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(54) Apparatus for positioning and clamping work-clamp pallet for machine tools

(57) An apparatus for positioning and clamping a work-clamp pallet (3), for facilitating changing of workpieces to be machined on the movable table (5)

of a machine tool, consists of a transferable work-clamp pallet (3) and a pallet-setting device (6).

Workpieces are clamped on the work-clamp pallet by means of its work-clamping devices and the work-clamp pallet (3) so prepared is transferred onto the work table (5) utilising the pallet-setting device (6).

The pallet-setting device is composed of a base plate (38) formed integral with or separate from the movable table (5) of the machine tool and carried on movable saddle thereof and transfer rails (39), guide rails (31), supporting blocks (35), positioning devices (32) and clamping devices (36) etc. provided in or on the base plate (38), the work-clamp pallet is transferred onto it with its castors rolling on the transfer rails (39) under guiding by the guide rails (31) and after high-precision positioning by the positioning devices (32) is powerfully clamped onto the supporting blocks by devices (36).



FIG.1

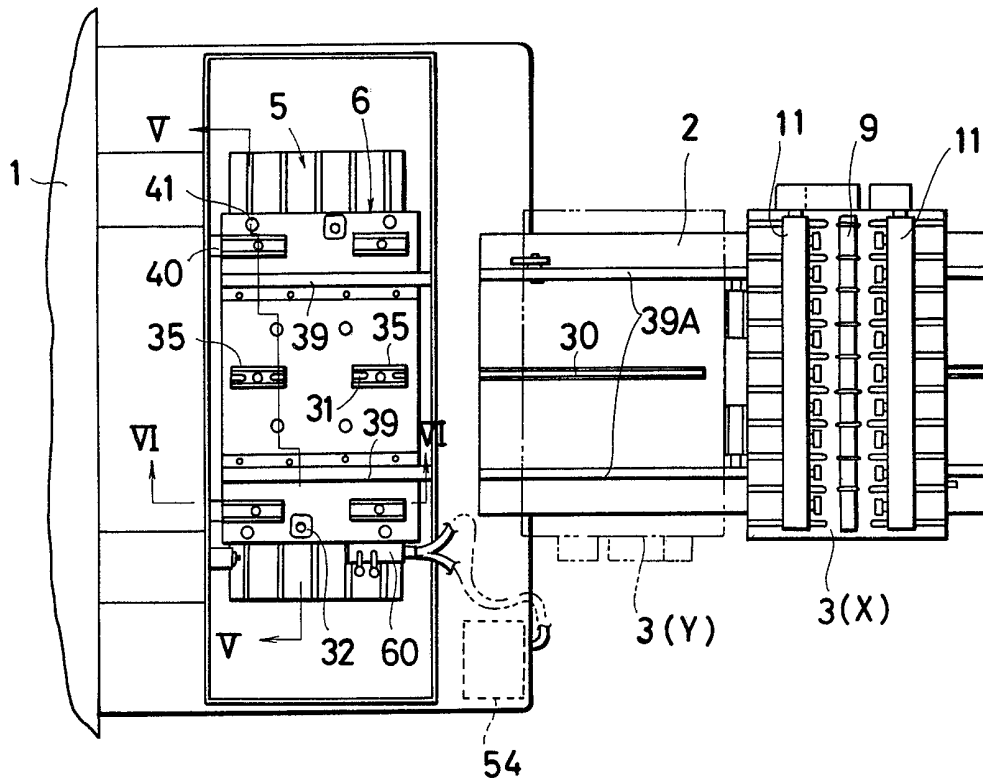


FIG.2

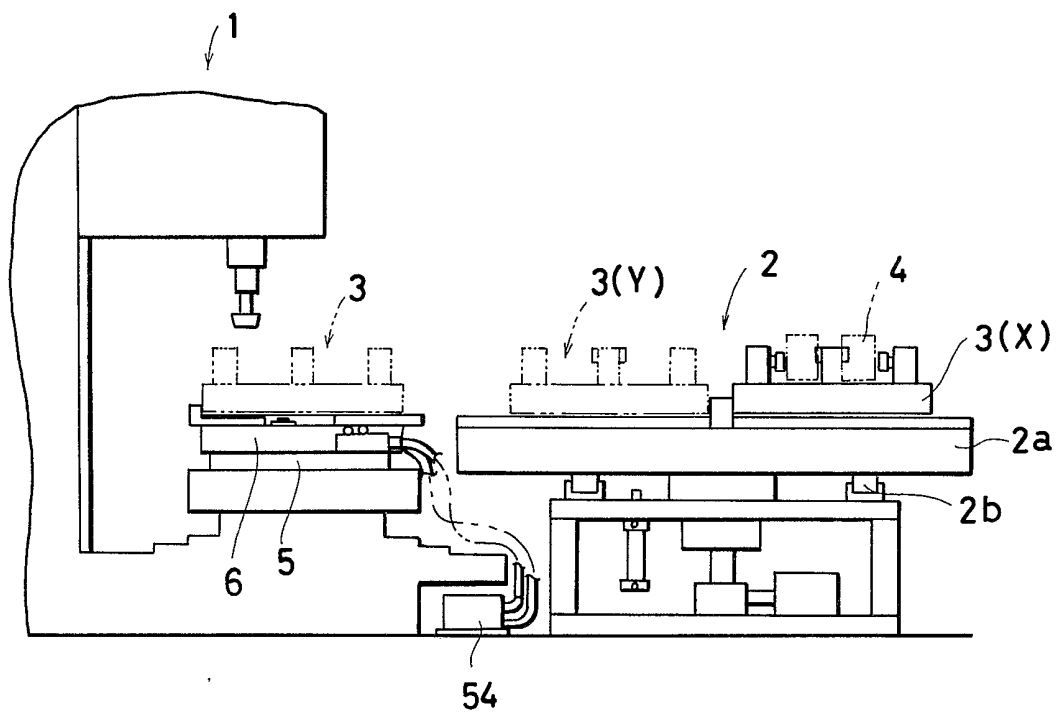


FIG. 3

