

[54] **DOUBLE-COMB-SHAPED TRANSFER APPARATUS**

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[51] Int. Cl.B65g 25/04

[58] Field of Search.....198/219, 218

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[57] **ABSTRACT**

Transfer apparatus for continuously transferring an elongated article comprises a central segment having two spaced apart parallel rows of comb-shaped projections of uniform pitch, outer segments on both sides of the central segment and having similar projections, the projections of the central and outer segments receiving the article in the notches formed between their projections and a crank mechanism for imparting a circular motion to the outer segments, the crank mechanism having a predetermined eccentricity related to the pitch of the projections.

7 Claims, 17 Drawing Figures

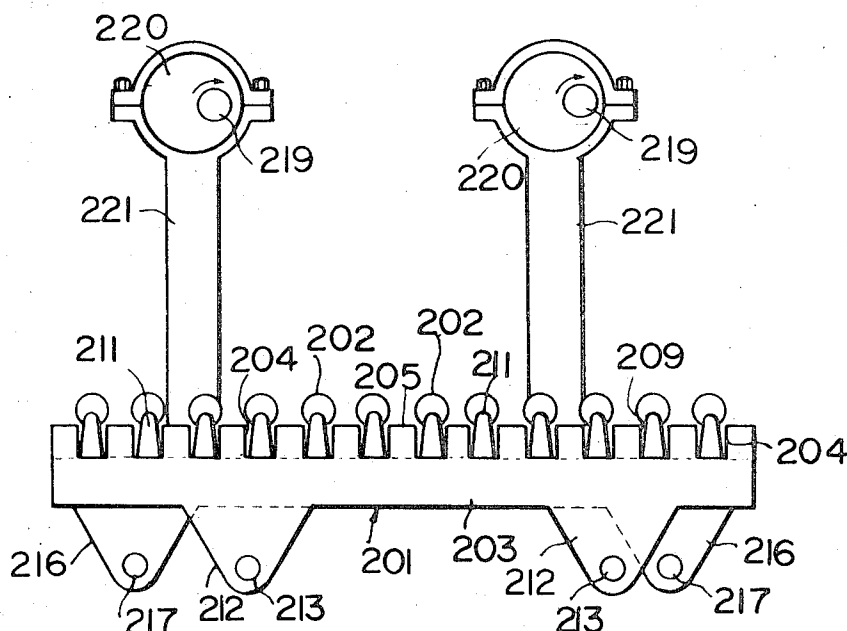


FIG. 1

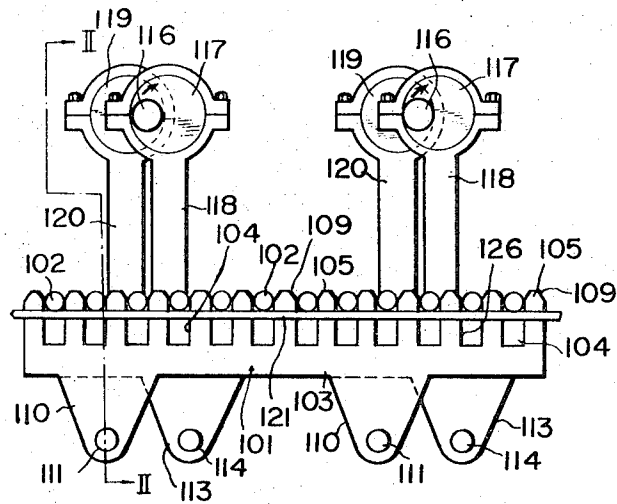
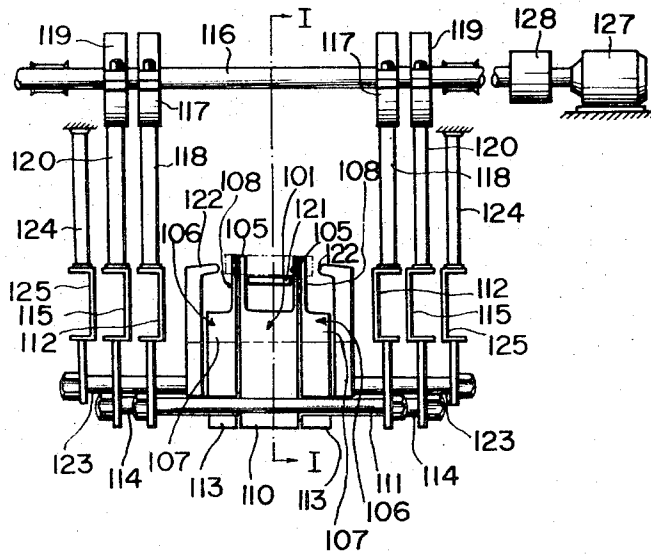


