

May 5, 1964

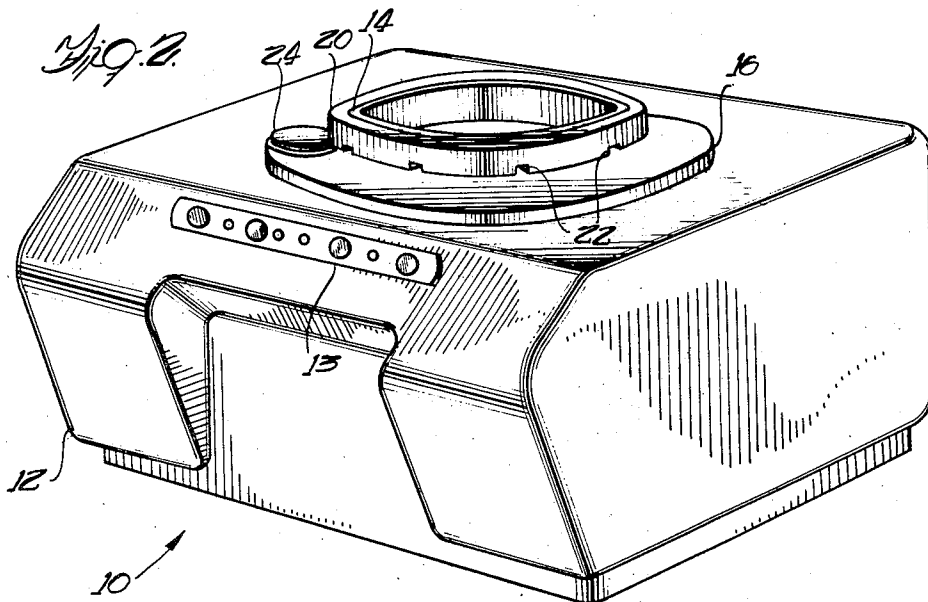
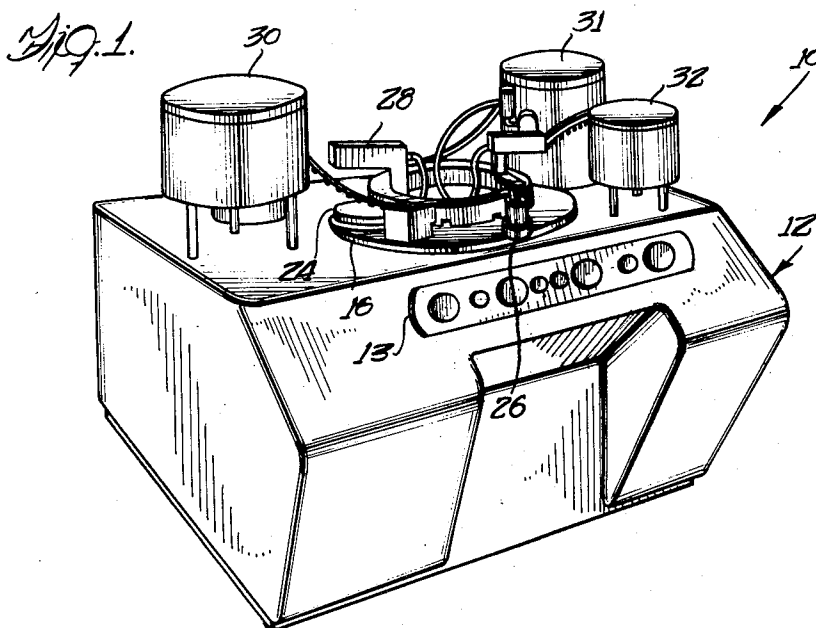
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3,131,455

