ABSTRACT: Rotary indexing table is provided with uniformly arcurately separated sequence of dependent drive pins located on theoretical circle radiused from center of table. Table is rotated stepwise by timed intermittent advance of successive pins by electric motor driving the present alternating drive and lock mechanism. Succession of (nonconsecutive) pins alternately have (for example) No. 1 pin advanced an arcuate segment (thereby turning table by this amount), then No. 3 pin held during dwell period, then No. 2 pin advanced a like segment, then No. 4 pin held, etc. Pin-engaging mechanism underlying table top comprises (a) constantly rotating motor-driven arm radiused from outside circle of pins with its distal end inscribing an arc thereacross, the arm pivotally, distally carrying an open top, open-ended channel wherein (each successive) No. 1 pin is received, moves reciprocably lengthwise to the channel due to the movement of the laterally embracing channel walls, and then emerges from the same end of the channel, during the course of a fractional rotation of the drive arm. During remainder of arm's continuous rotation, linkage connected to rotary arm and comprising (b) bellcrank, fulcrumed at point outside of circle of drive pins, terminally carries arcuate open top channel in which it receives No. 3 pin in the channel; by rocking or reciprocable movement of the arcuate channel, it locks the pin and table against movement during dwell period. Upon release of No. 3 pin from mouth of arcuate, bellcrank channel, the rotating drive arm immediately picks up (next) No. 2 pin in its pivoted straight channel, in repetitive sequence. Direction of table movement is reversible by reversing the motor. Additionally, by means of another bellcrank-activated lifting arm and cam drive from the same drive shaft which carries the radial arm, a central toolplate or platform may be raised and lowered synchronously with each arcuate advance of the table, the timing of which is adjustable simply by rotating the cam.
REVERSIBLE INDEXING MECHANISM

This invention relates to indexing tables; these are rotary platforms used in automated assembly operations and the like, the tables being revolved by a drive mechanism which produces intermittent or stepwise arcuate movement of the table. There is a pause or dwell period between each step, so that a person located at a work station can perform some task on each successive workpiece which the table momentarily brings in front of him. Or the operation may be completely automated so that another mechanism acts on the workpiece at each stop at that station. Likewise, each segment of the circumference of the rotary table may constitute a separate work station; that is, if the table makes 12 stops in one rotation, it may service 12 work stations, each performing a different operation in sequence.

Indexing or drive mechanism used to obtain such interrupted movement from a continuously rotated drive shaft, in the past has included various cam, ratchet and pawl, geneva, and other mechanisms. Many such mechanisms were relatively complicated and had various disadvantages such as failure to effect a firm hold during the dwell period, inability to produce direction reversal, reliance on oscillating movement to effect a timed advance of the table, etc.

Accordingly the present invention provides a new and improved indexing mechanism which is comparatively simple in construction, having low frictional drag so as to accommodate variable speeds, capable of direction reversal at will (simply by reversing the motor or drive shaft), and effecting a positive locking action during the dwell period. In addition, a vertically reciprocating (central) platform or surface is provided which moves synchronously with the intermittent movements of the rotary table. Such accessory platform(s) can cooperate to supply or remove a necessary element or tool in relation to the workpiece at successive stations. For example, transport to or from the platform can be effected by blower or vacuum line; and movement of the platform may serve to meter and deliver (as from an overhead hopper) a unit at each pause of the rotary table.

In brief, such an annular table is provided with a circle of arcuately spaced apart contact elements such as dependent pins which are located on a circle radiused from the rotary axis of the table. The number of such drive pins (e.g. 12) corresponds to the number of pauses or stops which the table will make in a complete revolution; this may correspond to the number of work stations or be greater than the number of stations A (vertical) rotary drive shaft is located outside the circle of drive pins and carries a constantly rotating arm, part of whose path overlies the circle of pins. As noted in the preceding abstract, the drive arm forms part of a composite mechanism which spadelessly underlines the tabletop so as to make contact with individual pins of said circle in a particular sequence which produces an alternate drive and hold for the table without oscillating movement of the drive element.

The pusher or propelling element may be considered to be a straight, open top and open-ended channel or guide element pivotally carried by the outer end of the rotating arm in such position that when it is tangent to the circle travelled by its pivot point, one end of the channel embraces a drive pin and then moves its channel length therealong so as to eject the pin therefrom (after reciprocal movement of the channel) when the rotating arm has arcuately moved a predetermined segment (e.g. 120°) of a circle; such movement has thereby advanced the drive pin and table by one step or segment (e.g. one-twelfth) of its own circumference.

