Aug. 23, 1966 H. FISCHER ETAL 3,268,094

APPARATUS FOR TRANSFERRING WORKPIECES AND THE LIKE

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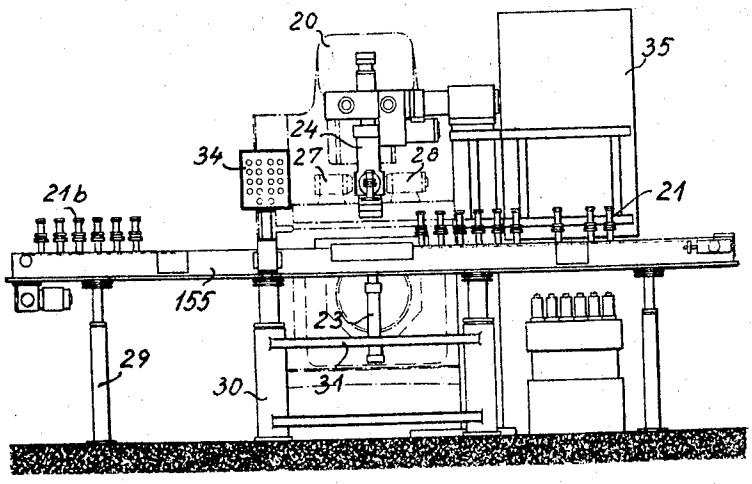


Fig. 1

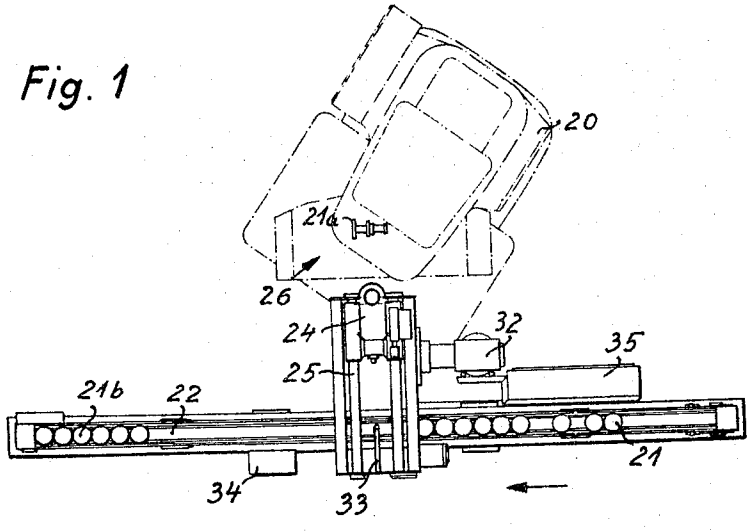


Fig. 2

Inventors:
HEINRICH FISCHER
MAX KRIEGL

BY Michael J. Striker
their ATTORNEY

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Filed June 9, 1964 5 Sheets-Sheet 2