MULTI-STATION PROCESSING MACHINE

Filed March 7, 1960

4 Sheets-Sheet 1



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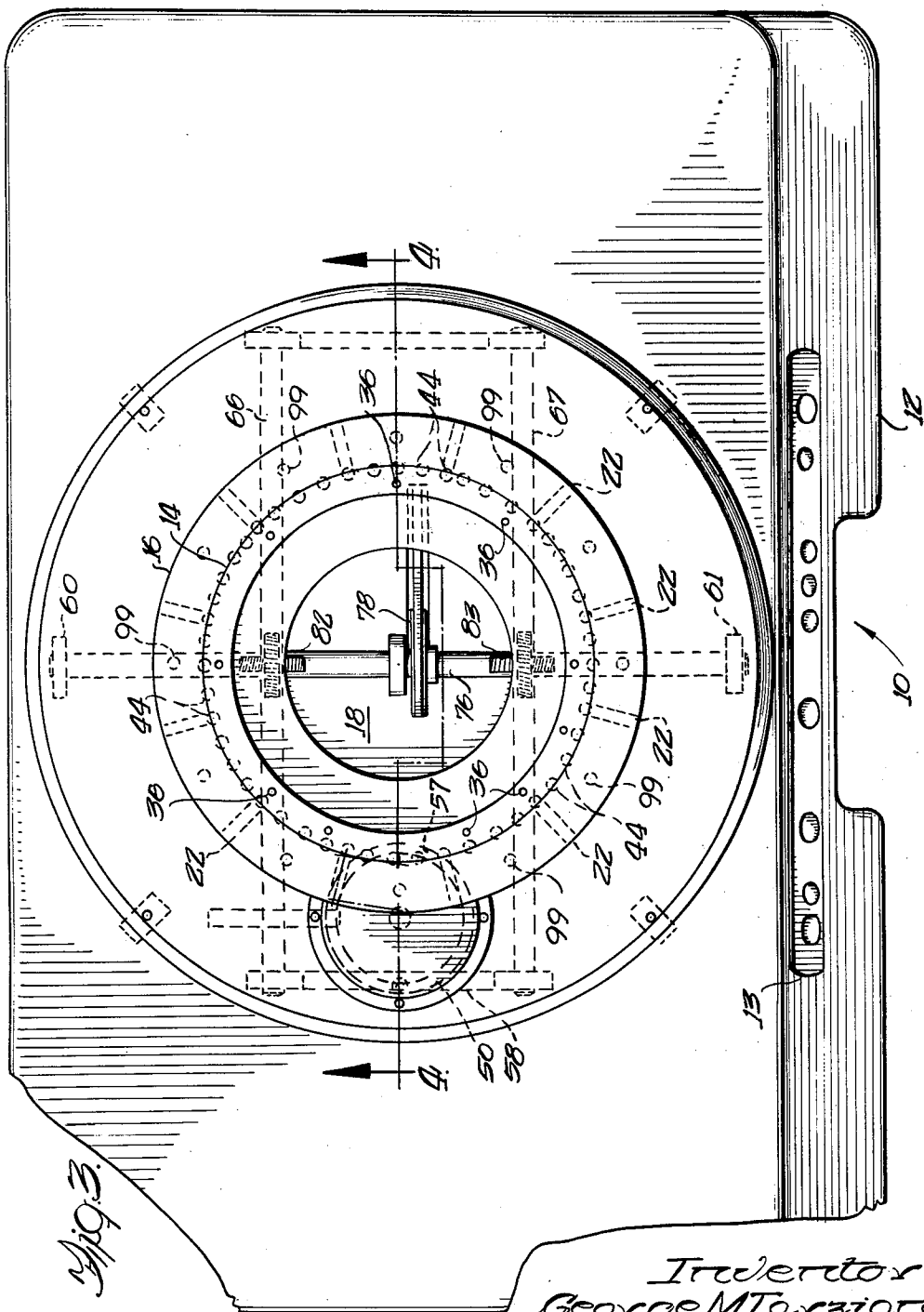
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4 Sheets-Sheet 2