FIG. 2.



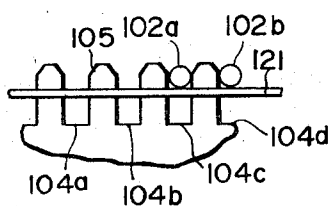
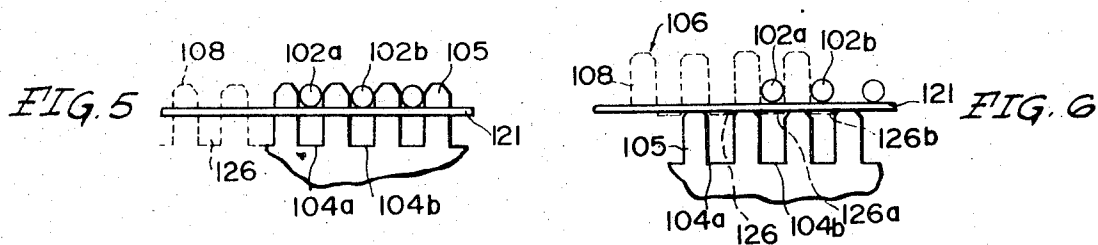
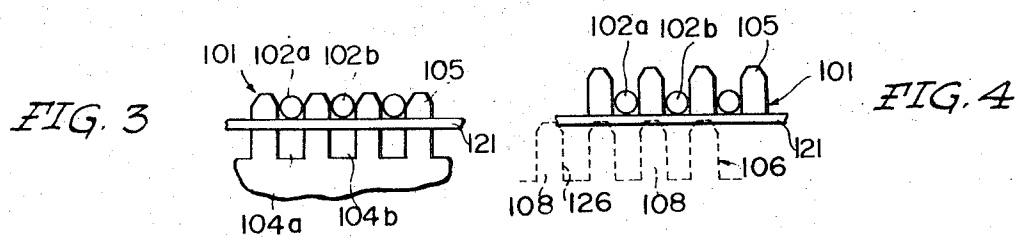


