A transfer apparatus for the successive transfer through a plating bath or a coating tank of a plurality of small elongate articles, comprising a plurality component units adapted for the automatic branching and transfer of the articles into, through and from the plating bath or coating tank, and so mechanically coordinated that the plating or coating operation can be performed automatically and without interruption of operation.

12 Claims, 22 Drawing Figures
SUCCESSIVE TRANSFER APPARATUS FOR SURFACE TREATMENT OF ELONGATE ARTICLES

This invention relates to a transfer apparatus for the continuous transfer of elongate articles through a surface processing tank, such as a plating, bath, coating bath, or the like.

In automatic machining or assembly devices, a chute or a chain conveyor system is sometimes used for the transport of small-sized articles such as screws, pins, or the like successively and in trim order. In the case of the plating devices, however, no devices are known and utilized whereby small articles such as screws, pins, or the like can be transported in succession through the plating bath for a plating operation as these articles are difficult to process severally without lowering the operational efficiency. However, in recent days, there is an increasing demand for devices enabling the positive and uniform surface processing of these articles on their entire peripheral surfaces.

Moreover, it has often been experienced that the plating step requires usually much more time than the pre-processing steps, such as a pickling step. In consequence, by having one processing line divided or branched into a desired number of lines, the efficiency of the transport operation can be remarkable improved.

The present invention seeks to provide an apparatus comprising various component units which are mechanically inter-related to each other so as to fully satisfy the above-mentioned requirements.

SUMMARY OF THE INVENTION

The invention resides in means forming a plurality of processing lines for the elongate articles, each line having a path comprising in succession a section leading into a processing tank or other vessel, a section leading through the tank or vessel, and a section leading from the previous section out of the tank or vessel. Means are provided for feeding articles in single line or row into each processing line for progress therethrough. A vertically disposed transfer unit is located in the downwardly first section and has means for stepwise movement of articles from a position above the tank to a position in the lower portion of the tank. The section in the tank has a member with a plurality of article-receiving recesses arranged in a row, one end recess of which is arranged to receive articles in succession from the transfer unit. Crank means connected to various members of the section in the tank imparts a succession of forward and rearward strokes thereto to move articles in the row from one to the other of the recesses while rotating the articles about their axes. As each article arrives at the other end recess it is picked out of the recess and lifted out of the tank by a grasping unit.

The present invention will now be described in detail with reference to the accompanying drawings showing a preferred embodiment thereof, and in which:

FIG. 1 is a top plan view of the overall apparatus;
FIG. 2 is a side elevational view thereof;
FIG. 3 is an enlarged view of section A of FIG. 2 showing the detailed construction of the distributing unit;
FIG. 4 is a cross-sectional view taken on the line IV—IV of FIG. 3;
FIG. 5 is a front view of the gripping/transport unit;
above-described manner, both the pincers 121 and stopper are lowered through levers 126, 134 kept in
direct contact with cams 125, 133. The contour of
cams 125, 133 is selected so that the pincers 121 and
stoppers 122 are lowered with a fixed distance
therebetween. When the pincers 121 and stopper
means 122 are brought to the predetermined positions,
the stopper means 122 are brought to a stop, and the
pincers 121 alone start to be raised, on account of
specifically selected cam surfaces of cams 125, 133.
Thus, the article so far held by the pincers 121 is now
released and placed on the movable table 110. Then,
the stoppers 122 start to be raised and both the pincers
121 and the stoppers 122 are brought simultaneously to
their predetermined upper positions.

The pincers guide member 131 kept in the stationary
position is now moved in an arc on account of the rotat-
ing cam 129 and brought to its former position for
 gripping the following article.

Referring to FIGS. 3 and 4, a cam 113 is secured to a
rotating shaft 112 connected to a drive unit 900 (FIG.
1). A lever 115 swung at 116 is kept in pressure contact
with cam 113 through its roller 114 under the action of
a compressed spring 136. A rack 118a secured to some
stationary device has two rack portions on either sides
of the lever 115. These rack portions engage with two
gears 119a secured to a short shaft 117 slidably
received in an oblong hole on the upper part of the lever
115. Thus, the shaft 117 is moved horizontally as
viewed in FIG. 4 as the drive shaft 112 rotates. Gear
119b is also secured to shaft 117 and meshes with a rack
118b secured to the bottom of the movable table
110. Thus, as the shaft 117 is moved back and forth in
FIG. 4, gear 119b is set into rotation, and the desired
reciprocating motion imparted to the table 110.