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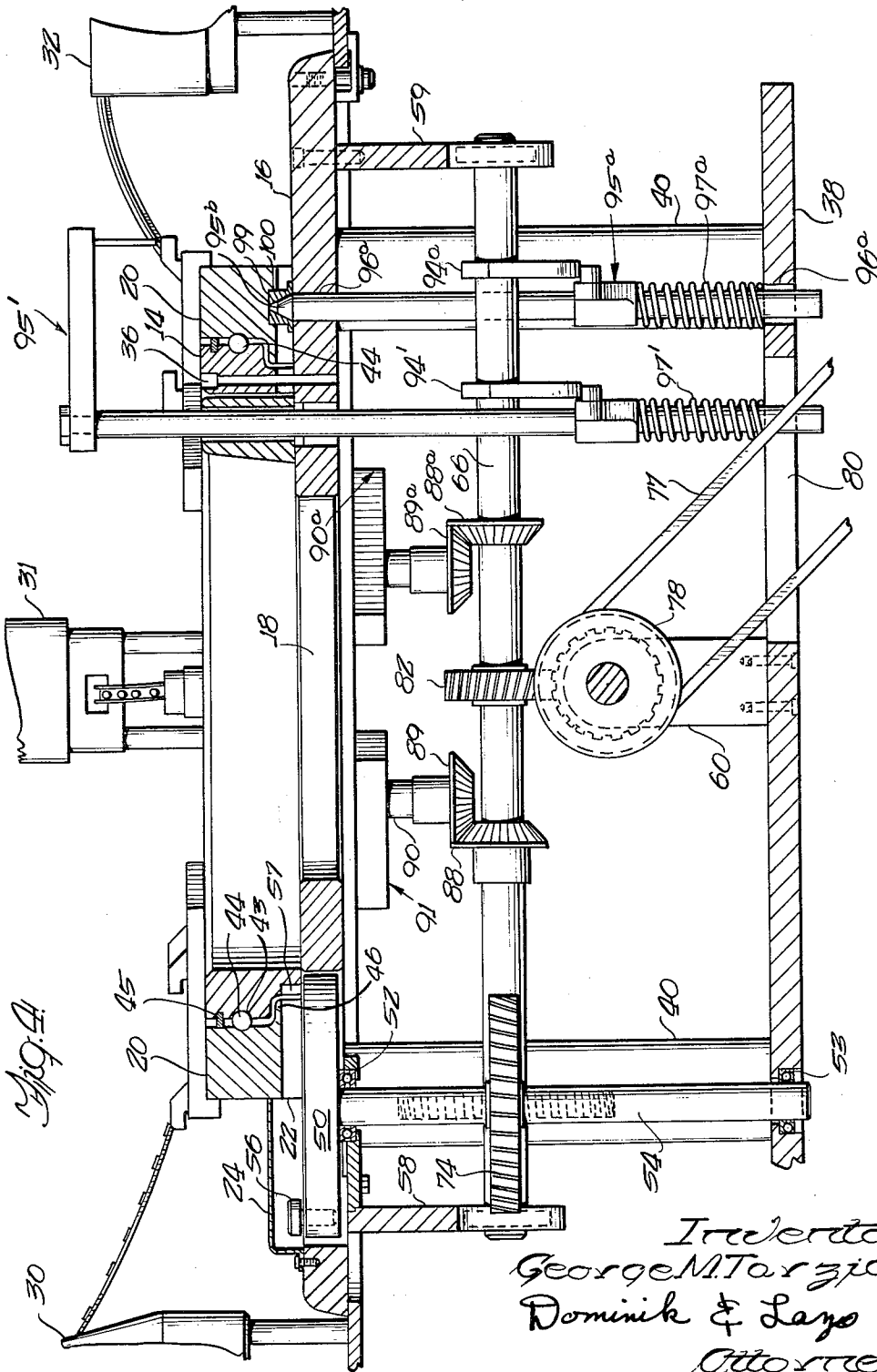
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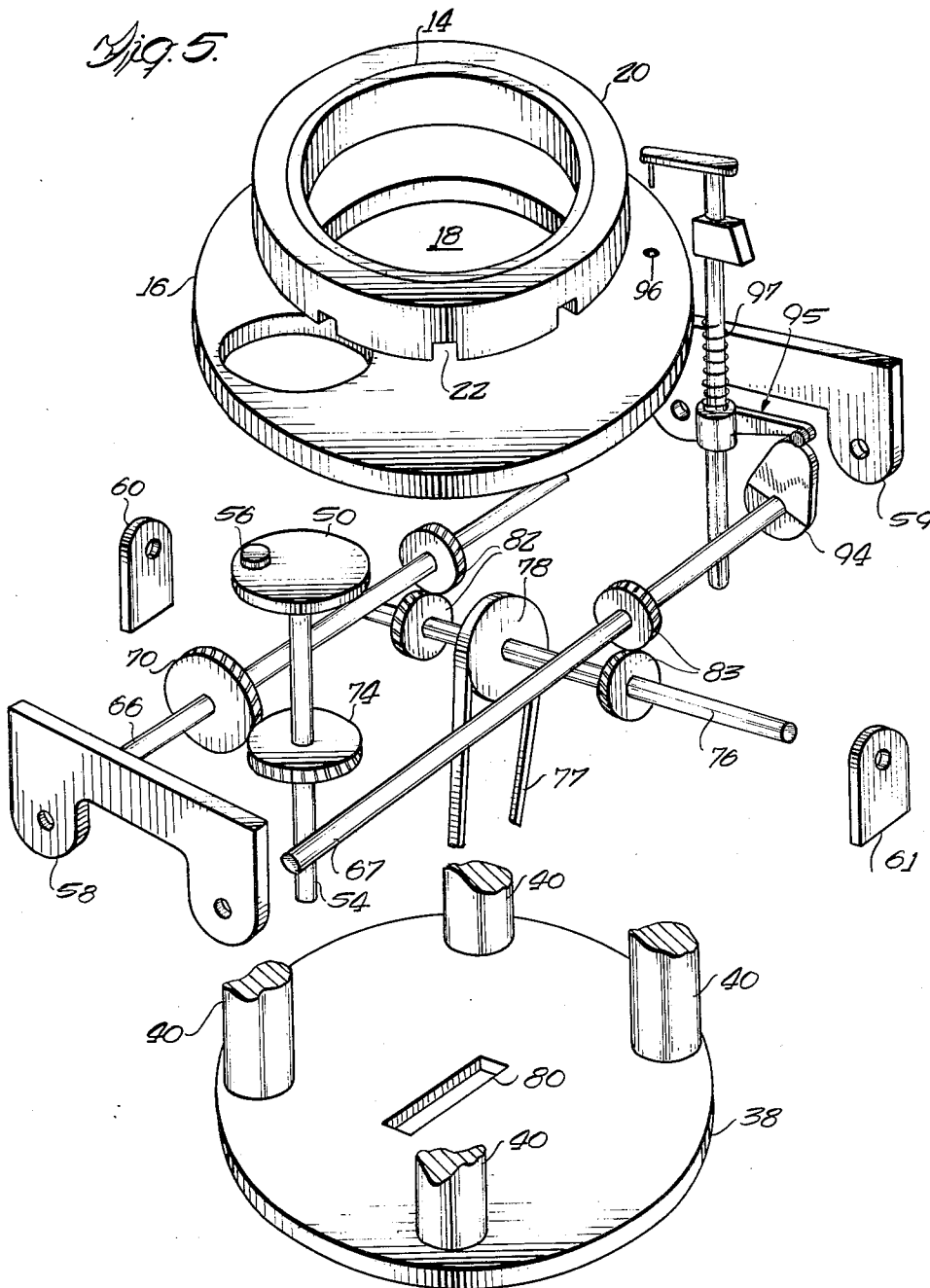
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4 Sheets-Sheet 4



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3,131,455

MULTI-STATION PROCESSING MACHINE

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7 Claims. (Cl. 29—38)

This invention relates to a device for multi-station processing of work pieces. In one preferred embodiment this invention relates to improvements in a class of machinery for multi-station processing of work pieces which constitutes a basic unit that is flexible for adaptation to a wide variety of assembly or other processing setups.

