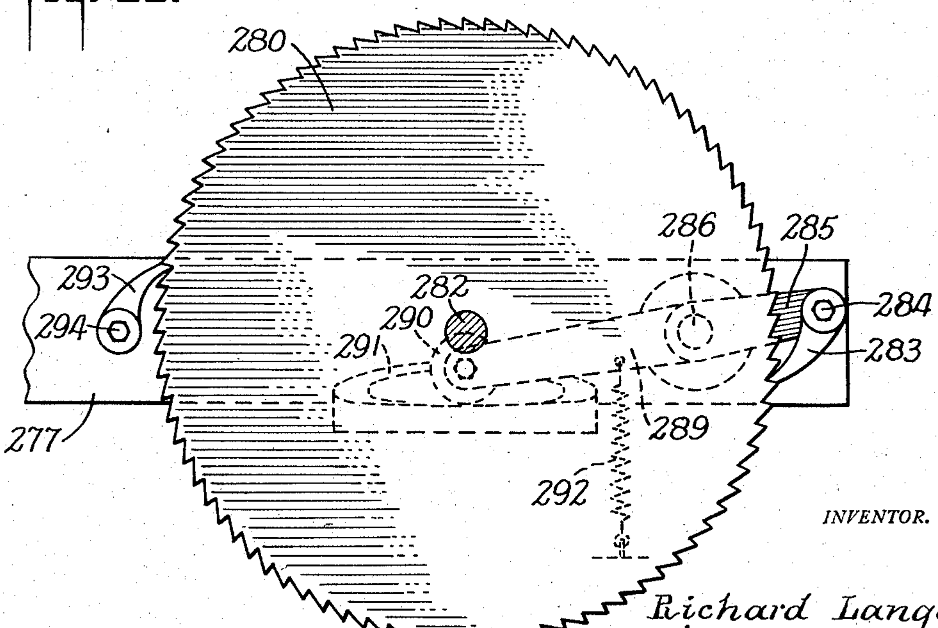


Fig. 25.



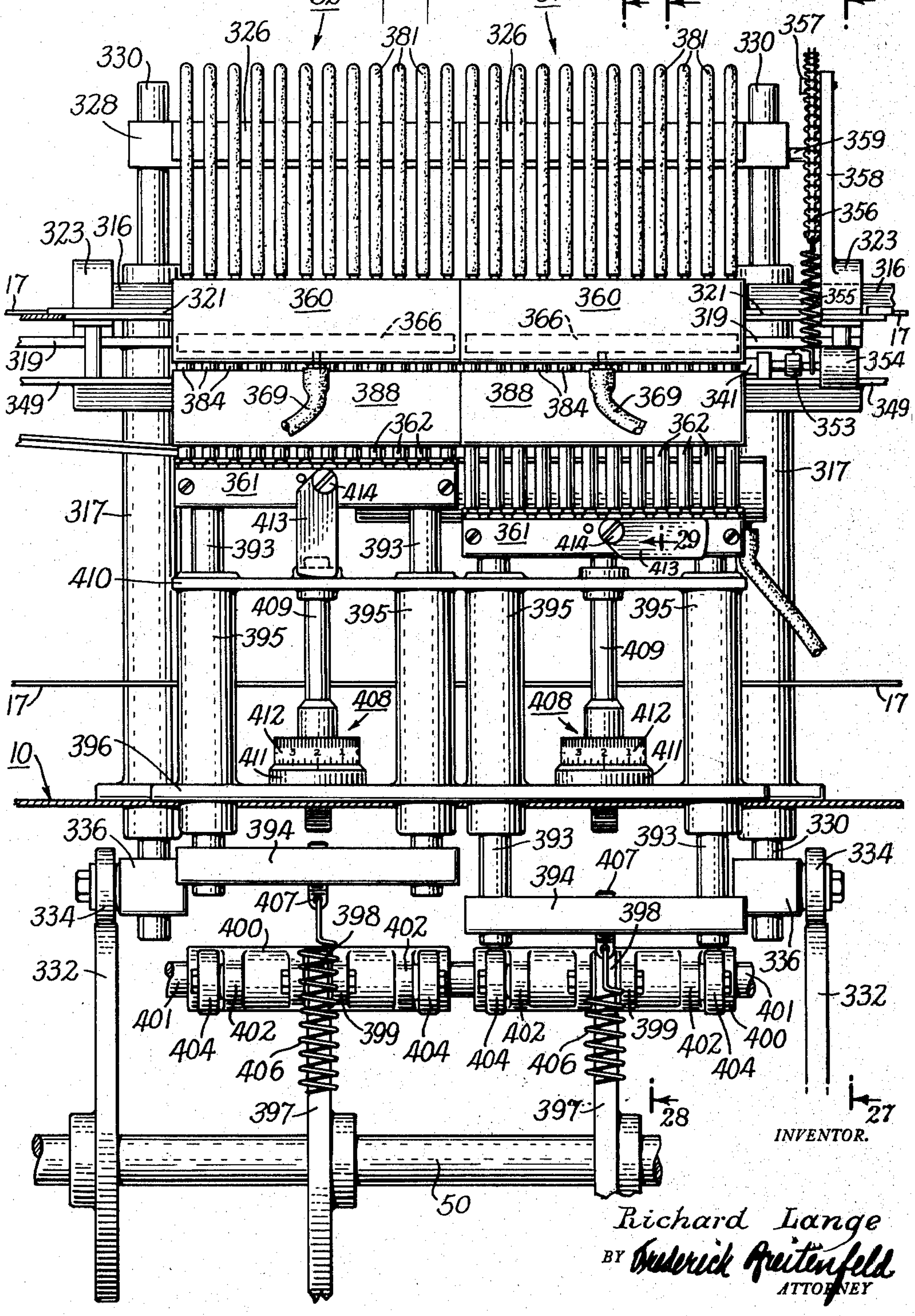
INVENTOR.

Richard Lange

BY Frederick Breitenfeld

ATTORNEY

FIG. 26.



INVENTOR.
Richard Lange
BY Frederick Breitenfeld
ATTORNEY

July 28, 1959 R. LANGE 2,896,381

METHOD AND APPARATUS FOR TREATING AND FILLING AMPOULES

Filed May 27, 1954 25 Sheets-Sheet 17

Fig. 27.

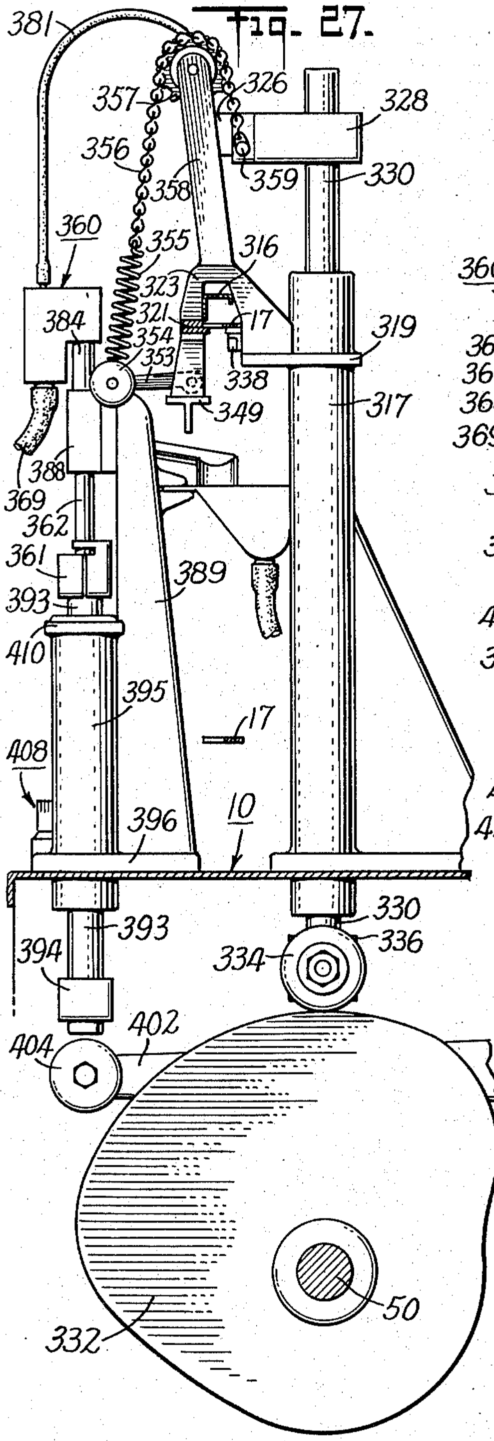
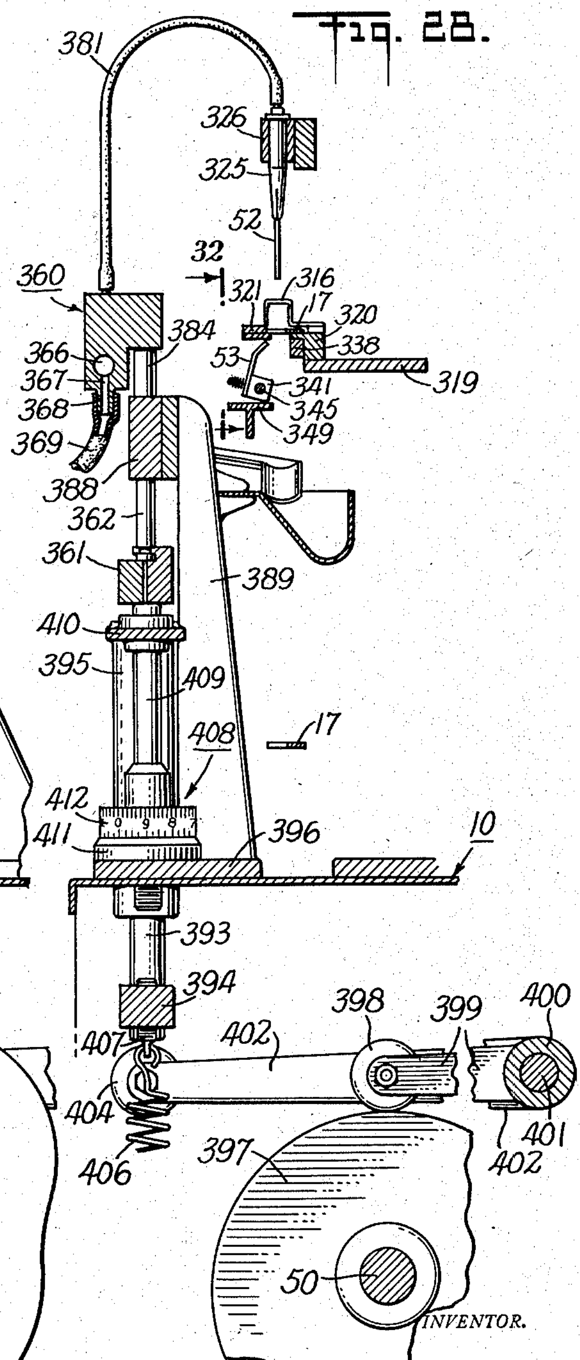


Fig. 28.



INVENTOR.

Richard Lange

BY Frederick Breitenfeld

ATTORNEY

July 28, 1959 R. LANGE 2,896,381

METHOD AND APPARATUS FOR TREATING AND FILLING AMPOULES

Filed May 27, 1954 25 Sheets-Sheet 18

Fig. 29.

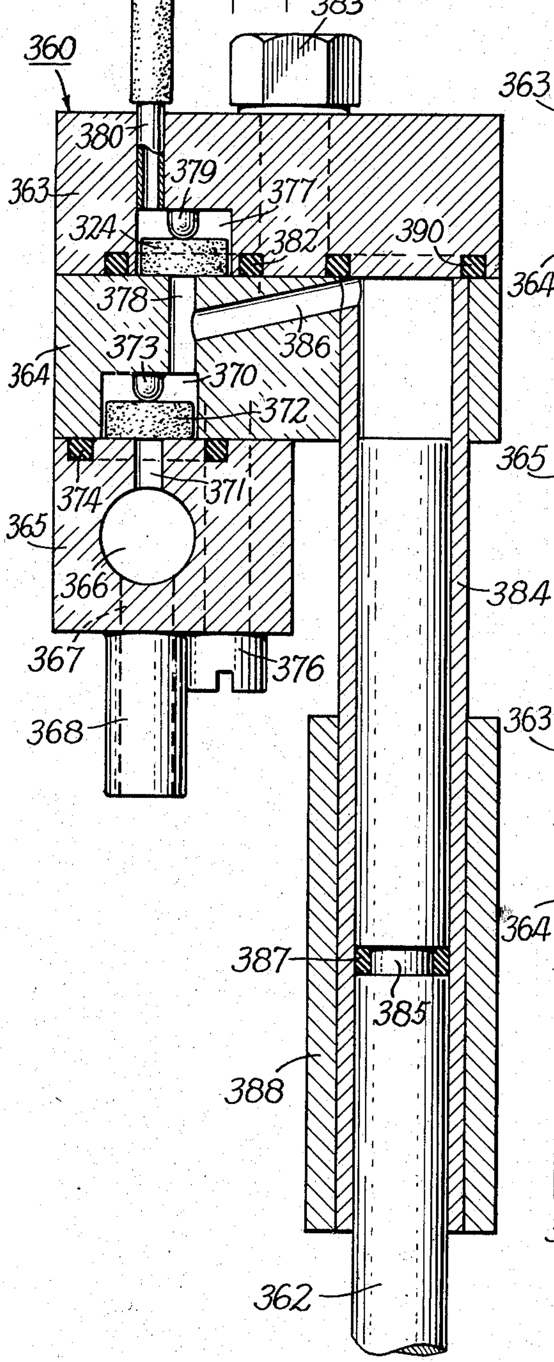


Fig. 30.

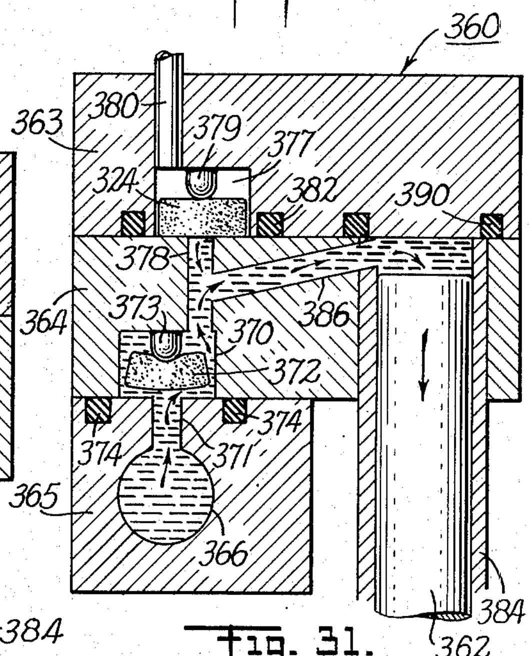
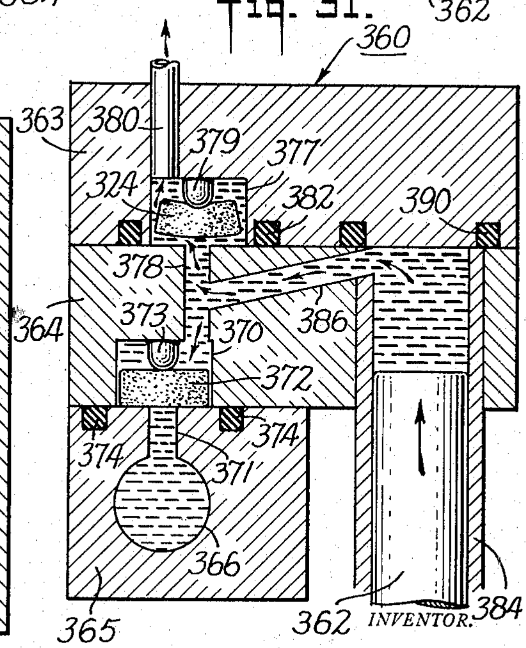


Fig. 31.