In the present embodiment, the articles 20 are placed
on a fixed table 21 through gripping/delivery unit 120,
placed on and conveyed by the movable table 110 to
the two transfer lines, and transferred to the
relay/transmitting units 200a, 200b through the
gripping/delivery units 120a, 120b.

Reference is now made to FIGS. 7 and 8 showing a
preferred embodiment of the relay/transmitting unit
200, comprising an inner comb-shaped segment 210
and outer comb-shaped segment 220 and two pairs of
cracking means 230a, 230b secured to their peripheral
portions. Each comb-shaped segment 210, 220 has a
series of projections on its upper side edge in the form
of comb-teeth defining a plurality of article-receiving
recesses and performs a crank motion phase shifted
180° relative to each other through the linkage thereof
with the cracking means 230a, 230b, so as to transport
to articles 20 stepwise towards the distributing units 120c,
120d. This relay/transmitting unit 200 may be designed in
the same way as the feed unit 400 to be described, or
in any desired way, provided that articles can be
replied between the distributing units horizontally and
at a fixed distance from each other. Following the
relay/transmitting unit 200, the two lines are branched
into four through the way of distributing unit 120c,
movable tables 110a, 110b and gripping/delivery units
120d, 120e, 120f, 120g, 120h. The articles 20 can then
be fed into the processing bath in the four transfer lines
by means of vertically disposed transfer units 300a,
300b, 300c, 300d arranged on the respective line ends.

Reference is now made to FIGS. 9 to 11 showing a
preferred embodiment of the vertical transfer unit 300
comprising a movable segment 310 and a fixed seg-
ment, with comb-shaped strikers 370 provided op-
tionally. A guide plate 311 for the segment 310 is
secured to two guide plates 312 for articles 20 being
transported. As shown in FIG. 11, shafts 317, 354 are
secured to the projected sides 313, 314 of the movable
segment 310 and the projected sides 351, 352 of the
fixed comb 350. These shafts 317, 354 are passed
through the oblong holes on the comb-shaped strikers
370a, 370b. Said projected sides 313, 314, 351, 352,
and the comb-shaped strikers 370a, 370b are placed in
opposition and close proximity to each other with a
small gap 315 adapted for prevention of articles 20
from dropping unintentionally, and provided with sub-
stantially horizontal grooves 316, 353, 371, 372 at a
fixed vertical distance therebetween equal to the pitch
of transfer of the articles through the unit 300. This
vertical distance, which is equal to that between the ar-
ticle 20 and the article 20a, should be selected to the
proper value for the particular transfer apparatus and
in function of the vertical stroke of the movable comb
310, as will become more apparent from the following
description.

The vertical transfer unit 300 operates as follows:

When the movable comb 310 has reached its upper-
most position as shown in FIG. 9, the article 20 is
charged from the direction shown by the arrow mark.
As will be later described, the comb-shaped striker
370b suspendedly attached to the fixed comb 350 is
raised a small distance equal to the vertical extent of
the oblong hole on the fixed comb 350. Thus, the arti-
cles 20a, 20b . . . 20e so far received within the horiz
ontal grooves on the projected sides 351, 352 of the fixed
comb 350 are set into an impulsive movement and
snugly positioned in the center of the aligned grooves
(FIG. 9).

When the movable comb 310 is then lowered
together with the comb-shaped striker 370a suspen-
dedly attached thereto, the articles 20a, 20b . . . 20e
are received within the horizontal grooves 316, 371
and moved down therewith. At this time, the comb-
shaped striker 370b, urged into the impulsive move-
ment, is now lowered to the initial position.

When the movable comb 310 approaches its lower-
most position (FIG. 12), the comb-shaped striker 370a
moving downwards therewith is brought to a stop with
the lever 318 abutting on the lower edge of the elon
gated openings formed on the guide plates 312. The
movable comb 310 can descend further downwards the
small distance equal to the vertical extent of the oblong
hole. Thus, the comb-shaped striker 370a will perform a
relative upward motion to the movable comb 310, so
that the articles 20a, 20b . . . 20e are set into an impul-
sive movement and positioned again in the center of
the aligned grooves. The article 20e is released and sup-
plied to the double-comb type forwarding unit 400.

