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## (54) IMPROVEMENTS IN OR RELATING TO WORKPIECE PROCESSING SYSTEMS

(71) We, AXIS S.p.A., an Italian Body Corporate, of Hamlet Morrocco, Tavarnelle Val Di Pesa, Firenze, Italy, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to workpiece processing systems.

According to the present invention, there is provided a workpiece processing system comprising workpiece carriages each arranged to carry a workpiece to be processed, means defining an active conveyor path passing adjacent a plurality of processing stations, means defining an endless conveyor movable along said path, said conveyor having means defining positions for the workpiece carriages to be conveyed along said path, means operative to feed workpiece carriages to predetermined positions of the conveyor, means associated with the processing stations for removing workpiece carriages from the positions for processing at the corresponding stations and to deposit the workpiece carriages into the positions after processing of the associated workpieces, said positions consisting of a plurality of groups of positions, in each said group of positions, individual positions being designated to receive workpiece carriages only of those workpieces which are at a predetermined stage in the processing operation, detecting means for detecting filled and empty positions in predetermined locations of the positions along the path, said detecting means being operable to control the operation of the workpiece carriage removal and depositing means whereby the removal and depositing means only remove workpiece carriages from and deposit workpieces into, the designated positions, and means enabling the carriages of any incompletely processed workpieces to be returned to the beginning of the active conveyor path.

Further according to the present invention, there is provided a workpiece processing system comprising an endless conveyor movable along an endless path in a hori-

zontal plane, said path passing adjacent a plurality of processing stations, removable carriages for carrying workpieces to be conveyed along said path, said conveyor having predetermined positions at which the carriages can be located, a guide track for guiding the carriages along the path, means associated with the processing stations for removing workpiece carriages from the conveyor positions for processing the associated workpieces at the corresponding stations and to deposit the workpiece carriages into the conveyor positions after processing the workpieces the predetermined positions on the conveyor consisting of plurality of groups of positions, in each said group of positions individual positions being designated to receive only carriages of workpieces which are at a predetermined stage in the process, and means for sensing the presence of filled and empty positions in specific locations of the conveyor along its path, said sensing means controlling the removal and depositing means, whereby the removal and depositing means only remove carriages from, and deposit carriages into, the appropriate designated positions.

The invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figures 1 and 2 are a schematic plan view and side elevation of an embodiment of a workpiece processing system in accordance with the invention;

Figures 3 and 4 are cross-sections to an enlarged scale, showing an endless flexible conveyor and a carriage of the system shown in Figures 1 and 2; and

Figures 5 and 6 are respectively, a vertical section and a section taken along line VI—VI of Figure 5 showing a driving and control system of the system as shown in Figures 1 and 2.

In the embodiment shown in the drawings, 101 denotes an elongate casing (see Figure 2) in which are arranged two opposed guides 103, 105 extending in a closed loop to form a continuous conveyor track lying in a horizontal plane and having two parallel rectilinear portions which are joined at the ends

by curved portions 107. Along the opposite faces of the guides 103 and 105 are located rollers 109 mounted in stationary positions to form tracks for workpiece conveying members 110 which form carriages. The carriages 110 are arranged in an endless loop and are entrained by an endless conveyor chain 112 (or other flexible endless member), the chain being suitably guided along a path located between the guides 103, 105 and the tracks formed by the rollers 109.

Work stations such as those indicated at 114, 116, 118, 124, and intended to effect the same operation or different operations on the workpieces, are provided along a rectilinear portion A of the track. The station 118 may operate in parallel on two workpieces to effect the same operation in a slower manner than those effected, for instance, at the stations 114, 116, 124. The station 118 may be associated with two mechanical grippers or hands 126 for transferring the workpieces to and from the conveyor portion A by angular movement in a horizontal plane. A similar mechanical gripper is associated with each of the other stations 114, 116, 124.

A carriage 110 can be engaged by the mechanical grippers and transferred together with the workpiece P transported thereby and which still has to undergo an operation. The workpiece P may for instance, be a stator or an annular rotor of an electric motor, on which a winding is to be applied or another preliminary or complementary or subsequent operation is to be carried out. In the case of an annular workpiece P, the workpiece is located in an annular recess of the carriage 110 (see Figures 3 and 4), and the carriage has jaws 130 articulated at 132 to the carriage 110 and biased by springs 134 in such a direction as to engage the workpiece P. The jaws 130 can be opened by means of suitable pushers (not shown) which act in the direction of the arrows  $f_4$  of Figure 4 and which pass through suitable recesses in the carriage 110 to act on arms 134A of the jaws. The pushers are arranged to act in correspondence of loading and unloading positions of the manual or automatic type. Unloading may also be provided from the final work station 124, when the arrangement is such that at least at this station the carriage 110 is carried from the conveyor to the work station together with the workpiece P for the final operation.

The several carriages 110 each have a downwardly directed projection 113 which is engaged by the chain 112 between pairs of adjacent upwardly-directed projections 143 of the chain in such a manner that each carriage 110 may be removed by a mechanical gripper, such as 126. The pairs of adjacent projections 143 each define a discrete carriage-receiving and thus workpiece-receiving, position on the conveyor chain.