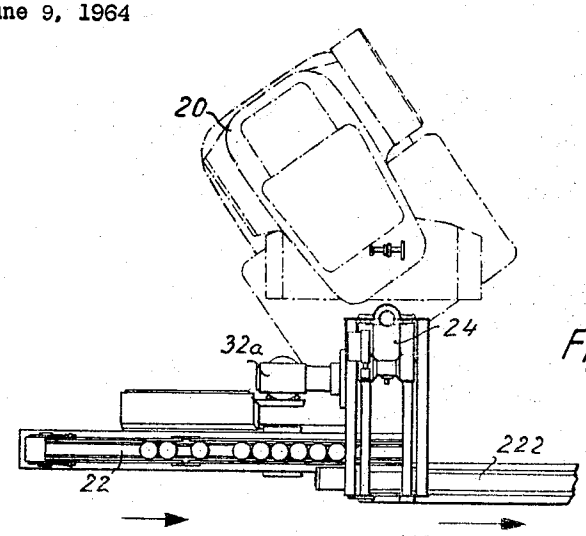


Fig. 3

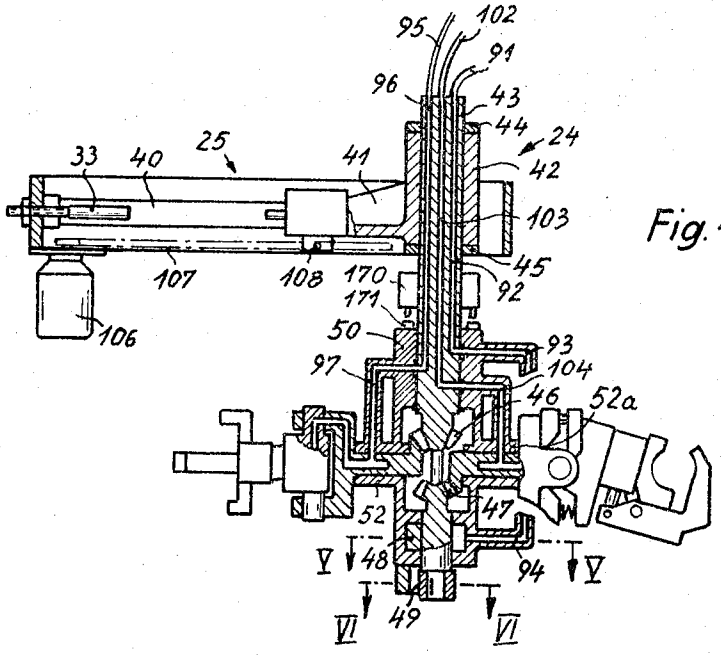


Fig. 4

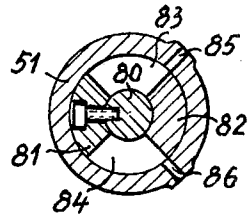


Fig. 5

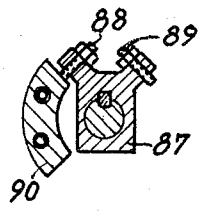


Fig. 6

Inventors:
HEINRICH FISCHER
MAX KRIEGL

BY Michael J. Striker
their ATTORNEY

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APPARATUS FOR TRANSFERRING WORKPIECES AND THE LIKE

Filed June 9, 1964 5 Sheets-Sheet 3

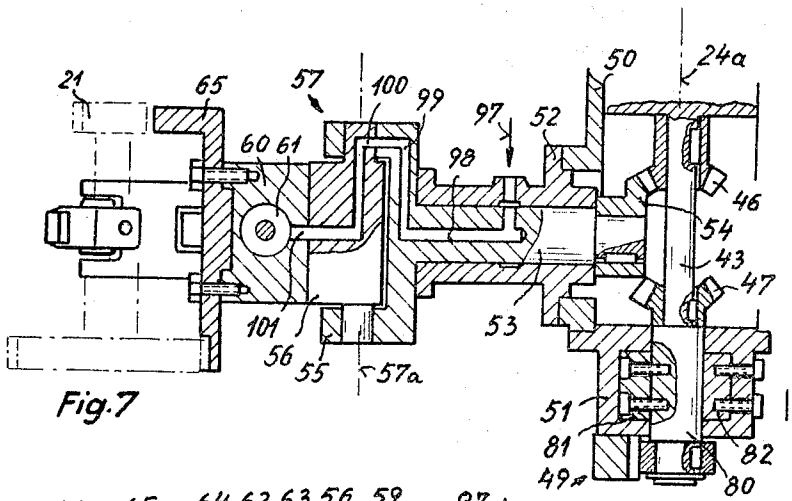


Fig.7

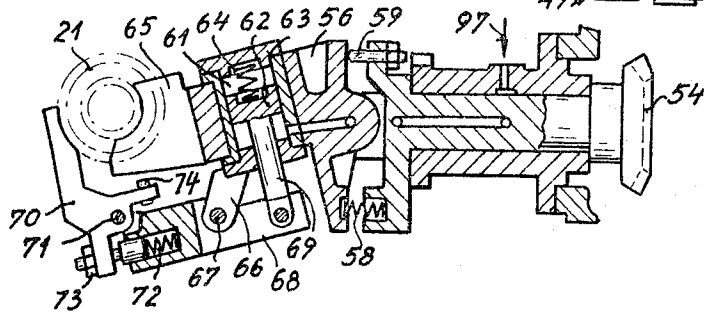


Fig.8

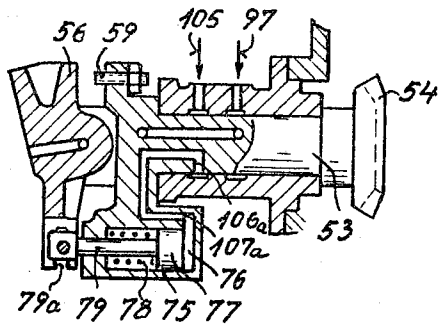


Fig. 9

Inventors:
HEINRICH FISCHER
MAX KRIEGL

BY Michael J. Striker
their ATTORNEY

Aug. 23, 1966 H. FISCHER ETAL 3,268,094

APPARATUS FOR TRANSFERRING WORKPIECES AND THE LIKE

Filed June 9, 1964 5 Sheets-Sheet 4

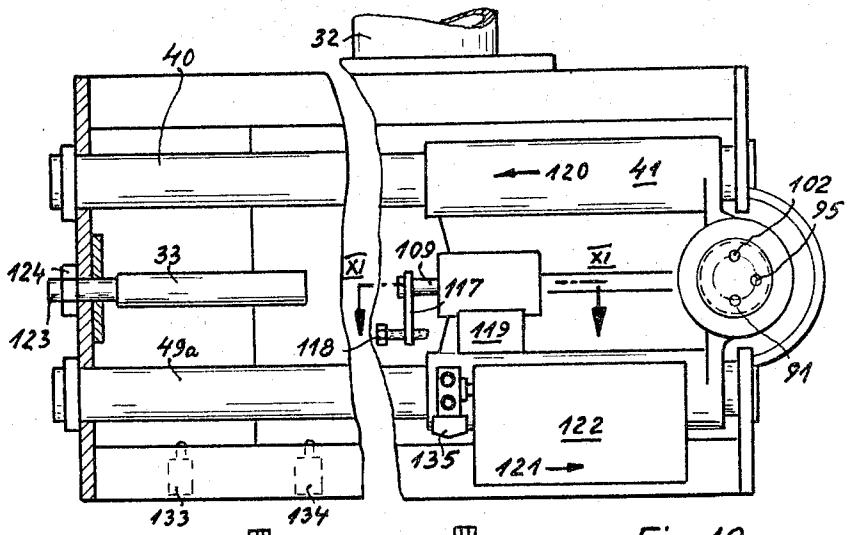


Fig. 10

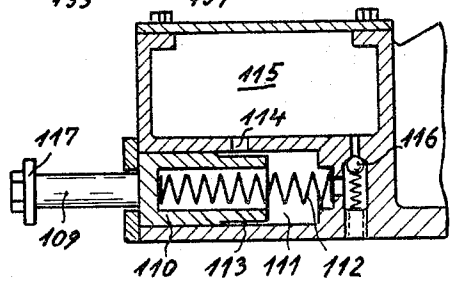
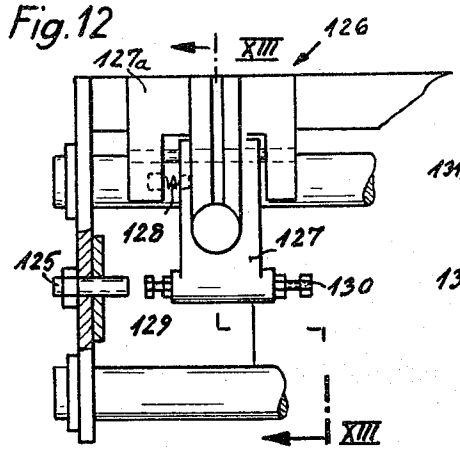


Fig. 11

Fig. 12



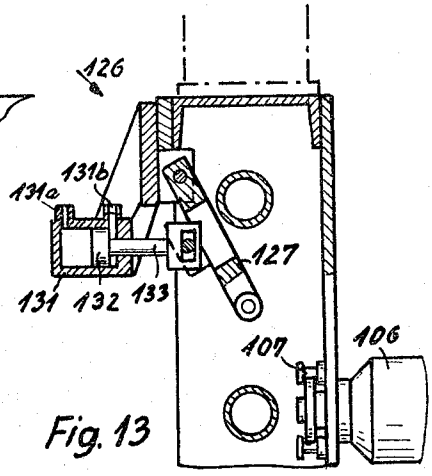


Fig. 13

Inventors:
HEINRICH FISCHER
MAX KRIEGL

BY Michael J. Striker
their ATTORNEY

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APPARATUS FOR TRANSFERRING WORKPIECES AND THE LIKE

Filed June 9, 1964 5 Sheets-Sheet 5

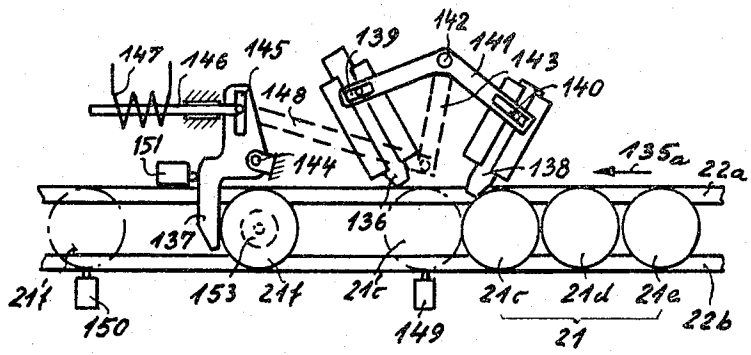


Fig. 14

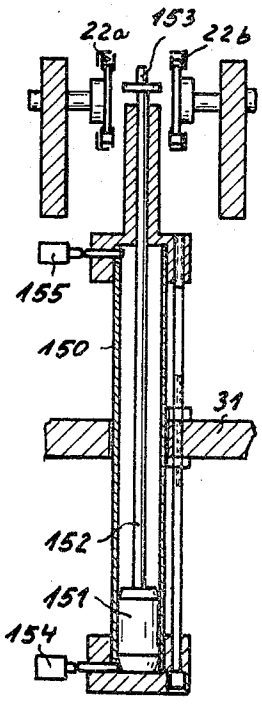


Fig. 15

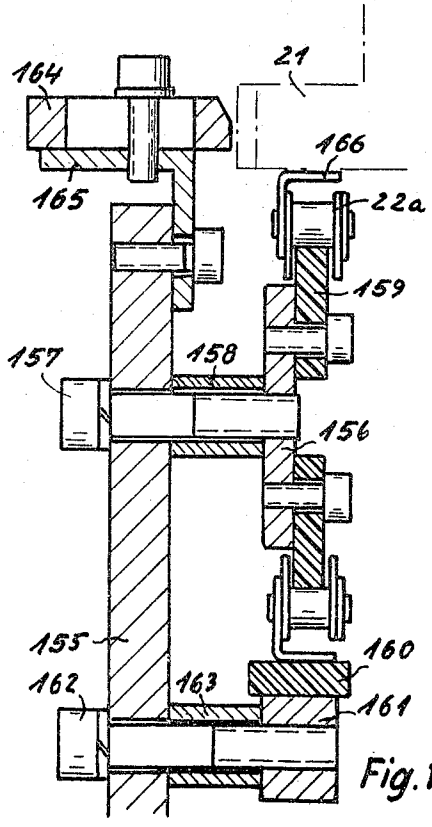


Fig. 16

Inventors:
HEINRICH FISCHER
MAX KRIEGL

BY Michael J. Striker
their ATTORNEY

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3,268,094
APPARATUS FOR TRANSFERRING WORKPIECES AND THE LIKE

Heinrich Fischer and Max Kriegl, both of Munich, Germany, assignors to Carl Hurth Maschinen- und Zahnradfabrik, Munich, Germany

Filed June 9, 1964, Ser. No. 373,740
16 Claims. (Cl. 214—1)

The present invention relates to material handling apparatus, and more particularly, to an apparatus for transferring blanks, semifinished workpieces, finished workpieces and similar articles.

It is an important object of the invention to provide an apparatus which insures planned, continuous and automatic or semiautomatic progression of workpieces or similar discrete products through a manufacturing plant.