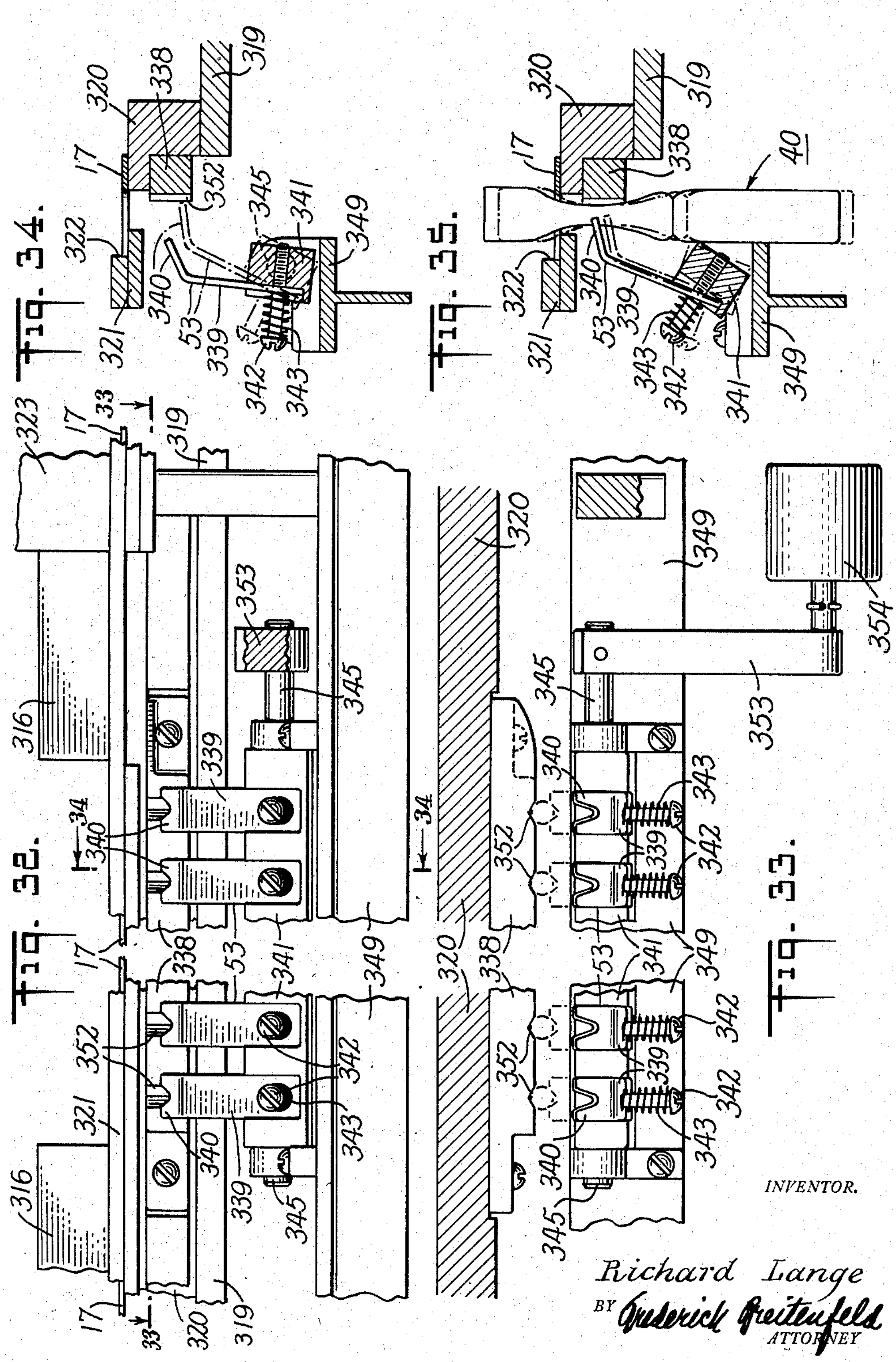


INVENTOR.
Richard Lange
BY Frederick Breitenfeld
ATTORNEY

July 28, 1959 R. LANGE 2,896,381

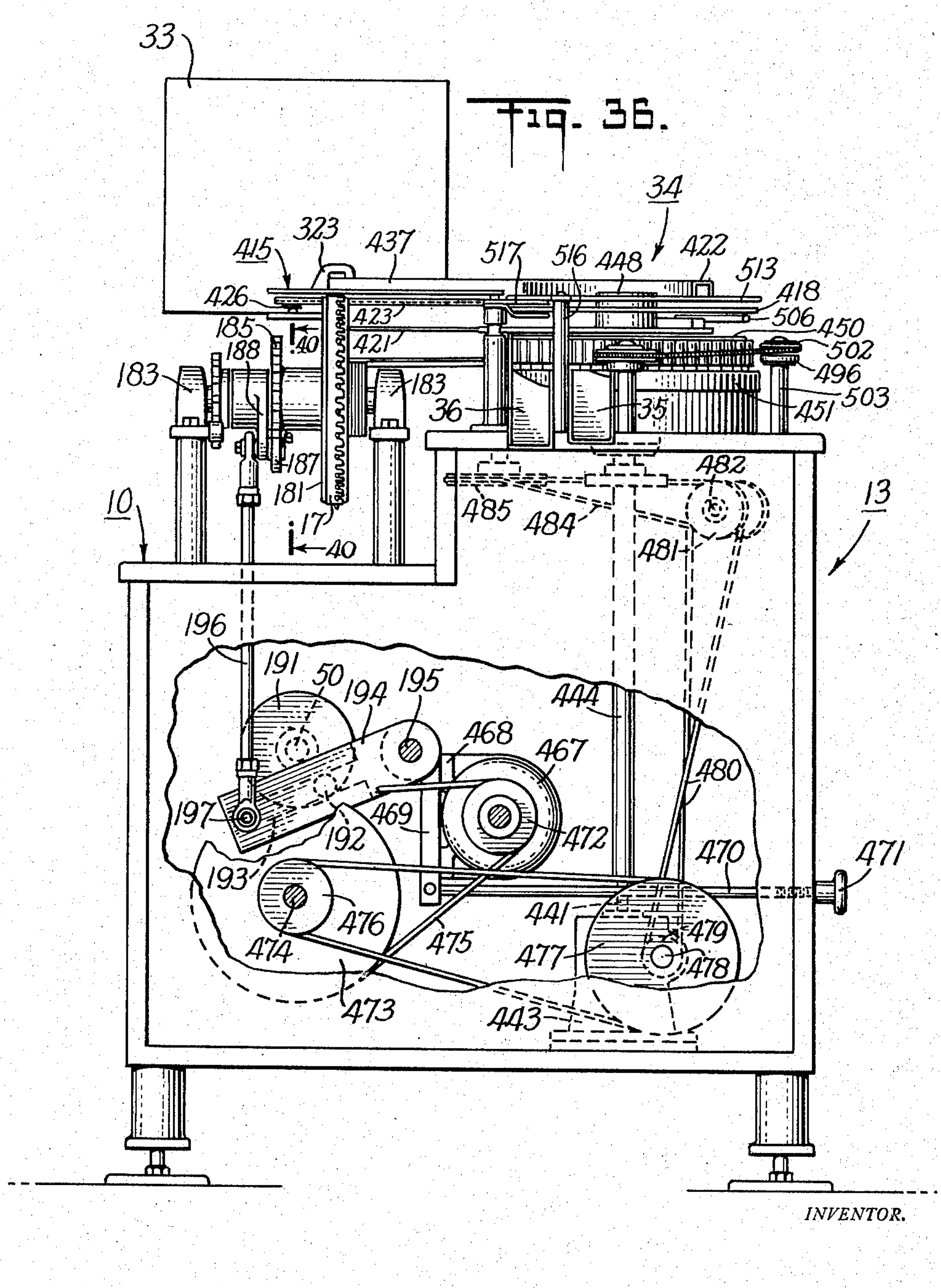
METHOD AND APPARATUS FOR TREATING AND FILLING AMPOULES

Filed May 27, 1954 25 Sheets-Sheet 19



INVENTOR.
Richard Lange
BY Frederick Breitenfeld
ATTORNEY

Fig. 36.



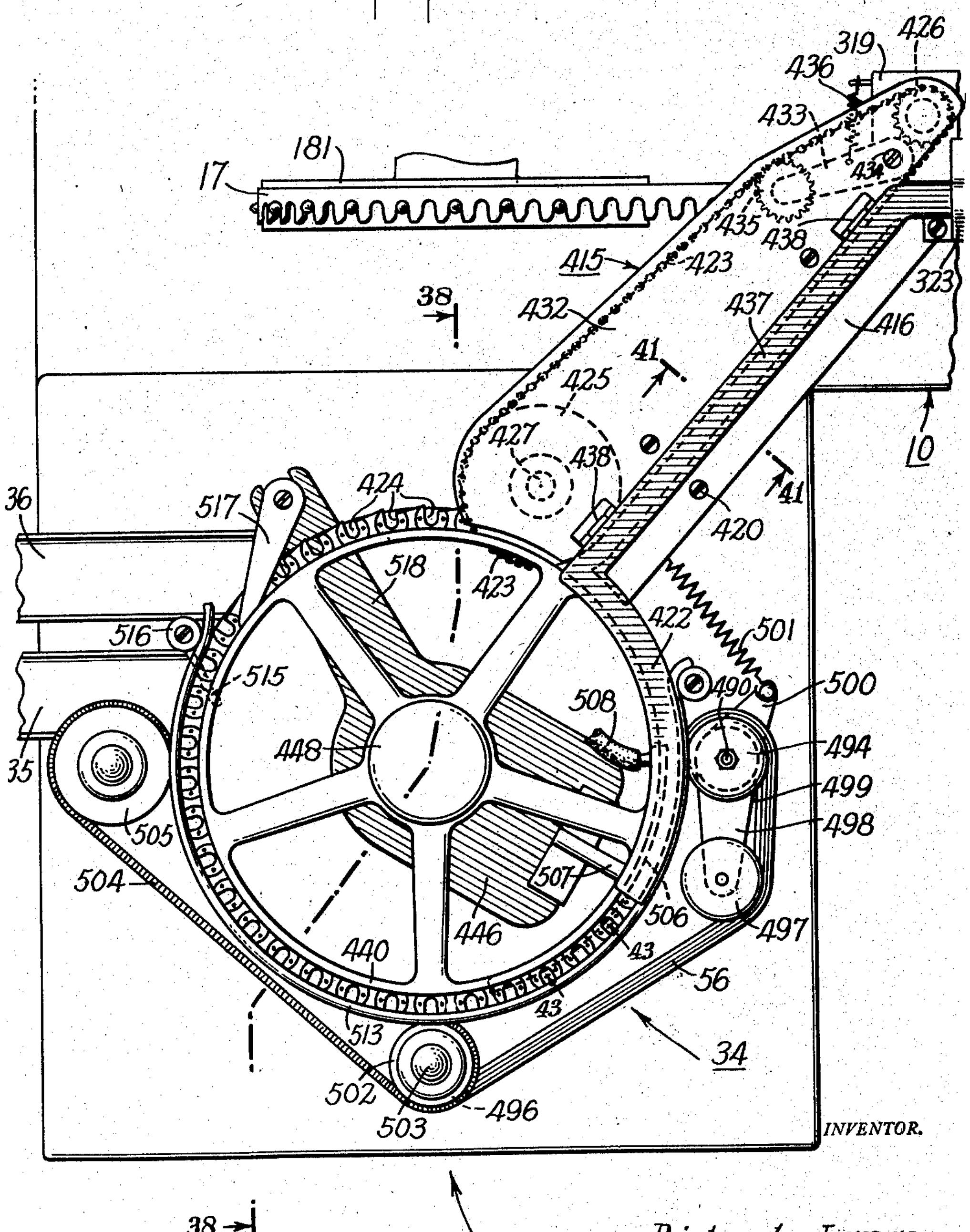
INVENTOR.

Richard Lange
BY Frederick Breitenfeld
ATTORNEY

METHOD AND APPARATUS FOR TREATING AND FILLING AMPOULES

Filed May 27, 1954 25 Sheets-Sheet 21

FIG. 37.



INVENTOR.

Richard Lange

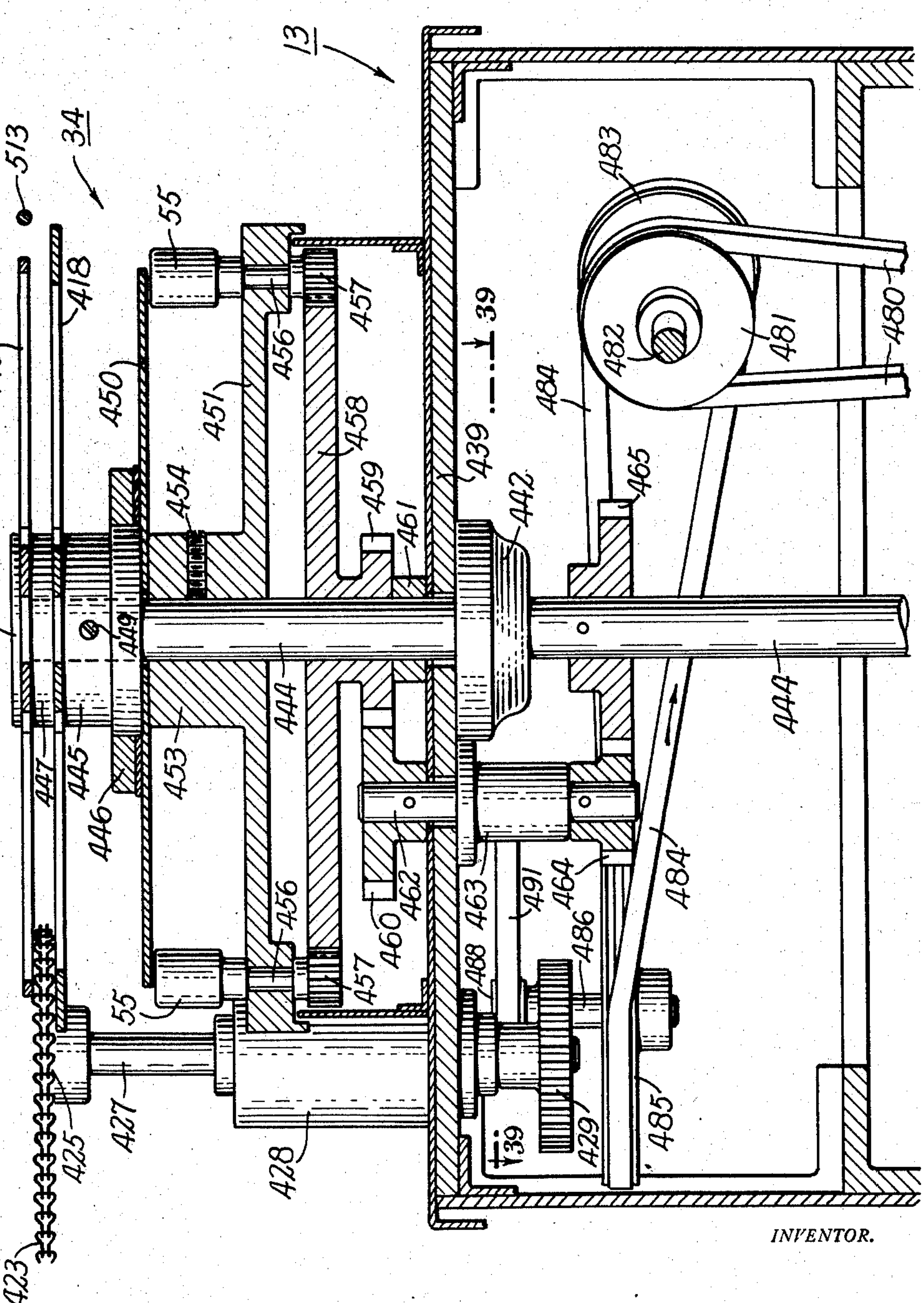
BY Frederick Gretenfeld

ATTORNEY

METHOD AND APPARATUS FOR TREATING AND FILLING AMPOULES

Filed May 27, 1954 25 Sheets-Sheet 22

Fig. 38.



INVENTOR.

Richard Lange

BY Frederick Breitenfeld

ATTORNEY

FIG. 39.

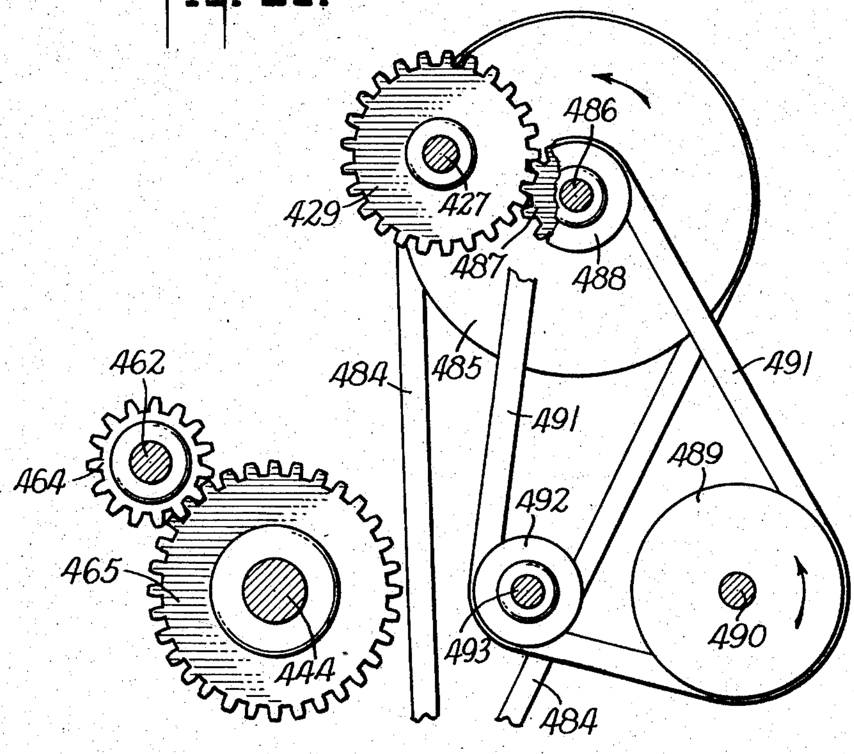
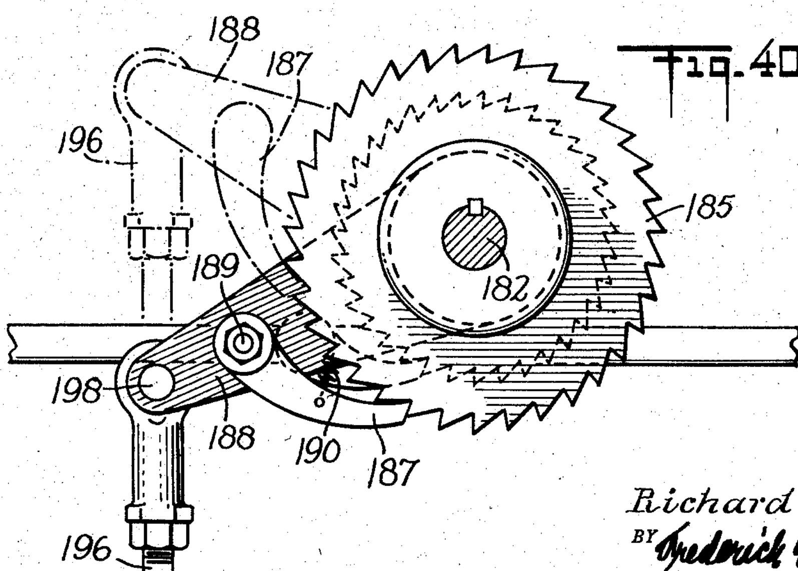
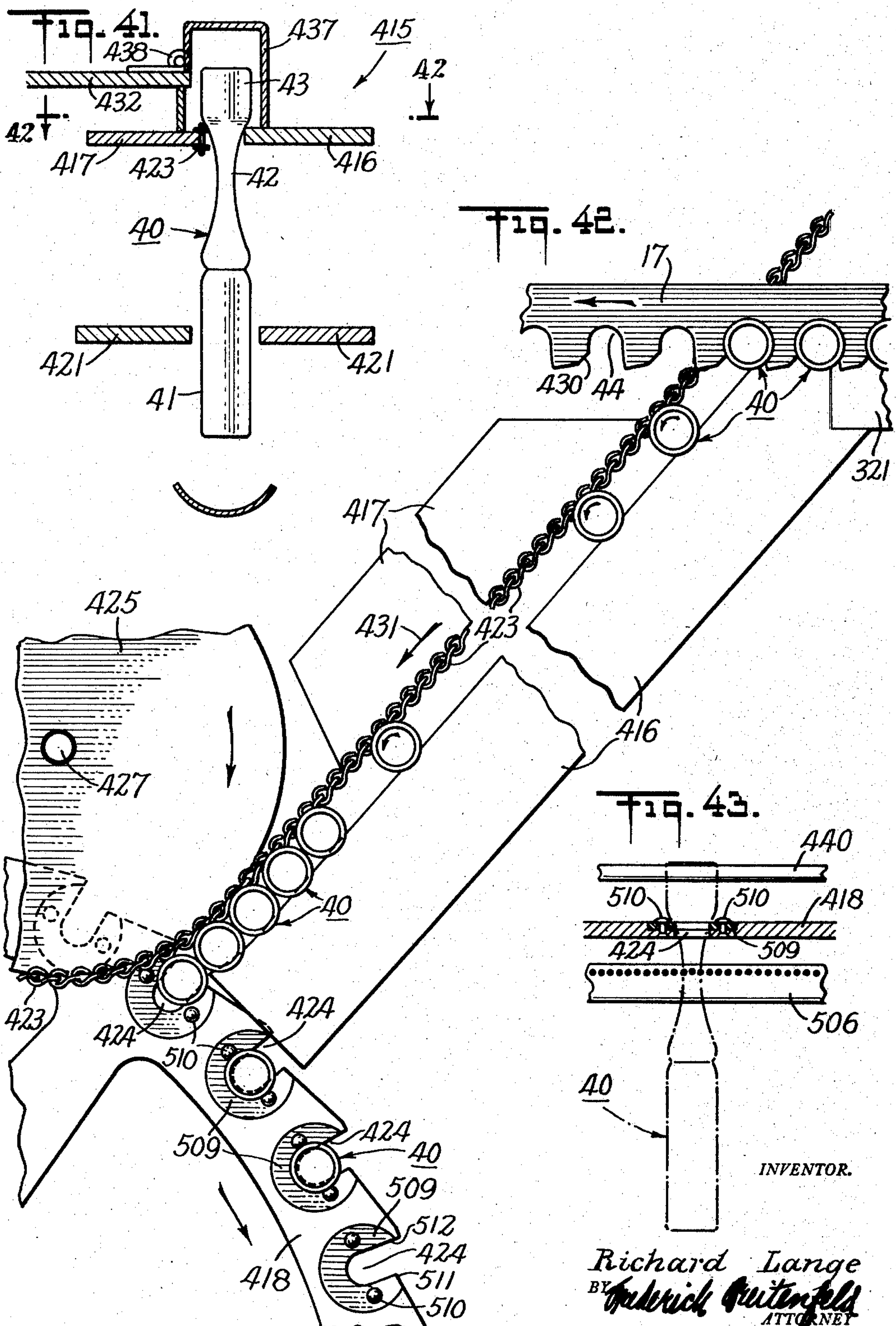


FIG. 40.