One machine of this class that is known to me is described in United States Patent No. 2,903,914 issued to me on September 15, 1959 for a "Drive Mechanism for Automatic Assembly Machines." Machines of this class comprise a means for transporting work pieces past one or a plurality of working stations. It is the general object of this invention to provide improvements in machines of the class thus described.

It is also a general object of the instant invention to provide improvements in machines of the class described, which improvements provide a novel arrangement of apparatus that permits a novel positional relationship between some of the working stations relative to the ring.

One preferred embodiment of the invention includes the more specific object of providing such novel disposition of elements to the end that working stations can be disposed inside and outside of the means for transporting which preferably is a rotatable ring. It is also within the contemplation of the objects of invention to provide a machine of the class described which, by reason of this novel arrangement of elements, permits the disposition of a greater number of working stations about the working ring than the prior art machines known to me that are of similar size and capacity.

While individual different aspects of my invention present only one of the foregoing objects, it is also within the objects of my invention to include one or more of the preceding objects in combination.

One preferred embodiment of my invention contemplates a frame having an open portion with a rotatable ring surrounding the frame open portion. Drive means intermittently rotate the ring and are disposed remote from the frame open portion. The elements are arranged so that the open portion is unobstructed to the end that working stations can be disposed both interior of and exterior to the open portion.

Other objects, advantages and features will become apparent to those skilled in the art from the following specification and drawings wherein:

FIG. 1 is a perspective view of an assembled encased machine constructed according to the invention having in combination therewith a plurality of working stations.

FIG. 2 is a perspective assembly view of an encased embodiment of the invention with the working stations removed.

FIG. 3 is a top plan view according to FIG. 2 of an encased embodiment of my invention, showing within the casing certain of the novel arrangements of parts for accomplishing one or more of the objects thereof.

FIG. 4 is a cross-section of a machine constructed according to the invention taken through section 4—4 of FIG. 3 and having certain working stations representatively illustrated.

FIG. 5 is an exploded perspective view showing the positional relationship of parts within and without the casing of one embodiment of the machine constructed according to the invention.

Throughout the drawings the same reference numerals refer to the same parts.

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A preferred embodiment of a multi-station processing machine 10, constructed according to the invention is seen in FIGS. 1—3, where such machine is enclosed by a casing 12 and has a control panel 13. The control panel 13 contains a plurality of start and stop buttons and indicator lights, none of which are numerically denoted and all of which constitute conventional elements for indicating the machine to be in operation, starting and stopping it, and if desired to control and/or indicate the speed of rotation of selected elements or of an element.

As seen in FIG. 2, an annular stationary ring 14 is affixed to a work table or to upper cage plate 16 which comprises a portion of a frame assembly, the details of the latter being further disclosed below in connection with FIGS. 3 and 4. The frame, and more particularly the upper cage plate 16, has a central open portion 18 (FIGS. 3 and 4) which is most advantageously located at a central position within the frame and at a central position within the upper cage plate.

A rotating ring 20 is supported by a hereinafter disclosed bearing means with at least its upper surface (FIGS. 3 and 4) in sliding contact with the stationary ring. The ring 20 has therein a plurality of means for engaging a drive means, namely radial slots 22, which are appropriately disposed for cooperating with drive means inside the drive means cover 24 to rotate the ring 20 as required. It is to be understood that the means within 24 is for the present only broadly disclosed and will be described in further detail in connection with the remaining figures.

Turning now to FIG. 1, an external working station 26 is disposed external to the two rings 14 and 20 and is secured to the upper cage member 16 of the frame. Another working station, namely internal working station 28, is disposed inside of the two rings and is secured to the frame and preferably to both the upper and lower cage plates. Other working station components 30, 31 and 32 are supported, either from the casing 12 or more preferably from some portion of the frame. One example of working stations and of the various types of functions that can be carried out there is disclosed in my patent on a "Drive Mechanism for Automatic Assembly Machines," supra; since the details of the working stations are not any part of the invention, no further description is made herein and reference is made to my patent for representative details of these working stations and the operations capable of being carried out thereat.