Desirably the contacted portion of the drive pin is freely rotatable on its own axis when within the pivoted guide channel, and it thereby turns with the channel. The channel is tangent to the circle at both entry and exit of the pin; between these two positions it has moved from one side of the drive circle to the other so as to change its angle 180° (i.e. two right angles) relative to the radial arm. The channel itself, while pivoted to the radial drive arm, is fixedly carried by a linkage or intermediate arm which is distally pivoted to a bellcrank. The latter is fulcrummed to a fixed point (i.e. not to the movable tabletop) with its terminal end forming a second radial arm and carrying an arcuate guide element or channel which by rocking movement from the bellcrank pivot point, oscillatingly engages another drive pin during the dwell period (while the radial drive arm turns 240° in the above example), thus locking the table against rotation during this period. Since the pivot points for the bellcrank and for the radial drive arm are both located outside the circle formed by the drive pins, and are stationary in contrast to the rotating tabletop, the arc followed by the guide element of the outer end of the first radial arm in pushing a drive pin, thus measures the chord of the arcuate distance moved by a drive pin at each intermittent step.

In addition, a vertically reciprocable central platform is synchronously movable with each stepwise movement of the rotary table. This is effected by a lifting arm horizontally connected to the central post, which arm is carried by one arm of a bellcrank, the other arm of which by a throw rod is rocked by an eccentric cam as the latter is rotated by the drive shaft simultaneously with the radial drive arm. Changing the rotational position of the cam serves to adjust the up and down timing or sequence of the central platform relative either to the dwell period or to rotation of the table.

A presently preferred embodiment of the invention is here illustrated by the example of the accompanying drawings wherein.

FIG. 1 is a top plan view of a rotary table operated by the present intermittent drive and lock mechanism, with part of the tabletop and all of the central platform broken away to show the mechanism beneath.

FIG. 2 is a vertical section and elevation taken along the staggered line 2—2 of FIG. 1, with a portion broken away.

FIG. 3 is a vertical axial sectional view taken along the line 3—3 of FIG. 1 with portions in elevation.

FIGS. 4 and 5 are transverse sections taken through the center post and showing the mechanism at different positions, FIG. 4 with a drive pin being moved by reason of its engagement with the straight channel, and FIG. 5 with another drive pin being held against table rotation by reason of its engagement in the arcuate channel.

The present operating mechanism for the rotary table is mounted on a generally horizontal shelf or base B which may be placed on a floor or elevated therefrom as convenient. An electric motor M is supported on the base, with its horizontal drive shaft 10 (FIG. 1) carrying a pulley 12 which is connected to another pulley 14 by a drive belt 16. The pulley shaft 18 drives reduction gears in housing 20 from which a takeoff or drive shaft 22 projects vertically upward. A radial arm 24 is fixed to the drive shaft by a clamping bolt 26 which draws together the split end of the arm. It will be seen that the actuating arm 24 rotates in an endless horizontal circle above the top of the gear housing 20 and spaced beneath the flat top or work surface S of the rotary table, which surface extends outward from a central bearing collar 27 so as to overlie the operating mechanism.

Pivoted to the outer or distal end of the actuating arm at 28 is a horizontally flat, intermediate arm or link 30 which along the upper face at its pivoted end 28 carries the first guide element or means in the form of an elongated, open top and open-ended, straight channel 32. The underface of the tabletop S has a ring of downwarly projecting contact elements or drive pins P (here 12 in number), arcutely spaced apart equidistant along a theoretical circle which is centered at the rotational axis X of the rotary top S. Desirably the dependent portion of each contact pin P has a freely rotatable outer sleeve 34 which is secured to the table S by an upward directed shaft or screw 35 which may extend through the rotary surface to receive the nut 37 (thereabove (Bush or counter sunk as desired). The outer circumference of the sleeve 34 is such as to be receivable in sliding contact between the parallel sidewalls 31, 33 of the channel 32 as the channel length is drawn downward starting at the mouth A, as the actuating arm rotates through an arc or segment of a circle. During such ar-
The arcuate movement of the radial arm 24, the channel which embraces the pin P (which cannot change its position on the rotary table) is caused by the movement of the pin 28, but the pin (and table) are simultaneously being pushed along the line of travel by the rotating arm 24 (and its guide channel 32).

When the drive pin enters the channel mouth A, the channel is momentarily tangent to the circle described by the rotating pivot point 28; the two arms 24 and 30 are perpendicular to each other. When the pin P later emerges from the mouth end of the channel, the latter is again tangent to the circle and the two arms 24 and 30 are perpendicular along their opposite edge. That is, the radial arm 24 (at its outer pivot point 28) has traveled through an arc of its own circumference, which cuts an arc of the circle formed by the circle of drive pins P; the rotary table has thereby been advanced by the distance of this latter arc since the distal end of the rotary arm carries the drive pin with it (within the guide channel which moves reciprocally relative to the pin). During the remainder of each complete rotation of the radial arm 24, that is, when the channel pivot point 28 is outside the circle of drive pins P, the channel is disengaged from all pins; this is the dwell period of the table. As here illustrated this overlapping arc or drive period of the rotary arm is 120° of its rotation, and the compound dwell period is 240°. However, this ratio can be changed by adjustment of the length of the radial arm 24, as long as the channel mouth A is located tangent to the circle of pivot point 28, at both the entry and exit positions of the drive pin P. The rotation of the channel relative to the pin moving lengthwise within it, is accommodated by the freely rotatable, outer sleeve 34 of the pin P.