INVENTOR.
Richard Lange
BY *Frederick Breitenfeld*
ATTORNEY



INVENTOR.
Richard Lange
BY
ATTORNEY

July 28, 1959 R. LANGE 2,896,381

METHOD AND APPARATUS FOR TREATING AND FILLING AMPOULES

Filed May 27, 1954 25 Sheets-Sheet 25

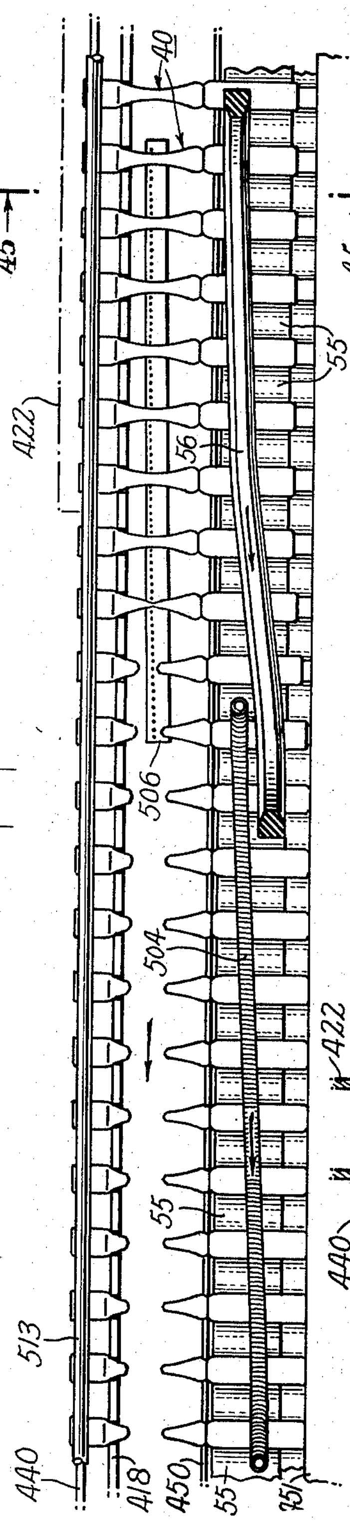


Fig. 44.

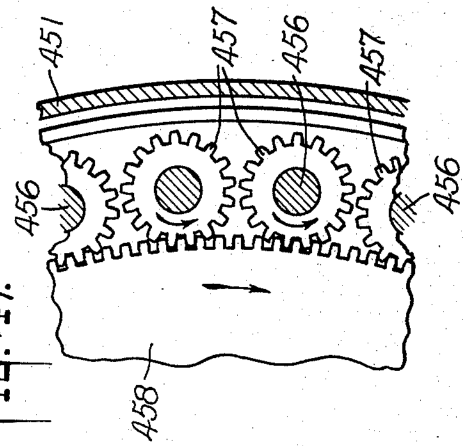


Fig. 47.

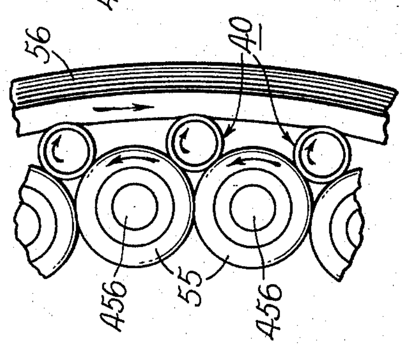


Fig. 48.

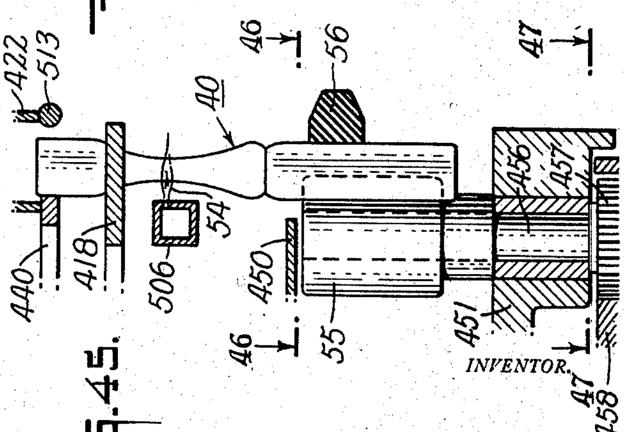


Fig. 45.

INVENTOR.
Richard Lange
BY Frederick Breitenfeld
ATTORNEY

United States Patent Office

2,896,381

Patented July 28, 1959

2,896,381

METHOD AND APPARATUS FOR TREATING AND FILLING AMPOULES

Richard Lange, Leonia, N.J., assignor to Hodes-Lange Corporation, North Bergen, N.J., a corporation of New Jersey

Application May 27, 1954, Serial No. 432,715

22 Claims. (Cl. 53—37)

This invention relates generally to a method and apparatus for packaging materials, and has particular reference to the cleaning, sterilizing, filling and sealing of small ampoules, vials and similar containers.

The packaging of products such as liquid medicines and pharmaceuticals requiring sterile containers wholly and reliably free of all foreign matter presents many problems. Certain drugs, and particularly the costlier ones, are preferably packaged in small single-treatment quantities of the order of one or two cubic centimeters to avoid possible contamination of larger amounts of the drug through frequent exposure of the container and its contents. Packaging of materials such as drugs in small quantities has heretofore involved rather tedious and complicated procedures requiring many manual operations and considerable undesirable handling of the ampoules. Such practices not only greatly increase the possibility of contamination prior to the final ampoule sealing process, but add materially to the cost of the product. Moreover, where the ampoules or containers are either individually or collectively handled by operators before sealing it is exceedingly difficult to speed up production by coordinating the successive steps in the process.

This invention has as one of its principal objects the provision of a simple and effective method and apparatus for handling, cleaning, sterilizing, filling and sealing small glass ampoules or the like, whereby the entire process can be accomplished more rapidly and inexpensively and with an avoidance of substantially all possibility of contamination of either the material or container before sealing is finally effected. This end is attained by means of an apparatus which can function automatically and whose operations are accurately and precisely coordinated to effect thorough and complete cleaning and sterilizing of the ampoules, and then filling and sealing, with little or no delay between steps and without any material exposure of the sterilized containers either before or after filling.

Another object of the invention is to provide an entirely practical, compact, efficient and dependable apparatus for processing, filling and sealing ampoules under completely sterile conditions wherein all manual operations are eliminated except for the initial deposit of empty ampoule blanks in bulk into the apparatus and the removal from it of the filled and sealed ampoules. The apparatus is of such a character that it may be operated in its entirely in sterile atmospheres in order to prevent all possibility of contamination of either the containers or the material inserted into them.

A more particular object of the invention resides in the provision of a unique conveying device for reliably supporting and transporting containers such as glass ampoules from a loading station to a series of cleaning, sterilizing, filling and sealing stations whereby the ampoules may be successively treated, either singly or in groups, in a continuous fashion, without interruption or extraneous handling.

In this connection it is a special feature of the invention to provide for the support and transportation of the ampoules from station to station in an upright condition, i.e., with the open end upward.

A further objective of the invention is an improved ampoule conveyor system wherein the ampoules may be subjected to relatively high sterilizing temperatures for extended lengths of time without subjecting the conveyor system itself to any adverse mechanical problems. This is attained through the employment of special cooperating conveyor means which embody simple, effective and dependable structures for effecting the automatic transfer of the ampoules from one conveyor to another for the sterilizing process and returning them to the original conveyor for the filling and sealing processes.

More particularly, it is a feature of the invention to employ a main conveyor traveling in a linear path from the loading station to the final sealing station, and to coordinate a step-by-step intermittent advance of the main conveyor with a secondary conveyor located at the sterilizing station and so movable that ampoules transferred to it from the main conveyor are transported through the sterilizing area along arcuate paths and ultimately returned to and re-transferred to the main conveyor.

Still another of the more particular objects of the invention resides in providing an improved mechanism for feeding empty glass ampoules into position on the conveyor system. Ampoules of the type adapted to hold very small quantities of liquid are usually packaged row on row in a carton, with cardboard spacers between the rows, and the ampoules in an upright position. The removal of the ampoules from these cartons and engagement with a conveyor has presented a problem where high loading speeds are desired without injury to the ampoules. The feeding of ampoules to a conveyor belt at a rate commensurate with the speeds of operation readily attainable in the other steps in the process cannot be safely and dependably obtained with conventional feeding methods. The present improved feed avoids this difficulty and permits ampoules to be loaded onto a conveyor at unusually high speeds. In achieving this end means are provided for utilizing the packing spacers to facilitate the loading of the ampoules onto the conveyor, and for automatically removing each spacer just prior to the deposit of the associated ampoules on the conveyor.

Still another object of the invention resides in an improved method and apparatus for thoroughly washing and rinsing the ampoules prior to sterilization, including positive extraction of the washing and rinsing fluids to effect removal of solid particles. By means of the invention, the rinsing is followed by the removal of all residual fluid remaining in the ampoule and the drying of its outer surface so that a clean and virtually dry ampoule is provided for immediate sterilization. This is important because even small quantities of water on an ampoule will effectively prevent rapid and complete sterilization as all moisture must be evaporated before the temperature of the ampoule can be raised to a point that will insure complete destruction of all bacteria and other microorganisms.

Other objects of the invention relates to the filling of the ampoules after sterilization. To fill ampoules at relatively rapid rates, and to accurately measure the quantity of liquid deposited in each ampoule without spilling or splashing it on the neck or other parts of the ampoule, presents a problem not heretofore effectively solved. While accurate measuring methods are known they are either limited to manual operation or are too slow or inaccurate for the present purpose. Accordingly, it is another object of the invention to provide a means for rapidly and accurately filling ampoules that will not only measure precise quantities of fluid for deposit in the ampoules but is also adjustable so that any predetermined quantity, within limits, can be accurately measured and inserted. A high order of accuracy is achieved by means of a new and improved adjustable pump and cooperating injection apparatus whereby the liquid is deposited wholly within the ampoule which is accurately aligned with the injection means so that undesirable droplets on the neck are completely avoided.

Still another object of the invention is to provide a new and improved means for preventing the entry of ambient air into the unfilled part of the ampoule prior to sealing, in order to avoid contamination when the apparatus is operated in atmospheres that may not have been adequately purified. This procedure includes a flushing of the ampoule, after filling, with a sterile inert gas, and the retention of the gas therein without entailing the insertion of plugs or other complicated or relatively expensive devices.

A still further object of the invention resides in the provision of new and improved ampoule sealing means that automatically function at high speed, and in continuous fashion, to seal the neck of each successive ampoule and at the same time form a bead-like seal devoid of sharp corners or edges. This apparatus also functions to discard the part of the neck of the ampoule that is separated from the ampoule proper when the seal is effected, and to discharge the filled and sealed ampoules into a collecting container.

A further object of the invention is an improved means for automatically transferring the filled ampoules from the intermittently advancing main conveyor to the continuously operating sealing machine. The apparatus allows ampoules which may arrive at the sealing station in batches, to be collected and fed at a uniform rate to the sealing mechanism.

The embodiment of the invention herein chosen for illustration is a completely automatic device for receiving, cleaning, sterilizing, filling and sealing containers such as glass ampoules of the type referred to. This apparatus is specifically intended for processing small ampoules for pharmaceuticals, but it will become apparent as the description proceeds that certain features thereof are also adaptable for use with other types of containers such as larger bottles and other vessels, especially in respect to the manner in which inherent difficulties heretofore involved in handling and processing such vessels, as well as in controlling exact quantities of fluid, have been successfully overcome, and also in respect to those features of construction, arrangement and mode of operation whereby processing speeds heretofore unattainable have been secured with complete safety and dependability.

Among the special features of the invention are: the highly improved loading mechanism which contributes in large part to the attainment of the high operating speeds; the manner in which thorough, complete, and rapid sterilization is effected, and the sterilized ampoules protected against possible contamination by ambient air prior to filling and sealing; the use of a separate carriage or conveyor for supporting the ampoules during the heating stage, thereby avoiding the difficulties normally encountered in subjecting a long conveyor to wide changes in temperature such as those encountered in sterilizing processes; the means whereby the ampoules, after filling, are immediately flushed with an inert gas and maintained in an inert atmosphere until the necks of the ampoules are heated in the sealing process to effect the sealing; and the completely automatic and comprehensive functioning of the apparatus as a whole. In this connection it is to be noted that it is possible to operate the equipment in a decontaminated atmosphere and to provide (if desired) for remote loading of the empty ampoules, and deliver of the finished ampoules, at points outside of the sterile enclosure, whereby it is not even necessary to have an operator present while the machine is functioning.

Actual tests with this apparatus have indicated that glass ampoules designed to hold between 1 cc. and 2 cc. of fluid can be easily processed at a continuous rate of at least several ampoules per second.

The above and other objects and advantages will become more apparent from the following description and accompanying drawings forming part of this specification.

In the drawings:

Figure 1 is a front elevation of one embodiment of the invention;

Figure 2 is a plan view of the apparatus shown in Figure 1;

Figures 3A–3H illustrate diagrammatically the several operations automatically performed by the apparatus shown in Figure 1;

Figure 4 is an end elevational view (from the right) to the apparatus shown in Figure 1 to illustrate certain features of the loading mechanism and drive means;

Figure 5 is a cross-sectional view of Figure 4 taken along the line **5—5** thereof;

Figure 6 is another cross-sectional view of Figure 4 taken along the line **6—6** thereof and showing certain details of the loading apparatus and ampoule inverting means;

Figure 7 is a further cross-sectional view of Figure 4 taken along the line **7—7** thereof and showing certain details of the ampoule receiving hopper constituting part of the loading means;

Figure 8 is a view of the hopper of Figure 7 as observed in the plane **8—8** of that figure;

Figures 9 and 10 are fragmentary views of the hopper showing two steps in the transfer of ampoules from the hopper to the main conveyor;

Figure 11 is a cross-sectional view taken along the line **11—11** of Figure 4 and showing part of the loading means, the conveyor belt, and certain of the cleaning stations;

Figure 12 is an enlarged detail view on line **12—12** of Figure 11 to illustrate the manner in which the ampoules are engaged with the conveyor belt;

Figure 13 is a view of Figure 12 taken along the line **13—13** thereof;

Figure 14 is a view along the line **14—14** of Figure 12;

Figure 15 is a cross-sectional view of Figure 11 taken along the line **15—15**, showing certain details of the ampoule rinsing apparatus;

Figure 16 is an enlarged cross-sectional view along the line **16—16** of Figure 11, illustrating in full lines a lowered position of the washing head and in dotted lines the raised position thereof;

Figure 17 is a fragmentary front elevation of the final part of the rinsing apparatus, showing also the evacuation and drying mechanisms;

Figure 18 is an enlarged cross-sectional view along the line **18—18** of Figure 17 showing details of the residual fluid evacuation station;

Figure 19 is a cross-sectional view of the evacuation head of Figure 18 in the raised position;

Figure 20 is a cross-sectional view of Figure 17 taken along the line **20—20** thereof and showing among other details the cooperation of the sterilizing conveyor with the main conveyor;

Figure 21 is an enlarged view of the main conveyor belt and the sterilizer or rotary conveyor, and shows the manner in which ampoules are transferred therebetween;

Figure 22 is a cross-sectional view of Figure 21, taken along the line **22—22** thereof;

Figure 23 is another cross-sectional view of Figure 21 taken along the line **23—23**;

Figure 24 is a further cross-sectional view of Figure 21 taken along the line **24—24** thereof;

Figure 25 is a plan view of Figure 22 taken along the line **25—25** to illustrate certain details of the drive mechanism for the rotary conveyor;

Figure 26 is a front elevation of the ampoule filling apparatus including the pumping means and adjustment therefor;

Figure 27 is a cross-sectional view of Figure 26 taken along the line **27—27** thereof;

Figure 28 is a cross-sectional view of Figure 26 along the line **28—28** thereof showing certain details of the pump and the ampoule aligning means;

Figure 29 is an enlarged cross-sectional view of Figure 26 along the line **29—29**, illustrating the pump valving mechanism;

Figures 30 and 31 are views similar to Figure 29 to demonstrate two phases of the pump operation;

Figure 32 is an enlarged cross-sectional view of Figure 28 along the line **32—32** thereof and shows the ampoule aligning means at the filling station;

Figure 33 is a cross-sectional view of Figure 32 along the line **33—33** thereof;

Figure 34 is another cross-sectional view of Figure 32 taken along the line **34—34** thereof;

Figure 35 is a view of the ampoule aligning means, similar to Figure 34, and illustrates its cooperation with an ampoule;

Figure 36 is an end elevational view (from the left) of the apparatus shown in Figure 1, with parts cut away to show certain details of the operating mechanism;

Figure 37 is an enlarged plan view of the sealing apparatus shown in Figure 36;

Figure 38 is a cross-sectional view of Figure 37 along the line **38—38** thereof;

Figure 39 is a cross-sectional view along the line **39—39** of Figure 38;

Figure 40 is a cross-sectional view of Figure 36 along the line **40—40**, showing the drive mechanism for the main belt conveyor;

Figure 41 is a detail cross-sectional view of Figure 37 along the line **41—41**, illustrating the ampoule enclosure means for retaining the flushing gas within the filled ampoules;

Figure 42 is an enlarged view along plane **42—42** of Figure 41 of a part of Figure 37 with the gas cover removed, to show the transfer of the filled ampoules to the sealing means;

Figure 43 is an enlarged detail of Figure 37 along the line **43—43** thereof;

Figure 44 is a front elevation of the sealing apparatus of Figure 37 with a part of the periphery of the sealing carriage and the associated belts displayed in a plane development to illustrate the operation thereof;

Figure 45 is an enlarged cross-sectional view of Figure 44 along the line **45—45**; and

Figures 46 and 47 are cross-sectional views of Figure 45 along the lines **46—46** and **47—47** thereof respectively.