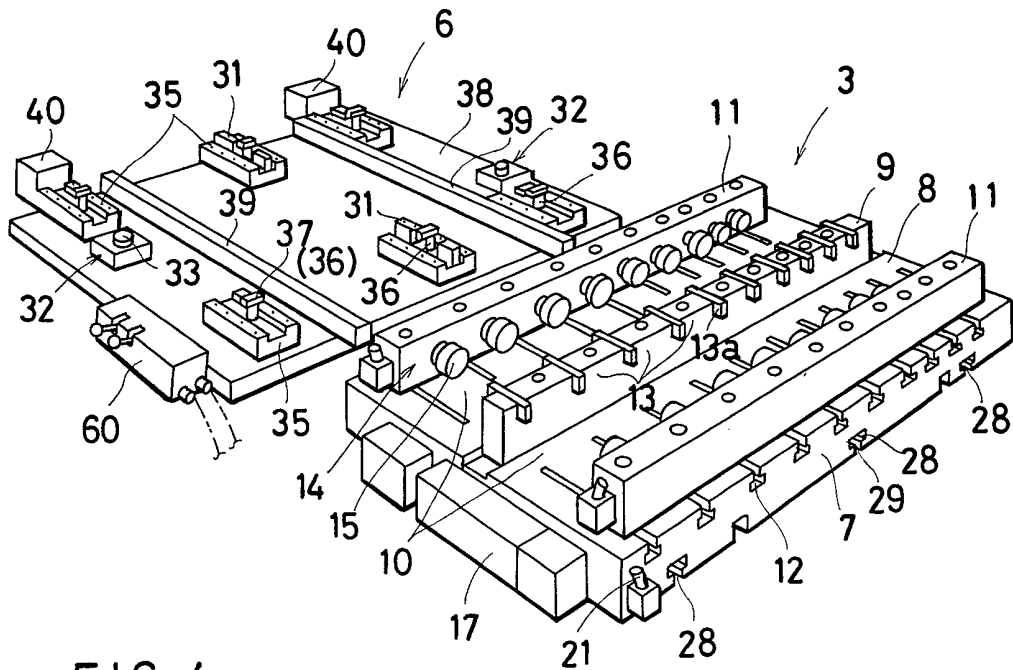


FIG. 4

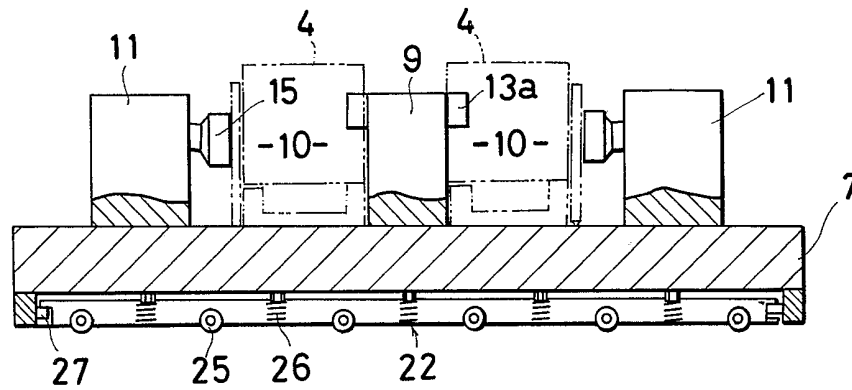


FIG. 5

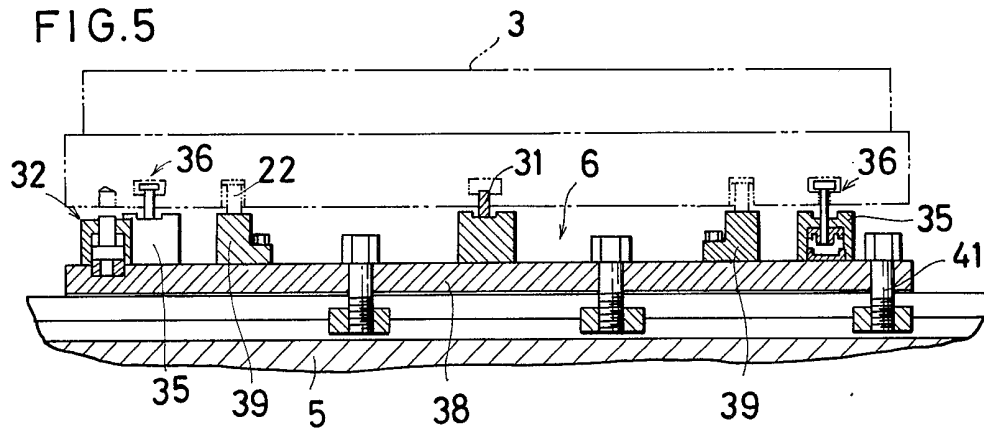


FIG.6

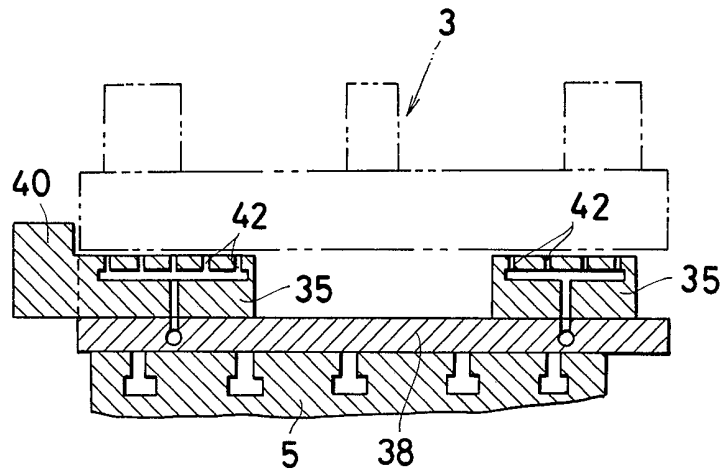


FIG.7

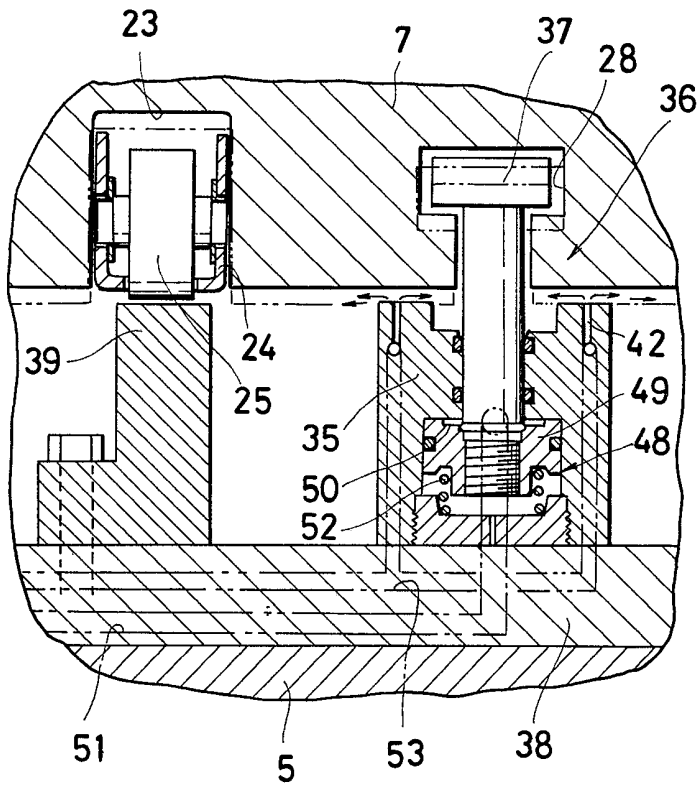


FIG.8

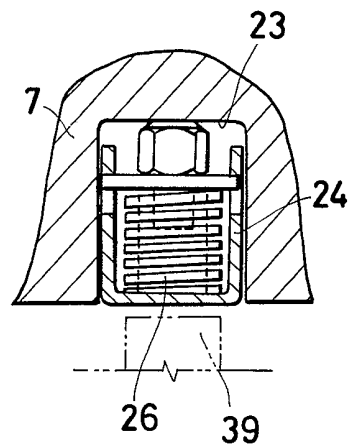


FIG.9

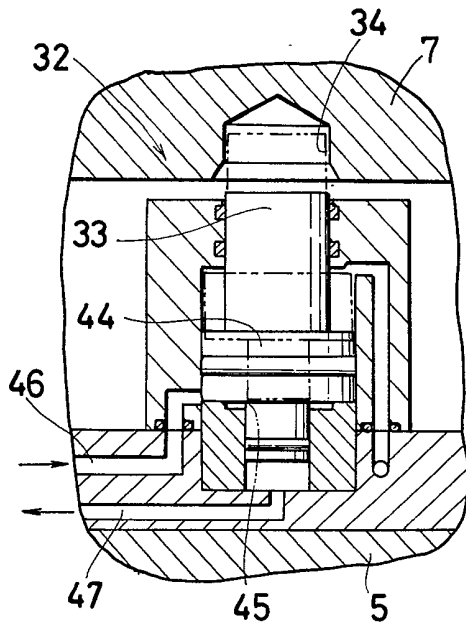


FIG.10

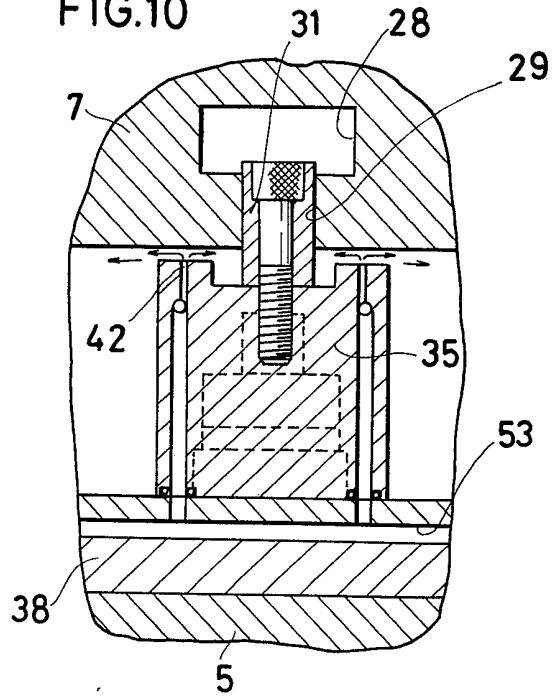


FIG.11

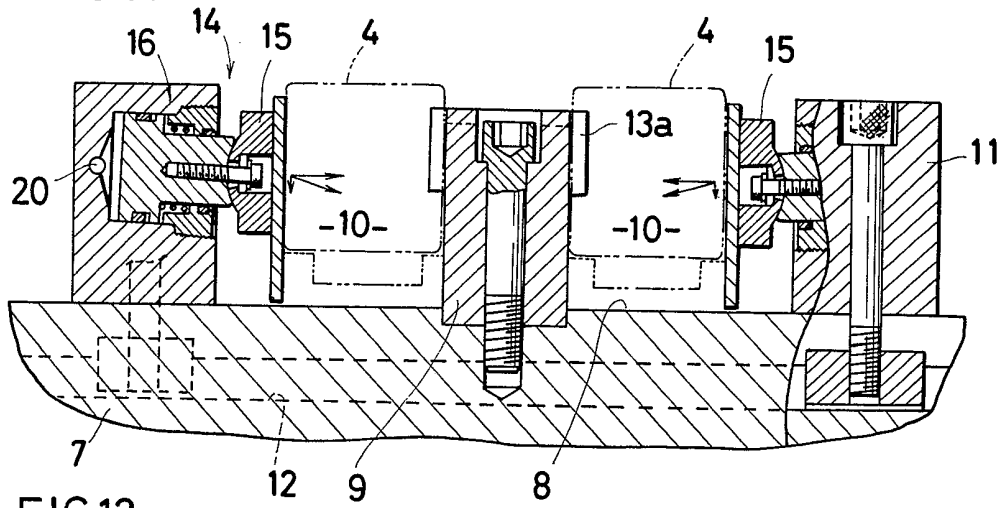


FIG.12