The distal end of the intermediate arm 30 is pivotally connected at 36 to one end of a bellcrank D which fulcrums at 38 upon a ball bearing carried atop a post 39. The post is anchored to a bracket arm 40 which projects laterally from the outer end of a generally radially directed support wall 42 which extends outward beneath ledge 43 from the tubular center post 44 of the table. The distal end of the bellcrank D forms a second radial arm and carries a second guide element or oscillating lock means disposed to hold the surface S by rollingly engaging successive drive pins P during each dwell period that the particular leading (or following—depending upon the direction of rotation) drive pin is out of the first guide element or channel 32. Such lock means, which is continually in motion by its connection to the continuously rotating radial arm 24, consists of a transverse, arcuate-shaped, open-end channel having an open end or mouth 46 and an inner end positioned to receive successive drive pins P which (by movement of the channel 46 itself) travel to the end 48 and then return to the mouth 47. Thus during the pin-disengaged or dwell period of each rotation of the radial arm 24, the arcuate guide channel 46 fixedly carried by the second radial arm which forms part of the bellcrank D makes one oscillation, moving its channel 46 lengthwise along the drive pin P which is received therein the instant that another drive pin is disengaged by the straight channel 32. The arcuate curvature of the channel 46 is radiused from the fixed pivot point 38 (which also, like the drive shaft 22, is outside of the circle of pins P); hence the distance of the contacted pin within the channel 46, from the fixed pivot point 38 does not change during oscillation of the bellcrank. Therefore the pin within the channel 46 (and its attached rotary table S) is securely held during this dwell period, without interfering with the constant rotation of the primary drive shaft 22 and without slippage or backlash in the table. Thus it will be seen that the short arm of bellcrank D forms an oscillating arm (which during reciprocable swings of its arcuate channel or guide 46 slidingly holds one contact drive dwell period) which can move between a fixed arcuate channel or guide of contact elements, thereby to lockingly restrain said last contact element and the support structure during such moving engagement.

Within the tubular center post 44 of the table, centered by lower (FIG. 3) and upper (FIG. 2) bearing rings 45, 49, is a vertically reciprocable, cylindrical post X occupying the rotational axis of the table. A central platform or plate 50 is mounted atop the post by means of an attachment collar 51 and clamp screw 52, plus vertical anchor screws 53. Simultaneous with each arcuate advance of the table S, the post X is moved vertically up and down by a horizontal lifting arm 54 which projects through a side opening 41 in the tubular post 44 with its end inserted in a transverse socket 55 of the post and fastened by a screw 56. The outer end 57 of the lifting arm is slidingly held in a vertical slot 17 of an upright guide plate 29 which extends laterally from the support wall 42. Intermediate the length of the lifting arm 54, the arm is journaled in a hanger 66 which is suspended by pivot 60 from the horizontal arm 58 of a bellcrank 59 on a horizontal shaft 67, with its other arm 61 terminally secured to one end of a throw rod 62. The other end 63 of the throw rod is threaded inserted radially in a cam ring 64 which embraces an eccentric cam 65 which is rotated by the drive shaft 22. Accordingly, for each rotation of the drive shaft 22 (which both produces a dwell period and advances the rotary table S) so as to rotate said pin 28, the throw rod 62 is reciprocated lengthwise. This rocks the bellcrank 59 which moves the lifting arm 54 (together with the top platform 50) up and down once for each rotation of the primary drive shaft 22. When the intermediate arm 30 and radial arm 24 are disposed parallel and overlying as seen in FIG. 5 (mideast position), the center platform 50 is at its uppermost position, that is, raised to receive feed material or like. Alternately this sequence or correlation can be changed or reversed simply by changing the rotational position of the cam 65.

An upright, protective shield 19 may extend around the mechanism with its upper margin disposed just beneath and set back from the edge of the rotary tabletop S, and with its adjacent ends fastened together by screws 21 to upright slats 23 which may be secured respectively to the outer end of the radial support wall 42 or fastened to the top of the base B by anchorplates 25. Various modifications of the supporting structure may be made. There may be several reciprocating platforms, of various heights if desired; or in some cases these may be completely eliminated. It will be apparent that a particular configuration of table and supporting structures will be adapted to the nature of the work being programmed for performance in association therewith.