Another object of the invention is to provide an apparatus, also called automatic or semiautomatic transfer machine, which is especially suited for delivering workpieces from one or more conveyors to one or more machine tools or vice versa.

A further object of the invention is to provide an apparatus of the above outlined characteristics which may be rapidly and conveniently converted for handling of differently configurated and/or dimensioned workpieces and which is readily convertible to move such workpieces along a shorter, longer, arcuate, straight or composite pathway.

An additional object of the invention is to provide an apparatus wherein the workpieces or similar articles may be conveyed between different levels and without any appreciable danger of damage, contamination or breakage.

Still another object of the instant invention is to provide an improved transfer unit which may be utilized in an apparatus of the above outlined characteristics and which is capable of manipulating two or more workpieces in a simultaneous operation.

A concomitant object of the invention is to provide improved lifting, shock absorbing, actuating, spacing, conveying and other devices which may be used with advantage in an apparatus of the above outlined characteristics.

A further object of the invention is to provide an apparatus for transferring gear blanks, finished gears, gear clusters and many other types of discrete products to and from one or more gear shaving, burnishing, lapping and similar machines.

Another object of the invention is to provide a readily transportable apparatus which may be assembled for temporary or permanent use in connection with a single lathe, milling machine or another machine tool, or with a battery of such machines.

Still another object of the invention is to provide an apparatus for controlled advance of discrete workpieces along an assembly line with a control system which enables the component parts of the apparatus to perform their functions in a fully automatic way, at required intervals, with requisite force, through desired distances and with utmost accuracy so that the number of supervisory personnel may be reduced to a minimum even when the associated machine tool or tools will operate at full capacity.

An additional object of the invention is to provide an apparatus for transferring workpieces or similar articles in orderly and planned fashion so that such articles may be received on conveyors and/or at the working stations of cooperating machine tools, and to construct the apparatus in such a way that it occupies little room as well as that it occupies room which is readily available in manufacturing plants without blocking access to the working stations.

Another very important object of the invention is to provide a highly versatile apparatus of the above outlined characteristics which may be used with equal advantage in connection with many different types of machine tools, which can be adjusted to be useful in a large variety of work schedules, which can be used in connection with many types of conventional conveyors, which may be adjusted to take workpieces from a first conveyor to a working station and from such working station to a second conveyor, and which may be used in connection with different sizes or makes of a given machine tool as well as in connection with totally unrelated machines such as lathes, spline milling tools, gear shaving machines and the like.

A further object of the invention is to provide an apparatus for transporting workpieces directly between the working stations of two or more machine tools.

With the above objects in view, one feature of the present invention resides in the provision of an apparatus for transferring workpieces and similar discrete articles to and from the working stations of machine tools and the like so that such articles may be removed from one or more conveyors to be delivered to a working station and vice versa. In its simplest form, the apparatus comprises a guide which is preferably mounted on a separate ground-contacting stand so as to be transferrable from one machine to another and which defines an elongated preferably horizontal pathway one end of which is adjacent to a working station, a transfer unit which is mounted on the guide to reciprocate along the pathway between a first position at which it is adjacent to the working station and one or more additional positions adjacent to one or more conveyors or to a lifting device which may deliver or receive articles from the transfer unit, and means for reciprocating the transfer unit along the pathway so that the transfer unit may pick up articles at the working station for delivery to the conveyor or conveyors, or vice versa. The transfer unit comprises two or more preferably symmetrically disposed horizontal or inclined arms arranged to orbit (swivel) about a fixed vertical axis which is perpendicular to the pathway, and each arm is provided with a specially configurated gripper or hand distant from the axis about which the arms revolve back and forth and which is provided with article-engaging fingers capable of grasping the articles and of releasing them when necessary.

In accordance with a preferred embodiment of the invention, each gripper comprises at least two fingers at least one of which is movable with reference to the other thereof, and at least one finger may comprise several articulately connected levers which are movable with reference to each other and with reference to the other fingers, preferably in response to automatic impulses and at such intervals as are necessary for a given operation. The fingers are connected to a back portion of the respective gripper which back portion is articulately secured to the respective arm, and each arm is preferably mounted on a spindle of the transfer unit in such a way that it may revolve about its own axis, either in response to operation of a special motor or in response to orbiting about the aforementioned fixed vertical axis.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved apparatus itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood upon perusal of the following detailed description of certain specific embodiments with reference to the accompanying drawings, in which:

FIG. 1 is a front elevational view of an apparatus for transferring gear-shaped workpieces to and from a

gear shaving machine which is shown by phantom lines;

FIG. 2 is a top plan view of the structure shown in FIG. 1;

FIG. 3 is a similar top plan view of a slightly modified apparatus which serves to feed workpieces from a first conveyor to a gear shaving machine and to deliver them from the shaving machine to a second conveyor;

FIG. 4 is a larger-scale vertical section through the transfer unit of the apparatus which is shown in FIG. 3;

FIG. 5 is a horizontal section through a fluid-operated motor of the transfer unit as seen in the direction of arrows from the line V—V of FIG. 4;

FIG. 6 is a section as seen in the direction of arrows from the line VI—VI of FIG. 4 and illustrates a stop device of the transfer unit;

FIG. 7 is a greatly enlarged horizontal section through one arm of the transfer unit shown in FIG. 4;

FIG. 8 is a similar horizontal section through the arm subsequent to rotation through 90 degrees;

FIG. 9 is a horizontal section through a portion of a slightly modified arm;

FIG. 10 is an enlarged top plan view of a carriage for the transfer unit of FIG. 4;

FIG. 11 is a section as seen in the direction of arrows from the line XI—XI of FIG. 10 and illustrates a cushioning or shock-absorbing device for the transfer unit;

FIG. 12 is a fragmentary top plan view of the structure shown in the left-hand part of FIG. 10 and illustrates a modified cushioning device;

FIG. 13 is a section as seen in the direction of arrows from the line XIII—XIII of FIG. 12;

FIG. 14 is a top plan view of a spacer device which moves the workpieces into the range of the transfer unit;

FIG. 15 is a vertical section through a lifting device which serves to deliver or to receive workpieces from the transfer unit; and

FIG. 16 is a transverse section through a conveyor which may feed or receive workpieces from the lifting device of FIG. 15.

Referring to the drawings, FIGS. 1 and 2 illustrate schematically an apparatus which is utilized for transferring workpieces to and from a machine tool **20**, for example, a gear shaving machine. The workpieces **21** travel along the upper stringers of an endless chain conveyor **22** to reach the platform of a lifting device **23** which moves them to a higher level and into the range of a novel transfer unit **24**. This transfer unit is reciprocable in a horizontal plane along a guide **25** including a series of horizontal tie rods, and is arranged to transfer workpieces seriatim to a shaving (working) station **26** of the machine **20**. A workpiece **21***a* is shown in FIG. 1 in the gap between a pair of work clamping members in the form of tailstocks **27**, **28** which may engage its ends after the workpiece has been turned through 90 degrees to take the position shown in FIG. 2. Just before the workpiece **21***a* has been moved to the position of FIG. 1, the transfer unit **24** has withdrawn a finished worbkpiece **21***b* from the space between the tailstocks **27**, **28** and thereupon returns such finished workpiece onto the platform of the lifting device **23**. The latter lowers the finished workpiece **21***b* to the level of the upper stringers of the conveyor **22** so that the workpiece may advance in a direction to the left, as viewed in FIG. 1 or 2, and to a next treating or processing station. A single file of finished (i.e., shaved) workpieces **21***b* is shown at the left-hand end of the conveyor **22**. Such workpieces may be fed to a precision finishing machine tool, for example, to a burnishing or lapping machine, not shown. In the embodiment of FIGS. 1 and 2, each workpiece **21**, **21***a* or **21***b* comprises a shaft and a plurality of coaxial gears having different diameters.

The conveyor **22** is supported by legs **29**, **30** and its width may be adjusted in a manner to be described in connection with FIG. 16. The legs **29**, **30** are adjustable vertically so that the exact level of the upper stringers of the conveyor **22** may be selected in accordance with requirements in connection with a given machine tool. The lifting device **23** is adjustably supported by a horizontal support member **31** and its initial position may be selected at different vertically spaced levels so that it may lift the workpieces to a desired position. It is often preferred to construct this lifting device **23** in the form of a fluid-operated jack (shown in FIG. 15) which is provided with suitable, preferably adjustable, stops so that its stroke may be selected at the will of the operator.