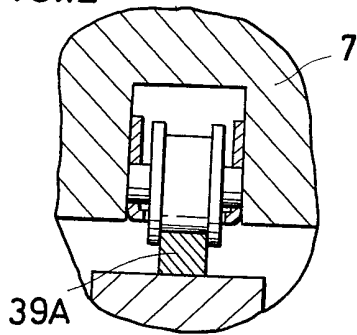


FIG.13

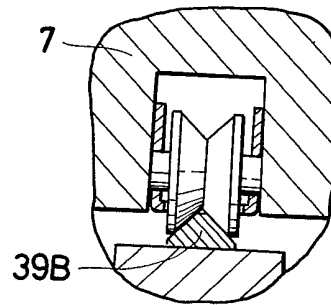


FIG.14

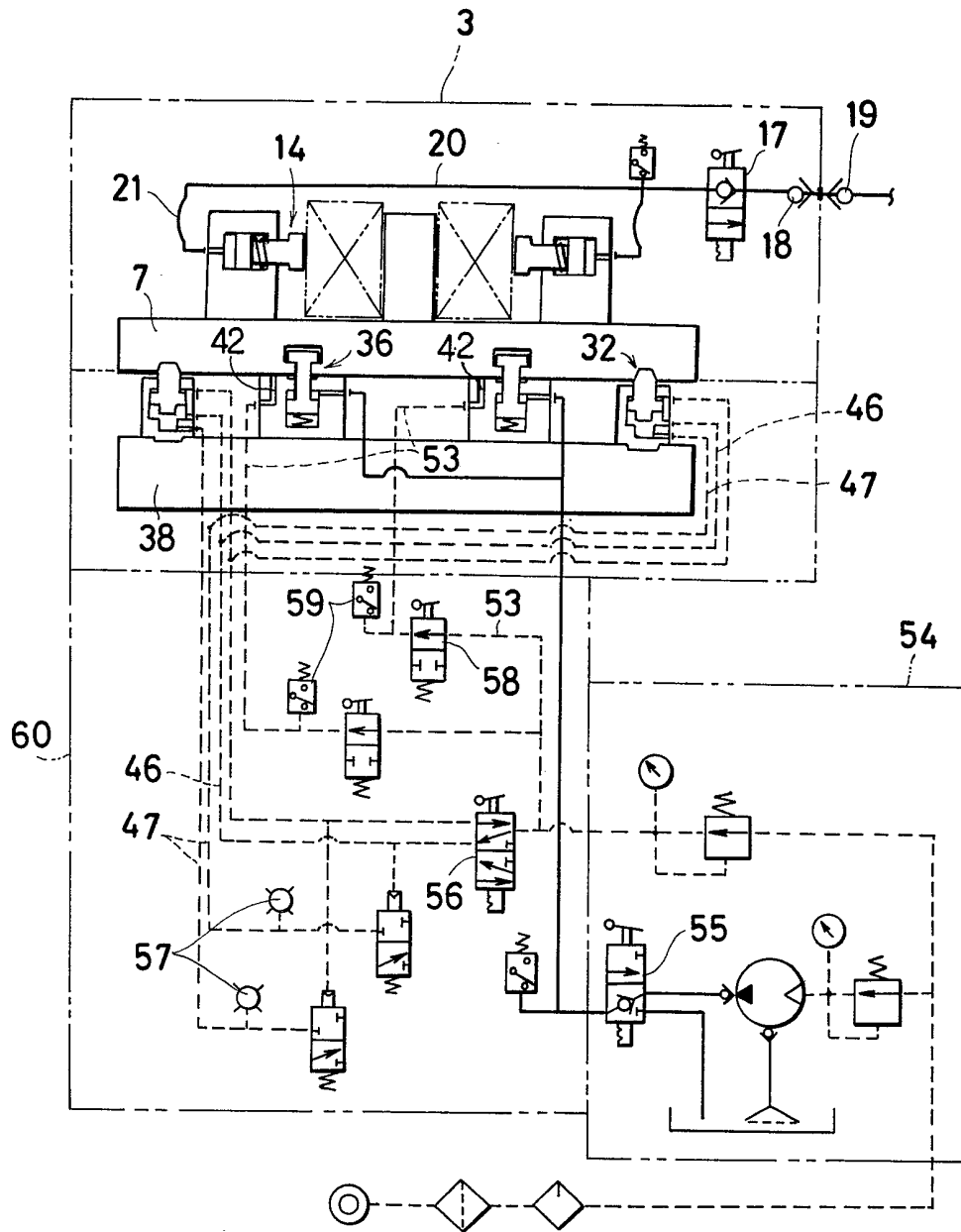


FIG.15

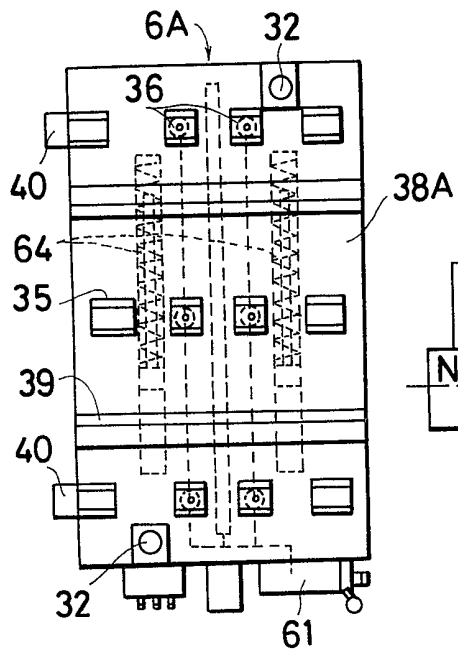


FIG.18

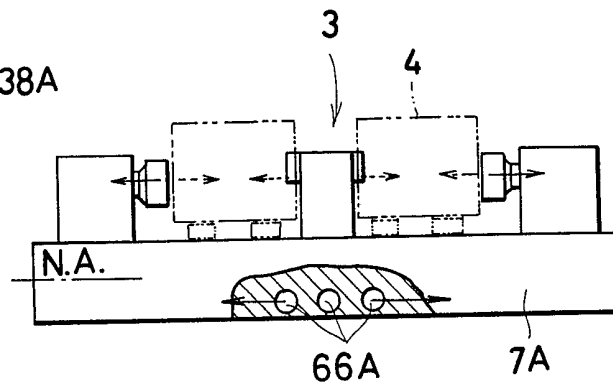


FIG.16

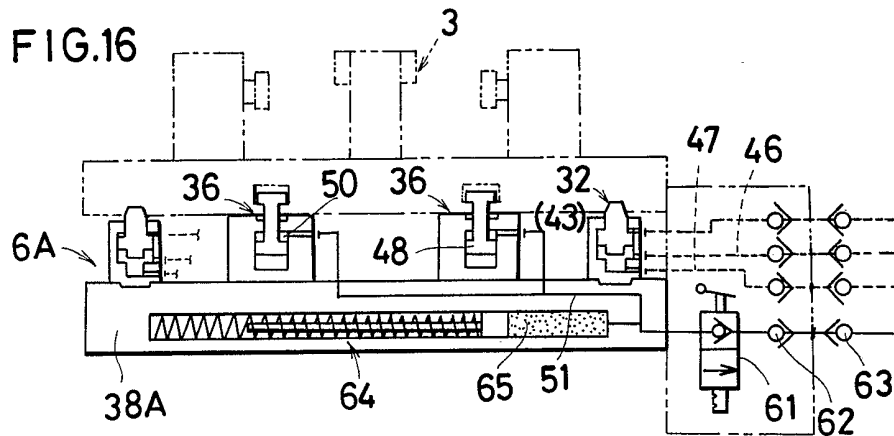


FIG.17

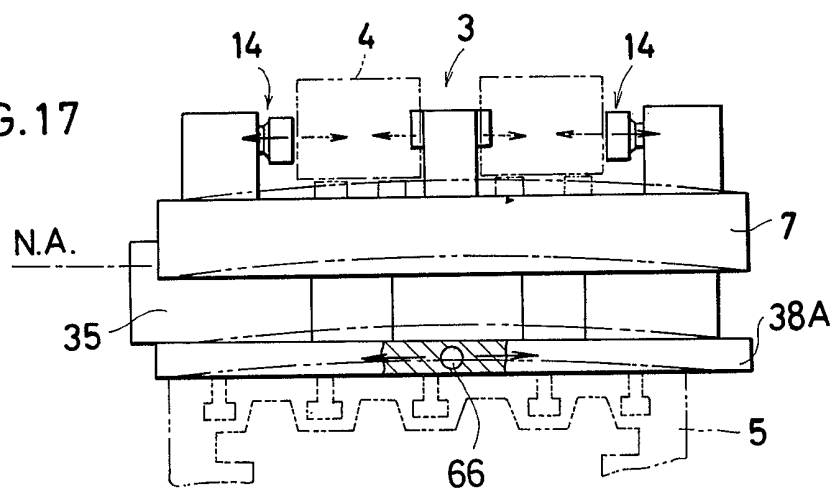


FIG.19

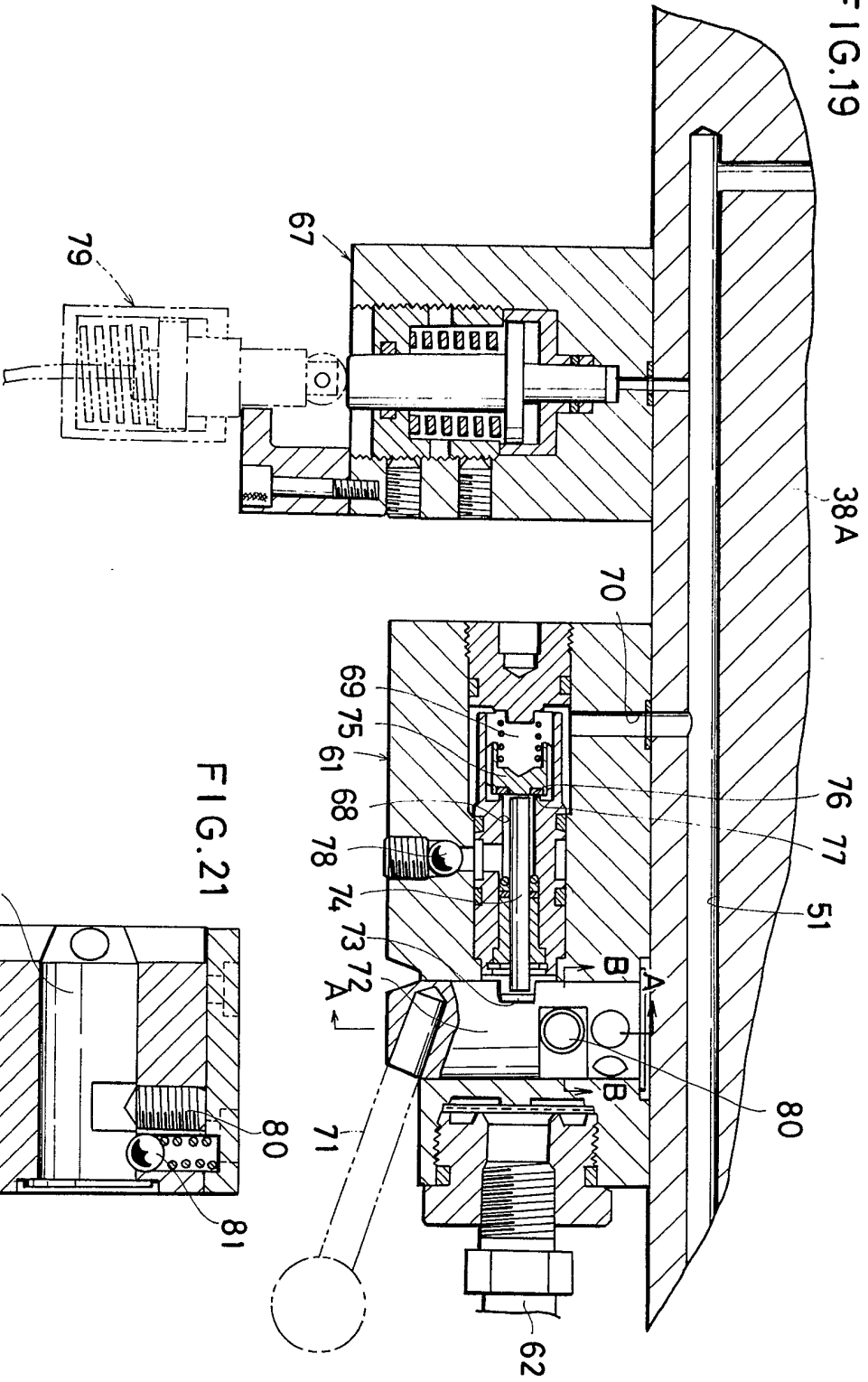
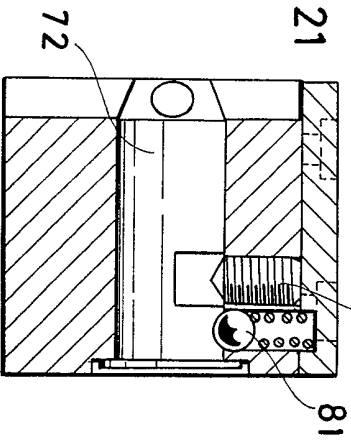