When the movable comb 310 is gains elevated in its
position, the comb-shaped striker 370a is brought to its
former relative position to the movable comb 310, and
moved upwards therewith. The articles 20, 20a . . . 20d
are now received in the horizontal grooves 353, 372
(FIG. 13) and the movable comb 310 is raised with
comb-shaped striker 370a with the articles 20, 20a . . .
20d freed from the grooves 316, 371 (FIG. 14), until it reaches its upper position shown in FIG. 9 for receiving the following article.

Referring now to FIGS. 15, 16, the comb-shaped striker 370a is suspendedly attached to the movable comb 310 through several shafts 317 secured to the projected sides 313, 314, said shafts 317 passing through the oblong holes on the comb-shaped striker 370a with vertical extent equal to the short distance in the above sense. On each article guide plate 312, there is an elongated opening in which slides a lever 318 formed on the comb-shaped striker 370a. The vertical extent of such opening is selected to be equal to the stroke of the movable comb 310 when the oblong hole is added to the lower end thereof. Supposing that the movable comb 310 is moving downwards with the comb-shaped striker 370a and brought to the position higher than the lower end of its travel by the short distance above referred to, the comb-shaped striker 370a is brought to a stop, with its lever 318 abutting on the lower edge of the elongated opening. But, on account of the mounting mode of the movable comb 310 to the comb-shaped striker 370a, explained in the foregoing, the movable comb 310 can descend further the small distance in the above sense for causing impulsive upward movement of the comb-shaped striker 370a with respect to the movable comb 310.

Referring to FIGS. 17 and 18, the comb-shaped striker 370b is suspendedly attached to the fixed comb 350 by several shafts 354 passed through oblong holes equal to the distance the comb-shaped striker 370b is hit to move upwards. On the article guide plate 312, there is a slit equal in vertical extent to the same distance as above. A lever 355 secured to the comb-shaped striker 370b and slideable within said slit has its two edges bent as shown a lever 356 is secured to said movable comb 310 and move therewith between the bent edges of the lever 355. Supposing that the short distance equal to the vertical extent of the oblong hole, when added to the upper end portion of the space defined by the bend edges of the lever 355, is equal to the stroke of the movable comb 310, or of the lever 356 secured thereto, the lever 356 will be brought into abutting contact with the upper bent edge of the lever 355 as the comb 310 is moved to the position lower than the upper end of its stroke by the short distance in the above sense. Thus, the comb-shaped striker 370b accompanies the movable comb 310 with an impulse movement.

FIG. 19 shows the shape of the horizontal grooves 316, 371, 353, 372. The lower edges of these grooves are sloped with a gradient of 10° to 45° so that the article 20 is always inclined to slide down by its own gravity. Therefore, the comb-shaped striker 370a, 370b are by no means essential to the construction of the transfer unit 300. When the articles 20 are smeared with machine oil or like adhesive agents, however, they can hardly be transferred smoothly from the grooves 316, 371 to the grooves 353, 372 or vice versa. In this case, the comb-shaped strikers 370a, 370b will come into operation for compulsorily positioning articles on the bottom portion of the aligned grooves.

To the lower portion of the vertical transfer unit 300 inside the surface processing reservoir 30, there are the provided same number of the double-comb type feed or second forwarding units 400 as the transfer lines. As shown in FIG. 20, the unit 400 comprises a central comb-shaped section 410, two lateral comb-shaped sections 450 and cranking devices 470 as shown in FIG. 2 for imparting cranking movements to said sections 410, 450. On the upper surface of the central comb-shaped section 410, there are formed a number of paired parallel projections 411 defining a plurality of through-outs 412. The lateral comb-shaped sections 450 are arranged on both sides of the section 410 and formed with similar cut-outs 451 and 452 as those on the section 410. These sections 410, 450 are suspended by means of the cranking devices 470 adapted for imparting cranking movements phase shifted 180° relative to each other. The cranking device 470 in the present embodiment comprises a crank 471, suspenders 472 and shafts 474, 475 interconnecting the lower portions 473 of the sections 410, 450 and secured to the lower parts of the suspenders 472. The unit 400 may also be arranged in the same way as the unit 200 already explained, and the embodiment shown herein is not limiting. The offset distance of the cranks is designed to be equal to half the pitch of the cut-outs 451, 452.