In FIGS. 3 and 4 it is seen that a plurality of fasteners, such as bolts 36 are disposed in appropriately positioned bolt holes in the annular stationary ring 14 to thereby secure the latter to the upper cage plate 16, hence to frame. The bolts 36 can either engage tapped holes in 16 or, alternatively, pass through 16 where they are fitted with nuts. A lower cage plate 38 is provided and advantageously extends generally parallel to the plane in which the upper plate 16 is disposed. A suitable number of columns 40 are secured between the upper and lower cage plates, spacing them apart in parallel relationship, and providing a rigid structure. The columns 40 are attached to the respective cage plates in conventional fashion using, for example, machine screws.

The rotating ring 20 is rotatably supported from stationary ring 14, by inner and outer bearing races 42, 43 provided in the stationary and the rotating rings, respectively. The races receive therein a plurality of ball bearings 44, which support the two rings in proper positional relationship and also reduce the friction entailed during operation. The bearing 40 is prestressed by the outer ring 20. A bearing retainer is not required here, but one can be supplied where desired. The felt dirt seal 45 is preferably fitted in

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a groove in the outer ring and functions to exclude foreign matter such as chips, dirt, and the like from the bearing. The rotating ring has a radially inwardly extending flange 46 that permits the drive pin hereinafter described to move radially inwardly a proper distance to rotate the ring 20 to its next position. Alternative to the single piece construction of ring 20, it can be made in two parts, being split in half along a horizontal plane passing through the center of curvature of the outer race 43, as viewed in FIG. 4.

As best seen in FIG. 4, the drive means cover 24 is shaped to provide a shielded space over the drive means which includes: driving wheel 50 supported on a drive shaft for rotation in a recess in the upper cage plate. Radial bearings 52 and 53 rotatably support the drive shaft 54 from the upper and lower cage plates, respectively, of the frame. The drive shaft axis is such as to pass through the frame, i.e. the upper cage plate, external of the rotating ring. Thus, the drive means is remote from the stationary ring and open portion surrounded thereby. This secures the advantage that the open portion is sufficiently unobstructed that working stations can be disposed therein.

A drive pin 56 is rotatably mounted in the upper face of the drive wheel 50 at a position such that it can engage the radial slots 22 in the rotating ring when brought into appropriate kinematic juxtaposition relative thereto. It is to be noted that in the preferred embodiment the drive pin 56 is mounted on the drive wheel 50 at a radius such as to extend substantially completely underneath the stationary ring. The stationary ring is undercut at 57 to receive the drive wheel and to provide the necessary clearance for the drive pin when the machine is operating, it being understood that the radial slots 22 are appropriately proportioned for receiving the drive pin and permitting harmonic motion (as seen in FIG. 4) of the drive pin in a radial direction into and out of a slot.

At this point it would be well to define what is meant by "frame." Frame refers to the upper cage plate 16, lower cage plate 38, and the spacing means 40. Appropriate fasteners such as machine screws, Allen screws, welded and/or riveted joints are included where desired or necessary to provide a frame of the nature disclosed. The frame also includes appropriate shaft supporting members 58 and 59, in the preferred embodiment bolted by counter bored bolts to the upper cage plate, and lower shaft supporting members 60 and 61 (FIG. 5) which are secured in like manner to the lower cage plate. While these shaft support members may form a journal bearing for the shafts they receive, it is preferred that ball, roller, or even conical or roller thrust bearings be supplied to connect the respective members to their respective shafts. Due to the nature of the gearing and other positive drive members described hereinafter, it is preferable to provide a bearing capable of sustaining considerable thrust, although it is possible in some instances to design the unit to provide compensating thrust along the various shafts.

As best seen in FIG. 5, the supports 58 and 59 support between them a pair of parallel cam shafts 66 and 67. Helical gear 70 is supported as by keys (not shown) from the shaft 66, and drivingly engages a mating helical gear 74 which is secured as by keying to the drive shaft 54. The axes of the cam shafts are advantageously located in a plane parallel to the rotating ring on upper cage plate 16.

The two shafts 66 and 67 receive power from an electric motor, not shown, which drives the transmission shaft 76 disposed between the lower shaft supports 60 and 61, by means of a belt 77 which passes over a pulley 78 keyed to shaft 76 and through a slot 80 in the lower support cage 38 to engage a pulley or the like on the motor. Power is transmitted from shaft 76 through the appropriate pairs of helical gears denoted broadly as 82 and 83, to the shafts 66 and 67.

Two different means for actuating a working station

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are shown in FIGS. 3-5, respectively. In FIG. 4 a conical drive gear 88 secured on shaft 66 drives another conical gear 89 on stub shaft 90 which latter is supported from the frame by conventional bearing and pillow block means, not shown for clarity. The stub shaft 90 drives a working station, such as internal working station 28 of FIG. 1, through a transmission 91. The transmission may comprise a gear box, Geneva drive, slider crank, or other suitable subcombination for transferring and/or translating the motion of 90 into that required by the working station. Elements 88a, 89a, 90a, and 91a actuate a second working station. The conical gears are preferably keyed and secured to their shafts by conventional means.