FIG.21



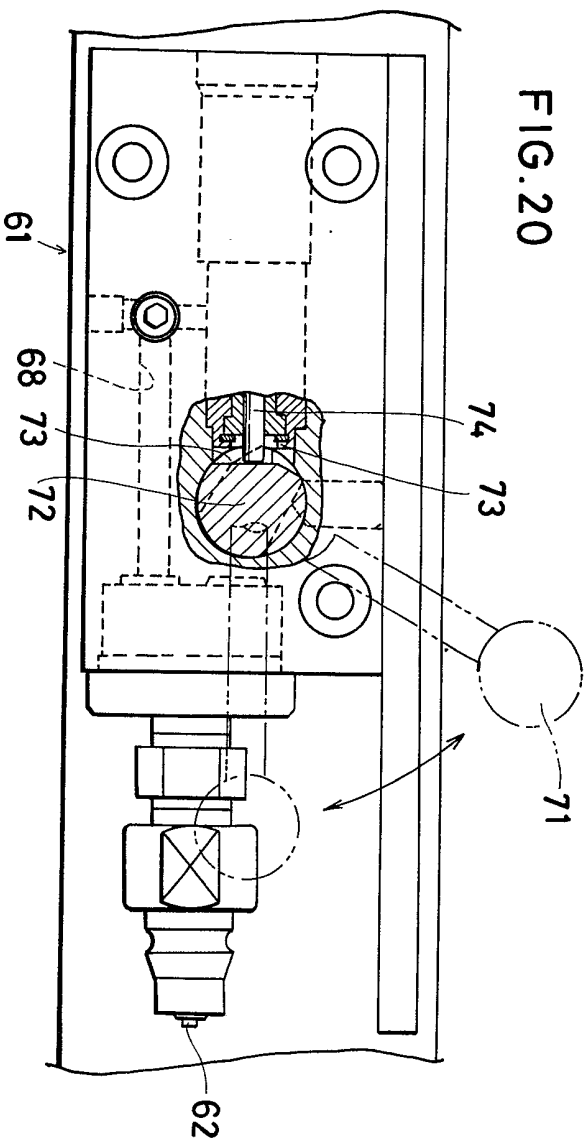


FIG. 20

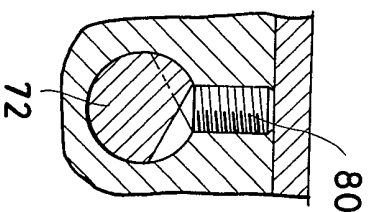


FIG. 22

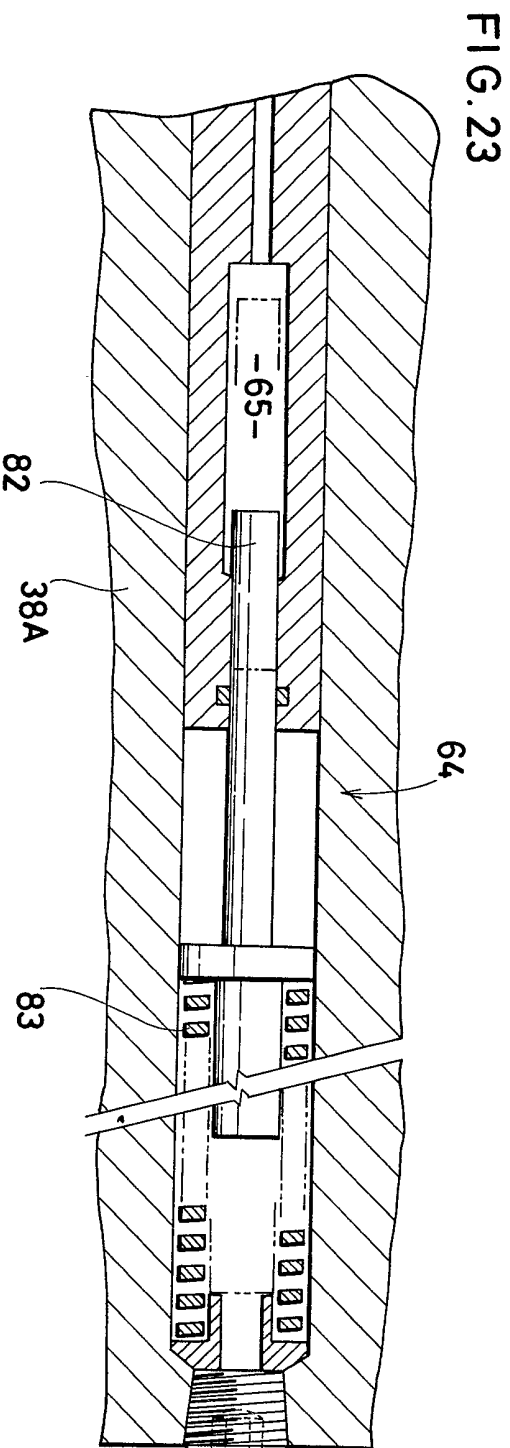


FIG. 23

FIG.24

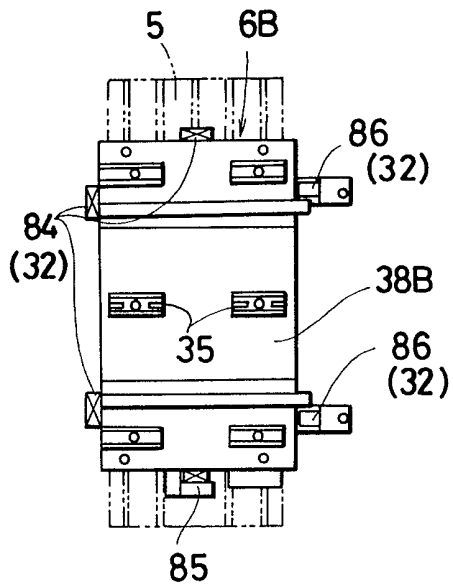


FIG.27

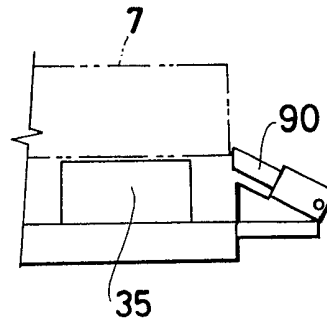


FIG.25

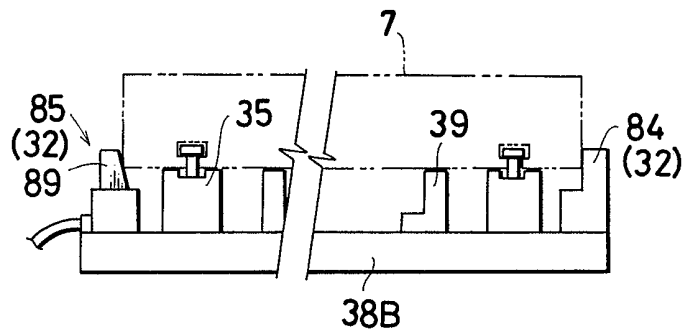


FIG.26

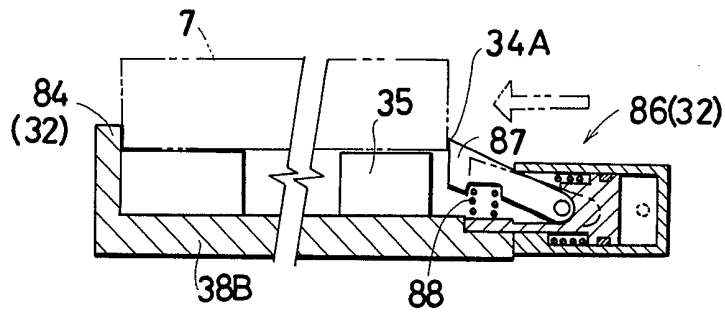


FIG. 28

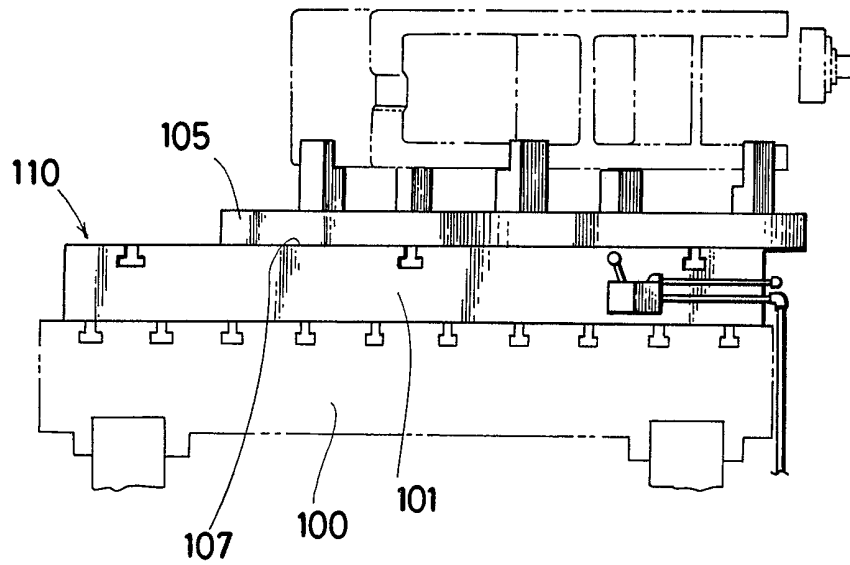
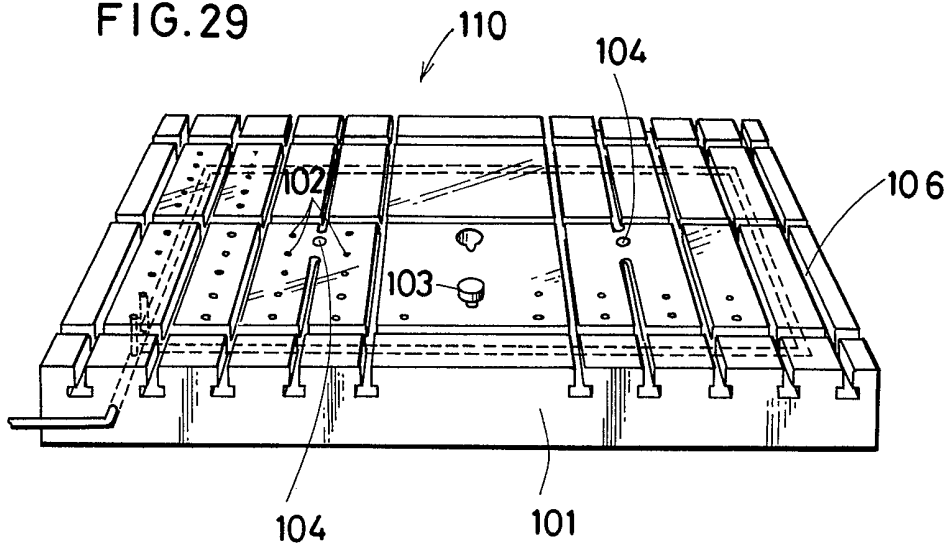


FIG. 29



SPECIFICATION

Apparatus for positioning and clamping work-clamp pallet for machine tools

BACKGROUND OF THE INVENTION

Field of the invention

The present invention relates to an apparatus for positioning and clamping a work-clamp pallet on the work table of various kinds of machine tools.

These years quite remarkable has been the progress of machine tools and NC machine tools including the so-called machining centers, in particular, are now gaining in popularity.

In these high-performance, automated machine tools the cutting or machining performance has been improved remarkably and automatic changing of tools, too, is already realized.

When a large number of relatively small works are arranged on the work table of an NC machine tool for machining, substantial efforts and care are required for the works have to be precisely positioned on the work table according to the design drawing and subsequently clamped thereon.

The machine tool manufacturers with their great enthusiasm for improvement of the machine's performance have generally been much less enthusiastic for automatization of work-changing and, consequently, much less remarkable has been the progress in this direction.

Hence, despite the high machining performance, the net working ratio is not more than 30 ~ 40% even for the latest models of machine tools.

Belatedly, however, the significance of this is now being recognized and the work-changing system by the use of the so-called work-clamp pallets is now taking root, being put to practical use if gradually, for increasing the speed and improving the efficiency of work-changing so as to sizably improve the overall working ratio and productivity of machine tools through reduction of the proportion of the work-changing work to the entire work of machine tool operation.

For improving the work-changing efficiency, the basic idea is to do the work of positioning and clamping works on the work-clamp pallet outside the work table of the machine tool and transfer the work-clamp pallet with a large number of works set on it onto the work table in exchange for the finished one, i.e. the work-clamp pallet with finished works on, to thus change the works quickly and efficiently.