The guide **25** for the transfer unit **24** is preferably mounted on a separate stand **32** which is placed on the floor close to the working station **26** so that the tie rods of the guide **25** may lead the gripping elements of the transfer unit between the lifting device **23** and the tailstocks **27**, **28**. Of course, the stand **32** may be replaced by a different supporting structure, for example, by a bracket or arm which is suspended from a side wall or from the ceiling of a factory hall, depending on the availability of space and on certain other factors. It is often advisable to construct the stand **32** as a separate part, i.e., not to connect the stand with the base or with another component of the machine tool, or to provide for a readily detachable connection between the stand and the machine. FIG. 1 shows that the stand **32** is adjustable vertically, again for the purpose of making the apparatus more versatile and to render it useful in connection with a great number of different machine tools or other mass-producing or mass-treating automatic or semi-automatic machines.

In FIGS. 1 and 2, the forward or outward stroke of the transfer unit **24** along the guide **25** is limited by a fixed but readily adjustable stop **33** which may cooperate with a cushioning device to be described in connection with FIGS. 10 and 11. The range of the transfer unit **24** (i.e., the range of its arms and gripping elements) may be adjusted in a number of ways, all as will be described later. As a rule, the transfer unit **24** will operate automatically, and its movements are preferably synchronized with the operation of the machine tool. However, it is advisable to provide a control panel **34** having a series of knobs or analogous control elements which serve to change the operating cycle of the apparatus at the will of the supervisor. The control elements on the panel **34** also serve to set the apparatus for a given operation. The electrical components of the apparatus are preferably assembled in a box **35**.

FIG. 3 illustrates a portion of a slightly different apparatus which comprises two chain conveyors **22**, **222**. The transfer unit **24** removes untreated workpieces from the conveyor **22** and returns treated workpieces or finished products to the conveyor **222**, or vice versa. The stand **32***a* for the guide of the transfer unit **24** in FIG. 3 is located to the left of the transfer unit. Also, FIG. 3 shows that the machine tool **20** is positioned mirror symmetrically with reference to the machine tool of FIGS. 1 and 2. This was done to indicate that the improved apparatus may be used in connection with many types of machines and with differently mounted machines. In other words, not only are the parts of the improved apparatus adjustable, interchangeable, shiftable and otherwise adaptable to a given type of machine tool, but the position of the entire apparatus with respect to a machine tool (or vice versa) may be selected in a way which is best suited in a given manufacturing plant.

FIG. 4 illustrates the transfer unit **24** and a portion of the guide **25**. The guide **25** comprises two parallel horizontal tie rods **40**, **49** (see also FIG. 10) which support a reciprocable carriage **41**. The carriage **41** constitutes a component part of the transfer unit **24** and is provided with a vertical sleeve or neck **42** which guides a vertical spindle **43**. The spindle is adjustable axially in the neck **42** and is held in a selected axial position by a pair of

lock nuts 44, 45 which are respectively located at the lower and upper ends of the neck. Of course, a portion of the spindle 43 is provided with external threads so that it may mesh with the lock nuts 44, 45. Such vertical adjustability of the spindle 43 enables the operator to select an optimum position for the gripping elements with reference to the guide 25. Furthermore, the neck 42 is preferably secured to the carriage 41 in such a way that it may pivot about a horizontal axis so that the axis 24*a* of the spindle 43 and the plane of the tie rods 40, 49*a* may make an angle other than 90 degrees. The spindle 43 does not rotate with reference to the neck 42 or carriage 41.

At a point close to its lower end, the spindle 43 carries two vertically spaced bevel gears 46, 47, see also FIG. 7, which constitute two sun gears of a planetary transmission. The lower end portion of the spindle 43 extends to a level below the bevel gear 47 and carries the casing 51 of a hydraulic motor 48 and an abutment or stop device 49. The bevel gears 46, 47 are surrounded by a transmission housing 50 which is rotatable on the spindle 43 but cannot move axially with reference thereto. The lower portion of the transmission housing 50 is rigid with the casing 51. In addition, the transmission housing carries a series of horizontal collars; in the embodiment of FIG. 4, the housing 50 is provided with two collars 52, 52*a* which are located diametrically opposite each other, and each of these collars accommodates a rotary arm 53. One of these arms is illustrated on a larger scale in FIGS. 7 and 8, and it will be noted that each arm 53 carries at its inner end a bevel gear 54 which constitutes a planet pinion and which meshes with the bevel gears 46 and 47. In FIG. 4, the bevel gear 54 of the lefthand arm 53 is shown in mesh with the upper bevel gear 46. At its outer end, each arm 53 carries a bifurcated holder 55 for the back portion 56 of a gripper or hand 57. The hand 57 shown in FIG. 7 is rockable about a pivot axis 57*a* which is perpendicular to the horizontal axis of the respective arm 53. The extent to which a hand 57 may rock about the corresponding axis 57*a* is determined by the position of an adjusting screw 59 (see FIG. 8) which is disposed at one side of the axis 57*a*. A helical expansion spring 58 acts between the holder 55 and the back portion 56 and serves as a means for biasing the hand 57 in abutment with the tip of the corresponding adjusting screw 59. If desired, the spring 58 may be replaced by a second adjusting screw so that the hand 57 may be rockably or non-movably fixed in any desired angular position with reference to the axis 57*a*.

It is to be noted that the drawings show simple journal bearings for all such parts which are mounted for rotation or for axial movement. Of course, in actual construction of my apparatus, at least some of the movable parts are mounted in suitable ball bearings or roller bearings to reduce friction and wear on such moving parts.

The outer end of each hand 57 carries a cylinder 60 which defines a cylinder chamber 61 for a reciprocable piston 62, see FIGS. 7 and 8. One end of the cylinder 60 is sealed by a removable cover 63 which is engaged by one end of a helical expansion spring 64. This spring 64 serves as a means for biasing the piston 62 toward the other end of the respective cylinder. Each cylinder 60 further supports a detachable gripping element 65 which is analogous to one or more fingers on a human or animal hand and which may be configurated with a view to come in actual engagement with a portion of a workpiece 21. In FIGS. 7 and 8, the gripping element 65 comprises two sector-shaped portions each of which may engage a gear at the respective end of the workpiece 21. The apparatus may be furnished with a spare set of gripping elements 65 each of which is useful in connection with a different type of workpieces. The gripping elements 65 are secured to the cylinders 60 by screws, bolts or by other readily detachable fasteners.

The cylinders 60 carry laterally extending inclined supporting brackets 66 for pivot pins 67. Each of these pivot pins supports a second gripping element or finger 68 which resembles a two-armed lever with one of its arms articulately coupled to the outer end of a piston rod 69. The piston rods 69 are fixed to the respective pistons 62 and may reciprocate in response to admission or evacuation of a fluid pressure medium from the lower cylinder chamber of the respective cylinder 60. Each finger 68 carries at its outer end a bell crank lever 70 which is articulately fixed thereto by a pivot pin 71 and which is biased against the workpiece 21 by a helical expansion spring 72. This spring bears against a plunger which is received in a blind bore of the respective finger 68 and whose position is adjustable by a nut 73. An adjustable stop pin 74 serves to limit the extent to which the lever 70 may be rocked by the spring 72. On removal of the pin 67, the lever 70 may be replaced by a differently configurated or dimensioned lever. This will be necessary when the apparatus is utilized for transferring a different make of workpieces or a series of differently dimensioned workpieces. FIG. 7 shows that the lever 70 engages the shaft of the workpiece 21 midway between its ends. It is obvious that the gripping element 65 may be replaced by an element which will engage the shaft of the workpiece 21 and that the lever 70 may be replaced by a differently configurated lever which will engage the gears at both ends of the workpiece. The levers 68, 69 together form a jointed digit whose parts are movable with reference to each other (about the axis of the pin 71) and which is movable with reference to the gripping element 65 (about the axis of the pin 67). If desired, the digit 68, 70 may be replaced with one having a single link or three or more links, depending on the nature of workpieces and on the type of transferring operation.