Numerical 476 denotes a stopper on the lateral comb-shaped sections 450. The crank movements performable with the double-comb type transfer unit may be of any types as desired. In the present embodiment, the cranking movement is such that the central comb-shaped section 410 moves in an arc towards the upper right while the lateral sections 450 move towards lower left. The articles 20 can be transported by the transfer unit 400 from left to right in FIG. 2 as they are rolled about their axes, and are lifted in trim order from the reservoir 30 through a lift unit 500 provided to each processing line.

The lift unit 500 is shown in detail in FIGS. 21 and 22 and comprises a grasping device 510 and a lift device 550. The former device 510 includes a body member 511 and a drive cam assembly 530. Said body 511 is swingly mounted about shaft 501 and has a movable cylinder 512 therein which is acted upon by a compressed spring 517 to move downwards inside the body member 511. A central shaft 525 is disposed inside the cylinder 512 and acted upon by a compressed spring 518 so as to move downwards inside the cylinder 512. Central shaft 525 has a cut-out 526 and a compressed spring 519 secured thereto and acts on a coupling shaft 520. The coupling shaft 520, urged in this way to move downwards inside the cylinder 512, has a pin 521 towards its bottom slidably engaged within cam slots 522, 523 on the fittings 515, 516 adapted for grasping the article 20 therebetween. These fittings 515, 516 are swingable about pins 514, 513 formed on the bottom of the cylinder 512. Thus, when the coupling shaft 520 is moved downwards, and the cylinder 512 encircling it remains stationary, the fittings 515, 516 swing about the pins 514, 513 for grasping or releasing the article 20 therebetween.

Next, the drive cam assembly 530 will be described. Numerical 531 denotes a drive shaft secured to cam plates 532, 533 which are kept in direct pressure contact with rollers 538, 538, 539 fitted on levers 536, 536, 537, respectively. These levers 536, 536, 537 are swingly mounted on a common shaft 535. The free ends of the levers 536, 536 are urged to move
downwards by abutment with pins 524, 524 of the cylinder 512 acted upon, as described, by the compressed spring 517. The free end of the lever 537 is received within the cut-out 526 on the center shaft 525 acted upon, as described, by the compressed spring 518. In this way, the three levers 536, 536, 537 are kept in pressure engagement with the cam plates 532, 532, 533 through the rollers 538, 538, 539, respectively. Numerals 527 denotes a bracket fitted to the body member 511 and carries a roller 528 at its foremost portion. Numerals 529 denotes a further bracket fitted to the top of the body member 511 and acted upon by a compressed spring 540 so as to cause the body 511 to turn clockwise about shaft 501. The roller 528 is thus kept in pressure engagement with cam plate 534. Thus, the cam plates 532, 533, 534 are set into rotation simultaneously with rotation of the drive shaft 531, so as to cause the levers 536, 536, 537 to oscillate in conformity with the respective cam surface configuration. It will be realized from the foregoing that by suitably selecting these cam surface configurations the article 20 grasped by the grasping fittings 515, 516 and lifted to the predetermined position with elevation of said fittings 515, 516 can be transferred to a position above support 555 of the lifting device 550 and there released with swinging of the body 511, brought about by rotation of the cam plate 534.

The lifting device 550 comprises two parallel arms 551, 552 swingable about shafts 553, 554 and a support 555 connected by a pin connection to the ends of the arms 551, 552. Numerals 556 denotes a drive shaft fitted with a crank 557 having a roller 558 at its end engaging in an elongated slot 559 formed on the arm 551. Said arm 551 is swung about shaft 553 through the rotational movement of the crank 557 thus causing the support 555 to move in an arc in retaining its horizontal position.

Thus, the article 20 grasped by the grasping device 510 is placed on the lift device through the grasping, lifting and swinging motions of the grasping device 510 and lifted to the next feed unit 600 through the lifting device 550.