General description of the apparatus

The loading mechanism of the apparatus shown is arranged to receive one or more gross of ampoules at a time and automatically to feed them row by row onto a horizontally moving conveyor belt which carries the ampoules through the various steps in the process. In Figure 1 the loading apparatus is shown at the right and the ampoules during the process travel from right to left. Although in this particular apparatus the ampoules are processed in groups of twelve at a time, it will be apparent that groups of any number can be processed with equal facility. The quantity of ampoules chosen to comprise each group is best determined by the manner in which the empty ampoules are packaged. In this case the apparatus is operable with single bulk packages of ampoules normally containing two gross, the ampoules being aligned in successive rows of twelve each. The feeding apparatus functions to feed one row at a time for processing, and this factor in turn sets the pattern for the operation of the conveyor which is driven intermittently to move each group of ampoules from one stage to the next, throughout the entire process.

After the ampoules are loaded on the main conveyor, they are carried successively through a total of five cleaning steps one of which washes the ampoules with a relatively strong washing solution and the remainder rinsing the ampoules with clear water. After the ampoules have been thoroughly cleaned, they are moved to the next station wherein the residual rinsing fluid is withdrawn from each ampoule and at the same time all water adhering to the bottom of the ampoule is removed by a suction device. The dried ampoules are then moved to a sterilizing station wherein each group of ampoules is successively transferred from the main conveyor to a rotary conveyor which carries the ampoules past a series of gas flames which heat them to a temperature of about 900° F. The ampoules are then permitted to cool for a short period of time after which they return to the original conveyor for advancement to the filling position. Here a plurality of pumps deposit a predetermined quantity of fluid into each ampoule. The filled ampoules are then preferably flushed with an inert decontaminated gas and moved directly via an intermediate transfer mechanism to the sealing device which melts a portion of the neck of each ampoule to provide a hermetic seal. The sealed ampoules are then discharged into a suitable container and are ready for packing.

The apparatus comprises an elongated central section **10** and a pair of outwardly extending end sections **12** and **13**. The right-hand section of the apparatus (as viewed in Figure 1) includes a control panel having appropriate control switches **14** and a pair of pilot lights **15**. On top of this section is the loading mechanism **16** which is adapted to be manually loaded with one or more gross of ampoules, and to successively feed these ampoules onto the conveyor **17** for transportation lengthwise along the central section **10**.

The ampoules carried by the conveyor **17** are processed successively at a washing station **18** and successive rinsing stations **19A–19D** with each station (in the illustrated case) handling twelve ampoules at one time. The washing and rinsing stations are provided with a single hood **20** adapted to carry off fumes and moisture vapor. The hood may be connected with suitable exhaust means such as the outlet pipe **21**.

Following the last rinsing step at station **19D** there is a preliminary drying or water evacuation station **22** adapted to remove residuary water remaining in the ampoules. Directly beneath this evacuation station is a suction pad **23** for drying the bottoms of the ampoules while the water is being evacuated from the inside. The cleansed and dried ampoules are then transferred to the sterilizing or heating station **24** over which there is a hood **25**.

At the heating station the conveyor **17** is in substantial alignment with a cooperating secondary conveyor **26** which is in the form of a series of radial spokes emanating from a central vertical axis of rotation. The conveyor **17** and the carrier **26** are synchronized in such a manner that the spokes of the carrier **26** will engage successive groups of ampoules, remove them from the belt **17**, and carry them through the sterilizing station where they are heated to a temperature of the order of 900° F. The ampoules continue along their arcuate travel beyond the heating station and are permitted to cool during the remainder of their 180° travel on the carrier **26** before reengagement with the conveyor **17**. The cooling station **27** may be defined as that portion of the ampoule travel between the heating means at station **24** and the region of re-transfer of the ampoules to the main conveyor **17**. A second hood **28** is disposed above the carrier **26**, and the hoods **25** and **28** are provided with suitable exhaust conduits **29** and **30** respectively.

After the ampoules are reengaged with the conveyor **17**, they are moved to the filling station **31** which includes pumping means for simultaneously filling the entire group of ampoules. Immediately upon filling, the ampoules are transferred to a gas flushing station 32 which removes the air from within the ampoules and leaves them filled with an inert decontaminated gas. These two stations are preferably enclosed by a cover 33 to prevent the escape of inert gas after the flushing step. The flushed ampoules are then transferred to the sealing station 34 positioned at the left-hand section 13 of the apparatus. This transfer is accomplished by means of a diagonally disposed transfer carrier that removes the ampoules from the conveyor 17 and engages them with the outer periphery of the sealing means 34. As will become apparent in the detailed description of the sealing apparatus, a portion of the neck of each ampoule is discarded during the sealing operation and the sealing means employs a pair of independent chutes 35 and 36 for discharging the filled ampoules and the discarded neck parts respectively.

The entire apparatus except for the sealing mechanism 34 is operated by a single longitudinal shaft 50 disposed lengthwise within the elongated central part 10 of the apparatus and driven by a motor in the section 12. In addition, several individual motors are employed for such purposes as producing vacuum for the cleaning stations, pumping the cleaning solution and rinsing water, driving the sealing mechanism, etc. These auxiliary motors as well as the main drive motor and electric heaters are controlled by the switches 14. The speed of the drive motor can be changed by the knob 61 to speed up or slow down the apparatus. In order to prevent overloading of the drive motor by starting it under load, a suitable clutch is preferably interposed between the drive motor and shaft 50 and operated by the control rod 58 shown most clearly in Figures 1 and 2. This rod extends across the entire front of the machine and enables an operator to start and stop the apparatus at any position along the front of the central section 10. The rod 58 also extends through the right-hand section 12 of the apparatus and is coupled with a main operating lever 59 pivotally attached to a bracket 60.

General description of the process

The ampoules of the type adapted to be handled by the apparatus are illustrated in Figures 3A–3H which show among other things the manner in which the ampoules are treated at each stage of the operation. These ampoules, denoted by the numeral 40, are generally cylindrical in shape and each one has a lower straight cylindrical section 41 whose length will depend upon the amount of liquid to be deposited therein. The upper section of the ampoule tapers inwardly to form a narrow neck 42, and then flares outwardly to form an upper opening 43 which is relatively wide to facilitate the cleaning and filling of the ampoule.

Figure 3A shows the feeding or loading step wherein each ampoule is guided into slot 44 on the conveyor 17 by means of a suitable guiding means 45. The washing and rinsing steps are substantially identical in operation and are illustrated in Figure 3B. The ampoule, while supported by the upper flared part of the neck 42, receives an injection tube 46 through which washing or rinsing solutions are injected. Sufficient force is used in these steps to flush out any heavy particles that may be in the bottom of the ampoule, and the fluid is withdrawn by means of vacuum apparatus 228 which completely surrounds the ampoule opening. After washing and rinsing of the ampoule, an evacuation tube 48 having an inclined end part 49 is inserted into the ampoule and rests on the bottom wall so as to completely remove all residual fluid from the bottom. At the same time, the ampoule is bodily lifted slightly by the suction pad 23 which thoroughly dries the outside of the ampoule.

Figure 3D illustrates the sterilizing step wherein the ampoules have been transferred to the rotary carriage 26 and are guided over heating flames 51 positioned beneath the ampoules. Cooling as illustrated in Figure 3E is effected while the ampoules are still engaged by the carriage 26 and before their return to the belt 17.

The filling and flushing operations are substantially identical and are indicated in Figure 3F. The ampoules have at this point been returned to the main conveyor belt 17, and just prior to insertion of the filling tube 52 each ampoule is raised by means of an aligning clamp 53 to align the neck 42 of the ampoule with the filling tube 52. In this way liquid can be deposited in the ampoule without splashing or causing the deposit of any of the liquid on the narrow neck 42. The filled and flushed ampoule is finally carried to the sealing step generally illustrated in Figure 3G at which time a suitable gas flame 54 functions to melt the neck 42 as the ampoule is rotated by rollers 55 and a belt 56. Melting of the neck 42 forms a hermetic seal in the completed ampoule as shown in Figure 3H and designated by the numeral 57.

Ampoule hopper and loading drum

The mechanism for feeding empty ampoules to the conveyor belt 17 is illustrated in Figures 1, 2 and 4–10 inclusive. It is designed to receive ampoules in bulk supply and feed them successively into notches 44 of the conveyor belt 17. The ampoules usually come packed in rectangular boxes with the open ends of the ampoules up.

Before describing the loading apparatus in detail, it may be observed that the loading of the ampoules is achieved by a mechanism mounted on the section 12 and supported by three spaced uprights 66, 67 and 68. A hopper is mounted between the uprights 66 and 67, and consists essentially of a V-shaped trough defined by walls 63 and 65 inclined at about 45° to the horizontal. A bulk supply of ampoules is introduced (in a manner to be described) to the inclined trough with the open ends downward against the wall 63, the ampoules being arranged in successive rows with cardboard spacers between the rows.

Alongside the hopper, supported between the uprights 67 and 68, is a drum 71 mounted for intermittent rotation on a horizontal axis that is substantially in alignment with the wall 65 but below the wall 63. The drum is provided with a series of radially arranged slots each of which is of a size to receive a plurality of ampoules in a row. The drum is rotated intermittently, in a clockwise direction as viewed in Figure 6, to bring the radial slots successively into substantial alignment with the wall 65 of the hopper. During each pause of the drum rotation the row of ampoules resting on the wall 65 is pushed endwise into the corresponding slot in the drum. When each loaded slot arrives at the lower vertical position (Figure 6) the ampoules in it are pushed endwise out of the remote end of the slot onto a guideway leading to the conveyor 17.

The pushing of the ampoules into the successive drum slots, and later out of them, is achieved by pushing mechanism that is also supported between the uprights 66 and 67, this mechanism comprising a pair of pushers mounted for reciprocation in a direction parallel to the drum axis, one of the pushers being aligned with the wall 65 of the hopper (to load a row of ampoules onto the drum), the other being aligned with the lower vertical slot of the drum (to push the row of ampoules out of the drum). In greater detail, it will be observed that the three spaced uprights 66, 67 and 68 are secured on the top wall 37 of section 12 by angle brackets 38 (Figure 4). The slotted drum is mounted between the uprights 67, 68; the hopper and the pushing mechanism between the uprights 66, 67.

The hopper 62 has a relatively long inclined wall 63 extending diagonally upward in one direction (toward the left as viewed in Figure 7) and a shorter wall 65 extending upward in an opposite direction, these walls defining an upwardly open V. The box of ampoules is loaded into the hopper 62 by inverting the carton so as to leave the ampoules resting in the hopper in an upside-down position with the several rows and separating spacers in orderly alignment. In order to facilitate the loading of the ampoules, the hopper **62** may include a movable section **64** hinged to the upper edge of wall **63** by suitable hinges so that it can be moved downwardly into a substantially vertical plane (Figure 1). The opened box of ampoules can be placed and held against the hopper part **64** when the latter is in the vertical position, and the part **64** is then raised to a point in line with the wall **63** to permit the box to slide downwardly against the wall **65**. The box is then removed leaving the ampoules and spacers in the hopper, the axes of the ampoules (and the spacers) lying parallel to the wall **65** with the open ends of the ampoules facing the wall **63**.

Between the uprights **67** and **68** is a circular drum cage **69** closed on one side by the upright **67** and on the other side by a substantially circular member **70** secured to and supported by the upright **68**. Within this cage is the rotary drum **71** (Figure 6) having (in this embodiment of the invention) eight radial slots **72** which intersect the surface of the drum and have their inner ends spaced from the central axis thereof. Each slot **72** is just about wide enough to receive one row of ampoules **40** and a separating spacer **73** as shown in Figure 6. The width of the drum is governed by the number of ampoules to be handled at one time which in the present instance has been chosen as twelve since the ampoules are packed in their original containers in successive rows of twelve each.

The drum **71** is thus adapted to receive ampoules from the hopper **63** in batches of a selected number such as twelve, and to carry them to a vertical position with their open ends up (see lower part of Figure 6) for discharge onto a sloping guideway leading to the belt conveyor **17**.

The rotary drum **71** rotates on a shaft **74** suitably journaled in the uprights **66** and **68**. Beneath the shaft **74** and parallel to it is a non-rotating shaft **75** also extending between the members **66** and **68**. On this shaft is a sliding collar **76** that carries a pair of plungers which simultaneously push one row of ampoules from hopper **62** onto the drum **71** and push another row of them out of the drum.

Reciprocating motion of the collar **76** is effected by the main drive shaft **50** and a pair of cams **11** and **39** carried thereby. A lever arm **77** lies between the cams **11** and **39** (see Figure 4) and has a slot **78** which engages the shaft **50** and is adapted to oscillate on it. A cam follower secured to one end of the arm **77** rides on the outer periphery of the cam **11** while a second cam follower **79** carried by the lever arm **77** on the opposite side of the shaft **50** rides on the second cam **39**. The cams function to move the lever arm **77** back and forth. The left-hand end of the arm **77** (as shown in Figure 4) is pivotally connected at **80** to an upwardly extending lever **81** pivoted to the section **12** at **82** for rocking motion in response to the action of the arm **77**. The upper end of the lever **81** is coupled to a bracket **83** (carried by the sliding collar **76**) by means of a link **84** pivoted both to the lever **81** and to the bracket **83**. Thus continuous rotation of the shaft **50** will produce reciprocating motion of the collar **76** and its associated bracket **83**.

The bracket **83** is suitably secured to a plate **87** (Figure 7) which forms the pusher for removing ampoules **40** from the lowermost slot **72** of the drum **71**. At its outer end the pusher **87** is secured to a member **88** that slides on both shafts **74** and **75** and carries a pusher **89**. This pusher is inclined at an angle of about 45° and is parallel to the wall **65** of the hopper **62**.

Reciprocating motion of the collar **76** and bracket **83** produces corresponding reciprocation of the pusher members **87** and **89** with the latter functioning to transfer a row of ampoules from the hopper **62** to the drum slot **72** that is then in alignment with the wall **65**. Successive reciprocations of the pusher **89**, with coordinated intermittent rotation of the drum **71**, loads the slots **72** successively. At the same time, as each slot **72** moves into its lowermost vertical position, pusher **87** functions to remove the ampoules therefrom for transfer to the conveyor **17**.

Rotation of the drum **71** is effected by the main drive shaft **50** functioning through a cam **91** (Figure 4), a pair of levers **92** and **101** and a ratchet and pawl **94** and **95** (Figure 5). The cam **91** may be a substantially circular plate mounted eccentrically on the shaft **50**. The lever **92** is pivoted at **96** and includes a cam follower **97** that rides on the periphery of cam **91**. A spring **98** secured to the lever **92** urges the cam follower **97** into constant contact with cam **91**. The vertical rod **93** is pivoted at **99** to the lever **92** and has its upper end pivoted at **100** to an arm **101** (Figure 5) rotatively mounted on the shaft **74**. Rotation of the shaft **50** and cam **91** produces reciprocation of the rod **93** and oscillation of the arm **101** on the shaft **74**. The arm **101** carries the pivoted pawl **95** at **102**, and the pawl cooperates with a plurality of notches **103** on the periphery of the ratchet **94** so that each time the rod **93** is moved upwards the pawl **95** rotates the ratchet **94** through a predetermined arcuate distance. Spring **104** connected between the pawl **95** and the link **101** constantly urges the pawl **95** against the ratchet **94**.

In order to insure accurate positioning of the drum **71** for pushing ampoules into and out of the slots **72**, two additional pawls **105** and **106** are preferably provided. The pawl **105** is mounted for rotation on a pin **107** secured to the upright **68**. Surrounding this pin is a spring **108** having one end fixed to the pin and the other end engaging the pawl **105** to urge it into contact with the ratchet **94**. This pawl prevents counter-rotation of the ratchet **94** on retraction of the pawl **95** as the rod **93** moves downwardly. The pawl or detent **106** is in engagement with one of the notches **103** whenever the pawl **95** retracts, to lock the ratchet **94** and consequently the drum **71** against any motion during this period of pause.

Pivoting of the detent **106** is controlled by a cam arm **109** formed on the part **101**. During periods of pause, the cam **109** is in its lower position and out of engagement with the cam follower **110** mounted on the detent **106**. In this position the detent **106** functions under the action of a spring **112** (surrounding the pawl supporting pin **113**) to move into engagement with one of the notches **103**. As the shaft **93** and link **101** reach their most retracted positions preparatory to further rotation of the drum **71**, the cam **109** engages the follower **110** and moves the detent **106** out of engagement with the ratchet **94**.