The chain 112 is driven by a driving sprocket 146 located at one of the curved portions of the track. The sprocket 146 is mounted on a drive shaft 152 driven by a pinion 148 meshing with a pinion of a drive unit 150.

The conveyor chain 112 has several groups of such workpiece-receiving positions, in each of which groups the respective positions are designated to receive workpieces at a different stage in the processing operation.

In order to designate the different workpiece-receiving positions, selection means are provided which are linked to the driving means of the conveyor chain. In this latter case, as shown in Figure 5, on the shaft 152 carries the members 146, 148, there is provided a group of cams 154, each of which is associated with a respective microswitch 158 via a feeler 156. The cams 154 each correspond to one of the positions in each group and are so arranged that the angular position of the respective cams will be representative of the instantaneous locations of the respective positions in each group. At each of the work stations sensing means are provided to detect the presence or absence of a workpiece at a given position in the corresponding group. Such sensing means may be micro-switches which detect the presence of a workpiece or the empty position in the desired location at which the picking-up or the depositing of the workpiece must be accomplished in the respective group.

The selection among the respective positions of each group and among occupied and empty positions is determined by the operative cooperation between the several micro-switches 158 and the sensing means at the work station. The grippers associated with the work stations are controlled by the cooperative operation between the microswitches and sensing means to ensure that the workpiece is only taken from, or deposited into, the correct designated position depending, respectively, on the operation to be carried out or the next operation to be carried out.

It may occur that certain workpieces are not operated on at some of the work stations and these workpieces are recycled along the return run of the conveyor so that these workpieces can be presented again to the remaining work stations to enable the processing operation to be completed.

We will now describe the operation in connection with workpieces in the form of electric motor rotors which are to be subjected to operations including winding of insulated wires and welding of the ends thereof to the commutators. The work stations positioned along the track include winding and welding stations. In this example at least the following are present on the conveyor-workpieces in an unwound state, wound workpieces still to be welded, and wound and welded workpieces. Correspondingly, in each

group of workpiece-receiving positions on the conveyor there will be a position designated to receive the unwound workpiece (designation 0), a position designated to receive the wound and unwelded workpiece (designation 1) and a position designated to receive the wound and welded workpiece (designation 11).

In operation, the unwound workpieces are deposited in positions which are designated 0 and the workpieces in these positions are picked-up for the winding operation at the winding station at which their presence is detected by the sensing means. At the winding station, the then wound but unwelded workpieces are deposited into empty positions designated 1 which are also detected by the sensing means. At the welding station the presence of the workpieces in the positions designated 1 so that these workpieces are picked-up for the welding operation. The then wound and welded workpieces are deposited into empty ones of the seats designated 11 and which, again, are sensed by the sensing means. As described earlier, the selection among the 0, 1, and 11 positions and among occupied and empty positions is determined by the operative co-operation between the sensing means at the work stations and the cams 154 and microswitches 158.

#### WHAT WE CLAIM IS:—

1. A workpiece processing system comprising workpiece carriages each arranged to carry a workpiece to be processed, means defining an active conveyor path passing adjacent a plurality of processing stations, means defining an endless conveyor movable along said path, said conveyor having means defining positions for the workpiece carriages to be conveyed along said path, means operative to feed workpiece carriages to predetermined positions of the conveyor, means associated with the processing stations for removing workpiece carriages from the positions for processing at the corresponding stations and to deposit the workpiece carriages into the positions after processing of the associated workpieces, said positions consisting of a plurality of groups of positions, in each said group of positions, individual positions being designated to receive workpiece carriages only of those workpieces which are at a predetermined stage in the processing operation, detecting means for detecting filled and empty positions in predetermined locations of the positions along the path, said detecting means being operable to control the operation of the workpiece carriage removal and depositing means whereby the removal and depositing means

only remove workpiece carriages from and deposit workpieces into, the designated positions, and means enabling the carriages of any incompletely processed workpieces to be returned to the beginning of the active conveyor path.

2. A processing system according to claim 1, wherein the endless conveyor is movable in a horizontal plane.

3. A processing system according to claim 2, further comprising guide means comprising opposed guides between which the carriages are guided, and bearing rollers which support the carriages.

4. A processing system according to any one of claims 1 to 3, wherein each of said carriages comprises a seat for receiving a workpiece of annular form, and means for releasably holding the workpiece in the carriage seat, said holding means being releasable in positions at which the workpieces are to be withdrawn from the carriages.

5. A processing system according to any one of claims 1 to 4, wherein the carriage removal and depositing means comprise mechanical gripping means.

6. A workpiece processing system comprising an endless conveyor movable along an endless path in a horizontal plane, said path passing adjacent a plurality of processing stations, removable carriages for carrying workpieces to be conveyed along said path, said conveyor having predetermined positions at which the carriages can be located, a guide track for guiding the carriages along the path, means associated with the processing stations for removing workpiece carriages from the conveyor positions for processing the associated workpieces at the corresponding stations and to deposit the workpiece carriages into the conveyor positions after processing the workpieces, the predetermined positions on the conveyor consisting of plurality of groups of positions, in each said group of positions individual positions being designated to receive only carriages of workpieces which are at a predetermined stage in the process, and means for sensing the presence of filled and empty positions in specific locations of the conveyor along its path, said sensing means controlling the removal and depositing means, whereby the removal and depositing means only remove carriages from, and deposit carriages into, the appropriate designated positions.