Each of the springs 58 and 72 may be replaced by different biasing means, for example, by hydraulic or pneumatic biasing device or by weights. FIG. 9 illustrates a portion of a slightly modified arm 53 wherein the spring 58 is replaced by a fluid operated single-acting cylinder 75. This cylinder is rigidly connected to or integral with the arm 53 and defines a chamber 76 for a piston 77 which may be reciprocated by a gaseous or liquid pressure medium. A return spring 78 serves to bias the piston 77 to a starting position, and the rod 79 of the piston comprises a head which is received in a slot 79*a* of the back portion 56. A pin secures the head of the piston rod 79 to the lower part of the back portion 56, as viewed in FIG. 9, so that the hand 57 will rock in a clockwise direction about the vertical axis 57*a* whenever the cylinder chamber 76 receives a supply of pressure medium.

The spring 72 of FIG. 8 may be replaced by a single-acting cylinder similar to or identical with the cylinder 75 of FIG. 9. Of course, and if it is desired to simplify the transfer unit, the parts 60–63 and 69 of FIG. 9 may be replaced by a spring (similar to the spring 58) which will serve to bias the finger 68 in order to keep the bell crank lever 70 in engagement with the workpiece 21. It is further obvious that the position of the spring 72 and of the cooperating plunger with the nut 73 may be reversed. The same applies for the mounting of the cylinder 75 in FIG. 9 and for the mounting of the cylinder 60 in FIG. 8, i.e., the piston rod 69 may be coupled to the back portion 56 if the cylinder 60 is mounted on the finger 68, and the piston rod 79 may be coupled to the arm 53 if the cylinder 75 is mounted on the back portion 56.

In FIG. 4, the gripping elements on the left-hand arm 53 are turned through 90 degrees with reference to the gripping elements on the right-hand arm. Thus, one of these arms may remove a horizontal workpiece from the working station 26 while the other arm may remove a vertical workpiece from the lifting device 23. If needed the transfer unit may comprise three or more arms 53 which may but need not be equidistant from each other and which may be mounted at different levels.

That portion (numbered 80) of the spindle 43 which extends through the casing 51 of the hydraulic motor 48

is fixedly but detachably connected with a piston or stator **81**, see particularly FIGS. 5 and 7. The casing **51** is rigidly connected to a partition **82** which cooperates with the piston **81** to define two cylinder chambers **83**, **84** communicating with fluid-conveying ducts **85**, **86** in the casing **51**. The lower end portion of the spindle **43** carries an annulus **87** with two adjustable stop screws **88**, **89**. These screws may come in abutment with a stop block **90** which is fixed to the housing **51**. The parts **87–90** together constitute the stop device **49**.

The hydraulic motor **48** serves to rotate the arms **53** between two end positions about the axis **24***a* of the neck **42** and through an angle determined by the block **90** and stop screws **88**, **89** of the stop device **49**. Of course, the block **90** may be readily detached from the casing **51** to be replaced by a differently dimensioned block in order to change the angle through which the arms **53** may rotate in response to operation of the motor **48**. Also, the block **90** may be replaced by an adjustable block and the transfer unit **24** then comprises suitable elements which may adjust the position of the block by remote control. For example, the configuration and the mounting of the block **90** may be selected in such a way that the arms **53** will be rotatable between three, four or more preselected angular positions. Such construction is of considerable advantage when the transfer unit is utilized for moving workpieces or other articles between three or more stations, for example, between a treating (shaving) station and two conveyors corresponding to the conveyors **22**, **222** of FIG. 3. Analogously, such transfer units may be used for transferring articles between a single conveyor and two or more machine tools.

The chamber **83** of the motor **48** receives or discharges pressure medium from a source (not shown) through a flexible conduit **91** and through conduits **92**, **93**, **94**, shown in FIG. 4. The conduit **94** communicates with the duct **85**. The chamber **84** may be filled or evacuated through a similar system of conduits (not shown) and duct **86**. When the motor **48** is in operation, the housing **50** rotates about the axis **24***a* shown in FIG. 7. The valves which regulate the flow of pressure medium into and from the chambers **83**, **84** are not shown in the drawings. The housing **50** rotates in response to rotation of the casing **51** and acts as a planet carrier to swing the arms **53** about the axis **24***a*. Consequently the bevel gears **54** are caused to rotate, because they mesh with the bevel gears **46**, **47**, and thereby cause each of the arms **53** to rotate about its own axis. Of course, it is not always necessary that the arms **53** rotate about their axes in response to rotation of housing **50** about the axis **24***a*; it is often advisable to provide a separate motor for each of the arms **53** so that such arms may be rotated independently of the spindle. Also, both arms **53** may be rotated by a common motor, similar to the motor **48**, and such common motor then cooperates with a stop device similar to the device **49** to select the angle through which the arms rotate about their axes at a predetermined stage of a transfer operation.

In order to move the fingers **68** toward or away from the gripping elements **65** (i.e., to move the bell crank levers **70** about the pins **67**), the cylinders **60** will receive a pressure medium through a system of conduits shown in FIGS. 4, 7 and 8. FIG. 4 shows a flexible conduit **95** for the left-hand finger **68** which is connected to the upper portion of the spindle **43** and which communicates with an axially extending conduit **96** in the spindle. The conduit **96** communicates with conduits **97**, **98**, **99**, **100** and **101**. The finger **68** for the right-hand arm **53** is movable in response to admission of pressure medium through a flexible conduit **102** and additional conduits **103**, **104** shown in FIG. 4. FIG. 9 shows an arrow **105** which indicates the flow of pressure medium through conduits **106***a*, **107***a* and into the cylinder chamber **76** to shift the piston **77** in order to rock the back portion **56**. The valves for regulating the flow of pressure medium through the conduits **91**, **95**, **102** and **106***a* are not shown in the drawings because the exact construction of the remaining parts of the hydraulic of pneumatic actuating system forms no part of the present invention.

As mentioned above, the carriage **41** is slidable along a pair of horizontal tie rods **40**, **49***a* best shown in FIG. 10. The tie rods **40**, **49***a*, are shown as being of circular cross section, and the carriage **41** is reciprocable by a reversible electric motor **106** through an endless flexible element here shown as a chain **107**. The chain **107**, shown in FIGS. 4 and 13, engages a motion transmitting pin **108** on the carriage **41**. The operative connection between the driving sprocket (shown in FIG. 13) for the chain **107** and the output shaft of the motor **106** comprises a suitable slip clutch of any known design, not shown. The direction in which the carriage **41** may travel along the tie rods **40**, **49***a* is determined by the motor **106** which is of the reversible polarity type. If the nature of the operation requires that the carriage **41** should change the direction of its movement with no delay whatever, the operative connection between the motor **106** and chain **107** preferably comprises a worm drive with an elastically deformable worm. Furthermore, it is obvious that the electric motor **106** may be replaced by a hydraulic or pneumatic motor.

The stroke of the carriage **41** is determined by the stop **33** which comprises a threaded portion **123** extending through a crosshead of the guide **25** and meshing with a lock nut **124**. The arrangement is such that the stop **33** may be adjusted axially of the tie rods **40**, **49***a* in order to change the stroke of the carriage **41** and transfer unit **24**.

In order to reduce the impact when the carriage **41** reaches the one or the other end of its stroke, the apparatus preferably comprises suitable cushioning or shock absorbing devices one of which is illustrated in FIG. 11. This cushioning device is mounted on the carriage **41** and may come in abutment with the stop **33**. It wil be noted that the cushioning device resembles a dash-pot which includes a piston rod **109** secured to a piston **110**, the latter being reciprocable in a cylinder **111**. The piston **110** is biased by an expansion spring **112** which is accommodated in the chamber of the cylinder **111** and which tends to push the piston rod **109** outwardly, i.e., in a direction to the left, as viewed in FIG. 10 or 11. The right-hand end portion of the piston **110** is of reduced outer diameter, as at **113**, so that the piston and the wall of the cylinder **111** cooperate to define an annular gap which may communicate with a radial port **114** bounded by a smooth surface and leading to a storage tank **115** for a compressible fluid. The width of the gap between the cylinder **111** and the piston portion **113** exceeds the normal clearance between these parts. A second communicative connection between the chamber of the cylinder **111** and the tank **115** may be established through a suitable one-way valve, here shown as a ball valve **116**. This valve is provided with a small spring and also includes an adjusting screw which enables the operator to regulate the pressure at which the ball moves away from its seat in order to allow fluid to flow from the tank **115** to the chamber of the cylinder **111**. If desired, the port **114** may be replaced by a suitable nozzle with an adjustable orifice so that the operator may control the rate at which fluid can flow through the gap between the end portion **113** of the piston **110** and the wall of the cylinder **111**. The free end of the piston rod **109** carries a laterally extending beam **117** whose free end carries an adjustable screw **118** which acts as a trip and is arranged to come in abutment with a switch **119** fixed to the carriage **41**, see FIG. 10, and connected in circuit with the motor **106**.