The present invention relates to the apparatus for positioning and clamping such work-clamp pallet on the work table of the machine tool efficiently with a high precision.

Description of the prior art

As the latest prior art concerning an apparatus for positioning and clamping a work-clamp pallet for machine tools may be cited one titled "Apparatus for lcoating and clamping a work member supporting fixture" (U.S. patent No. 4,179,106).

In the locating and clamping apparatus 110 of this prior art an auxiliary table 101 formed as the work table of a machine tool itself or fixedly secured to the

work table 100 is provided with a transfer means of air film type 102, a centering device 103, a plurality of positioning devices 104 and clamping devices (not shown) etc. and a work member supporting fixture 105 is transferred onto this auxiliary table 101 to be located and clamped thereon.

The abovementioned transfer means 102 consists of a large number of compressed air outlets in the topside of the auxiliary table 101 each provided with a valve ball for opening/closing thereof, which are opened when the work member supporting fixture 105 is placed thereon for an air film to be formed by the compressed air gushing out therethrough.

The centering device 103 consists of pins projecting upwardly from the auxiliary table 101, a plurality of the positioning devices 104 are plugging devices each consisting of a hydraulic cylinder and the clamping devices are hydraulic clamping devices carried in T-sectioned grooves 106 with their positions freely adjustable along the edges of the work member supporting fixture 105 placed on the auxiliary table 101 for clamping thereof.

The locating and clamping apparatus 110 described above is primarily for large-sized work member supporting fixtures 105 for clamping large-sized works thereon intended, more particularly, for work member supporting fixtures 105 mainly for horizontal type of machine tools and low in frequency of exchanging, and is known to have the following defects or shortcomings.

(1) As is apparent from the fact that its transfer device 102 is of the air film type, the topside 107 of the auxiliary table 101 is used for transferring the supporting fixture 105 thereon while at the same time it is the plane on which the same is located and clamped, hence there is an increased risk of chips being caught between the topside of the auxiliary table 101 and the bottom of the work member supporting fixture 105.

Moreover, since the work member supporting fixture 105 is to be clamped inclined, increased is the work positioning error with respect to the table 100.

