This invention relates to an automatic ampul drying machine. More particularly, the present invention relates to a drying machine wherein ampuls such as those used for medicinal substances may be quickly and efficiently dried and sterilized simultaneously by automatic means.

Therapeutic substances for intravenous and intramuscular administration are conventionally made up in dosage form in ampuls of various sizes. Sterility of the container and contents is imperative. The ampuls are conventionally first washed and then dried and sterilized prior to filling and sealing. Due to the irregular shape and varying size of the ampuls, it is difficult to handle the containers, particularly with the rapidity required in commercial operations and for maintaining sterility.

It is an object of this invention to provide an ampul drying machine wherein ampuls may be expeditiously dried and sterilized in a continuous, automatic manner. It is also an object of this invention to construct an improved ampul carrier assembly for an ampul drying machine which is adjustable both for ampuls which vary in capacity and for ampuls which vary slightly from specifications.

It is a further object of this invention to construct an improved ampul carrier assembly for an ampul drying machine wherein a plurality of ampuls may be quickly and readily inserted and removed for a continuous operation.

It is also an object of this invention to provide an improved ampul handling or transfer device for handling a plurality of ampuls, particularly adapted for removing ampuls from the drying machine.

The continuous automatic ampul drying machine of this invention comprises an elongated framework which may be mounted on any support. At each side of the two ends of the frame, sprocket wheels are set in bearing posts. An endless roller chain extends along each side of the frame between two sprocket wheels. Attached to these roller chains at spaced intervals and extending transversely across the machine are a plurality of ampul carrier assemblies each adapted to transport a plurality of ampuls through the machine. A driving means, such as an electric motor mounted on a support below the frame, acts through a suitable indexing means such as a ratchet and pawl or Geneva mechanism and the sprocket wheels to advance the roller chains and the attached ampul carrier assemblies according to a pre-set timing arrangement. The sprocket wheels are rotated simultaneously through a part of a revolution by the driving means and in turn drive the roller chains so that the ampul carriers advance intermittently. The overall operation of the drying machine is, however, continuous.

Ampuls are inserted into a carrier assembly at the loading station of the machine preferably the end containing the driving mechanism, and are transported open end upward over a series of heating elements such as gas burners mounted on the framework adjacent to the loading station. The heat from the heating element vaporizes any residual water from the preceding washing operation and simultaneously sterilizes the ampul. As the ampuls are carried through the remaining length of the machine, they cool sufficiently for removal at the unloading station and for further handling.

Mounted on the frame is a hood which substantially completely encloses the area above the frame, except for openings providing access at either end for loading and unloading. The top of the hood is preferably pyramidal in shape so as to collect hot gases or vapors rising within and to funnel the gases and vapors into a draw-off device such as a chimney.

A particular feature of this invention resides in the ampul carrier assembly which transports the ampuls through the drying operation. The carrier assembly comprises a rigid support bar attached at each end to the roller chains. Suspended from the support bar by rigid support means such as one or more fixed straps is a fixed carrier bar of L-shaped cross section. Attached to the support means by hinge means are second rigid support means such as one or more straps bearing on the lower end a companion carrier bar, also of L-shaped cross section, and at the upper end a counterweight, preferably in the form of an elongated bar. The second support means are movable, pivoting about the hinge means. The two carrier bars form an adjustable horizontal slot into which a row of ampuls is inserted and suspended from the carrier bars by means of the contrivances in the necks of the ampuls.

A second feature of this invention resides in an improved ampul handling or transfer device useful in handling a plurality of ampuls and particularly adapted for rapidly and conveniently removing a plurality of ampuls from the drying machine, especially when fewer ampuls than full capacity are carried by the ampul carrier assembly. The ampul transfer device comprises an elongated bar having an L-shaped cross section and a hollowed base acepting the bodies of a plurality of ampuls. Partitioning means provide individual seats or pockets for the ampuls. The partitioning means comprises a series of vertical grooves and ridges along the back of the device, i.e., the vertical arm of the L. Ampuls seated in the pockets of the transfer device are maintained separate from each other. The L-shaped cross section and grooved back facilitate the sealing of the ampuls in the device.

The accompanying drawings illustrate the construction and various features of the invention in detail.

Figure 1 is a right side elevation of the assembled ampul drying machine partly cut away to show the heating means and other details.

Figure 2 is a front elevation of the ampul drying machine showing the loading end of the device and details of the drive mechanism.