The cushioning device of FIG. 11 operates as follows:

When the motor **106** rotates in a sense to drive the carriage **41** in the direction indicated by an arrow **120** (see FIG. 10), the tip of the piston rod **109** will strike against the right-hand end portion of the stop **33** whereby

the piston rod yields and causes the piston **110** to move in a direction to the right, as viewed in FIG. 11, so as to compress the spring **112** and to expel some of the fluid from the chamber of the cylinder **111**, through the gap around the end portion **113** and via port **114** into the tank **115**. Initially, the flow of fluid from the cylinder **111** to the tank **115** takes place with little resistance, as long as the fluid is permitted to flow through the gap around the end portion **113**; however, the resistance to such flow increases markedly when the piston **110** moves to a position in which the end portion **113** is located to the right of the port **114** so that any fluid which can escape through the port **114** and into the tank **115** must flow through the minimal clearance between the internal surface of the cylinder **111** and the left-hand portion of the piston **110**.

When the piston rod **109** has performed a stroke of predetermined length, selected by the axial position of the trip **118**, the latter's tip engages and opens the switch **119** to arrest the motor **106** so that the carriage **41** comes to a halt and the transfer unit **24** is in a position to perform a given operation. For example, the parts **65**, **70** of FIG. 8 may deposit a finished workpiece **21***b* on the conveyor **22** of FIGS. 1 and 2.

When the motor **106** causes the carriage **41** to travel in the opposite direction (see the arrow **121** in FIG. 10), the spring **112** is free to expand whereby the fluid contained in the tank **115** opens the valve **116** and flows back into the chamber of the cylinder **111**. A second cushioning device **122** (see FIG. 10) becomes active when the carriage **41** approaches the right-hand end of its stroke.

The spring **112** and the fluid in the chamber of the cylinder **111** will brake the carriage **41** so that the transfer unit **24** travels at reduced speed just before the screw **118** strikes against the switch **119** to insure that the carriage comes to a gradual stop. In other words, the carriage **41** may be driven at full speed at the start of a movement in a given direction, and at reduced speed when it approaches the end of its stroke. This can be achieved in a different way by replacing the motor **106** with a variable-speed motor.

Though the nut **124** allows for axial adjustments of the stop **33** in order to regulate the stroke of the carriage **41**, such arrangement is normally used only in an apparatus which removes or deposits workpieces on a single conveyor, such as the conveyor **22** of FIGS. 1 and 2. When the transfer unit **24** cooperates with two conveyors, such as the conveyors **22**, **222** of FIG. 3, the apparatus preferably comprises a different stop device shown in FIGS. 12 and 13 and including two stops which operate alternatively. One of these stops takes the form of an externally threaded stop pin **125** which may be adjusted axially upon loosening of a lock nut shown in FIG. 12. The other stop includes an assembly **126**, best shown in FIG. 13, comprising a slide **127** which is pivotable at its upper end and which is also reciprocable in a suitable supporting bracket **127***a* shown in FIG. 12. The direction of such reciprocatory movement is horizontal, as viewed in FIG. 12, and the upper end portion of the slide **127** is biased by a spring **128** which tends to move this slide in a direction to the right. The slide carries two adjustable screws **129**, **130** which serve to select the first position of the carriage **41**. The means for pivoting the slide **127** about an axis which is perpendicular to the plane of FIG. 13 comprises a double-acting horizontal cylinder **131** and a piston **132** which is reciprocable in this cylinder and comprises a piston rod **133** whose free end is articulately secured to an intermediate portion of the slide. Conduits **131***a* and **131***b* serve to admit or evacuate a pressure medium from the cylinder chambers at the opposite ends of the piston **132**. It goes without saying that this fluid-operated cylinder **131** may be replaced by an electrically or electromagnetically operated pivoting device.

When the transfer unit **24** is to move to a position adjacent to the conveyor **22** of FIG. 3, the conduit **131***a* admits pressure fluid to the left-hand chamber of the cylinder **131**, as viewed in FIG. 13, so that the slide **127** pivots to the position of FIGS. 12 and 13. The carriage **41** is then free to advance in the direction indicated in FIG. 10 by the arrow **120** and strikes against the screw **130**. The slide **127** now begins to move in a direction to the left, as viewed in FIG. 12, and compresses the spring **128** which cushions the impact when the screw **129** reaches the tip of the pin **125**. The transfer unit **24** is in proper position with respect to the coveyor **22** and the trip **118** may open the switch **119** to arrest the motor **106**. When the carriage **41** is to perform a different stroke, the slide **127** is pivoted downwardly in response to admission of a pressure medium through the conduit **131***b* so that the piston rod **109** of FIG. 10 may reach the tip of the pin **125** because the screw **129** is not aligned with the pin **125**. The transfer unit **24** is then in proper position with respect to the conveyor **222**.

Referring again to FIG. 10, the framework of the guide **25** supports a series of electric switches **133**, **134** which are located in the path of a trip **135** mounted on the carriage **41**. Each of the switches **133**, **134** is adjustable in the longitudinal direction of the tie rods **40**, **49***a* and their purpose is to control movements of the carriage and transfer unit **24**. In the position of FIG. 10, the switch **133** will be ineffective because it cannot be reached by the trip **135**; however, the switch **134** may be used to reverse the motor **106** in response to movement of the carriage **41** in the direction indicated by the arrow **121**, or the switch **134** may serve to change the speed of the motor **106** so that the speed of the carriage **41** is reduced before the piston rod **109** strikes against the stop **33**. This presupposes that the motor **106** is of the variable-speed type.

It is preferred to provide the apparatus with a spacer device which moves the workpieces individually into the range of the transfer unit **24**. One form of such spacer device is illustrated in FIG. 14 and this spacer device is intended to move the workpieces **21** with reference to the conveyor **22** so that the transfer unit **24** may take the workpieces seriatim and without interference on the part of the next-following workpiece or workpieces. The spacer device of FIG. 14 is equally useful to insure that the transfer unit **24** may deposit articles on the conveyor **22** without being obstructed by workpieces which were deposited in preceding operations. The upper stringers of the conveyor **22** travel in the direction indicated by an arrow **135***a* and this conveyor comprises two narrower endless flexible chains **22***a*, **22***b*. The spacer device includes a first or main arresting member in the form of a pusher **136**, a second arresting member in the form of a two-armed lever **137** which arrests a workpiece that has been allowed to advance past the arresting member **136**, and a third arresting member **138** which also resembles a pusher and which is sort of a braking device to slow down the articles before one thereof can reach the arresting member **136**. The arresting members **136**, **138** are provided with pins which respectively extend into guide slots **139**, **140** of a V-shaped control lever **141** arranged to pivot about the axis of a fixed pin **142** located at a point close to the junction of its legs. The pin **142** is rigidly connected to one terminal portion of a link train including a link **143** which is located behind the plane of FIG. 14. The arresting member **137** is rockable about the axis of a fixed pivot pin **144**. One (the lower, as viewed in FIG. 14) arm of the arresting member **137** extends into the space between the chains **22***a*, **22***b* to come in actual abutment with the foremost workpiece **21***f*. The other arm of the arresting member **137** is provided with a guide slot **145** and receives a pin of the aforementioned link train. This link train includes a second link **148** which is articulately connected with the link **143** and with a push rod **146**. The connection between the link **148** and the push rod **146** includes that pin which extends into the guide slot **145** of the arresting member **137**. The push rod **146** may be reciprocated by mechanical, hydraulic,

pneumatic or electrical means. In the illustrated embodiment, the push rod **146** constitutes the core of an electromagnet and is surrounded by a winding **147**.