I claim:

1. Intermittent drive and lock mechanism for stepwise rotation of a rotary table and the like, comprising in combination:
   a series of contact elements arcuately spaced apart equidistant along a theoretical circle of a support structure such as a rotary table;
   two radial arms each pivoted off center to said circle upon a member which is stationary relative to said support structure, each of which radial arms distally carries a guide element adapted for movingly engaging a different one of said contact elements in alternate sequence, the first of which radial arms functions as a primary drive element for said mechanism including driving the second radial arm, and is continuously or intermittently reciprocating the support structure a step at a time by propulsion effectuated only during intermittent engagement between its guide element and successive contact elements, which engagement occurs during arcuate travel of the distal end of the first arm between ends of a segment of the theoretical circle of contact elements which ends are thus transected by its distal guide element;
   and linkage means connecting the two radial arms and adapted during the remainder of travel of said first radial arm to effect oscillating movement of the second radial arm, during which travel the guide element of the second radial arm is in moving engagement with said theoretical circle of contact elements, thereby to lockingly restrain said last contact element and the support structure during such moving engagement.
2. The mechanism of the preceding claim 1 wherein at least said first radial arm is pivoted outside the circle of contact elements so as to enable its guide element to follow an oppositely bowed arc which transects both ends of a segment of said circle of contact elements.

3. The mechanism of the preceding claim 2 wherein the guide element of said first radial arm consists of a straight channel pivotally carried by said first radial arm, and the guide element of the second radial arm consists of an arcuate channel fixedly carried by said second radial arm, each of said channels being adapted to receive successive ones of said contact elements movable therealong.

4. The mechanism of the preceding claim 1 which additionally includes vertically reciprocable means jointly operable with said primary drive element in correlation with the stepwise rotation of said support structure.

5. For operative combination with a rotary table having a generally annular series of uniformly separated contact elements adapted to move the table in an annular path by propagation of successive contact elements:
   an intermittent table driving and locking mechanism including continuously rotatable drive means, pivotally carrying adjacent its periphery, a longitudinal guide element disposed for propulsive engagement with successive contact elements during a segmental portion only of each revolution of the drive means, and acting by reciprocable lengthwise movement of the contact element therealong during said segmental movement of the drive means, whereby the rotary table is advanced a step; and
   linkage and leverage means coupled to said drive means and responsive upon further rotation of said drive means following said segmental movement, to restrain said rotary table by effecting oscillating contact generally transverse to said annular series of contact elements, with a subsequent contact element of said series.

6. The mechanism of the preceding claim 5 wherein said linkage and leverage means comprise a bellcrank, one end of which is disposable in table-restraining contact with successive contact elements, and an intermediate link pivotally connecting the other end of the bellcrank with said drive means.

7. The mechanism of the preceding claim 5 in combination with a rotary table having a generally annular series of dependent, freely rotatable contact elements which are successively engageable by said mechanism.

8. The mechanism of the preceding claim 5 wherein said linkage and leverage means includes a generally arcuate guideway disposed at the contact end of said bellcrank for oscillating contact with successive ones of said contact elements.

9. The mechanism of the preceding claim 5 in combination with a rotary table having a central platform and means for vertically reciprocating same synchronously with stepwise movement of the table effected by said continuously rotatable drive means.

10. The mechanism of the preceding claim 3 wherein said circle of contact elements is formed by freely rotatable drive pins.

11. The mechanism of the preceding claim 4 which includes means for selectively varying the sequence of vertically reciprocable movement, in correlation with stepwise rotation of said support structure.

12. The mechanism of the preceding claim 4 which includes bellcrank means having one arm coupled to said vertically reciprocable means, and throw rod means coupled to another arm of said bellcrank means.

13. A mechanism for stepwise movement of a support surface and the like, which surface is characterized by a progression of contact elements spaced apart at intervals corresponding to pauses along a line of travel of the support surface, said mechanism comprising in combination:
   an oscillating arm with one end pivotally mounted on a fixed support and its other end disposed intermittently to swivelingly contact and move arcuately along a thus-engaged contact element, thereby to restrain forward movement of said surface during a dwell period;
   a continuously rotatable drive arm having its distal end disposed during a portion of its rotation to operatively pushingly engage a successive contact element to move said surface along the line of travel following a dwell period;
   and linkage means connecting both said arms and adapted to synchronize their alternate engagement of successive contact elements respectively during dwell and travel periods concerned with continuous rotation of said drive arm.

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It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 45, there should be a period before "A". Column 3, line 17, "are" should read -- arc -- . Column 6, line 41, "concerned" should read -- concurrent -- .

Signed and sealed this 17th day of October 1972.

SEAL)
Attest:
EDWARD M. FLETCHER, JR.  ROBERT GOTTSCHALK
Attesting Officer  Commissioner of Patents