Figure 3 is a detail of the ratchet and pawl mechanism with the cam drive.

Figure 4 is a cross section on the line 4-4 of Figure 1.

Figure 5 shows a front view of the ampul carrier assembly.

Figure 6 is an end view of the ampul carrier assembly.

Figure 7 is a view in perspective of the ampul transfer device.

Figure 8 is a cross section of the ampul transfer device.

Referring to Figure 1, the loading station is designated A and the unloading station is designated B for convenience. Preferably the loading station is located at that end of the machine at which the drive mechanism is mounted. Frame 1 of the ampul drying machine is supported on legs 2. Suspended from the lower portion of legs 2 is a motor support 21 on which is mounted a conventional electric motor 25.

At opposite sides of loading station A of the ampul
drying machine, drive sprockets 10 are rigidly attached by shaft 49 which rotates in bearing posts 9 attached to frame 1. Idler sprockets 12 are similarly mounted on opposite sides of unloading station B on a shaft (not shown) in bearing posts 13 also attached to frame 1. At each side of the machine an endless roller chain 11 extends between a drive sprocket wheel and an idler sprocket wheel. Both roller chains operate together by virtue of the attachment of sprockets 16 to shaft 49. At intervals along each side of frame 1 are vertical brackets 14 to which are attached, at approximately the mid-point along the height of the brackets, angle iron chain supports 15. The angle irons 15 provide support surfaces for the lower halves of the roller chains 11. Also attached to vertical brackets 14, near the top thereof, are roller chain sprocket supports 16. At intervals along supports 16 are sprocket wheels 17 which engage and support the top halves of the roller chains.

Ampul carrier assemblies 19 are suspended transversely between the roller chains 11 at spaced intervals by means of standard roller chain attachments. The ampul carrier assemblies are advanced by movement of the lower halves of the roller chains from the loading station to the unloading station and are then returned by the upper halves of the chains as shown in Figure 1. The ampul carriers advance through the machine in a series of short movements, each movement being followed by a period of rest; such movement being provided by a suitable indexing device such as a ratchet and pawl or Geneva mechanism.

Mounted on the frame 1 of the machine, immediately behind the bearing posts 9, is a heating device 18, preferably a series of adjustable gas burners, extending transversely across the frame. The heating elements may be elevated or lowered by worm 23 and are spaced so that each element is directly beneath a carrier assembly 19 during the period at which the carrier assemblies are at rest as discussed below.

Hood 3, attached to frame 1 or hung from above, covers the top and sides of the entire machine leaving access only to the loading and unloading stations as shown in Figure 1. Hood 3 connects with a draw-off device for heat and vapors such as chimney 4. The hood may be provided with removable side panels (not shown) for access to the interior of the device.

The front view of the ampul drying machine shown in Figure 2 discloses details of the driving mechanism, the ampul carrier assembly 19, a plurality of ampuls 20 in position over settling plate 37 and the activating mechanism for the settling plate. Motor 5 drives shaft 41 by means of belt 7 extending between pulleys 6 and 8. Clutch 40 permits the machine to be stopped without stopping the motor. Shaft 41 is supported by bearing assemblies 35. On shaft 41 are mounted cans 34 and 36. Cam 34 actuates ampul settling plate 37 through lifting rod 42 by means of roller 50. Cam 36 actuates ratchet and pawl mechanism 38—39. Cam 34 is designed so as to move settling plate 37 upward in momentary contact with the ampul suspended in a stationary carrier assembly immediately above it. The settling plate exerts a slight upward force on each ampul so as to seat the carrier bars securely in the contractions in the necks of the ampuls. Cam 36 is designed so that a forward motion is transmitted to pawl 38 against ratchet 39 sufficient to rotate sprocket wheels 10 through a part of a revolution.

Figure 3 shows in greater detail the ratchet and pawl mechanism which drives the roller chains through sprocket wheels 10. Ratchet 39 is mounted on a flexible shaft 49 which rigidly connects drive sprocket wheels 10 so that they rotate simultaneously when ratchet 39 moves. Cam follower 46 mounted on lever 47 rides on cam 36. Eccentric 45 on cam 36 exerts a backward force on follower 46 causing lever 47 to pivot about hinge 48. Ratchet 39 is engaged and rotates drive sprocket wheels 10 through part of a revolution thus providing a forward motion to the roller chains. When eccentric 45 moves beyond the follower, springs 43 and 44 return the pawl assembly to the rest position and the roller chains stop.