Electric switches **149, 150, 151** are distributed along the path of the workpieces and in the path of movable parts of the spacer device to initiate or terminate certain steps of the transfer operation. For example, the switch **149** may initiate the release of a workpiece by the arresting member **137** so that such workpiece may travel between the chains **22***a*, **22***b* (arrow **135***a*) and to a next machine.

The spacer device operates as follows:

A single file of workpieces **21** (numbered **21***c*, **21***d*, **21***e*) is supported by the chains **22***a*, **22***b* and the foremost workpiece **21***c* is in abutment with the arresting member **138** so that it cannot advance toward the arresting member **136**. A treated workpiece **21***f* has been deposited by the transfer unit **24** and is in abutment with the arresting member **137**. The shafts of the workpieces are accommodated in the space between the chains **22***a*, **22***b* so that, as soon as the workpieces meet an obstruction (in this case, the arresting members **138** and **137**), the workpieces located upstream of such obstruction or obstructions are brought to a halt but the chains **22***a*, **22***b* and the workpieces located to the left of the arresting member **137** are free to continue their advance in the direction indicated by the arrow **135***a*.

When the circuit of the winding **147** is completed, the push rod **146** is caused to move in a direction to the right to rock the arresting member **137** in a clockwise direction and to release the finished workpiece **21***f*. At the same time, the main arresting member **136** is caused to extend into the path of the workpieces **21***c*–**21***e* and the arresting member **138** is withdrawn so that the workpieces **21***c*–**21***e* advance by a step and the foremost workpiece **21***c* comes in abutment with the arresting member **136**. This workpiece is now in the phantom-line position **21'***c*. The workpiece **21***f* (which was held by the arresting member **137** after it has been transferred from a machine tool by the unit **24**) is free to advance in a direction to the left and actuates the switch **150** (see the position **21'***f*) which deenergizes the electromagnet by opening the circuit of the winding **147** so that the push rod **146** moves to the left and the lever **137** moves in the path of the workpieces between the chains **22***a*, **22***b* to arrest the next finished workpiece which is to be transferred by the unit **24**. The unit **24** also removes the workpiece **21'***c* and transfers it to the working station. Th arresting member **138** abuts against the workpiece **21***d*.

The operative connection between the chains **22***a*, **22***b* and the transfer unit **24** is established by the lifting device **23**. As shown in FIG. 15, the lifting device may comprise a jack having an upright cylinder **150** which is vertically adjustably mounted on the support member **31**. The chamber of the cylinder **150** accommodates a piston **151** whose rod **152** extends upwardly into the space between the chains **22***a*, **22***b*. At its upper end, the piston rod **152** carries a detachable platform **153** (see also FIG. 14) which is in registry with the workpiece **21***f*, i.e., with that workpiece which abuts against the arresting member **137**.

Two electric switches **154, 155** are adjacent to the path of the piston **151** and are actuated when the piston respectively reaches the lower and the upper end of its stroke. The switches **154, 155** also form part of the automatic control system for the transfer unit and for the remaining parts of the improved apparatus. The conduits which regulate the flow of a hydraulic or pneumatic pressure medium into and out of the chambers of the cylinder **150** are not shown in FIG. 15.

When the piston **151** performs the next upward stroke, the workpiece **21***f* is lifted by the platform **153** and is raised to a position in which it may be engaged by gripping elements on one arm **53** of the transfer unit **24**. For example, the switch **155** may control a suitable solenoid valve (not shown) which then admits pressure medium into the chamber of the cylinder **60** shown in FIG. 8 so that the lever **70** may engage the workpiece **21***f* during subsequent transfer to the working or shaving station **26**.

The lifting device **23** can be considered to constitute a part of the conveyor system. Of course, the assembly of FIG. 3 will comprise two lifting devices.

The distance between the chains **22***a*, **22***b* of the conveyor **22** may be changed so that the space between these chains may accommodate workpieces and other articles of different width, height and/or length. Each of the chains **22***a*, **22***b* is trained around pairs of suitable sprocket wheels (not shown) which are mounted in a frame **155**, see FIG. 16. One sprocket wheel of each pair drives the respective chain and the other sprocket wheel is adjustable in a manner know per se to keep the chain under necessary tension. The chain **22***a* is adjustable in directions toward and away from the chain **22***b* (not shown in FIG. 16) by means of a series of distancing members **156** (only one shown) which extend between the upper and lower stringers of the chain **22***a*.

The distancing members **156** carry upper and lower rails **159** which extend between the links of the respective stringers of the chain **22***a*. Exchangeable sleeves **158** keep the distancing members **156** at a desired distance from the frame **155**, and the latter supports bolts **157** which mesh with central portions of the distancing members. The rails **159** may consist of wear resistant metallic or synthetic plastic material, for example, of sintered metal. The lower stringer of the chain **22***a* rests on a rail **160** carried by a mounting member **161** which is held in position by bolts **162** secured to the frame **155** and extending through exchangeable spacer sleeves **163**.

Lateral stops **164** provided on top of the frame **155** abut against the sides of the workpieces **21** to keep them accurately centered between the chains **22***a*, **22***b*. Each lateral stop **164** is adjustably secured to a bracket **165** which is bolted to the frame **155**. The other frame (not shown) for the chain **22***b* carries similar lateral stops. Each lateral stop **164** may consist of a single strip of material extending along the upper stringer of the respective chain or, alternatively, each such stop may comprise a series of aligned sections.

It is often advisable to prevent direct sliding contact between the workpieces **21** and the links of the chains **22***a*, **22***b*. FIG. 16 shows one of several L-shaped holders **166** which are secured to the links of the chain **22***a* and come in direct supporting engagement with the workpieces **21**.

It will be seen that the apparatus of the present invention is preferably provided or combined with conveyors in the form of chains which are not positively coupled to conveyed articles. Thus, the upper stringers of the chains **22***a*, **22***b* shown in FIG. 14 are free to travel with reference to the workpieces **21***c*, **21***d*, **21***e*, **21***f* to make sure that the chains can build up stacks or files of such articles. This is important in the event that one of the machine tools happens to be out of order while the other machine tools continue to operate. For example, and referring to FIGS. 1 and 2, if the machine tool **20** happens to break down, the machine which delivers workpieces **21** onto the right-hand portion of the conveyor **22** can continue to deliver such workpieces, and the workpieces will merely accumulate in front of the spacer device without being able to travel past the platform **153** of the lifting device **23**. Also, the conveyor **22** need not be arrested during such breakdown because its chains **22***a*, **22***b* are free to travel with reference to the workpieces. Of course, the length of the conveyor **22** may be much greater than shown in FIG. 1 or 2 so that this conveyor may accommodate a very large number of treated and/or untreated workpieces.

When the apparatus of the present invention is provided with a spacer device of the type or analogous to

the one shown in FIG. 14, the speed of the chains 22*a*, 22*b* preferably exceeds the speed at which the machine tool 20 treats the workpieces so that there will be relative movement between the chains 22*a*, 22*b* and the workpieces, and a certain number of workpieces (ready for treatment) will always be ready at the right-hand side of the arresting member 138.

The spacer device of FIG. 14 is particularly suited for use in an apparatus of the type shown in FIGS. 1 and 2 wherein the gripping elements on the arms of the transfer unit 24 receive and deliver workpieces to a single conveyor 22. Thus, the workpiece 21*f* shown in FIG. 14 is in a position in which (after lifting by the device 23) it may be grasped by the transfer unit 24 or in which it has been deposited by the transfer unit on the platform 153.

Referring again to FIG. 4, the switches 170 on the spindle 43 cooperate with cam shaped trips 171 on the housing 50 to control certain operations of the apparatus. These switches (and the aforementioned switches such as 154, 155, 133, 134, 149, 150, 151 and others) constitute elements of the control system which enables the apparatus to operate in a fully automatic or in a semi-automatic way.

The loading process is as follows: First, an empty hand is above the lifting device 211 (FIG. 14). The piston rod 152 (FIG. 15) then lifts a blank into the gripper. The latter rocks about its axis through an angle of 180 degrees, pivoting at the same time the blank horizontal position and moving it into between the tailstocks 27, 28 (FIG. 1), returns and takes up the next blank, and remains in this position until the first blank has been machined. Then, the empty arm enters the machine and takes up the finished workpiece. The gripper rocks about its axis, removing the workpiece from the machine and moving the next blank between tailstocks 27, 28. Then, it moves back to position 211 and deposits the workpiece onto the platform 153. The latter returns the workpiece to the conveyor, lifts a new blank into the gripper which takes up this blank and remains in this position until the workpiece has been machined. The cycle is then repeated as described above.