In FIGS. 3 and 5, a cam 94 is fixed as by a key to shaft 67 and reciprocatingly actuates cam follower 95, which transmits the reciprocation to a work station external of the rotating ring, such as 32 (FIGS. 1, 4). Holes 96 are provided in the stationary ring and cage plates for reciprocatably supporting the cam follower and allowing it to pass through in order to engage and actuate the working station. Appropriate spring means 97 bias the follower against the cam. Note from comparing FIGS. 4 and 5 that the cam follower and the spring can be disposed above (FIG. 5) or below (FIG. 4) the cam and cam shaft. The cam follower 95 preferably comprises a vertical member reciprocally mounted in 96 and having a cam-engaging finger extending horizontally to engage the cam.

Corresponding elements in FIG. 4 are denoted by primed numbers, whereby a cam 94' drives a cam follower 95' which is biased against the cam by a compressed helical spring 97'.

The preceding two paragraphs describe two of many working station actuating means. The type of means employed depends on the working station function—e.g. on-off, continuous, reciprocating, rotary, etc., or any combination of these. The term "cam shaft" is used to distinguish 66 and 67 from the shafts but is not employed to limit these two shafts to only cam action, as is evident from the gearing attached thereto. Also, the working station actuators are disposed where desired along shafts 66, 67, and also on shafts 54 and 76. Other shafts can be added, to be driven by either cam shaft.

A cam actuated holding means is shown in profile in FIGS. 3 and 4. This means serves to positively secure and to hold the rotating ring 20 in the position to which it is moved by the cooperation of the drive pin 56 with the walls defining the radial slots in the bottom of the rotating ring 20. The purpose is to provide a positive holding means that is driven in synchronism with the drive means to provide a positive moving and holding of the rotating ring.

Briefly, this mechanism comprises a cam 94a secured to the cam shaft that drives a cam follower 95a that is spring biased by the spring 97a into engagement with the cam. The cam follower 97a reciprocates in synchronism with the drive wheel responsive to the cam to thereby retract the shot pin 95b from the shot pin hole 99 defined by a bushing 100 disposed in the bottom of the rotating ring 20 at a location between the radial slots. A plurality of the bushings 100 are disposed between the slots as is seen in FIG. 3. Preferably, the shot pin is tapered, as are the walls of the bushing 100. In this fashion, the shot pin is accurately guided into a precise position and positively holds the rotating ring at such of the working stations as it is moved to. In general, the cam, cam follower system of the indexing means is similar to that described for the working station actuators.

In operation, as the cam shaft 66 or 67 for that matter (as 94a and 56 can be driven from either 66 or 67 and preferably are both mounted as in FIG. 4 to be driven by the same cam shaft) rotates, the cam 94a depresses the shot pin so that it is removed completely from the bushing 100 and withdrawn downwardly at least to within the

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bearing 96a on the upper cage plate. This occurs in a fixed time relation to the approach of the drive pin 56 to the radial slot 22. The cam is contoured in such a fashion as to maintain the shot pin withdrawn during the period that the shot pin is travelling radially inwardly and then outwardly from the slot 22. During this time, of course, the rotating ring 20 turns and is indexed to a new position. As the drive pin 56 leaves the slot 22, the cam 94a directs the shot pin to return to the shot pin hole which has been placed in registry with the bearing hole 96a. In this fashion, the assembly 94a-97a, 99 at 100, comprises a means to hold the rotating ring as the latter is indexed through its various positions responsive to the driving means. Thus is provided a positive, or mechanical lock that operates in synchronism with the drive means.

The novel construction provides the open portion in the upper cage plate of the frame, and thereby permits the disposition of working stations both interior of the stationary ring in the open portion and exterior to the rotating ring. A feature of this construction is the location of the driving means 50, 54, 56, remote from the open portion, e.g. outside of the rotating ring, to leave the open portion substantially unobstructed. The actuators and shafting therefor are, of course, disposed to engage their respective stations.

The advantage secured by the novel construction is that more stations can be concentrated in a small area. Increased concentration requires fewer operators and inspectors and thus reduces labor requirements. Particularly, the ring dial feature provides a closed or circular operations path which further increases the station concentration, especially when compared to straight-line working station arrangements which require operators at almost every station.

The gearing drives 70, 74, 82 and 83, 88 to 91, 88a to 91a, and the drive means 50, 54, 56 are all positive drives. Even the cam and follower 94 and 95 are positively driven via shaft 67. The entire machine is thus synchronized to the end that the rotating ring and working stations are all actuated in a fixed and predetermined time relation. There is no danger of synchronism loss due to loss of fluid pressure as in hydraulic or pneumatic machinery. Synchronous motors are not required as the power source, because perfect constant speed is not normally required, the maintenance of the synchronism or fixed time relation being the important thing.

In operation, power as from a squirrel-cage motor, is supplied to the pulley 78 via belt 77. Any belt slippage is of no moment as to the positive drive feature because it is the positive drive after power is put in the machine, and not beforehand, that is necessary to synchronism. The transmission shaft 76 and the cam shafts are continuously rotated responsive to such power as is received at the pulley, and similarly as to additional shafting (e.g. 98). The shaft 54 of the driving means also rotates continuously and intermittently brings the drive pin 56 into engagement with the walls defining radial slots 22 to intermittently rotate or move rotating ring 20 through an arc. Meanwhile, the work stations respond to shaft rotation and work pieces are placed on the rotating ring 20 for transportation from one station to another. The intermittency of the ring 20 provides a residence time or dwell of the ring at each work station.