The ampul carrier assembly is shown in detail in Figures 5 and 6. Support bar 28 extends transversely across the machine and is attached at each end to the roller chain by means of standard chain attachments 51. Suspended from support bar 28 by one or more fixed straps 30 is an elongated, fixed carrier bar 32 of L-shaped cross section. These elements comprise the fixed side of the carrier assembly.

Attached to straps 30 by means of hinge block 33a, hinge pin 33 and hinge means 29 are one or more movable straps 26. Fixed to the lower ends of straps 26 is elongated companion carrier bar 31 which also has an L-shaped cross section and coacts with carrier bar 32 to form an adjustable, self-compensating slot adapted to receive a plurality of ampuls. When a row of ampuls is inserted into the slot they are suspended from carrier bars 31 and 32 by the contractions in the necks. Carrier bars 31 and 32 may be tapered at each end so as to facilitate loading and unloading. At the upper ends of the movable straps 26 is attached counterweight bar 27. The counterweight is designed so that the movable side tends to pivot about hinge pin 33 and close the slot formed between ampul carrier bars 31 and 32 when the ampul carrier assembly is in a substantially upright position. Elements 26, 27, 29 and 31 comprise the movable side of the carrier assembly.

In order to quickly and conveniently transfer a plurality of ampuls, ampul transfer device 56 is provided, as shown in Figures 7 and 8. Ampul transfer device 56 comprises an elongated bar having an L-shaped cross section. The base of the elongated bar, i.e., the base of the L, is hollowed so as to accept the bodies of a plurality of ampuls. The back, i.e., the vertical arm of the L, is partitioned so as to provide a plurality of pockets 57 each accepting and seating one ampul. The pockets are formed by a series of vertical grooves in the back of the device, each conforming to the general contours of the body of an ampul. When viewed from the front, the partitioning means appears as a series of alternate 58 and ridges 60. The hollowed portion of the base of the L is deep enough to accept about one-half the body of an ampul. The back does not extend as high as the condition in the neck. Each ampul transfer device is designed to accommodate ampuls of a given size, e.g., 0.5 cc., 2 cc., 5 cc., etc. Each ampul may contain as many pockets as desired, but preferably the number of pockets equals the number of ampuls of a given size accepted by the ampul carrier assembly.

The ampul transfer device is adapted to readily remove the ampuls from the ampul carrier assembly when they reach and stop momentarily at the unloading station, particularly when less than a full load is borne by the carrier assembly. The L-shaped cross section facilitates seating of the ampul bodies in the transfer device during the brief period at which the mechanism is at rest. A hole smaller than the diameter of the body of the ampul may be provided in the base of each pocket if desired.

The automatic ampul drying machine operates as follows. Referring to Figure 1, an operator at loading station A prepares to insert into the horizontal slot of ampul carrier 19 a row of ampuls preferably by means of an ampul transfer device containing a plurality of ampuls. The shaft 49 of the drive sprocket wheels 10 of the ampul carrier assembly is preferably at a 30° to 45° angle with the vertical as illustrated in Figure 1. When empty, the slot formed by the fixed and movable sides of the carrier is virtually closed. As the carrier stops at the loading position, the ampuls, in an upright position, are urged
from the side into the slot formed by carrier bars 31 and 32 until it has opened sufficiently for the constric-
tions in the necks of the ampuls to slide in and be grasped by carrier bars 31 and 32. By virtue of having one fixed
side and one hinged side, the width of the slot auto-
mathematically compensates itself for variations in the diame-
ters of the constrictons and by virtue of the counter-
weight 27 the ampuls are prevented from sliding out of
the slot. The ampuls are thus suspended from the
ampul carrier assembly and the transfer device, if em-
ployed, is removed.

At the expiration of the preset pause in the movement
of the ampul carrier assembly, the carrier moves for-
ward one position. The loaded carrier 19 is at this
time directly over settling plate 37 (shown in Figure
2) with the ampuls in a vertical position. As soon as the
 carrier comes to rest, the settling plate is actuated
upward so as to move the ampuls slightly in an upward
direction permitting the carrier bars to be securely seated
in the constrictons in the necks of the ampul.