A similar operation can be carried out with a device comprising only one arm; however, in this case, working time is prolonged by the fact that the machine remains idle during the entire loading cycle.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features which fairly constitute essential characteristics of the generic and specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. In an apparatus for transferring workpieces and similar discrete articles to and from the working stations of machine tools and the like, in combination, guide means defining an elongated pathway having an end adjacent to a working station; a transfer unit mounted on said guide means to reciprocate along said pathway between a plurality of spaced positions, said unit comprising a plurality of article-engaging arms arranged to orbit about an axis of rotation which is substantially perpendicular to said pathway; stop means for arresting said unit in each of said positions; shock absorber means provided on said unit and arranged to cooperate with said stop means so as to cushion the impact on engagement between said unit and said stop means; means for reciprocating said unit along said pathway at different speeds; and control means arranged to reduce the speed of said unit prior to engagement between said stop means and the respective shock absorber means.

2. A structure of the character described comprising a machine arranged to treat consecutive workpieces and similar discrete articles and comprising a working station at which the articles are located during treatment; conveyor means arranged to feed unfinished articles for treatment at said station; and an apparatus for transferring workpieces between said working station and said conveyor means, said apparatus comprising a guide defining an elongated pathway extending in a direction from said working station toward said conveyor means, a transfer unit mounted on said guide to reciprocate along said pathway, said unit comprising a plurality of article-engaging arms arranged to orbit about an axis which is substantially perpendicular to said pathway, and means for reciprocating said unit along said pathway so that said arms may engage articles at said working station for transfer of such articles toward said conveyor means or vice versa.

3. A structure as set forth in claim 2, wherein said conveyor means is arranged to advance the articles at a speed exceeding the rate at which the articles are treated at said working station so that a supply of articles accumulates on said conveyor means for transfer by said arms.

4. A structure as set forth in claim 3, further comprising spacer means adjacent to said conveyor means and arranged to maintain articles in positions necessary for engagement by said arms.

5. A structure as set forth in claim 3, wherein said conveyor means comprises a pair of endless flexible elements defining between themselves a space accommodating portions of conveyed articles, and wherein said spacer means comprises arresting members extendable into said space to arrest the articles, said flexible elements being movable with reference to such articles which are held against movement by said arresting members.

6. A structure as set forth in claim 4, wherein said spacer means comprises a pair of cooperating arresting members including a main arresting member movable into and out of the path of articles on said conveyor means and a second arresting member located past said main arresting member as seen in the direction of movement of said conveyor means, and means for selectively moving said arresting members into and out of the path of articles on said conveyor means.

7. A structure as set forth in claim 6, wherein said spacer means further comprises a third arresting member located ahead of said main arresting member and arranged to extend into the path of articles on said conveyor means when said main arresting member is withdrawn from said path.

8. A structure as set forth in claim 7, further comprising actuating means for moving said arresting members at predetermined intervals so that said second arresting member receives consecutive articles at intervals required for transfer of such articles to said working station.

9. A structure of the character described, comprising a machine arranged to treat consecutive workpieces and similar discrete articles and comprising a working station at which the articles are located during treatment; a first conveyor arranged to feed unfinished articles for treatment at said station; a second conveyor arranged to receive articles subsequent to treatment of such articles at said working station; and an apparatus for transferring workpieces between said working station and said conveyors, said apparatus comprising a guide defining an elongated pathway extending in a direction from said working station toward said conveyors, a transfer unit mounted on said guide to reciprocate along said pathway, said unit comprising a plurality of article-engaging arms arranged to orbit about an axis which is substantially perpendicular to said pathway, and means for reciprocating said unit along said pathway so that said arms may engage articles at said working station for transfer of such articles toward said second conveyor and that said

arms may also transfer articles from said first conveyor to said working station.

10. A structure of the character described, comprising a machine arranged to treat consecutive workpieces and similar discrete articles and comprising a working station at which the articles are located during treatment; conveyor means arranged to feed unfinished articles for treatment at said working station and to receive finished articles subsequent to such treatment, said conveyor means being located at a level which is different from the level of said working station; and an apparatus for transferring articles between said working station and said conveyor means, said apparatus comprising a lifting device arranged to receive and to deliver articles seriatim to said conveyor means, means for actuating said lifting device at intervals corresponding to the rate at which the machine treats workpieces at said working station, a guide defining a horizontal pathway extending between said working station and the path of movement of said lifting device, a transfer unit mounted on said guide to reciprocate along said pathway, said unit comprising a plurality of article-engaging arms arranged to orbit about a common vertical axis, and means for reciprocating said unit along said pathway so that said arms may receive articles seriatim from said lifting device for delivery to said working station or vice versa.

11. In an apparatus for transferring workpieces and similar discrete articles to and from the working stations of machine tools and the like, in combination, a conveyor comprising a pair of endless flexible elements having spaced parallel upper stringers arranged to advance a file of articles; guide means defining an elongated pathway extending substantially from said conveyor to a working station; a transfer unit mounted on said guide means to reciprocate along said pathway and comprising a plurality of article-engaging arms arranged to orbit about a common axis which is substantially perpendicular to said pathway; and means for reciprocating said unit along said pathway so that said arms may receive articles from the working station for transfer of such articles toward said conveyor or vice versa.

12. A structure as set forth in claim 11, wherein said conveyor comprises means for regulating the distance between said flexible elements so that said elements may convey differently configurated and differently dimensioned articles.

13. A structure of the character described, comprising a machine arranged to treat consecutive workpieces and similar discrete articles and comprising a working station at which the articles are located during treatment; conveyor means arranged to feed unfinished articles for treatment at said station; and an apparatus for transferring workpieces between said working station and said conveyor means, said apparatus comprising a guide defining an elongated pathway extending in a direction from said working station toward said conveyor means, a transfer unit mounted on said guide to reciprocate along said pathway, said unit comprising a plurality of article-engaging arms arranged to orbit about an axis which is substantially perpendicular to said pathway, means for reciprocating said unit along said pathway so that said arms may engage articles at said working station for transfer of such articles toward said conveyor means or vice versa, said conveyor means being arranged to advance the articles at a speed exceeding the rate at which the articles are treated at said working station so that a supply of articles accumulates on said conveyor means for transfer by said arms, and spacer means adjacent to said conveyor means and arranged to maintain articles in positions necessary for engagement by said arms, said spacer means comprising a pair of cooperating arresting members including a main arresting member movable into and out of the path of articles on said conveyor means and a second arresting member located past said main arresting member as seen in the direction of movement of said conveyor means, and means for selectively moving said arresting members into and out of the path of articles on said conveyor means, said second arresting member being arranged to arrest the articles seriatim in a position of registry with one of said arms when the transfer unit is moved to an end position distant from said working station.

14. A structure of the character described, comprising a machine arranged to treat consecutive workpieces and similar discrete articles and comprising a working station at which the articles are located during treatment; conveyor means arranged to advance articles past said working station at a speed exceeding the rate at which the articles are treated at said working station; transfer means for transferring articles seriatim between said working station and said conveyor means; and spacer means for regulating the movement of articles with said conveyor means, comprising first arresting means movable into and from the path of articles on said conveyor means to intermittently interrupt the advance of consecutive articles whereby the conveyor means travels with reference to the articles located upstream of said first arresting means, and second arresting means located downstream of said first arresting means and movable into and from the path of articles on said conveyor means to arrest an article which has bypassed said first arresting means in a position for engagement by said transfer means.

15. A structure as set forth in claim 14, wherein said spacer means further comprises third arresting means located upstream of said first arresting means and movable into and from the path of articles on said conveyor means for holding against movement with said conveyor means all such articles which are located upstream of said first arresting means while said first arresting means is outside of said path.

16. A structure as set forth in claim 15, further comprising an operative connection between said first and third arresting means for moving said first arresting means into said path when said third arresting means is withdrawn from said path and vice versa.

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MARVIN A. CHAMPION, *Primary Examiner.*