FIG. 7

FIG. 8

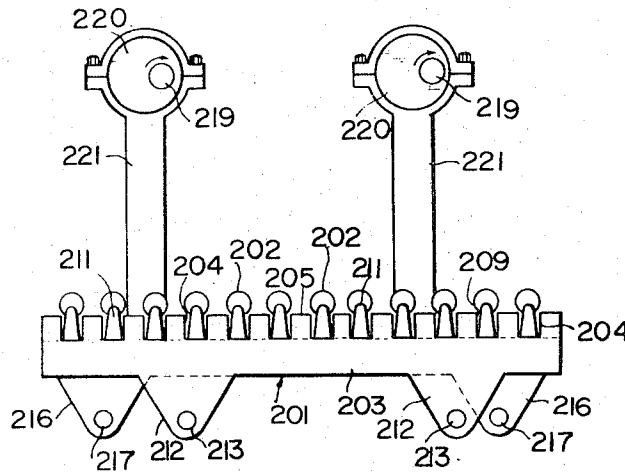


FIG. 9

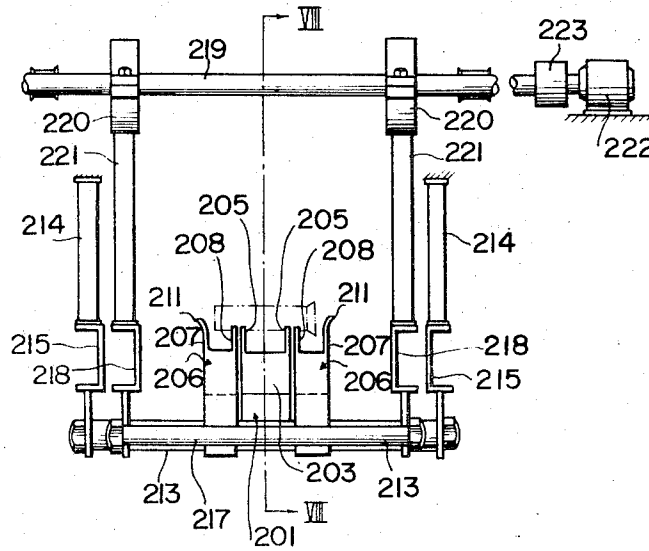


FIG. 10

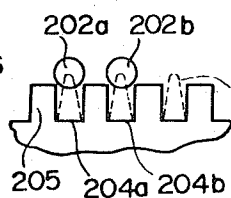
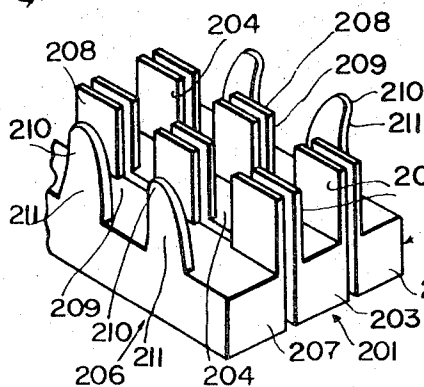


FIG. 11

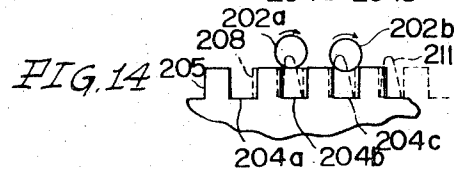
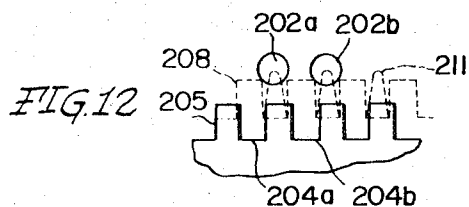


FIG. 16

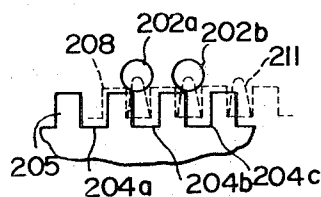
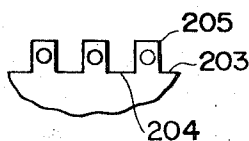


FIG. 13

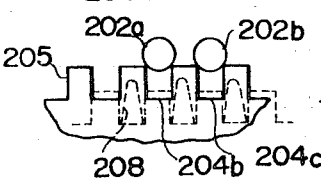


FIG. 15

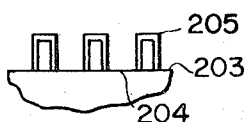


FIG. 17

DOUBLE-COMB-SHAPED TRANSFER APPARATUS

BACKGROUND OF THE INVENTION

This invention relates to transfer apparatus and more particularly to transfer apparatus for continuously and successively transferring elongated articles of circular cross-section such as short rods or screws.

According to one known type of transfer apparatus of type referred to above, a pair of parallel endless belts is used, the belts comprising a number of interconnected links with projected attachments for clamping the articles, and the articles are conveyed along a guide between the endless belts.

Such transfer apparatus is satisfactory for applications where it is merely desired to successively transfer a number of articles, but is not suitable for applications where the articles are subjected to a predetermined treatment, for example, plating, while the articles are being conveyed by the transfer apparatus, or where the transfer apparatus is subjected to a high temperature or used in a highly corrosive atmosphere. Under these conditions, it is of course necessary to fabricate the transfer apparatus with special materials. Especially, for a transfer apparatus utilizing endless chains, as it is difficult to shield the component parts thereof, such as bearings and drive mechanisms from the corrosive atmosphere, the cost of manufacturing the apparatus becomes high. Further, in a transfer apparatus for use in applications wherein the articles are subjected to some type of treatment such as plating, painting, rinsing, drying or shot peening while they are being supported and conveyed by the transfer apparatus, it is desirable to expose the entire surface of the articles so as to treat them uniformly.