Although particular embodiments of the invention have been shown and described in full here, there is no intention to thereby limit the invention to the details of such embodiments. On the contrary, the intention is to cover all modifications, alternative embodiments, usages and equivalents of the drive and control mechanism for intermittent rotating work tables as fall within the spirit and scope of the invention, specification, and appended claims.

I claim as my invention:

1. An automatic processing device for multi-station

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processing of workpieces comprising, in combination, a frame having a central open portion; an annular stationary ring surrounding said central open portion and secured to said frame, a rotating ring supported radially external to said stationary ring; bearing means interposed between said stationary ring and rotating ring; a pair of parallel cam shafts beneath said rings, each said cam shaft lying in a plane parallel to said rings and external to the projection of the frame central open portion; a main drive shaft parallel with said rings and perpendicular to said cam shafts; first gear means connecting said main drive shaft to said parallel cam shafts for rotating the latter in timed relation to said main drive shaft, a rotating ring drive shaft perpendicular to the plane of said rings with its axis exterior to said rotating ring and between said parallel cam shafts; an arm at the end of said rotating ring drive shaft, a drive pin extending from said arm in an axial parallel relationship with said rotating ring drive shaft; means defining radial slots within said rotating ring and on its lower portion and extending to define a peripheral slot opening, the entire length of said slot means proportioned to accommodate said drive pin; and second gear means for connecting the rotating ring drive shaft to a cam shaft; the whole in such proportion that the main drive shaft is positioned beneath the central open portion and the gear means are central of the parallel cam shafts thereby reducing torsional inaccuracies and maximizing the central open area while the cam shafts drive work stations both interior and exterior to said rotating ring and fixed ring in the central open area in fixed predetermined timed relation to the indexing of the rotating ring.

2. An automatic processing device for multi-station processing of workpieces comprising, in combination, a frame having a central open portion; an annular stationary ring surrounding said central open portion and secured to said frame, a rotating ring supported radially external to said stationary ring; bearing means interposed between said stationary ring and rotating ring; a pair of parallel cam shafts beneath said rings, each said cam shaft lying in a plane parallel to said rings, and external to the projection of the frame central open portion; a main drive shaft parallel with said rings and perpendicular to said cam shafts; first gear means connecting said main drive shaft to said parallel cam shafts for rotating the latter in timed relation to said main drive shaft, a rotating ring drive shaft perpendicular to the plane of said rings with its axis exterior to said rotating ring and between said parallel cam shafts; a wheel at the end of said rotating ring drive shaft, the upper face of which rotates adjacent the lower face of said rotating ring; a drive pin extending from the face of said wheel in an axial parallel relationship with said rotating ring drive shaft; means defining radial slots within said rotating ring and on its lower portion and extending to define a peripheral slot opening, the entire length of said slot means proportioned to accommodate said wheel drive pin; and second gear means for connecting the rotating ring drive shaft to a cam shaft; the whole in such proportion that the main drive shaft is positioned beneath the central open portion and the gear means are central of the parallel cam shafts thereby reducing torsional inaccuracies and maximizing the central open area while the cam shafts drive work stations both interior and exterior to said rotating ring and fixed ring in the central open area in fixed predetermined timed relation to the indexing of the rotating ring.

3. An automatic processing device for multi-station processing of workpieces comprising, in combination, a frame having a pair of parallel cage plates vertically spaced, the upper cage plate having a central open portion; an annular stationary ring surrounding said central open portion and secured to said upper cage plate, a rotating ring supported radially external to said stationary ring; bearing means interposed between said stationary

ring and rotating ring; a pair of parallel cam shafts beneath said rings, each said cam shaft lying in a plane parallel to said rings and external to the projection of the frame central open portion; a main drive shaft parallel with said rings and perpendicular to said cam shafts; first gear means connecting said main drive shaft to said parallel cam shafts for rotating the latter in timed relation to said main drive shaft, a rotating ring drive shaft perpendicular to the plane of said rings with its axis exterior to said rotating ring and between said parallel cam shafts; an arm at the end of said rotating ring drive shaft, a drive pin extending from said arm in an axial parallel relationship with said rotating ring drive shaft; means defining radial slots within said rotating ring and on its lower portion and extending to define a peripheral slot opening, the entire length of said slot means proportioned to accommodate said wheel drive pin; and second gear means for connecting the rotating ring drive shaft to a cam shaft; the whole in such proportion that the main drive shaft is positioned beneath the central open portion and the gear means are central of the parallel cam shafts thereby reducing torsional inaccuracies and maximizing the central open area while the cam shafts drive work stations both interior and exterior to said rotating ring and fixed ring in the central open area in fixed predetermined timed relation to the indexing of the rotating ring.