The motions of the ratchet **94** and shaft **74** are coordinated with the operation of the ampoule pushers **87** and **89** by appropriately adjusting the positions of the cams **11**, **39** and **91** on the shaft **50**.

As the pusher **89** transfers successive rows of ampoules from the hopper **62** into successive slots **72** of the drum **71**, it also transfers one of the spacers or cardboard separators **73** from the hopper to the drum along with each row of ampoules. However, as each slot reaches the lowermost position for discharge of the ampoules **40** under the action of pusher **87**, the cardboard spacer is not removed but remains within the slot **72**. In order to dispose of these cardboard separators, the housing **69** surrounding the drum **71** is provided with an opening **114** in line with the first slot position beyond the point of discharge of the ampoules, as shown in Figure 6. This permits the separators **73** to leave the slot **72** under the action of gravity and to be collected in a suitable container by means of a chute **115**.

In order to inspect the operation of the drum **71** during the operation of the apparatus, the outer shield **69** surrounding the drum is preferably provided with a shiftable section 85 mounted for arcuate motion in cooperating retaining grooves in the opposed walls 67 and 70. Figure 6 shows the section 85 in the closed position. When moved to the open position by means of a knob 121 it separates from the fixed section of the housing 69 at 122 to leave a narrow opening through which the operator can observe the movement of ampoules into the slot 72. This opening also facilitates maintenance of the apparatus, since the set screws 86 which secure the drum 71 to the shaft 74 are accessible therethrough.

On the hopper wall 65 there is a parallel movable wall 90 which is shifted whenever it is desired, for one reason or another, temporarily to discontinue the feeding of ampoules. This movable wall is carried on the end of a rod 123 which extends through a bushing 124 carried on the under side of the wall 65. In the operating position, the wall 90 lies flat against the wall 65 as shown in Figure 7. To prevent the feeding of ampoules, the rod 123 is pushed inwardly to move the plate 90 beyond the opening 125 in the wall 67 through which the ampoules are normally fed to the drum 71. This position is shown in dotted lines in Figure 7. To retain the wall 90 in this position, the bushing 124 is provided with a slot adjacent to the wall 65, and a notch 127 is formed in the rod 123. A keeper 128 pivoted to the wall 65 at 129 (Figure 8) is operative to move through the slot in the bushing 124 and engage with the notch 127 in the rod 123. To resume the normal feeding of ampoules, it is merely necessary to lift the keeper 128 by means of its knob 126 and permit the plate 90 to move back against the wall 65.

The hopper is also provided with an adjustable wall 111 (Figure 8) which is secured to the wall 63 of the hopper by means of a pair of bolts 116 cooperating with a pair of slots 117. The wall 111 can be moved inwardly and outwardly to accommodate boxes of ampoules that may vary slightly in width.

Figures 9 and 10 show two phases of the ampoule feeding procedure. The pusher mechanism 89 (Figure 4) is slotted to provide an upper pusher part for engaging the ampoules and a lower pusher part 132 (see Figures 9 and 10) for engaging the adjacent spacer 73. The lower part 132 is provided with a spring-pressed claw 133 which functions to transfer a spacer 73 into the drum 71 along with each row of ampoules 40. This claw is pivoted to the pusher part 132 at 134. Its motion is limited by a pin 136 mounted in the end of the pusher member 132 (compare Figures 9 and 10). A spring 137 secured to the pusher 132 at 138 urges the claw upwardly as shown in Figure 9. In this position there is a space between the downwardly facing shoulder 141 of the claw and the tapered upper edge 140 of the pusher 132.

In the operation of the pusher 89 to transfer a row of ampoules from the hopper 63 through its slot 125 into a slot 72 of the drum 71, the spring 137 urges the claw 133 upwards to engage the associated spacer 73 and thus carries it along with the ampoules into the drum slot 72 (Figure 9). It will be noted that the end of the movable wall 90 is curved upwardly at 142 to lift each ampoule slightly just before its transfer into the slot 72. In addition, a pliable leather finger 143 secured to the hopper wall 67 presses downwardly with a light pressure against each ampoule as it is forced through the opening 125. This insures the proper transfer of the ampoules in upright position into the slot 72, so that they cannot possibly overturn and jam.

When the entire row of ampoules is loaded into the slot 72, the pliable finger 143 returns to close the opening 125, as shown in Figure 10. During the retraction of the pusher 89 the next row of ampoules 40 falls into place, one by one, until the pusher 89 is withdrawn entirely through the slot 124 in the wall 111 of the hopper. During this action, the next successive spacer 73 is momentarily engaged by a pin 144 which has moved upwardly through an opening 145 at the bottom of the hopper 63, as shown in Figure 10. This prevents jamming. Upon complete retraction of the pusher 89, the pin 144 is retracted so that the leading row of ampoules 40 and the next successive row of ampoules come into adjacence and alignment as shown in Figure 9, with the spacer 73 between them.

The operation of pin 144 is illustrated in Figure 7. The pin extends upwardly from an arm 146 of bell crank 147 which is pivoted at 148. The downwardly extending arm 149 of this bell crank is provided with a cam follower 150 which rides on cam 151 under the action of a suitable spring 152. The cam 151 is mounted on the shaft 74 and rotates in coordination with the drum and the operation of the pushers 87 and 89.

For safety purposes, the pusher 87 and the associated supporting and operating apparatus is preferably enclosed by a housing 153 (Figure 7), having a fixed cover part 154 and a slidable cover part 155 secured to and carried by the pusher 87.

From the foregoing description it will be evident that the feeding mechanism is highly effective for automatically moving ampoules from a hopper onto a conveyor belt and at the same time inverting them so that they can be placed on the belt in any desired position. This desirable result, as well as the rapidity and reliability of the operation, is attributable at least in part to the moving of the ampoules in groups with the assistance of the intervening spacers or separators to keep them in line as shown in Figs. 9 and 10. Moreover, considerable time and effort is saved on the part of the operator as the need for manually removing these spacers is completely eliminated. Loading is quickly and easily effected simply by inverting a carton of ampoules into the hopper and then merely lifting the box to leave the ampoules and their spacers in the same relative positions in the hopper, ready for feeding. Obviously, if desired, any selected number of ampoules can be accommodated at one time or even automatically fed to the machine from some remote position.

Feed of ampoules onto main conveyor

The ampoules discharged from the lowermost slot 72 of drum 71 (Figure 6) are guided onto the belt 17 by means of an inclined guide designated 45 in Figure 4 and shown in detail in Figures 5, 12, 13 and 14. This guide is made up of three sets of substantially parallel guide members 157, 158 and 159, each set consisting of a pair of spaced strips. It is the uppermost set that supports the ampoules in suspended condition (Figure 12). The guide members are held in spaced parallel relationship by a pair of aligning structures 160 and 161 (Fig. 4). The structure 160 (Figure 5) comprises a pair of bolts 162 extending through the guides 157—159, and spacers 163 for holding the guide members in proper relationship. The bolts 162 are mounted on a lower transverse link 164 that is spaced from the bottom guide members 159 by the lowermost spacers 163. The guide structure 161 (Figure 12) is similar. The entire guide 45 is resiliently supported at its feed and discharge ends by resilient bracket members so that it may be vibrated. At its outer end, the guide is supported by a plate 168 (Figure 12) which forms part of the supporting means for the belt 17. One of the guide members 157 is held on the support 168 and slightly above the belt 17 by a bolt 171, spacers 169, and a pair of resilient washers 170.

Figure 12 illustrates best how the ampoules 40 are guided to the belt 17 by gravity, with the actual support of the ampoules being accomplished by the guide members 157 which engage the necks of the ampoules while the lower guide members are provided merely for the purpose of confining the ampoules and preventing them from swinging as they proceed downwardly.

In order to effect a smooth engagement of the ampoules with successive notches 44 in the belt 17 as it moves continuously past the guide **45**, the outer lower guide member **159** (which extends below the belt **17**) is curved sharply in the direction of movement of the belt (Figure 14) so that the lower end of each ampoule is moved slightly in advance of the upper end of the ampoule at the moment of engagement with the belt. It has been found that this arrangement effectively prevents undesirable swinging of the ampoules at the time of engagement and effects a smooth and dependable loading. In addition to the curved end part **172** of the guide member **159**, a curved spring **173** may be carried on the end of the inner guide member **159** and bent in the direction of the curved end part **172** to prevent bouncing of the bottom ends of the ampoules.

In the loading region the belt **17** is guided on a support **174** and belt guide **175** carried by part **168** (Figure 12). In order to avoid any possibility of the ampoules falling out of the notches **44** of the belt **17** immediately after the loading operation as pictured in Figure 12, the belt is further provided with an opposing guide **176** (Figure 13) having a recessed portion **177** to receive and slidably support the belt **17**. This guide **176** starts at a point just beyond the loading point (Figure 13) and retains the ampoules in their respective notches on the belt **17** throughout the several cleaning and rinsing operations presently to be described.

In order to facilitate the travel of the ampoules down the guide **157** for engagement with the belt **17**, a vibrating mechanism **179** (Figure 4) is secured to the guide by means of a bracket **180**. This inertia vibrator produces minute vibrations of the guide **157** that are helpful in preventing any sticking or jamming of the ampoules.

Conveyor supporting and operating mechanism

The main conveyor **17** which is provided with the plurality of slots or notches **44** for carrying the ampoules throughout the several operations is an endless metal strap or belt that is supported at the opposite ends of the part **10** of the apparatus by means of two drums **178** and **181** (see Figures 2, 11 and 36). These drums have peripheral pins engaging with the belt notches **44**. The driving drum **181** is at the left-hand end of the apparatus (as viewed in Figures 1 and 2) and is rotatably supported on a shaft **182** extending between journals **183** (Figure 36). Secured to and movable with the drum **181** is a ratchet wheel **185** (Figure 40). The ratchet wheel is driven by a pawl **187** carried by a lever **188** rotatably supported on the shaft **182**. The pawl **187** is pivoted at **189** and is held against the ratchet by a spring **190**.

The lever **188** and pawl **187** are driven by the main drive shaft **50** through a non-linear linkage (Figure 36) comprising a wheel **191** having an eccentrically located pin **192**. The wheel **191** is rotated with the shaft **50**. The pin **192** engages a slot **193** in a link **194** which is pivoted to the frame at **195** so that it will oscillate upwardly and downwardly about the pivot **195** as the shaft **50** is rotated. The outer end of the link **194** is coupled to the pawl operating lever **188** by means of a connecting rod **196** pivoted to the link **194** at **197** and to the lever **188** at **198**.

It will be noticed that in the operation of this drive mechanism the link **194** is moved upwardly when the pin **192** is farthest from the pivot **195**, so that the upward movement of link **194** is relatively slow. As the pin **192** continues in its clockwise path by reason of rotation of the wheel **191**, its downward travel is effected when it is relatively close to the pivot **195** and thus the link is moved downwardly at a more rapid speed than it is moved upwardly. The downward motion of the link **194** functions to drive the belt **17** which is thus moved forwardly at a relatively rapid speed. The return trip of the pawl **187** is performed at a slower speed and provides sufficient time for the ampoules to be processed at each of the several stations. The pawl **187** is set to operate to advance the belt **17** twelve notches (which results in the simultaneous processing of twelve ampoules at a time) whenever the feeding mechanism previously described is set to feed the ampoules in groups of twelve to the belt **17**.

The belt supporting drum **178** is shown in Figures 4 and 11. This drum is rotatably supported on a shaft **199** having splined or toothed end portions **200**. The shaft **199** extends through a pair of supporting brackets **202** which in turn carry toothed racks **203** which engage the shaft ends **200**. Also carried on the shaft **199** is a sprocket **205**. About this sprocket is a chain **206** secured at one end to the sprocket **205** by an anchoring link **207**. This chain extends about the sprocket and its lower end is attached by means of a spring **208** to an anchoring eye **201**. The spring **208**, together with the chain **206** and sprocket **205**, acts constantly to pull the shaft **199** and of course the drum **178** to the right (as pictured in Figure 11) and thus maintains constant tension in the conveyor belt **17** notwithstanding changes in ambient temperature that might affect its length.

Ampoule washing and rinsing stations

The washing station **18** and the rinsing stations **19A–19D** embody substantially identical structures and each is provided with means for processing a predetermined batch of ampoules (e.g., twelve) at one time. Both the washing and rinsing operations are performed by inserting the washing or rinsing fluid into the ampoule under pressure and extracting the fluid by means of a vacuum.

At each station there is a bank of parallel downwardly directed hollow tubes mounted at their upper ends in a header block. The tubes are spaced apart by exactly the center-to-center spacing between each pair of conveyor slots **44**. The header block is provided with two chambers at right angles to the tubes, one chamber being in communication with a source of fluid under pressure, the other with a vacuum. The header block moves up and down in predetermined timed relation to the intermittent conveyor advance so that each descent brings the tubes accurately into the ampoules that have come to rest at that station, and each rise withdraws the tubes from the ampoules so that they may be moved on to the next station.

Figure 15 is a sectional view through the header block and related parts at the first rinsing station **19A**, while Figure 16 is a similar view on an enlargegd scale through the mechanism at the washing station **18**. In Figure 16 the full lines depict the tubes when they are almost in their furthest downward position, the dot-and-dash lines show them in their raised position. The same reference numerals are used in Figures 15 and 16 since the construction of each header block and its bank of tubes is the same at each of the stations **18** and **19A–19D**.

Referring now to Figures 15 and 16 it will be observed that each header block **228** is supported by a bar or bracket **209** which in turn is provided with a pair of collars **210** engaging vertical actuating rods **211**. Each rod **211** (of which at least two are provided for each header block bracket **209** in order to stabilize the motion) is supported in a vertical tubular bracket member **212** having a base **213** and a triangular brace **214** secured thereto. The base **213** is mounted in any desired manner on the covering wall of the section **10** of the apparatus. The bore in the bracket tube **212** extends through the base **213**, and the bottom end of each rod **211** has a wheel **215** adapted to ride on the periphery of a cam **216**. This cam **216** (along with others identical with it) is fixedly mounted on the main drive shaft **50**. These cams function to move the header blocks at the stations **18** and **19A–19D** upwardly and downwardly as the shaft **50** is rotated.

During its travel past these stations the conveyor **17** continues to rest partly on the support **174** (Figure 12) and partly on the opposed guide 176 (Figure 13). Beneath and behind the support 174, at the washing and rinsing stations, is an angular shield 217 that prevents washing and rinsing fluids from wetting the drive mechanism on the interior of the machine. These fluids are caught in a trough 218.

Each of the header blocks is provided with a pressure inlet 220 and a suction outlet 221. The inlet 220 at the washing station 18 conducts a suitable detergent through pipe 219 (Fig. 4) while the inlets 220 at stations 19A–19D conduct a rinsing solution. The latter group of inlets may be connected to a common manifold 222 (Figures 2 and 15) while the corresponding suction lines 221 are connected to a suction manifold 223. The suction manifold 223 is supported on a pipe 224 communicating with the manifold 223 and extending downwardly through base 213 to a hose 225 leading to a suction pump (not shown). The pressure manifold 222 can be supported by and attached to the suction manifold by means of brackets 226. The pressure manifold is coupled to a source of rinsing fluid by means of a hose 227.

Each header block 228 is provided with a somewhat rectangular chamber 229 that communicates with the pressure inlet tube 220. The chamber 229 extends throughout the length of the block 228, and near it is a second elongated chamber 231 which communicates with the suction line 221 via a pipe connection 235 (Figure 16). Each of the tubes 46 has a body part 233 extending through the housing 228 and provided with inlet openings 234 aligned with the rectangular chamber 229.

In addition to the openings 229 and 231, the block 228 is provided at the bottom with a series of enlarged cavities 236 each of which communicates with the passage 231 by means of a short connecting passage 237. The body 233 of each tube 46 is centrally aligned within its individual cavity 236 and is held in position in the block 228 by means of a threaded cap screw 238 to which the upper end of the nozzle body part 233 is attached. Thus the nozzles 46 can be readily replaced by removing any desired cap screw 238 since this automatically withdraws the corresponding body 233 and its associated nozzle.

When the washing station header block is in its furthermost downward position (slightly beyond the position shown in full lines in Figure 16), the nozzles 46 extend through the necks of ampoules 40 and well into the base parts thereof. The uppermost part of each ampoule enters reasonably snugly into the lower part of the corresponding cavity 236; and the baffle 217 enters into the recess 232 on the underside of bracket 209. Thus washing fluid is forced through inlet tube 220, chamber 229, and holes 234 into and through nozzles 46. The pressure of the fluid is maintained high enough to thoroughly clean the ampoules and to carry solid particles (if any) upwardly out of the top of each ampoule. During this cleaning operation, suction is applied to the chamber 221 by means of the flexible suction tube 221. The fluid leaving the mouth of each ampoule 40 is therefore drawn upwardly through the cavity 236 so that very little of the solution will drip down over the ampoule and into the trough 218.

It will be noted (Figure 11) that the trough 218 is provided with a partition 239 positioned directly beneath the joinder of the washing station 18 and the first rinsing station 19A. This partition is for the obvious purpose of preventing intermixture of the cleaning solution on one side with the rinsing solution on the other.

If the washing fluid that is used is of a character that can be or might desirably be re-used, that portion that is spilled during the washing operation and not withdrawn by the vacuum line 221 of the washing station header block is caught by the trough 218 and returned to the source of supply via a drain pipe 240. The drain for the rinse water is designated 241.

The apparatus thus subjects each successive group or batch of ampoules to a thorough washing and then to a succession of rinsing operations. The performance of these cleaning actions by a forceful flow of fluid under pressure and a positive withdrawal of the fluid by suction results in an unusually reliable and complete cleansing of each ampoule as a preliminary to its sterilization. Moreover, because of the batch treatment of a multiple number of ampoules at one time, and the automatic functioning of the mechanism as described, exceedingly high speeds of operation can be attained.

Of course the several stations 18 and 19A–19D can be modified, if desired. For example, two or more stations might be operated so as to process the ampoules successively with additional cleaning or washing fluids, either of the same or of different types; or one or more of the end stations might be hooked up to inject steam or other gas for preheating or further cleansing purposes; and obviously any selected number of washing and rinsing stations of the kind described can be provided for.