SUMMARY OF THE INVENTION

It is therefore an object of this invention to provide novel transfer apparatus wherein the component elements thereof for transferring articles and the drive mechanism thereof are physically separated.

Another object of this invention is to provide novel transfer apparatus capable of supporting the articles with minimum contact area, thus exposing the surface of the articles to the maximum extent.

Still another object of this invention is to provide improved continuous transfer apparatus for elongated articles having circular cross-section which imparts rolling motion to the articles when they are conveyed.

Yet another object of this invention is to provide novel transfer apparatus wherein the pitch of the incremental movement of the articles can be adjusted.

According to this invention, these and other objects can be accomplished by providing comb-shaped transfer apparatus comprising a stationary central segment having two spaced apart parallel rows of comb-shaped projections of uniform pitch, outer segments disposed on both sides of the central segment and having projections similar to those of the central segments, the projections of the central and outer segments receiving the article in the notches formed between their projections, and a crank mechanism connected to the and outer segments for imparting thereto a circular motion, the crank mechanism having a predetermined eccentricity related to the pitch of the projections.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front view of an embodiment of a transfer apparatus embodying the invention;

FIG. 2 shows a side elevation thereof;

FIGS. 3 to 7 are explanatory views showing the various operative steps of the central and two outer segments;

FIG. 8 is a front view showing a second embodiment of this invention;

FIG. 9 shows a side elevation thereof;

FIG. 10 is a partial perspective view of the stationary segment and two movable outer segments;

FIGS. 11 to 15 are explanatory views showing the various operative steps of such stationary and movable segments; and

FIGS. 16 and 17 are partial front views of two modified forms of the projections.

DETAILED DESCRIPTION OF ILLUSTRATED EMBODIMENTS

Referring to FIGS. 1 to 7 illustrating the first embodiment of the invention, reference numeral 101 denotes a central combshaped segment comprising of an elongate rectangular bar 103 of a width sufficient to support articles 102 to be transferred, such as small-sized screws or short rods. As best shown in the front view of FIG. 2, the bar 103 is formed on its both sides with upright flanges, each having equally spaced apart rectangular notches 104 each of a width slightly larger than the diameter of the article 102. Thus, a series of projections or teeth 105 of a constant pitch are formed on the upper edge of each flange of the bar 103. Two outer comb-shaped segments 106 are positioned on either side of central segment 101 with small gaps therebetween. Each outer segment 106 comprises an elongate rectangular bar 107 of the same length as central segment 101, the bars 107 being provided with an upright flange on the side thereof facing segment 101. Such upright flange is also formed with a series of projections 108 in the form of comb teeth defining a series of rectangular notches 126 therebetween and registering with the projections 105 on central segment 101. Segments 105, 108 are chamfered as at 109 so as not to interfere with the articles being transferred when the central segment 101 and two outer segments 106 are set into operation.

The central segment 101 has two or more bearing lugs 110 on its lower surface for receiving bolts 111 extending at right angles with respect to the bar 103, opposite ends of bolts 111 being carried by reinforcing members 112. In a similar way, each of the outer segments 106 has two or more aligned bearing lugs 113 for receiving bolts 114 at right angles with respect to bar 117, opposite ends of the bolts 114 being secured to other reinforcing members 115 arranged on the outer sides of reinforcing members 112 as shown in FIG. 2. Above the center and outer segments 101 and 106, there are provided a pair of crank shafts 116 parallel to bolts 111, 114, crank shafts 116 being driven in the same direction by a driving motor 127 through a speed reducer. Circular disc shaped cranks 117 are eccentrically connected to shafts 116 at the same phase angle, as shown in FIG. 1 and the lower ends of crank arms 118 extending downwards from cranks 117 are secured

to the reinforcing members 112 carrying the bolts 111 associated with the central segment 101. Crank shafts 116 also carry circular disc shaped cranks 119 at positions 180° out of phase with respect to cranks 117. The lower ends of crank arms 120 associated with cranks 119 are secured to the reinforcing members 115 carrying the bolts 114 for the two outer segments 106. In this embodiment, although the central and two outer segments 101 and 106 are connected to the crank shafts 116 of the crank mechanism through crank arms 118 and 120, other connecting means may also be employed. It is to be understood that the eccentricities of 117 and 119 are equal to one half of the pitch of the projections 105 and 108 on the two segments 101 and 106, respectively. The eccentricities may be adjusted as desired.