At the time the loaded carrier 19 moves forward to a
position above settling plate 37, the succeeding empty
carrier moves forward to the loading position. The next
movement of the roller chain advances the loaded car-
rier forward from its position above the settling plate
and the newly loaded carrier moves into that position.
After several advances of the loaded carrier from the
settling plate, the loaded ampul carrier arrives at a
position over the first of the series of gas burners placed
transversely across the frame. The ampuls suspended in
the carrier pass over the first burner and then with
each succeeding cycle of the timing mechanism advance
and pause directly over each properly spaced burner.

Sufficient burners are provided so as to produce adequate
heat to both drive off any moisture contained in the
washed ampuls and also to sterilize the ampuls. Each
succeeding loaded ampul carrier follows the same se-
quence.

After passing the heating elements, each row of am-
 pulus is carried forward by the ampul carriers with the
same intermittent motion through the remaining length
of the machine. This section of the machine is of suf-
ficient length so as to permit the ampuls to cool enough
to be handled at the unloading station.

The unloading position at station B is reached when
the ampul carrier is at an angle of about 30° to 45° with
the vertical as shown in Figure 1. As each ampul car-
rier arrives at its unloading station with its load of
dry and sterile ampuls and passes briefly, an operator
removes the ampuls. This is accomplished expeditiously
by seating a transfer device such as 56 over the bodies
of the ampuls and sliding it laterally to remove them
from the slot of carrier 19. The empty ampul carriers
are carried back by the roller chain in an inverted posi-
tion through the upper portion of the machine to re-
turn to position A for repetition of the process.

One complete cycle of the mechanism occurs with
one revolution of shaft 41 and includes the period the car-
rier are at rest, begin to advance, complete their
forward motion, and come to rest again. During each cycle
the mechanism operates as follows. When the
motor is started and the clutch is engaged, shaft 41
begins to rotate. Starting from the stationary position
with everything at rest, the pawl is just about to push
the indexing mechanism forward. Eccentric 45 on cam
34 moves forward engaging follower 46, which
reaches the follower 46, it imparts the forward motion
to the ratchet and pawl mechanism through lever 47
and indexes the sprockets and chains through one posi-
tion. Eccentric 45 then moves beyond its follower, the
indexing movement is finished and the carriers stop.

The period the settling plate is in the down-
ward or lower position and the eccentric on cam 34 ap-
proaches its follower. Immediately after the indexing
movement has finished, the eccentric on cam 34 then
raises the settling plate by means of lifting rod 42 to
raise the ampuls slightly and securely seat them in the
carrier. The eccentric on cam 34 then passes beyond its
follower. As the period of rest is concluded, eccen-
tric 45 again approaches follower 46 to initiate a
new cycle. While the carriers are at rest several rows of
ampuls are being heated by the gas burners and the
operators at the loading and unloading stations carry out
their respective functions.

The timing for each cycle may be varied to suit in-
dividual requirements. This is determined by the spac-
ing of the carriers and by the speed of operation. A
greater distance between ampul carrier assemblies tends
to increase the time required for each cycle although
this may be counterbalanced by higher speed operation
of the motor. The indexing mechanism is designed to ad-
vance the carriers the same distance by which they are
separated.

It has been found to be convenient to mount the
respective carriers about two inches apart on the roller
chain. The eccentric on cam 36 and the pawl and
ratchet mechanism are then designed to rotate the drive
sprocket wheels 19 through that portion of a revolution
so as to advance the roller chain and the carrier as-
ssembles the same distance during each cycle. The speed
of operation may be varied by conventional means, e. g.
by utilizing a variable pitch pulley on the motor and
mounting the motor on a sliding base.

The heating elements 18 are preferably adjustable
both as to position and as to the amount of heat sup-
plied. The elements are mounted on the frame the same
distance apart as the ampul carrier assemblies so that
an element is properly located beneath a row of ampuls
during the rest phase of the cycle.

The support bar 28 may contain a series of holes in
order to aid in the dissipation of heat and to decrease
the weight of the carrier assembly. The carrier as-
sembly may be designed to accommodate any desired
number of ampuls. A convenient length is one which ac-
commodates 16 one cc., 16 two cc., or 9 five cc. ampuls.
The counterweight 27 is a metal bar attached to movable
straps 26 and is of sufficient weight to maintain the
carrier bars securely in closed position when transport-
ing its load of ampuls.