Evacuation and drying station

At the evacuation and drying station 22, adjacent to the final rinsing station 19D, there is a block 242 (Figures 17–20) which is secured to the bracket 209 (Figures 15–16) and hence moves up and down with the latter. It carries a bank of tubes 48 which enter the ampoules beneath them whenever the block 242 is lowered (Figure 18) and rise out of the ampoules when the block 242 is raised (Figure 19).

The block 242 is provided with a series of vertically arranged openings for slidably receiving a corresponding series of individual evacuation members 244. Each of these is hollow and terminates at its lower end in the evacuation tube 48, the upper end being connected by a flexible hose 249 to a source of vacuum. Downward motion of each member 244 is limited by a shoulder 247 adapted to engage the top surface of the block 242.

The under side of the block 242 is formed with a longitudinal recess 245 into which the necks of the amopules 40 enter when the parts are in the relationship of Figure 18.

The lower end 250 of the non-circular upper part of each member 244 is of circular section and has a diameter slightly smaller than the diameter of the neck of the amopule 40. This cylindrical section 250 is tapered inwardly at 251 to merge with the suction nozzle 48. The lower end of the nozzle 48 is tapered upwardly as shown at 49 (Figure 3C) to prevent any possibility of the formation of an air tight seal between the end of the nozzle and the bottom of the ampoule 40.

Directly beneath the ampoules 40 as they are supported on the conveyor belt 17 at the drying station 22 is a reciprocating drying table 23 which is arranged to remove any fluid which may be adhering to the bottom of the ampoules as a result of the washing and rinsing operations. This drying table comprises an elongated body 256 (Figures 17–19) having a length approximating equal to the distance occupied by two batches of ampoules on the conveyor belt 17. The body 256 is provided with a substantially co-extensive passage 257 and a recess 258 on the upper side thereof for receiving and holding a felt pad 259. A plurality of holes 260 are drilled in the bottom of the recess 258 and communicate with the longitudinal passage 257. This passage 257 is in turn connected with a suction hose 261 by means of a short pipe 262 (Figure 18). The member 256 is supported in a horizontal position at the upper end of a vertical shaft 264 slidably supported within a vertical guide 265. The rod 264 extends downwardly (Figure 20) and carries a cam follower 266 on its bottom end for cooperation with the periphery of cam 267. This cam is fixedly mounted on the shaft **50** and functions to reciprocate the shaft **264** in synchronism with the operation of the conveyor belt and the evacuation head **242**. The suction hose **261** coupled with the drying device **23** is connected to the suction manifold **223** through a control valve **268**.

In the operation of the evacuation and drying station, both the drying member **23** and the evacuation head **242** are in their retracted positions as shown in Figure 19 as the ampoules are moved into position. At this point, the block **242** is moved downwardly and the drying table **23** is moved upwardly. The table **23** engages the bottoms of the ampoules **40** and lifts each amopule out of positive engagement with its slot **44** on the belt **17**. Simultaneously, the suction nozzles **48** have moved downwardly through the necks of the ampoules **40** until their lower ends engage the bottoms of the amopules. Movement is continued until the members **244** are displaced upwardly relative to the block **242**. This is shown in Figure 18 and insures positive engagement of the nozzles **48** with the bottoms of the ampoules and at the same time avoids any danger of damaging the ampoules. The nozzles withdraw all residual fluid from within the ampoules and at the same time the application of a vacuum to the chamber **257** of the drying table **23** removes water from the underside of the ampoules. Upon completion of this operation, the block **242** moves upwardly out of engagement with the ampoules **40** and simultaneously the drying table moves downwardly, gently lowering the ampoules back onto the conveyor **17**.

As the ampoules are advanced beyond station **22** and prepared for engagement with the circular carriage **26**, they are again engaged by the drying table **23** and displaced upwardly out of engagement with the belt **17**. This action further dries the ampoules exteriorly and also facilitates the transfer of the ampoules to the carriage **26** for sterilization as will be presently described.

Sterilizing and cooling

Sterilization and cooling of the ampoules after they have been cleaned, rinsed and dried is accomplished by the transfer of the ampoules to the circular carriage **26** which transports them from the belt **17** past a series of heating heads during which time the ampoules are heated to a temperature of about 900° F. The rotation of the carriage **26** is adjusted so that after the ampoules are heated, there is a time lapse of about two to three minutes before the ampoules are reengaged with the belt **17** for transportation to the filling station. Figure 1 shows the general relationship of the carriage **26** with the longitudinal conveyor belt **17**, while the detailed structure of this carriage and the associated heating means are shown in Figures 21–25 inclusive.

The carriage **26** consists essentially of a wheel mounted for intermittent rotation on a vertical axis and provided with a plurality of open-end radial slots Each slot is adapted to support a batch of aligned ampoules (e.g., twelve). The axis of rotation is substantially in line with the path of travel of the conveyor **17** so that each pair of diametrically opposite slots comes successively into alignment with the conveyor belt. The movements are so synchronized that during each advancement of the conveyor the carriage remains stationary, and during each period of pause of the conveyor the carriage rotates. As the conveyor belt moves it shifts one batch of ampoules onto one radial slot of the carriage and removes another batch of ampoules (which have by that time been sterilized and cooled) from the diametrically opposite slot of the carriage. In effect, the rotary carriage is an auxiliary conveyor that removes one ampoule batch after another from its linear path of travel and transports it laterally through an arcuate path of 180° and then transfers it back to the main conveyor. The result is a tremendous saving of space, a safeguarding of the main conveyor from the undesirable effects of the heat of the sterilizing procedure, and an ability to retain the ampoules under continuously automatic control throughout the entire range of treatment.

Referring now to Figures 21–25, it will be observed that in the illustrated form of the invention the carriage **26** comprises a central circular part **274**, having a plurality of radially disposed spaced fingers **275**. The spaces **276** between them are just wide enough to accommodate the necks of the ampoules **40** and to support them in substantially the same manner as they are supported by the belt **17**. The extending fingers may each be formed of a rod bent upon itself to form a substantially diverging structure with the ends of the rods embedded in and securely fastened to the periphery of the central part **274**. In this way, the outer ends of the fingers can be gently curved to provide a bevelled mouth or open end for each radial slot to facilitate entrance of the ampoules **40**. Both the fingers **275** and the supporting plate **274** are located directly beneath the belt **17** with the axis of rotation substantially in alignment with the latter.

This rotary device is rotatably supported by a vertical member **279** (Figure 22) mounted on a horizontal part **277** of a supporting framework secured on the central section **10** of the apparatus as by means of a pair of bracket members **278**. Directly below the carriage **26** and on the same shaft **282** is a ratchet **280**. Rotation of the ratchet is accomplished by a pawl **283** (Figure 25) pivotally mounted at **284** on the outer end of a short link **285**. This link is carried on the upper end of a shaft **286** rotatably mounted on the frame member **277**. On the lower end of the shaft **286** is a second link **289** carrying a cam follower **290**. This cam follower rides against the side of a cam **291** which functions to produce periodic oscillation of the shaft **286** and consequently of the link **285** and its pawl **283**. The cam follower **290** is held against the cam **291** by a suitable spring **292** secured at one end to the link **289** and at its other end to the frame of the apparatus. Similarly suitable spring means (not shown) is provided for urging the pawl **283** against the periphery of the ratchet **280** so that as the pawl **283** is moved back and forth, it will periodically advance the ratchet and the carriage **26**.

In order to prevent reverse rotation of the carriage, there is a second pawl **293**, pivotally mounted at **294** to the upper end of a frame member **295**. This pawl **293** is also provided with a suitable spring (not shown) for urging it against the periphery of the ratchet **280**.

The cam **291** is mounted on and driven by the main shaft **50** so that the rotation of the carriage **26** will be synchronized with the translation of the belt **17** as previously described.

As will be noticed in Figure 22 it is preferable that each of the fingers **275** slope slightly downward away from the part **274** in order to facilitate the transfer of the ampoules from the belt **17** to the carriage **26**. In effecting the transfer of the ampoules, the belt **17** carries a group from the evacuation station, previously described, into engagement with the radial slot that is at that moment in alignment with the belt **17**. As the belt is halted to permit processing of the ampoules, cam **291** functions to displace the carriage in a clockwise direction, as viewed in Figure 2, through an arcuate distance equivalent to that between successive slots. At the time this motion takes place, the drying table **23** (Figure 17) has moved upwardly to raise the ampoules so that the narrower parts of the necks of the ampoules are presented to the slot **276**. As the carriage **26** is rotated, the ampoules are disengaged from the belt **17** and are carried by the edges of the adjacent fingers **275**.

In order to remove any water which may have been spilled on the belt **17** after the ampoules have been transferred to the circular carriage **26**, a small perforated vacuum head **269** (Figure 17) is positioned transversely thereof and at a point beyond the place of transfer. This head is provided with a vertical tube **270** secured to a bracket member **271** and coupled to the vacuum manifold by means of a short tube **272** and a control valve **273**.

During the travel of the ampoules on the carriage **26**, it is important that they maintain the same spacing that was provided by the belt **17** in order to insure proper reengagement of the ampoules with the belt after the heating and cooling processes. This alignment is accomplished by a plurality of arcuate spacer members **297—298** arranged beneath and above the fingers **275** respectively. These spacers are best illustrated in Figures 22 and 23 and extend for a distance of approximately 180° about the front portion of the carriage **26** as viewed in Figures 2 and 21. By this arrangement of spacers, the ampoules are confined within predetermined arcuate paths and are maintained in their radial alignment from the time they leave the belt **17** at a point adjacent to the fluid extraction station **22** until they reengage the belt at a point adjacent to the filling station **31**.

As soon as the ampoules leave the belt **17**, they pass a series of gas flames provided by a plurality of radially arranged gas burners **296** coupled with a common gas manifold **300** (Figure 23). The gas manifold and radial burners are fixedly supported by a bracket **301** mounted on a radial bracket member **302** carried by the central carriage support **279** (Figure 22). Each gas burner is provided with a series of flame ports **51** positioned between successive guides **297**. The entire burner covers an arcuate distance of about one-third of the entire 180° travel of the ampoules on carriage **26**. Immediately above the path of travel of the ampoules during the heating and sterilizing process, is an exhaust hood **25** which carries off the heat and gases generated in this process and includes a downwardly depending safety shield **305** (Figure 1).

Support for the spacers **297** is attained by a series of three upright members **306** (Figures 1 and 21) secured at their lower ends to the section **10** of the apparatus and having radial arms **307** fastened to and supporting the spacers **297** in proper alignment. The spacers **298** are similarly supported.

After the ampoules **40** pass the heating means **296**, they pass beneath a second exhaust hood **28** which removes the heat radiated by the ampoules. The time of travel of the carriage **26** is preferably so regulated that it takes two to three minutes for the ampoules, after leaving the sterilizing station **24**, to reengage the belt **17**. This permits the ampoules to cool slowly and steadily to a temperature that is low enough to prevent any adverse effect upon the fluid to be inserted into the ampoules. Normally, this temperature is of the order of 100° F., although it is apparent that with proper arrangement of the various components, any desired temperature at this point can be attained.

In the discussion of the structure of the circular carriage **26**, it was pointed out that the radial fingers **275** preferably slope slightly downwards from the plane of the central part **274** (Figure 22). This produces a small gap between the fingers **275** and the belt **17**, and in order to insure positive reengagement of the ampoules with the belt **17**, it is desirable to bring the fingers into closer proximity therewith in the region of such reengagement. This end is attained through the use of a short cam positioned beneath the carriage **26** and arranged to cooperate with the ends of the fingers **275** to lift them successively as they pass beneath the belt.

This structure is shown in Figure 24 and comprises a cam member **309** carried by one of the upright members **306**. This cam is positioned beenath the belt **17** and slightly forward thereof, and contacts the tips of the fingers **275**. In Figure 24, the fingers **275** travel from left to right and the left-hand edge of the cam **309** is therefore formed with a gently tapered leading portion **312** which successively engages the fingers and raises they to a level coinciding with the underside of the belt **17**. The right hand edge **313** of the cam **309** terminates at a point in front of the belt **17** so that it will not interfere with the endwise movement of the ampoules from the slots **276** as the belt **17** is displaced to carry the ampoules from such slots to the filling station. To the right of the cam **309** is a small wheel or roller **314** mounted with its uuppermost point in line with the upper surface of the cam **309**. This wheel engages the ends of the fingers **275** and maintains them in the raised position until they move beyond the belt **17**. In this way adjoining fingers are held in the raised position while the ampoules are removed from the intervening slot. The wheel or roller then functions to control the return of each finger to the lowered position and avoids a snap action that would otherwise result.

The transfer of the ampoules from the belt **17** to the carriage **26** overcomes a serious difficulty heretofore encountered in endeavoring to effect heat sterilization without removing the articles from the conveyor belt. An elongated conveyor belt of the type shown in this application would expereince substantial elongation and contraction of successive sections, if it were passed through an oven at a temperature in the range of 900° F. This action would make it difficult to control the alignment of the ampoules with the cleaning, rinsing and filling stations and would also result in considerable weakening of the belt itself. In addition, a considerably longer belt would have to be employed in order to provide adequate time for the sterilizing and cooling operations and this would further aggravate these undesirable conditions. Through the employment of the rotary carriage **26**, these difficulties are avoided and the ampoules can be carried throught he apparatus by a device that is not subjected to any material temperature changes. Moreover, a large group of ampoules can be sterilized substantially simultaneously, and in addition time is provided for necessary cooling before their return to the principal conveyor belt. Thus the conveyor belt is not only protected against sharp temperature changes but the entire equipment can be made very much smaller without in any way affecting the speed at which the ampoules can be processed.

The individual exposure of the ampoules to the direct action of a gas flame has the added advantage that they can be raised with great rapidity to a temperature of the order of 900°, and maintained at that temperature, whereby complete drying and sterilization can be achieved in a period of 80 seconds, whereas equivalent sterilization heretofore performed by indirectly heated ovens has involved temperatures of only 350° and a duration up to three and a half hours.

In the illustrated embodiment the heating station occupies about 50–60° of rotation of the carriage **26**, but it is apparent that this may be shortened or lengthened depending upon particular requirements. In addition, forced cooling can be provided, if desired, to reduce the temperature of the ampoules to any selected value, prior to their return to the main conveyor belt.

Filling and gas flushing stations

Upon the return of the sterilized ampoules to the belt **17**, as previously described, they are carried to the filling and gas flushing stations **31** and **32** which are preferably enclosed in a substantially air-tight housing or cover **33** as shown in Figure 2. This housing is preferably filled with an inert gas used for flushing the ampoules immediately after they are filled, and thus prevents the entrance of contaminated air into and about the ampoules during these operations. In order further to insure protection of the sterilized ampoules from decontamination, a cover **316** (Figure 2) encloses the tops of the ampoules **40** after they leave the carriage **26** and this cover communicates with the inside of the housing **33** so that the decontaminated inert gas can flow outwardly through the cover **316** and thus protect the sterilized ampoules. The filling and gas flushing stations **31** and **32** are illustrated in Figures 26 through 35 inclusive.

These stations are identical in structure and therefore only the filling station 31 will be described in detail.

The primary support for these stations and their operating mechanisms comprises a pair of vertical tubular pillars 317 (Figure 26) secured in fixed relation upon the framework of the apparatus. These upright members 317 carry a connecting element 319 (Figures 27, 28, 34, 35) which has an elongated member of L-shape section 320 for engaging and supporting the back portion of the belt 17. The front support for the belt 17 comprises an elongated member 321 of either unitary or composite construction, having a recessed part 322 (Figures 34, 35) in which the belt 17 rides. The member 321 is supported by several U-shaped bracket members 323 (Figure 27) which bridge the belt 17 and are supported on the element 319. The conveyor guides 320 and 321 are similar to those designated 175 and 176 in Figures 12 and 13.

The filling operation is performed by a plurality of parallel vertical hollow tubes or needles mounted in a bank upon a carrier that moves them up and down in timed relation to the intermittent conveyor advancement. The needles are spaced apart by amounts corresponding to the spacing of the ampoules as each batch is brought to rest at the filling station. Accuracy of alignment between the filling needles and the ampoules into which they are to enter and then withdraw is highly important at this station and is therefore enhanced by a special mechanism that lifts the ampoules from the conveyor belt at the time of filling and pin-points them along a precision positioning gauge.

The filling nozzles 52 at the filling station are adapted to be inserted through the necks of the ampoules 40 so that the fluid is discharged well within the cylindrical body portion thereof. At the gas flushing station, however, the nozzles 52 may have to be limited in their travel so that they do not contact the liquid that has already been deposited in the ampoules.

Each nozzle 52 is carried on the end of an enlarged hollow body part 325 (Figures 27, 28) fixedly mounted within a longitudinal block 326 secured at its ends to a pair of collars 328. Each collar is mounted on the upper part of a vertical operating shaft 330 slidably mounted within one of the tubular columns 317. The shafts 330 extend downwardly into adjacence with cams 332 mounted on the main drive shaft 50 and cooperating with cam followers 334 carried at the lower ends of the shafts 330 by means of collars 336. Rotation of the shaft 50 and of the cams 332 functions to move the filling and flushing nozzles 52 into and out of engagement with the ampoules in synchronism with the operation of the belt 17.

In filling the ampoules with a fluid, it is important to prevent deposition of any material on the necks of the ampoules either during the filling operation or during retraction of the nozzles, because the ampoules are subsequently sealed at their narrow neck portions by melting the glass, and any deposition of material on the inside of the neck interferes with the effectiveness of the sealing and may produce charring that would be of a contaminating character. To prevent this, an automatic means is provided for insuring precision alignment of the ampoules with the nozzles 52 just prior to the time when the nozzles are lowered into the ampoules.

Referring to Figures 32, 34 and 35 it will be observed that a plurality of clamps 53 operate to engage the necks of the ampoules and to lift them from engagement with their respective notches 44 in the belt 17. More specifically, each of the fingers 53 is provided with an elongated lower flat section 339 and an offset notched end part 340. These arms are mounted on a transverse bar 341 by means of screws 342 and cooperating springs 343. In addition the bar 341 is provided with a plurality of recesses for receiving the lower ends of the sections 339 thus maintaining them at all times in proper spaced relation. The outer notched end of each offset section 340 is adapted to engage the neck 42 of the ampule. The block 341 is mounted for arcuate movement between the full-line positions of Figures 34 and 35, by means of trunnions 345 journaled in an elongated frame member 349.