An elongated flat strip shaped guide member 121 is provided for supporting articles being transferred, the opposite ends of the guide member being secured to a stationary member, not shown, such as the inner wall of a plating tank containing the present transfer apparatus. The guide member is received within a space between projections 105 of the bar 103. The relative height of this guide member 121 is so selected that the level of the lower surface thereof about coincides the upper surfaces of bars 103 and 107 when the bars 103 and 107 are moved to their uppermost positions by the rotation of crank shafts 116, and that the level of the upper surface of the guide member is slightly higher than that of the upper end portions of the projections 105 and 108 when bars 103 and 107 are moved to their lowermost positions by the rotation of crank shafts 116. See FIGS. 3-7.

A pair of stop members 122 having the same length as the bar 107 are arranged on either sides of and parallel to the bar 107 for preventing the articles 102 from displacing transversely and dropping from the guide member 121. Stop members 122 are secured to the inner ends of two or more bolts 123, similar to bolts 111, 114 for the segments 101, 106. The outer ends of these bolts 123 are secured to reinforcing members supported by stationary hangers 124.

The transfer apparatus shown in FIGS. 1 to 7 operates as follows.

Articles 102 to be transferred are received horizontally on the guide member 121, with their opposite ends resting in the notches 104 and 126 of the segments 101 and 106, respectively.

When the transfer apparatus is started, articles 102 are successively supplied from one end of the moving segments 101 and 106, e.g. from the upper left-hand side as seen in FIG. 1, and are transferred sequentially to the right by the circular motion of segments 101 and 106 by sliding over projections 105 and 108 between notches 104 and 126 thereof.

FIGS. 3 to 7 inclusive shows the various operative steps of the transfer operation effected by the present apparatus. In the position shown in FIG. 3, the projections 105 of the segment 101 and the projections 108 of the segments 106 are aligned with each other. For the sake of description, this operative position of the segments 101 and 106 is assumed to be zero rotational angle of the crank shaft 116. When the crank shaft 116 is rotated in the clockwise direction as shown by an arrow in FIG. 1, the central segment 101 and the outer

segments 106 are moved along arcuate paths towards the upper right-hand side and the lower left-hand side, respectively. When the cranks 117 and 119 are rotated 90°, the segments 101 and 106 are brought to the positions shown in FIG. 4. With movement of the central segment 101, the articles 102a and 102b contained within notches 104a and 104b are rolled to the right along the guide member 121. At this time, outer segments 106 are moved towards the lower side of the guide member 121 and then towards the left without interfering with the rolling motion of articles 102a and 102b.

When the cranks 117, 119 are further rotated to the operative position displaced 180° from their respective starting positions, the central segment 101 and two outer segments 106 are displaced one pitch towards the right and towards the left, respectively, and are brought to the operative position shown in FIG. 5 wherein their notches are again aligned with each other. During this operative step, articles 102a and 102b roll along guide member 121 as the central segment 101 is moved to the right.

Upon further rotation of cranks 117 and 119, the central segment 101 is moved along an arcuate path towards the lower left-hand side of the guide member 121, while the two outer segments 106 are moved in an arcuate path towards the upper right hand side. When the cranks are rotated to positions displaced 270° from their starting positions, the segments 101 and 106 are brought to their operative positions shown in FIG. 6 wherein articles 102a and 102b are contained within notches 126a and 126b of the segments 106 and are rolled towards the right along the guide member 121.