In general the overall length of the drying machine
may vary widely but must be sufficient to provide adequate
space for a plurality of heating elements, e. g. 6 to 10,
for drying and sterilizing, as well as sufficient protected
area to permit the ampuls to cool for further handling.
A convenient length has been found to be about 12 to 15 feet but this of course may be varied to suit circum-
stances.

If desired, a cooling means such as a stream of
cool, sterile air may be introduced into the cooling
area.

Other variations, readily apparent to one skilled in
the art, are also within the scope of this invention.

We claim:

1. An automatic ampul drying machine which com-
 prises an elongated frame mounted on supporting
 members, a drive shaft suspended from said frame and
 operatively connected to a driving means, two drive
 sprocket wheels mounted at opposite sides above a first
 end of said frame, two idler sprocket wheels mounted at
 opposite sides above the second end of said frame, an
 endless chain suspended between the drive and idler
 sprocket wheels at each side of the frame, an index-
 ing mechanism connecting said drive shaft and said
driver sprocket wheels adapted to rotate the drive sprocket
 wheels and advance the chains intermittently, a plurality
 of ampul carrier assemblies transversely suspended
 between the endless chains, each ampul carrier assembly
 comprising a support bar adapted to be attached by
each end thereof to said endless chains, fixed support means
 suspended from said support bar, a carrier bar attached
 in a horizontal position to the end of said fixed support
means, movable support means attached to said fixed support means by hinge means, a movable companion carrier bar attached in a horizontal position to said movable support means, said movable carrier bar forming an adjustable slot together with said fixed carrier bar, and a counterweight attached to said movable support means in a position remote from the carrier bar and so aligned with respect to the hinge means as to close said slot while the carrier assembly is in ampul transporting position, a heating device mounted on said frame adjacent to the driving section, and a hood substantially covering said machine.

3. An automatic ampul drying machine comprising a drying section and a cooling section which comprises an elongated frame mounted on supporting members, a drive shaft suspended from said frame and operatively connected to a driving means, a sprocket wheel mounted in bearing members at opposite sides of each end above said frame, the two sprocket wheels mounted at the driving end of the machine being rigidly connected by means of a shaft and comprising the driving sprocket wheels, the two sprocket wheels mounted at the opposite ends of the machine comprising the idler sprocket wheels, a roller chain suspended between the driver sprocket wheel and the idler sprocket wheel at each side of the frame, support means for the roller chain along each side of the machine, a ratchet and pawl mechanism actuated by a cam on said drive shaft and adapted to rotate the driver sprocket wheels intermittently thereby advancing the endless chain in a series of short forward motions with a pause between each advance, a plurality of ampul carrier assemblies transversely suspended between the endless chains, each ampul carrier assembly comprising a support bar adapted to be attached by each end thereof to said endless chains, fixed support means suspended from said support bar, a carrier bar attached in a horizontal position to the end of said fixed support means, movable support means attached to said fixed support means by hinge means, a movable companion carrier bar attached in a horizontal position to said movable support means, said movable carrier bar forming an adjustable slot together with said fixed carrier bar, and a counterweight attached to said movable support means in a position remote from the carrier bar and so aligned with respect to the hinge means as to close said slot while the carrier assembly is in ampul transporting position, a heating device mounted on said frame adjacent to the driving section, and a hood substantially covering said machine.

4. In an ampul drying machine, an ampul carrier assembly which comprises a support bar adapted to be attached by each end to a heating means, fixed support means suspended from said support bar, a carrier bar attached in a horizontal position to the end of said fixed support means, movable support means attached to said fixed support means by hinge means, a movable companion carrier bar attached in a horizontal position to said movable support means, said movable carrier bar forming an adjustable slot together with said fixed carrier bar, and a counterweight attached to said movable support means in a position remote from the carrier bar and so aligned with respect to the hinge means as to close said slot while the carrier assembly is in ampul transporting position.

5. In an ampul drying machine, an ampul carrier assembly which comprises a support bar adapted to be attached by each end to a roller chain, fixed straps suspended from said support bar, a carrier bar of L-shaped cross section affixed to the ends of said fixed straps in a horizontal position, movable support means attached to the fixed straps by hinge means located near the support bar, a movable companion carrier bar having an L-shaped cross section rigidly affixed in horizontal position to said movable straps, said movable support means attached to said fixed carrier bar forming an adjustable slot together with said fixed carrier bar, and a counterweight attached to said movable support means in a position remote from the carrier bar and so aligned with respect to the hinge means as to close said slot while the carrier assembly is in ampul transporting position.

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