The arms or fingers 53 cooperate with an opposed precision aligning member 338 (Figures 34, 35) carried by the belt supporting member 320. The member 338 extends forwardly slightly beyond the base line of belt slots 44 and is provided with a series of V-shaped grooves 352 in exact alignment with the nozzles 52.

In the operation of this aligning means the block 341 is rocked by means of a lever 353 fixedly attached to one of the trunnions 345 (Figures 32, 33). This rocking or rotation is in a clockwise direction as viewed in Figure 34 and functions to move the ends of the fingers 53 toward engagement with the cooperating aligning member 338. This engagement is indicated in dotted lines in Figure 34 and occurs when there is no ampoule intervening. However, when an ampoule 40 is positioned between the end of a finger 53 and the corresponding groove in the aligning member 338 (as shown in Figure 35) the arm 53 moves inwardly until it contacts the neck of the ampoule 40 (dotted position of Figure 35). It moves the neck of the ampoule firmly into engagement with the aligned groove 352 in the member 338 and upon continued movement of the block 341 it moves upwardly into the full line position of Figure 35. This slides the ampoule 40 bodily out of engagement with the belt notch 44 in which it was resting and into a precise alignment with the nozzle 52 which is presently to descend into it.

The rocking of the block 341 and its complement of fingers 53 can be accomplished by the reciprocating action of the vertical shafts 330. In the construction illustrated, the outer end of the lever 353 (Figure 27) is provided with a weight 354 that tends to hold the lever in the horizontal position shown. Extending upwardly from the outer end of the lever 353 is a spring 355 having a chain 356 attached thereto and extending over a rotatably mounted sprocket 357 carried by an upwardly extending arm 358. The other end of the chain is fastened at 359 to the collar 328. As the rods 330 move downwardly, the chain 356 is moved over the sprocket 357 and functions through the spring 355 to lift the lever 353. This results is positively and accurately positioning each ampoule as the filling nozzle enters into it, so that there is no contact whatsoever between the nozzle and the ampoule wall. When the rods 330 rise to withdraw the nozzles, the fingers 53 release the ampoules which then fall back gently into suspended relation to the conveyor 17.

The rotation of the lever 353 is limited by the action of the fingers 53 against the necks 42 of the ampoules 40, and the finger springs 343 as well as the main spring 355 are so constructed that at no time can sufficient pressure be exerted on the ampoules to damage them.

The pumping mechanisms at stations 31 and 32 are substantially identical, with one pump functioning to insert a predetermined quantity of fluid into each ampoule, while the other pump is used for the injection of an inert gas. For simplicity, these two pumps can be made identical although it is quite apparent that other types of pumps would be equally effective for the gas flushing operation.

Each pump comprises a plurality of separate and distinct pumping mechanisms coordinated and arranged with means for controlling the action so that the amount of fluid inserted into each ampoule can be carefully and accurately predetermined and adjusted. The details of the pumping mechanism are best shown in Figures 27–31. It comprises an upper stationary part 360 and a lower part 361 movable up and down. The stationary part is connected at 369 (Figures 27, 28) to the supply of the fluid with which the ampoules are to be filled, and carries the bank of outlets 381 leading to the filling nozzles 52 respectively. Within the part 360 there are valves whose operation controls the drawing of fluid from the supply and the discharge of this fluid to the outlets **381**. The operation of the valves is brought about by the up and down movement of plungers **362**, carried by the movable part **361**, within cylinders **384** carried by the part **360**.

The fixed part **360** of the pump, and the manner in which the plungers and valves operate, is best seen in Figures 29–31. The part **360** is advantageously of composite construction, having a top section **363**, a central section **364** and a lower section **365**. The lower section **365** is provided with an elongated header chamber **366** which communicates via a passage **367** with the tubular hose connector **368** to which the hose **369** is connected. The central section **364** has a set of cup-like valve chambers **370** formed on its underside and communicating with the header chamber **366** by individual passageways **371**. Each chamber **370** is adapted to hold a valve member **372** of resilient material (such as rubber, plastics, or the like) and has a downwardly extending boss **373** which touches the top side of the valve member **372**. In operation, the valve member **372** deflects upwardly about its periphery (Figure 30) when fluid is drawn upwards from chamber **366**, and is normally forced downwards into closed position (Figures 29, 31)when pressure is applied to the space above it.

In order to effect an air-tight seal between the sections **364** and **365**, the section **365** is provided with a circular groove or depression surrounding each of the passages **371** and a gasket O ring **374** is positioned within this circular recess. The section **465** is secured to the section **364** by studs **376** extending through the section **365** into cooperating threaded openings in the section **364**.

The upper section **363** of the pump part **360** is provided with a similar set of valve cavities **377**. Each cavity is connected with a corresponding chamber **370** by an individual passage **378**. The cavity **377** is provided with its own valve member **324**, identical with the valve member **372**, and has a boss **379** bearing against it. A tube **380** extends upward from each chamber **377** and is coupled with one of the discharge hoses **381**. In operation the valve member **324** remains normally closed (Figures 29 and 30) or when suction is applied to the space beneath it; and it deflects upwardly around the boss **379** (Figure 31) when pressure beneath it forces fluid upwardly into and through the cavity **377**.

The sections **363** and **364** are sealed by circular gaskets or O rings **382** surrounding the cavities **377**, and are held together by bolts **383** which extend through the upper section and are threadably engaged with the central section.

The upper section is also provided with a series of seals **390** surrounding a set of downwardly extending cylinders **384** within which the plungers **362** move up and down. Each of these cylinders is secured within the central section **364** and its upper end is connected by a passage **386** to the vertical passage **378**. A tight but slidable seal is provided between each plunger **362** and its cooperating cylinder **384** by means of an annular sealing member **387** set within a plunger groove **385**.

The entire set of cylinders **384** is supported within a block **388** carried on upright supports **389** secured at their lower ends to the framework of the apparatus.

The plungers **362** are all supported on and simultaneously reciprocated by means of the movable pump part **361** to which they are secured at their lower ends. The part **361** is in turn supported by a pair of vertical shafts **393** which extend downwardly through tubular supporting pillars **395** having a common base **396** fastened to the framework of the apparatus. The upper ends of the rods or shafts **393** are fixedly secured to the plunger operating part **361** and are connected at the bottom by a cross arm **394**.

Vertical motion of the shafts **393** is effected by a cam **397** mounted on the common drive shaft **50** (Figure 28).

This cam cooperates with a cam follower **398** mounted on an arm **399** which has its other end secured to a sleeve **400** mounted for rocking movement on a shaft **401**. Extending outwardly from the ends of the sleeve **400** are a pair of arms **402** which carry rollers **404** positioned to contact the bottom ends of the shafts **393** (Figure 26). The rods **393** are urged downwardly by means of a spring **406** connected at **407** to the cross arm **394** and at its other end to a fixed part of the frame.

In operation, as the cam **397** is rotated, it and the spring **406** function to move the lever **399** together with the arms **402** upwardly and downwardly. As the arms **402** move upward, they act on the lower ends of the shafts **393** to move them and the pistons **362** in an upward direction. This action forces fluid into the ampoules. As the arms **402** move downwardly, the pistons **362** will follow under the action of the spring **406** and in so doing will draw in liquid through the inlet **369** and prepare for the next filling cycle.

Figures 30 and 31 illustrate this action. In Figure 30 the plunger has started on its downward travel. By reason of prior pumping operations, the chamber **366**, connecting passage **371**, chamber **370**, upper connecting passage **378**, transverse passage **386** and the upper end of the cylinder **384** have been filled with fluid. As the plunger moves downwardly, it draws liquid from the chamber **366** upwardly through the valve **372**, the passages **378** and **386** to keep the space above the plunger **362** completely filled. After the plunger has moved to its lowermost position (as determined by the adjustment of the micrometer **408** hereinafter to be described), it moves upward again as shown in Figure 31. The valve **372** is now closed and fluid is forced from the chamber above the plunger through the passages **386** and **378**. This opens the valve **324** and discharges fluid through the outlet conduit **380** and tube **381** to the associated nozzle **52**.

The displacement of the pistons **362** controls the amount of fluid that is deposited in each ampoule and is accurately adjustable by a micrometer assembly **408** positioned between the upright pillars **395** (Figure 26).

The micrometer assembly consists essentially of a vertically adjustable stop positioned to be encountered by the pump part **361** on its downward travel. This limits the downward movement of the plungers to an accurately controllable degree, thus affording a similar accurate control of the charges of fluid drawn from the supply into the several pumping mechanisms and subsequently delivered to the ampoules.

The adjustable stop or abutment is in the form of a shaft **409** (Figures 26 and 28) that extends through a transverse plate **410** secured to the upper ends of the uprights **395**. The lower end of the rod **409** is threaded and extends down through the micrometer head. The latter has a base **411** and a calibrated dial **412**. The base **411** is secured to the frame member **396** while the calibrated dial **412** is rotatable and cooperates with the threaded portion of the shaft **409** to move it upwardly and downwardly. The top end of the micrometer shaft **409** is the stop that cooperates with the underside of the transverse pump operating member **361** to limit its downward motion. In the pumping assembly shown at the right in Figure 26, the transverse part **361** is in a stopped position in contact with the top end of the shaft **409**. Since the operating shafts **393** are connected with the member **361** their downward motion is also limited. As a result, the cam wheels **404** have moved downwardly out of actual contact with the lower ends of the shafts **393**. Increased capacity of the several pumps is obviously attained by retraction of the shaft **409** to permit the pump operating member **361** to augment its downward travel, while smaller capacities are obtained by limiting the downward motion of part **361** by raising the shaft **409**. The divisions on the dial **412** of the micrometer **408** are preferably accurately calibrated in terms of fluid volume so that the amount of fluid pumped by each of the several pistons **362** can be precisely adjusted.

In order to discontinue the action of any pumping assembly, in case such discontinuance becomes necessary or desirable, an arm **413** is pivoted at **414** to the central part of the transverse pump operating member **361** and is arranged to be moved from the horizontal position shown at the right of Figure 26 to the vertical position shown at the left. When this arm is in its vertical position, the pump member **361** to which it is pivoted is held in its uppermost position with the lower ends of the shafts **393** completely out of reach of the cam followers **404** throughout their entire travel.

By means of the pump described, extremely high degrees of accuracy in pumping predetermined quantities of fluid can be readily attained. Moreover, the valve mechanisms **372** and **324** function to provide unusually effective yet simple seals against reverse flow of the fluid and have been found to perform well with a wide variety of materials and for extended periods of operation. Cleaning of the pump mechanism and replacement of the valves and seals can be readily and easily effected by removal of the screws **376** and **383** to separate the three sections. This procedure can be accomplished in relatively short periods of time so that operation will not be materially interrupted. If desired, the entire pump can be readily removed and a new pump quickly and easily installed. This is often desirable when a change is to be made in the type of material to be placed into the ampoules.

Because of the effectiveness of the pumping mechanism, it may also be used satisfactorily with an inert gas that can be used to flush the filled ampoules as described above. The pump at the left of Figure 26 is intended for this purpose and may be substantially the same in every respect as the pump hereinbefore described.

Ampoule transfer to sealing station

After the ampoules have been filled with fluid or other material, they are advanced by means of the conveyor belt **17** and a special cooperating transfer mechanism to the sealing station **34**. This station is forwardly offset from the line of travel of the conveyor **17** (Figure 2). In their passage through the sealing station the ampoules are supported on the periphery of a rotary carrier. The movement of this carrier is continuous and not intermittent. To transfer the filled ampoule batches from the intermittently advancing conveyor **17** to this continuously moving rotary carrier, a transfer mechanism of the character shown in Figures 37, 41, and 42 is employed.

A guideway **415** comprises a pair of parallel plates **416** and **417** spaced one from the other and extending from the belt **17** to a point slightly underlying the periphery of the rotary ampoule supporting carrier **418**. The plate **416** may be supported at the end nearest the belt **17** by attachment to the front belt supporting member **321**, and the other end of this guide may be supported on any appropriate frame part or bracket by means of a screw **420** or the like (Figure 37). Directly beneath the guides **416** and **417** are cooperating guide plates **421** (Figure 41) supported in a similar manner and adapted to guide the bottom sections of the ampoules. A continuously driven chain **423** frictionally engages the ampoules and carries them from the belt **17** to the notches **424** in the rotary member **418**. This belt is designed to partially engage the edge of the guide strip **417** and is carried by a friction disc or wheel **425** and a sprocket **426** (Figure 37). The friction disc **425** does the driving and is supported just above the member **418** by means of a rotatable shaft **427** (Figure 38) journaled in a vertical supporting member **428** and having a driving gear **429** at its lower end. The sprocket **426** supports the other end of the chain loop and is rotatably mounted on the end of the framework member **319** (Figure 36).

In order to effect a smooth transfer of the ampoules **40** from the belt **17** to the transfer mechanism **415**, the leading edges of the slots **44** of the belt **17** are tapered as shown at **430** (Figure 42) so that as each successive ampoule encounters the chain **423** it will be moved out of its slot **44** and along the guideway **415** in the direction of the arrow **431**. The speed of the chain (which moves the ampoules by means of slight frictional engagement) substantially exceeds the speed of movement of the belt **17** during each advance of the latter so that each successive ampoule is removed from the belt before any injurious squeezing of the ampoule between belt **17** and chain **423** could occur.

The sprockets **425** and **426** as well as the return travel of the chain **423** are preferably enclosed by a safety guard **432**. Tension can be maintained on the chain by means of a lever **433** pivoted to the frame **434** and carrying on its outer and an idler sprocket **435** urged outwardly against the chain **423** by means of spring **436** secured at one end to the lever **433** and at the other end to the frame part **319**.

The ampoules are protected against possible contamination during their travel from the gas filling station **32** to the sealing station **34** by a hood or cover **437** which encloses the upper ends of the ampoules from the time they leave the hood **33** (enclosing the filling stations **31** and **32**) until they are actually sealed. The cover **437** extends from the hood **33** to the point of intersection of the belt **17** and transfer mechanism **415** (Figure 37), then along the mechanism **415**, and then it is curved as shown at **422** to enclose the ampoules during the initial part of their travel about the periphery of the sealing wheel or carrier **418**. It is supported by a pair of hinges **438** secured to the safety guard **432** (Figure 41).

The transfer mechanism performs the important function of safely transferring the ampoules from the intermittently operated conveyor belt to the continuously rotating sealing wheel by means of a frictional means that avoids positive engagement of the ampoules and yet is able to remove them at adequate speed from the conveyor belt. Since positive engagement is avoided, the ampoules are enabled to stack up in close proximity at the sealing end of the chain (Figure 42) and to be fed from there uniformly and in succession to the wheel **418**.

Ampoule sealing

The ampoules remain on the periphery of the rotary carrier through approximately 270° of travel, and during this time each ampoule is rotated on its own axis. The rotary carrier advances the individually rotating ampoules past a sealing flame **54** which acts upon the narrow neck **42** of each ampoule. Concurrently with the resultant softening of the glass the lower and upper parts of the ampoule are drawn apart in the direction of the ampoule axis. This results in providing a seal **57** on the tip of the filled part of the ampoule and in severing from it the upper part **43** which is now no longer needed and can be discarded.

The rotating carriage mechanism includes the ampoule carrying wheel **418** having the plurality of ampoule holding notches **424** in its periphery. In connection with these notches it has been found that metallic slots present a number of difficulties, including susceptibility to mechanical shock, undesirable temperature stresses during heating, and inability of the slots adequately to retard rotation of the upper parts of the ampoules during the sealing operation. These problems can be effectively solved by the use of inserts **509** (Figures 42, 43) of tetrafluoro-ethylene or equivalent material. These inserts can be secured in suitable recesses by rivets **510**; they are shaped to cover the major part of the trailing edge **512** of each slot **424** and the entire leading edge **511**. In this way as each ampoule is picked up by the trailing edge of one of the slots, mechanical shock is avoided. Then during the heating and sealing process, the inserts effectively insulate the ampoules and at the same time adequately retard rotation of the ampoule parts 43.

The rotating carriage mechanism as a whole is shown in cross-section in Figure 38, and includes an upper disc 440 spaced above the notched wheel 418 and of slightly smaller diameter. This upper disc functions to assist in the retention of the upper portions 43 of the ampoules in the notches 424 after completion of the sealing and until they are discharged. The members 418 and 440 are carried on the upper end of a central drive shaft 444 extending vertically through a journal 442 secured to the frame part 439. The shaft 444 is an extension of and coupled to a drive shaft 441 extending upwardly from a speed reducing mechanism 443 (Figure 36). The structure for attaching the rotary members 418 and 440 to the shaft 444 has been illustratively shown as including a pair of collars 445 and 447, the collar 445 being beneath the part 418 and the collar 447 being interposed between the wheels 418 and 440. The collars and the wheels, together with the cover plate 448, are fixedly secured to one another by any suitable fastening means and the entire assembly is attached to the shaft 444 by means of a set screw 449.

Directly beneath the collar 445 is a stationary member 446 and a stationary circular plate 450, these parts being concentric with the shaft 444 but not rotatable with it. Beneath the plate 450 is a member 451 which carries a plurality of upstanding vertical rollers 55 along its periphery. The member 451 is provided with a hub 453 fixed to the shaft 444 by means of a set screw 454. The rollers 55 are mounted side by side and spaced one from the other, the positioning of these rollers being coördinated with the slots 424 on the wheel 418 so that each ampoule as it depends from its slot 424 will engage the periphery of two successive rollers 55 as shown in Figure 46.

Each of the rollers 55 is supported on the upper surface of the member 451 by a shaft 456 extending downwardly through the member 451 and provided on its lower end with a gear 457. The gears 457 are planetary with respect to a central gear member 458 concentric with but not directly connected to the shaft 444. Beneath the gear 458 is a smaller gear 459 preferably formed integrally therewith and adapted to engage an offset gear 460. The gear 458 is supported in the plane of the gears 457 by a thrust bearing 461.

The gear 460 is mounted on a jack-shaft 462 supported by a journal 463 attached to the underside of the frame part 439. The bottom end of this shaft carries a gear 464 which meshes with the gear 465 secured to and driven by the main shaft 444.

As the shaft 444 is rotated in a clockwise direction, as viewed in Figure 37, the ampoule carrying members 418, 440 and 451 will likewise rotate in a clockwise direction. The central gear 458 will also rotate in this direction but since it is driven through the gear train 465, 464, 460 and 459 it will rotate more rapidly than the shaft 444. This increased speed will cause individual rotation in a counter-clockwise direction of the gears 457 and their respective rollers 55, as shown by the arrows on these rollers in Figure 46.