When the cranks 117, 119 make one complete rotation, both movable segments 101 and 106 are brought to their operative positions shown in FIG. 7 wherein the relative position of the segments 101 and 106 is exactly the same as that shown in FIG. 3, but the articles 102a and 102b are taken out from the notches 104a and 104b of the central segment 101 and placed within the notches 104c and 104d of the same segment 101 located two pitches ahead of the notches 104a and 104b.

By the repetition of the above described cycle of operation, the articles supplied to the left-hand end of the movable segments 101 and 106 at a rate of one article per one half revolution of the cranks 117 and 119, can be transferred sequentially towards the right at a speed equal to two pitches of projections 105 and 108 per each revolution of the cranks 117 and 119.

As above described, movable segments 101 and 106, reinforcing members 112 and 115 and crank arms 118 and 120 are moved in unison along circular paths identical to those of cranks. It is thus seen that as the cranks perform a constant-speed circular motion, the speed of the articles 102 contained in the notches 104 and 126 and rolling along the guide member will change sinusoidally. More particularly, when central segment 101 and two outer segments are aligned with each other as shown in FIG. 3, the moving speed of the articles will be reduced to zero, whereas in the operative position of the segments shown in FIG. 4, which is 90° advanced from the position shown in FIG. 3, the speed of the articles will be increased to a maximum. The speed is reduced again to zero when the segments 101 and 106 are again aligned with each other as shown

in FIG. 5. This mode of the speed change of the moving articles is repeated each time the cranks are rotated one half revolution.

Where it is desired to increase or decrease the passage time interval of the moving articles through their low speed zone around their stop positions, a known periodic speed change means 128 comprising an eccentric shaft or a cam is provided between the prime mover 127 and the crank shafts 116, thereby varying periodically the crank speed as desired at a frequency of one half revolution of the crank shaft.

As will be noted from the foregoing, since according to the invention, the central segment and the two outer segments arranged in parallel with each other are subjected to the circular motions at different phases so as to transfer the articles placed on the guide member on the central segment through the medium of the notches formed on both segments, the article 102a on the center segment 101 as shown in FIGS. 3 to 7 will be still contained in the same notch 104a when the segment 101 is moved a distance equal to the crank diameter while cranks 117 and 119 are rotated 180°. Since outer segments 106 are moved along similar circular paths upon completion of one revolution of the cranks, the article 102a so far contained within the notch 104a is now transferred into notch 104c located two pitches ahead of notch 104a, thus effecting efficient transfer.

Moreover, as a circular motion is imparted to the central and two outer segments through the crank arms from the crank mechanism arranged above these segments, even in the environment wherein the segments are exposed to a high temperature or corrosive atmosphere, the crank mechanism can be well protected by placing it spaced from the segments.

For this reason, it is possible to fabricate the crank mechanism with cheaper materials.

In addition with the novel transfer apparatus, articles are transferred continuously and sequentially with fixed intervals therebetween and since the contact points between the articles and guide member and the projections vary continuously, the present transfer apparatus may be used advantageously in applications where the surface of the articles is required to be treated uniformly as in plating, coating, washing, drying and shot-peening operations. The present apparatus is especially suitable for a plating operation, because the guide member can be used as a cathode electrode.

While in the above described embodiment, both the center and outer segments are rotated by the crank mechanism for transferring elongated articles, it will be clear that the central segment may be stationary and both of the outer segments may be rotated.

FIGS. 8 through 17 show a modification wherein only the outer segments are rotated.

Referring to FIGS. 8 to 17 inclusive, reference numeral 201 denotes a stationary central segment comprising an elongated rectangular bar 203 having a width about one half the length of the articles 202 to be transferred, such as small screws or the like. The bar 203 is provided with equally spaced apart notches 204 having a width slightly smaller than the diameter of the article on both upper side edges, thus defining a series of projections 205 in the shape of combs, the teeth of the combs having a constant pitch. On both sides of the stationary central segments 201, there are provided two

movable outer segments 206 with a small gap therebetween. Each one of the movable segments 206 comprises a rectangular bar 207 having the same length as and a smaller thickness than the central segment 201. The inner upright flanges facing the central segment 201 are provided with equally spaced apart comb-like projections 208 of the same spacing as projections 205 on the central segment 201. Each segment 207 is also formed with a series of stopper projections 211 on the opposite side and in the positions corresponding to the notches 209 between adjoining projections 208. The upper end of each projection 211 is slightly bent outwardly as shown in FIG. 9.