7. A workpiece processing system substantially as hereinbefore described with reference to the accompanying drawings.

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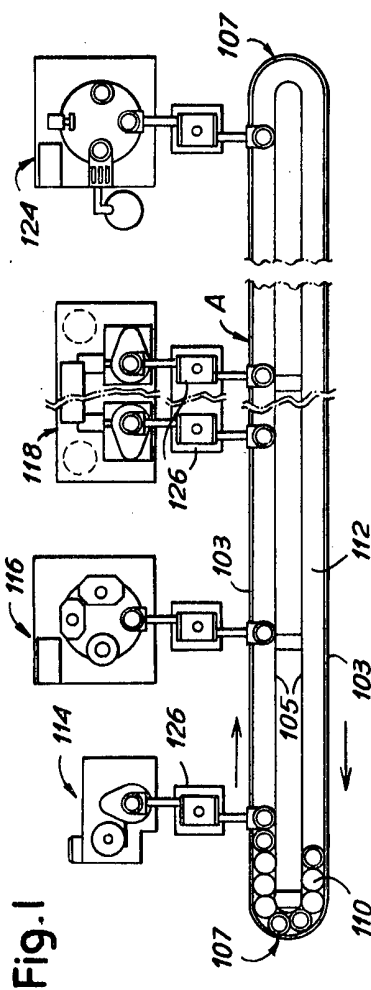


Fig. 3

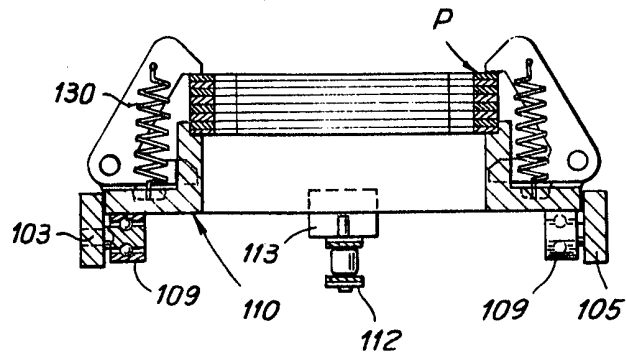


Fig. 4

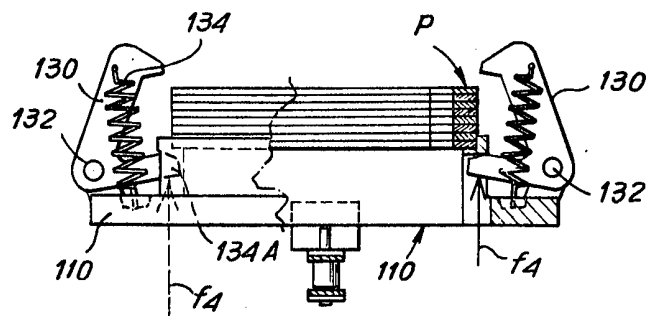


Fig.5

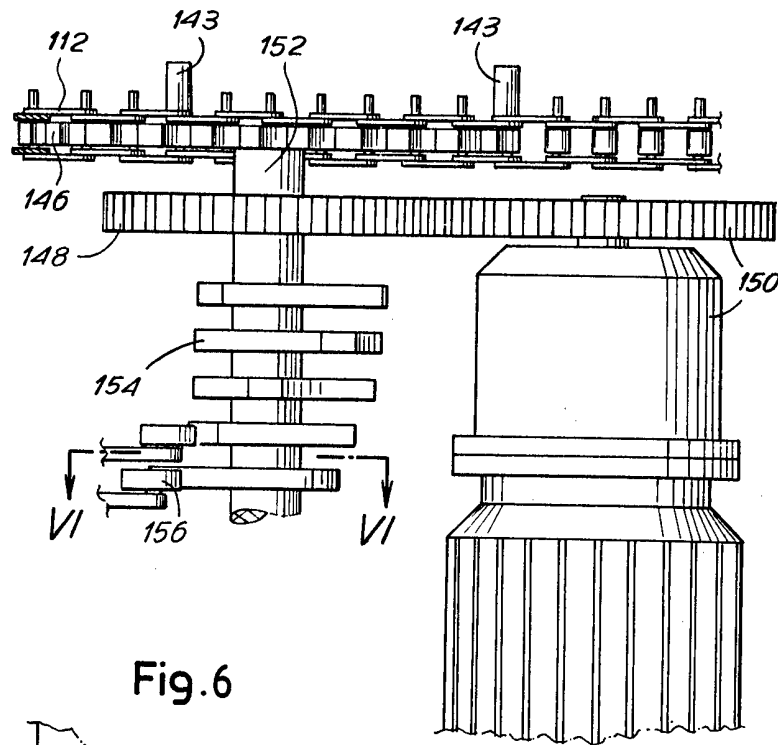


Fig.6