4. An automatic processing device for multi-station processing of workpieces comprising, in combination, a frame having a pair of vertically spaced parallel cage plates, the upper cage plate having a central open portion; an annular stationary ring surrounding said central open portion and secured to said frame, a rotating ring supported radially external to said stationary ring; bearing means interposed between said stationary ring and rotating ring; a pair of parallel cam shafts beneath said rings, each said cam shaft lying in a plane parallel to said rings; a main drive shaft parallel with said rings and perpendicular to said cam shafts; first gear means connecting said main drive shaft to said parallel cam shafts for rotating the latter in timed relation to said main drive shaft, a rotating ring drive shaft perpendicular to the plane of said rotating ring with its axis exterior to said rotating ring and between said parallel cam shafts; an arm at the end of said rotating ring drive shaft, a drive pin extending from said arm in an axial parallel relationship with said rotating ring drive shaft; means defining radial slots within said rotating ring and on its lower portion and extending to define a peripheral slot opening, the entire length of said slot means proportioned to accommodate said wheel drive pin; and second gear means for connecting the rotating ring drive shaft to a cam shaft.

5. An automatic processing device for multi-station processing of workpieces comprising, in combination, a frame having a pair of vertically spaced parallel cage plates, the upper cage plate having a central open portion; an annular stationary ring surrounding said central open portion and secured to said frame, a rotating ring supported radially external to said stationary ring; bearing means interposed between said stationary ring and rotating ring; a pair of parallel cam shafts beneath said rings, each said cam shaft lying in a plane parallel to said rings; a main drive shaft parallel with said rings and perpendicular to said cam shafts; first gear means connecting said main drive shaft to said parallel cam shafts for rotating the latter in timed relation to said main drive shaft, a rotating ring drive shaft perpendicular to the plane of said rotating ring with its axis exterior to said rotating ring and between said parallel cam shafts; an arm at the end of said rotating ring drive shaft, a drive pin extending from said arm in an axial parallel relationship with said rotating ring drive shaft; means defining radial slots within said rotating ring and on its lower portion and extending to define a peripheral slot

opening, the entire length of said slot means proportioned to accommodate said wheel drive pin; second gear means for connecting the rotating ring drive shaft to a cam shaft; and locking means actuated by one of said cam shafts acting in an axis perpendicular to said cam shaft and engaging the underneath side of said rotating ring to selectively secure the same between the indexing steps.

6. An automatic processing device for multi-station processing of workpieces comprising, in combination, a frame having a central open portion; an annular stationary ring surrounding said central open portion and secured to said frame, a rotating ring supported radially external to said stationary ring; bearing means interposed between said stationary ring and rotating ring; a pair of parallel cam shafts beneath said rings, each said cam shaft lying in a plane parallel to said rings and external to the projection of the frame central open portion; a main drive shaft parallel with said rings and perpendicular to said cam shafts; first gear means connecting said main drive shaft to said parallel cam shafts for rotating the latter in timed relation to said main drive shaft, a rotating ring drive shaft perpendicular to the plane of said rings with its axis exterior to said rotating ring and between said parallel cam shafts; an arm at the end of said rotating ring drive shaft, a drive pin extending from said arm in an axial parallel relationship with said rotating ring drive shaft; means defining radial slots within said rotating ring and on its lower portion and extending to define a peripheral slot opening, the entire length of said slot means proportioned to accommodate said wheel drive pin; second gear means for connecting the rotating ring drive shaft to a cam shaft; and locking means actuated by one of said cam shafts acting in an axis perpendicular to said cam shaft and engaging the underneath side of said rotating ring to selectively secure the same between the indexing steps.

7. An automatic processing device for multi-station processing of workpieces comprising, in combination, a frame having a pair of vertically spaced parallel cage plates, the upper cage plate having a central open portion; an annular stationary ring surrounding said central open portion and secured to said frame, a rotating ring supported radially external to said stationary ring; bearing means interposed between said stationary ring and rotating ring; a pair of parallel cam shafts beneath said rings, each said cam shaft lying in a plane parallel to said rings and external to the projection of the frame central open portion; a main drive shaft parallel with said rings and perpendicular to said cam shafts; first gear means connecting said main drive shaft to said parallel cam shafts for rotating the latter in timed relation to said main drive shaft, a rotating ring drive shaft perpendicular to the plane of said rings with its axis exterior to said rotating ring and between said parallel cam shafts; a wheel at the end of said rotating ring drive shaft, the upper face of which rotates adjacent the lower face of said rotating ring; a drive pin extending from the face of said wheel in an axial parallel relationship with said rotating ring drive shaft; means defining radial slots within said rotating ring and on its lower portion and extending to define a peripheral slot opening, the entire length of said slot means proportioned to accommodate said wheel drive pin; second gear means for connecting the rotating ring drive shaft to a cam shaft; and locking means actuated by one of said cam shafts acting in an axis perpendicular to said cam shaft and engaging the underneath side of said rotating ring to selectively secure the same between the indexing steps; the whole in such proportion that the main drive shaft is positioned beneath the central open portion and the gear means are central of the parallel cam shafts thereby reducing torsional inaccuracies and maximizing the central open area while the cam shafts drive work stations both interior and exterior to said rotating ring and fixed ring in the central

open area in fixed predetermined timed relation to the indexing of the rotating ring.

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