The central segment 201 has two or more bearing lugs 212 on its lower surface for receiving bolts 213 extending at right angles with respect to segment 207. The opposite end of the bolts 213 are secured to reinforcing members 215 which in turn are supported by fixed supporting members 214.

Two outer segments 206 are also formed with bearing lugs 216 on their lower surfaces for receiving bolts 217 having shorter lengths than bolts 213 for the central segment 201. Bolts 217 are arranged in parallel with bolts 213 and are secured at both ends to movable reinforcing members 218 arranged inwardly of an in parallel with reinforcing members 215. Above the segments 201 and 206, there is provided a crank mechanism comprising a pair of crank shafts 219 and two circular disc shaped cranks 220 eccentrically secured thereto and having downwardly extending crank arms 221, the lower ends of which are secured to the reinforcing members 218. The crank shafts 219 are arranged in parallel with bolts 213 and 217 and are driven in the same direction.

The eccentricities of cranks 220 from the center of crank shafts 219 are slightly smaller than the pitch of the projections 208 and 205 on segments 206 and 201. The spacing between the adjoining projections 208 and 205 or the width of notches 209 and 204 is selected to be about three-fourths the diameter of the article 202 to be transferred, so that the latter is supported stably by the confronting edges of the adjoining projections.

The operation of this second embodiment is as follows. The articles 202 to be transferred are supported horizontally in the upper portions of the notches 204 and 209 of the stationary central segment 201 and the two outer segments 206 by means of the edges of the adjoining projections defining such notches.

Articles 202 shown in FIG. 8 as positioned above notches 204 and 209 are supplied sequentially from one side, for example the left hand side as viewed in FIG. 8 when the apparatus is started. These articles are then transferred sequentially towards the right by the circular movements of the outer segments by rolling over projections 205 and 208.

FIGS. 11 to 15 show various steps of transferring the articles 202. In FIG. 11, projections 205 of segment 201 and the projections 208 of outer segments 206 align with each other. For the sake of description, this position is assumed to be the starting point or zero angle of rotation of the crank shafts. When crank shafts 219 are rotated in the clockwise direction as shown by arrows in FIG. 8, the outer segments 206 are moved towards the upper right-hand side as shown by dotted lines in FIG. 12 while carrying articles 202a and 202b

in the notches between their projections 208. Thus, the articles 202a, 202b which have been contained in notches 204a and 204b of the central segment 201 in the step shown in FIG. 11 are now moved towards the right. At this time, the angular positions of articles 202a and 202b in notches 204 and 209 are not varied so that these articles 202a and 202b will be transferred towards the right as they are carried by the edges of the adjoining projections 208 of the outer segments 206 while maintaining the same angular positions as before. Further rotation of crank shafts 219 lowers the projections 208 of outer segments 206 concurrently with shifting them towards the right, as indicated by the dotted lines in FIG. 13. Angular positions of articles 202a and 202b are still the same as those in FIGS. 11 and 12. As the outer segments 206 are further lowered until the upper ends of projections 208 attain the same level as those of projections 205 of the central segment 201, projections 205 of the central segment 201 and projections 208 of the outer segments 206 do not align, because as above described the eccentricities of cranks 220 are selected to be less than the pitches of projections 205 and 208. It will thus be seen that articles 202a and 202b are carried temporarily by the one edge of the projections 205 of the central segment and the one edge of the projections 208 of the outer segments, so that the articles 202a and 202b are supported in relatively narrow gaps 204b and 204c at a slightly higher level. At this time, articles 202a and 202b are slightly rotated because they are now supported by one edge of projections 208 and by one edge of projection 205. As the outer segments 206 are further lowered until the upper ends of projections 208 become lower than the upper ends of projections 205, the edges of projections 208 of movable outer segments which have been supported the articles are also lowered as shown in FIG. 14. As a consequence, articles are now supported entirely by the edges of the projections 205 of the central segment, and are positioned within notches 204b and 204c as shown in FIG. 15 at angular positions different from those shown in FIG. 11 wherein they are disposed within notches 204a and 204b. The movable segments 206 are further moved towards the lower left-hand side from the position shown in FIG. 15 and then raised through their lower dead centers to the positions shown in FIG. 11 thus completing one cycle of operation.