The motive power for the operation of the parts at the sealing station is derived from an electric motor 467 (Figure 36) which carries an adjustable "Reeves" type pulley 472 coupled by a belt 475 to a pulley 473 of enlarged diameter carried by a shaft 474 suitably journaled in the frame of the apparatus. The motor is on a base 468 secured to a bracket 469 which hangs from the pivot 195. The lower end of the bracket 469 is attached to a rod 470 extending outwardly through the front of section 13 and provided with a knob 471 threadably engaged therewith. With this arrangement rotation of the knob can be caused to vary the speed of the driven pulley 473. For example, if the knob 471 is rotated in a clockwise direction as viewed from the front, it will increase the tension on the belt 475 and this will cause the flanges of the "Reeves" pulley to separate and the belt 475 to ride inwardly of the pulley 472 and thereby reduce the speed of rotation of the driven pulley 473.

The pulley 473 in turn drives a relatively small pulley 476 also carried by the shaft 474. This pulley is coupled to another pulley 477 carried by a shaft 478 which extends to the gear train within the speed reducing housing 443. As hereinbefore described, the shaft 441 is the driven shaft emanating from the mechanism 443 and is coupled to the main drive shaft 444.

Also mounted on the shaft 478 is a pulley 479 which is coupled by a belt 480 (Figures 36 and 38) to an upper pulley 481. This pulley is on a shaft 482 journaled in a suitable manner to the frame and carrying a pulley 483. Pulley 483 is coupled by a belt 484 to a pulley 485 mounted on the lower end of a vertical shaft 486. This shaft carries a gear 487 (Figure 39) that meshes with the gear 429 to operate the transfer mechanism 415 previously described.

On the upper end of the shaft 486 is a pulley 488 (Figure 39) that functions with the belt 491 to drive a pulley 489 carried by a vertical shaft 490. Tension is maintained on belt 491 by an idler pulley 492 carried on a shaft 493 that is spring loaded so as to constantly urge the pulley 492 against the belt. The shaft 490 extends upwardly and carries on its upper end a pulley 494 (Figure 37) substantially on the level of the upper edge of the rollers 55. This pulley drives a belt 56 which rides about the outside of the rollers 55 to engage the ampoules 40 as shown in Figures 3, 37, 44 and 45. This belt extends around the periphery of the sealing drum for about 90° and is supported at its far end by an idler pulley 496 (Figures 36, 37). The outer or return side of the belt 56 passes over a pulley 497 carried on the end of arm 498 of the bellcrank 499. This bellcrank is pivoted on shaft 490 and its other arm 500 is coupled to a suitable frame member by means of a spring 501 which urges the pulley 497 outwardly against the belt 56 to maintain it in tension.

The idler pulley 496 is at a lower level than the pulley 494 so that the travel of the belt 56 which skirts the periphery of the plurality of rollers 55 proceeds in a downward direction as shown in the development of Figure 44. Immediately above the pulley 496 and on the same shaft 503 is a second pulley 502. A coiled-spring belt 504 engages the pulley 502 at one end and an idler pulley 505 spaced about 90° further along the periphery of the sealing drum at the other end. The pulley 505 is mounted at a lower level than the pulley 502 as may be observed in Figures 36 and 44 so that both the belt 56 and the spring belt 504 function to exert a continuing axial downward force on the ampoules.

Sealing of the ampoules is effected by melting the narrow necklike part 42 of each ampoule. This is accomplished by a plurality of gas flames 54 produced by an arcuate burner 506 (Figure 37) positioned beneath the wheel 418 and extending arcuately from a point in line with the shaft 490 for a distance of about 30°. This burner is supported by means of an inwardly extending bracket 507 suitably attached to the stationary member 446. Fuel in an appropriate form, such as a mixture of gas and oxygen is fed to the burner 506 by means of a suitable hose 508 coupled with the burner.

In the operation of the sealing means, the ampoules 40 in the slots 424 of the wheel 418 have their lower parts in engagement with the rollers 55 and with the inner surface of the belt 56. In addition the upper part of each ampoule rides between the outer surface of the upper wheel 440 and a surrounding rodlike guide 513 (Figure 38) which helps to retain the ampoule within the slot 424. The belt loop 56 rotates in a counter-clockwise direction as viewed in Figure 37 and functions with the rollers 55 to rotate each ampoule on its own axis in a clockwise direction as shown in Figure 46.

It will be observed in Figure 44 that the first several ampoules at the right of this figure are supported with their lower parts **41** appreciably above the top surface of the rotatable member **451**. As the ampoules travel past and are heated by the burner **506**, the neck parts **42** of the ampoules begin to melt. At the same time, as the belt **56** rotates the ampoules, it also tends to pull them downwardly. As the glass is heated to the melting point (as illustrated by the ninth ampoule from the right in Figure 44) the upper portion, by reason of the friction of the slot **424**, ceases to rotate while the base of the ampoule continues rotating as previously described. This effectively breaks the upper part away from the lower part of the ampoule and permits the flame to form a beadlike seal over the top of the ampoule. By this time, or shortly thereafter, the belt **56** and the cooperating belt **504** have brought the sealed ampoules firmly against the base **451**, while the severed neck parts are still held in position in the slots **424** immediately above the ampoules from which they were separated. During the remaining travel, the ampoules are permitted to cool and when they reach a point spaced about 90° from the original loading position, they are discharged via a chute **35** (Figure 37) positioned immediately beneath a discharge scraper **515**. As the ampoules arrive at the discharge point the scraper deflects them and causes them to fall into the chute **35** which carries them to a suitable container for subsequent packing. The discarded upper parts of the ampoules are dislodged from the slots **424** in a similar way by a scraper **517** pivoted to a supporting arm **518**. This scraper rides against the periphery of the upper disc **440** and the discharged neck parts are carried to a collecting container by a chute **36**.

It is to be observed that this mechanism constitutes an automatic device which functions continuously and reliably to form a beadlike seal on the end of each ampoule that passes, avoiding any need for separate mechanical severing apparatus to part the filled ampoule from the upper part of the original ampoule blank. Moreover, the seal is effected rapidly and precisely while the ampoule is still in the gas atmosphere as provided by the hood part **422** which prevents ambient air from contacting the filled ampoules.

Conclusion

The entire apparatus is readily adaptable to operation in a sealed room (if desired), having a pressurized decontaminated atmosphere; and it may be operated with or without the immediate presence of an operator.

While the embodiment of the invention herein illustrated and described is particularly intended for the processing of glass ampoules, it is apparent that the structure as a whole, and many of its parts either separately or in combination, will be useful for processing and sealing other types of containers, and that numerous modifications, alterations and changes may be made in the described apparatus by those skilled in the art without necessarily departing from the true scope and spirit of the invention.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. In a process of sealing glass ampoules, the steps which consist in advancing each ampoule past a sealing flame directed against its midportion, drawing the lower part of the ampoule downwardly away from the upper part while the glass is soft, rotating the ampoule on its axis during its subjection to said flame, and continuing the rotation of the lower part of the ampoule during its downward movement away from the upper part.

2. In a process of treating ampoules, the steps which consist in feeding ampoules batch by batch to a conveyor on which they are arranged in linear succession, moving said conveyor intermittently to transport said batches in the direction of ampoule alignment to a succession of treatment stations, at least one of said stations being a washing station and another a filling station, washing the ampoules at said washing station and filling them at said filling station, and in the region between said washing and filling stations removing each successive batch of ampoules from said conveyor, moving it to a sterilizing station, sterilizing the ampoules at said station, and re-transferring the sterilized batch to said linear conveyor.

3. In a process of treating ampoules, the steps which consist in suspending the ampoules open end up on a horizontally movable conveyor, advancing said ampoules to a succession of treatment stations, subjecting each ampoule at a group of successive stations to a washing and rinsing procedure in which at least one forceful stream of liquid is introduced into the lower part of the ampoule and withdrawn by suction out of the open upper end, and subjecting the ampoule at at least one subsequent treatment station to an evacuation by suction of liquid remaining in the interior of the ampoule and to a removal of adhering liquid from its exterior surface.

4. In a process of treating ampoules having narrow necks, the steps which consist in suspending the ampoules open end up on a horizontally movable conveyor, advancing said ampoules to a filling station, and at said station temporarily engaging the neck of each ampoule at its narrowest part to lift the ampoule from suspended relation to the conveyor and to brace said engaged neck against movement in an accurately predetermined filling position, then filling said ampoule.

5. In a process of treating ampoules having narrow necks, the steps which consist in suspending the ampoules open end up on a horizontally movable conveyor, advancing said ampoules to a filling station, temporarily engaging the narrowest part of the neck of each ampoule at said station to lift the ampoule from suspended relation to the conveyor and to brace said engaged neck in a substantially immovable accurately predetermined filling position, filling said braced ampoule by an instrument introduced downwardly into the ampoule and subsequently withdrawn and all without contact therewith, and thereafter restoring the filled ampoule to its suspended state on said conveyor and transporting it beyond said filling station.

6. In an ampoule treating apparatus, an elongated conveyor belt, a pair of spaced sprockets mounted for rotation on horizontal axes and supporting said conveyor belt as a closed loop having upper and lower substantially horizontal spans, means on said conveyor for removably engaging ampoules in linear alignment and holding them in suspended relation thereon, means for advancing the upper span of said conveyor intermittently, mechanism at the trailing end of said upper span for feeding ampoules thereto, batch by batch, mechanism at the leading end of said upper span for withdrawing ampoules therefrom, a series of treatment stations arranged along the path of travel of said upper span, and mechanism at each station for operating upon each batch of ampoules as it comes to rest at said station.

7. The combination with the apparatus defined in claim 6, of a sterilizing station positioned laterally with respect to said conveyor belt, and an auxiliary conveyor in operative proximity to the upper span of said conveyor belt for withdrawing said ampoule batches in succession from said belt, conveying them to and past said sterilizing station, and re-transferring them to said belt, said auxiliary conveyor comprising a wheel-like carrier mounted for intermittent rotation on a vertical axis substantially coinciding with the plane of said conveyor belt loop.

8. The combination with the apparatus defined in claim 6, of a sealing station positioned laterally with respect to said conveyor belt, a continuously rotating carrier at said sealing station, and an ampoule transferring mechanism interposed between the leading end of said upper span of the conveyor belt and said rotating carrier, said transferring mechanism comprising a guide track for supporting ampoules in single-file suspension

thereon, and an advancing means engaging and dislodging successive ampoules on said conveyor belt and shifting them onto and along said guide track.

9. Cleaning apparatus for ampoules comprising a nozzle for forcibly discharging a cleaning fluid within the ampoule, suction means adapted to be coupled with the mouth of said ampoule for simultaneously withdrawing fluid therefrom, a suction nozzle movable into said ampoule into contact with the bottom thereof for withdrawing fluid remaining therein, and means including a pad and associated suction means for drying the outside of said ampoule.

10. Drying apparatus for ampoules suspended in an upright position on a movable belt, comprising a reciprocating head movable up and down in a path parallel to the axis of the ampoules, a suction nozzle carried by said head with its axis aligned with the path of movement of said head, means for moving an ampoule into alignment with said nozzle and moving said nozzle downwardly into said ampoule, a fluid absorbent pad including suction means associated therewith disposed beneath said nozzle, and means for moving said pad in a path parallel to the axis of said nozzle, the last said moving means being coordinated with the movement of said head whereby said pad is moved upwardly to engage and move said ampoule axially toward said nozzle when the latter is within said ampoule to bring the end of the nozzle into engagement with the inside bottom of said ampoule.

11. In an ampoule processing apparatus having an elongated belt for transporting groups of ampoules to successive processing stations, a sterilizing station including heating means offset from said belt, and an ampoule conveyor coordinated with said belt and provided with a part adapted to align with said belt for removing successive groups of ampoules from said belt, transporting them to the sterilizing station, and then returning them to another position on said belt.

12. Apparatus for filling ampoules comprising a belt conveyor for the ampoules, means for injecting a predetermined quantity of liquid into each ampoule, means including a gas for flushing residual air from said ampoule, and a gas filled chamber alongside of and parallel to said conveyor and at least partially enclosing said flushed ampoules.

13. Apparatus for filling ampoules, comprising a belt conveyor for the ampoules, a filling station for injecting a predetermined quantity of liquid into each ampoule, a flushing station for injecting a gas into each filled ampoule to flush out residual air, and a gas filled inverted channel over said belt at a point following said flushing station for preventing the reentry of air into the flushed ampoules.

14. The combination with ampoule processing apparatus and a series of ampoules suspended from a belt with the open ends upward, of means for accurately aligning each ampoule with said processing apparatus comprising a fixedly positioned member having a notch therein on one side of the ampoule to be aligned, an arm having an ampoule engaging notch in one end thereof and mounted for movement through an arcuate path for engagement and disegagement of said ampoule, and a resilient coupling between said arm and mounting whereby said arm upon being moved into the ampoule engaging position is displaced upwardly relative to its mount to urge said ampoule against said member and displace it upwardly out of engagement with said belt.

15. Apparatus for sealing ampoules having a narrow neck-like part between its ends comprising means for suspending each ampoule to be sealed, ampoule rotating means for engaging the lower part of each ampoule, heating means, a drive for moving said suspending and rotating means in unison to carry each ampoule past the heating means to melt the neck-like part, and means for exerting a force upon the lower part of each ampoule tending to move it downwardly away from the upper part during said heating whereby the frictional engagement of said upper part with said suspending means will interrupt rotation thereof as the neck-like part is melted and produce relative rotation of said upper and lower ampoule parts to sever and seal the lower part.

16. Apparatus for sealing ampoules according to claim 15 wherein said suspending and ampoule rotating means are moved through an arcuate path and said rotating means comprises an inclined belt frictionally engaging the outer sides of said ampoules.

17. Apparatus for sealing ampoules according to claim 15 wherein said heating means includes a plurality of gas flames and said ampoules are moved uniformly through an arcuate path past said flames.

18. Apparatus for filling open-ended ampoules comprising a longitudinally transportable belt, means for leading said ampoules onto the belt for suspension therefrom and transportation therewith, a plurality of treating stations along said belt path for cleaning and sterilizing said ampoules in groups, a filling station along said belt path for inserting a predetermined quantity of liquid into each ampoule, and a sealing station including heating means for melting an annular section of each ampoule wall to hermetically seal the ampoule.

19. Apparatus for packaging liquids in open-ended ampoules each having holding means between its ends, comprising a belt having spaced notches in one side thereof for suspending said ampoules by said holding means, driving means for said belt, means for loading ampoules onto said belt, a plurality of treating stations along said belt path for cleaning and sterilizing said ampoules in groups of at least one, a filling station alongside said belt for inserting a predetermined quantity of liquid into each ampoule, and a sealing station including heating means for melting at least part of the ampoule wall to hermetically seal each of said sterilized and filled ampoules.

20. Apparatus for packaging liquids in open-ended glass ampoules, comprising a longitudinally moving belt having spaced notches along its length, a transverse guide for suspending and feeding one ampoule at a time into each of said notches for longitudinal transportation with its open end upward, individual washing and rinsing stations for successively washing and rinsing each ampoule including suction means at each station for withdrawing the washing and rinsing fluids, a suction station including a tube for insertion into and contact with the bottom of each ampoule to withdraw all residual rinsing fluid, a sterilizing station including heating means and a secondary conveyor, said secondary conveyor having a part adapted to move into and out of alignment with the belt for disengaging said ampoules successively from the longitudinal belt, transporting them past the heating means and returning them to engagement with said longitudinal belt, a filling station including filler tubes for depositing a predetermined quantity of liquid into each ampoule, a sealing station, and conveyor means for transporting said filled ampoules to the sealing station, said last station including heating means for melting an annular portion of each ampoule wall to successively hermetically seal each of said ampoules.

21. In ampoule treating apparatus, a conveyor belt provided with notches within which ampoules may be supported in freely suspended relation to the belt, an auxiliary conveyor comprising a rotary element mounted on a vertical axis of rotation substantially coincident with said belt, means for intermittently advancing said belt, means for intermittently rotating said rotary element, the movements of the latter occurring during the periods of rest of said belt, said rotary element including radial arms adapted to align successively with said belt and in direct proximity thereto, whereby each advance of the belt is adapted to bring a new batch of ampoules into alignment with an arm of the rotary element, and each advance of the rotary element is adapted to withdraw such a batch laterally from the belt and at the same time

restore a similar batch thereto at the adjacent advanced area of the belt.

22. In ampoule treating apparatus, the combination with the mechanism defined in claim 21, of sterilizing means arranged beneath the semi-circular path of travel of said ampoules during their engagement with said rotary element, said sterilizing means comprising heating means directly operable upon the freely suspended ampoule bodies.

References Cited in the file of this patent

UNITED STATES PATENTS

740,320	Seely	Sept. 29, 1903
955,551	Reinsberg	Apr. 19, 1910
1,179,602	Bernheim	Apr. 18, 1916
1,222,598	Bernheim	Apr. 17, 1917
1,880,257	Kiefer	Oct. 4, 1932
1,925,502	Schaeffer	Sept. 5, 1933
1,942,885	Tevander	Jan. 9, 1934
1,977,138	Newey	Oct. 16, 1934
2,064,378	Kantor	Dec. 15, 1936
2,072,344	Risser	Mar. 2, 1937
2,164,530	Larsen	July 4, 1939
2,172,509	Howard	Sept. 12, 1939
2,237,699	Fechheimer	Apr. 8, 1941
2,393,389	Lippold	Jan. 22, 1946
2,530,230	Cozzoli	Nov. 14, 1950
2,543,280	Everett	Feb. 27, 1951
2,561,404	Nordquist	July 24, 1951
2,579,855	Pockel	Dec. 25, 1951
2,585,863	Smith	Feb. 12, 1952
2,609,756	Wright et al.	Sept. 9, 1952
2,621,841	Simpson	Dec. 16, 1952
2,639,554	Zons	May 26, 1953
2,655,870	Yohpe	Oct. 20, 1953
2,679,918	Vargo et al.	June 1, 1954
2,683,521	Reynolds	July 13, 1954
2,689,677	Unger	Sept. 21, 1954
2,749,688	Cozzoli	June 12, 1956

FOREIGN PATENTS

45,439	France	May 20, 1935