This unit 600 has the same construction as the units 200 or 400 already described, and is used for feeding articles 20 sequentially towards right in FIGS. 1 and 2. So far, the articles 20 have been fed in the desired number of lines but they are not collected in one place by means of a hopper 700, and charged into a container 800. The drive unit 900 for driving each unit is so designed that a main shaft 903 is set into rotation from drive power source 901 comprising a motor and a speed reducer, for example, through a torque limiter 902, and each unit is driven from this main shaft 903 through bevel gears 904. In the case of the grasping and lift devices 510, 550, however, a suitable intermittent drive is necessary to fit between them and the main shaft 903.

According to the novel transfer apparatus of the present invention, many advantages are attainable, such that the surface treatment can be fully automated, and the quality of the surface processed materials considerably enhanced. Especially, as the conveying means immersed inside the reservoir are of the mechanical type, the materials processed may be safeguarded against adverse processing conditions, such as high temperatures and corrosive atmosphere, in the case of a plating operation, and satisfactory operation may be assured.

What is claimed is:

1. A successive transfer apparatus for surface treatment of a plurality of elongate articles in a processing reservoir comprising:

   feed means for feeding said articles in at least one feed line;
   a distributing unit receiving the articles from said feed means, said distributing unit having a grasping and delivery device and a support block for longitudinally separating or branching the articles from said feed line of said feed means into a plurality of branch feed lines and distributing said articles into respective branch transfer systems;
   a relay-transmitting unit receiving the articles from each of said branch feed lines of said distributing unit, each relay-transmitting unit having a plurality of comb-shaped segments provided with a number of longitudinal constant pitch grooves in which said articles are received, said comb-shaped segments carrying out a cranking movement with a phase shift of 180° relative to each other for feeding said articles from groove-to-groove in a spaced manner from each respective branch feed line;
   a processing reservoir a vertical transfer unit receiving articles from each of said relay-transmitting units, each vertical transfer unit having a vertically movable comb and a fixed comb of a constant width and a given length, said combs being mounted vertically in close proximity and in opposition to each other and having on the opposing sides thereof a number of constant pitch grooves, said vertical transfer units moving said articles in said grooves vertically to said processing reservoir;
   a double-comb type transfer unit receiving the articles from each of said vertical transfer units, each of said transfer units being immersed in said processing reservoir and including comb-shaped segments provided with a plurality of longitudinal constant pitch grooves in which said articles are received, said segments being cranked with a phase shift of 180° relative to each other for rolling axially and advancing said articles groove-by-groove in a spaced manner through said processing reservoir, said double-comb type transfer units being similar in construction to said relay-transmitting units; and
   a grasping unit for removing processed articles from said double-comb type transfer units in said processing reservoir, said grasping unit comprising a swinging grip device for selectively gripping an article, a driving cam mechanism operably coupled to move said grip device, and a lift device for lifting said grip device, the lift device including a plurality of levers swingable in parallel relation and a support fitted to the ends thereof.

2. Apparatus according to claim 1 wherein said relay-transmitting units transfer said articles in a step-by-step manner.

3. Apparatus according to claim 1 wherein said double-comb type transfer units transfer said articles in a step-by-step manner.
4. Apparatus according to claim 3 wherein said processing reservoir is located below said relay-transmitting unit, and wherein said relay-transmitting unit is downwardly inclined toward said processing reservoir.

5. Apparatus according to claim 4 wherein said double-comb type transfer units are upwardly inclined.

6. Apparatus according to claim 1 comprising a common drive means operatively coupled to said feed means, distributing unit, relay-transmitting unit, vertical transfer unit and double-comb type transfer unit.

7. Apparatus according to claim 1 wherein said distributing unit includes a conveyor-type means reciprocably movable substantially perpendicular to said feed line of said feed means for branching said articles.

8. Apparatus according to claim 1 wherein said distributing unit includes a plurality of grasping and delivery devices for branching said articles.

9. Apparatus according to claim 4 wherein said distributing unit includes a plurality of cascaded grasping and delivery devices to first branch said feed line into a first plurality of lines, and to then branch said first plurality of lines into a second plurality of lines.

10. Apparatus according to claim 1 wherein the comb-shaped segments of each relay-transmitting unit have an eccentricity of one half the pitch of the comb.

11. Apparatus according to claim 1 wherein the comb-shaped segments of each double-comb type transfer unit have an eccentricity of less than one half of the comb pitch.

12. Apparatus according to claim 1 wherein said grasping unit includes a plurality of swingable grip devices, the number of which is the same number as the number of branch lines passing through said processing reservoir.

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