Through the repetition of the above described operation, elongated articles which are supplied to the extreme left end of the apparatus at a rate of one article per one revolution of the crank shafts are continuously and sequentially transferred towards the right at a rate of one pitch of the projections per each crank shaft revolution, while the contact points thereof with the movable and fixed segments are constantly varied as they are transferred a distance equal to one pitch.

When it is desired to increase as much as possible the time interval in which the peripheral surfaces of the articles are exposed to surrounding atmosphere, a conventional intermittent driving mechanism or a periodic speed change mechanism may be arranged between the crank shafts 219 and the prime mover 222 so as to increase the time interval during one complete revolution of the crank shafts in which the movable segments 206 are lowered to disengage from the articles being transferred. Instead of solid projections 205 and 208

described above, they may also, be formed with central openings as shown in FIG. 16, or they may be formed from bent wire pieces as shown in FIG. 17.

According to this modified embodiment, as the eccentricity of crank 220 is made slightly less than the pitch of projections 205 and 208, it is possible to gradually vary the contact points between the article and the projections, thus gradually rotating the article about its axis as it is advanced a distance equal to the pitch. Moreover, since the articles are supported by the point contacts afforded by the edges of the projections 205 and 208 substantially all peripheral surfaces of the articles can be exposed to the surrounding atmosphere. This feature coupled with the above described incremental rotation of the article makes the novel apparatus suitable to uniform surface processing operations, such as continuous plating, coating, washing, drying and shot-peening operations.

In addition, on account of the provision of stopper means 211 on the movable segments 206 on opposite sides of their notches 209, the articles carried by projections 208 are positively prevented from displacing laterally and dropping off from between said projections, thus assuring a smooth and continuous transfer and processing operation.

What is claimed is:

1. A transfer apparatus for continuously transferring an elongated article, comprising:

- a stationary central segment having two spaced apart parallel rows of comb-shaped projections of uniform pitch to define notches between adjacent ones of said projection;
- outer segments disposed on both sides of said central segment and having respective rows of comb-shaped projections similar to those of said central segment, said projections of said outer segments being provided on the sides of said outer segments close to said central segment, said projections of said central and outer segments receiving said article in the notches between said projections;
- stop members provided for said outer segments on the sides thereof opposite said central segment at portions corresponding to the notches between projections of said outer segments; and
- a crank drive mechanism separated from and coupled to said outer segments by means of crank arms for imparting a circular motion thereto, said crank drive mechanism comprising two pairs of cranks each pair being mounted on respective separate drive shafts, and said crank drive mechanism having a predetermined eccentricity related to the pitch of said projections.

2. The transfer apparatus as claimed in claim 1 wherein said projections of said central segment are dephased 180° with respect to said projections of said outer segments and wherein said eccentricity of said crank mechanism is equal to one half of said pitch so as to transfer one article per one revolution of said crank mechanism.

3. The transfer apparatus as claimed in claim 1 which further comprises a strip shaped guide member positioned between said rows of said projections, said guide member serving to transfer said article while imparting rolling to said article.

4. The transfer apparatus as claimed in claim 3 wherein said strip shaped guide member is stationary.

5. The transfer apparatus as claimed in claim 1 which further includes a periodic speed change mechanism associated with a drive shaft of said crank mechanism, said periodic speed changing mechanism varying the rotational speed of said crank drive shaft at a period of one half revolution, thereby adjusting the pass time of said article in its low speed zone about the stop position thereof.

6. The transfer apparatus as claimed in claim 1 wherein the eccentricity of said crank mechanism is smaller than half the pitch of the projections of said outer segments.

7. The transfer apparatus as claimed in claim 1 wherein said stop members are integrally formed with said outer segments.

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