(2) The pins of the centering device 103 are projected above the topside of the auxiliary table 101, this interfering with sideway transfer of the work member supporting fixture 105 onto the auxiliary table 101.

Moreover, while the centering pins are provided for centering of the work member supporting fixture 105, the work member supporting fixture 105 is free to turn when it is lifted to float on the air film, this interfering with precise and efficient positioning thereof.

(3) The clamping devices are made to clamp the work member supporting fixture 105 along its edges, hence the T-sectioned grooves 106 in the topside of the auxiliary table 101 are indispensable. This means that the auxiliary table 101 is required to be thick enough to allow for the depth of the T-sectioned grooves 106 and bound to be that much heavy, this being a fatal defect for the movable table 100 of an NC machine tool or the like which is required to be quickly shiftable with a high precision.

(4) The transfer device 102 of the air film type is high in compressed air consumption, hence in-

creased is the energy cost.

The consumption of compressed air is bound to be increased remarkably especially when this type of transfer device 102 is applied to the auxiliary table 5 106 with the T-sectioned grooves in the topside thereof.

SUMMARY OF THE INVENTION

The present invention seeks to eliminate the 10 defects of the prior art described above.

Preferably, the present invention should enable the machining precision of works to be improved by precisely positioning and clamping a work-clamp 15 pallet with works set thereon on a machine tool's work table.

For accomplishment of this, it is so arranged that a work-clamp pallet is placed on and clamped to a plurality of supporting blocks arranged on a base plate of a pallet-setting device of the present invention so as to minimize depositing of chips on the 20 supporting blocks and also to facilitate removal of chips possibly deposited thereon to thereby ensure against chips being caught between the supporting blocks and the work-clamp pallet.

Also, the present invention should preferably enable quick positioning and subsequent clamping of the work-clamp pallet on the pallet-setting device for the desired improvement of a machine tool's working ratio.

For that several lines of transfer rail are set on the base plate, while the work-clamp pallet is provided with castor-type transfer means, so that the work-clamp pallet can be moved rolling on the rails and also provided is a guide rail for guiding the moving 35 work-clamp pallet.

It is thereby possible to first stop the work-clamp pallet transferred onto the pallet-setting device with a stopper or the like and immediately thereafter position it quickly with a high precision by means of 40 provided clamping devices and subsequently clamp it in place by clamping devices also provided.

Furthermore, the present invention should enable the gross weight of the movable table carried on a movable saddle of a machine tool to be minimized 45 for the desired improvement of the machine tool's high machining speed feature and high machining precision feature as well as saving of the manufacturing cost of the work-clamp pallet.

For that the base plate of the pallet-clamping apparatus may be made as thin as possible as a plate and not as a block and the transfer rails, supporting blocks, positioning devices and clamping devices may be made with their heights limited to the required minimum.

The present invention may be provided with means for generation of inverse bending moment for cancelling or off-setting the bending moment caused in the work-clamp pallet by the clamping force of the work-clamping device of the work-clamp 60 pallet, in order to improve the work machining precision.

The present invention may be arranged to allow the use of the work-clamp pallet with hydraulic hoses detached therefrom by making it detachable 65 from the hydraulic hoses extending from a hydraulic

pressure source with its clamping devices supplied with a required level of hydraulic pressure.

The present invention provides an apparatus for positioning and clamping work-clamp pallet for 70 machine tools composed of a work-clamp pallet and a pallet-setting device, wherein

the work-clamp pallet is to be transferred onto and out of the work table of a machine tool with a plurality of works clamped thereon and is composed 75 of a base block, a plurality of work-clamping devices provided thereon and a set of castor-type transfer means provided in the underside thereof, of which the base block has its topside or each of its sides constituting a work-clamping face, has a longitudinal 80 transfer guide face provided on the underside thereof, has longitudinal as well as lateral positioning means provided at a plurality of points far off the transfer guide face and has clamping means also at a plurality of points far off the transfer guide face, 85 a plurality of the work-clamping devices are arranged in pairs on the work-clamping face of the base block, and

a set of the castor-type transfer means has their individual castors arranged longitudinally as well as 90 laterally on the underside of the base block shiftable between a lower projecting rolling position and an upper retracted stopping position,

the pallet-setting device is for positioning and clamping the work-clamp pallet on the work table of 95 the machine tool and is composed of a base plate and transfer rails, guide rails, supporting blocks, positioning devices and clamping devices, of which the base plate is placed on a movable saddle of the machine tool to be laterally movable,

the transfer rails are set longitudinally raised above the topside of the base plate in at least two, left and right, lines on which moves the work-clamp 100 pallet with its castor-type transfer means,

a plurality of the supporting blocks are fixedly 105 secured to the topside of the base plate at at least four - two longitudinal and two lateral - points, the topside thereof constituting a horizontal reference plane above the topside of the base plate on which the work-clamp pallet rests level,

the guide rails are linearly arranged longitudinally and are fixed with their topside raised above the horizontal reference plane so as to be in sliding contact with the transfer guide face of the work-clamp pallet for guiding the pallet to ensure against 110 lateral shifting,

a plurality of the positioning devices provided in the base plate are to engage with the positioning means of the work-clamp pallet for longitudinal as well as lateral positioning thereof, and

a plurality of the clamping devices the base plate is also provided with have each of their clamping arms shiftable between an unclamping or clamp-releasing position and a clamping position and when it is at the unclamping position, the clamping means of the 125 work-clamp pallet is released to allow it to move longitudinally and when it is at the clamping position, the same is engaged for the work-clamp pallet to be clamped onto the supporting blocks.

BRIEF DESCRIPTION OF THE DRAWINGS

Figures 1 ~ 14 show a principal embodiment of the present invention and Figures 15 ~ 27 alternative embodiments thereof, while Figures 28 and 29 relate to the quoted prior art, of which

Figure 1 is a plan view of the work table and pallet-changing table of a machine tool;

Figure 2 is a side view of what is shown in *Figure 1*;

Figure 3 is a perspective view of a clamp setting device and a work-clamp pallet;

Figure 4 is a vertical sectional side view of part of a transfer means of the work-clamp pallet;

Figure 5 is a vertical sectional view taken along the line V-V in *Figure 1*;

Figure 6 is a vertical sectional view taken along the line VI-VI in *Figure 1*;

Figure 7 is a vertical sectional front view of the transfer means and clamping devices of the work-clamp pallet;

Figure 8 is a vertical sectional front view of a spring portion of the transfer means of the work-clamp pallet;

Figure 9 is a vertical sectional front view of a positioning device;

Figure 10 is a vertical sectional front view of a supporting block and guide rail;

Figure 11 is a partial vertical sectional side view of essential parts of the work-clamp pallet;

Figures 12 and 13 are vertical sectional front views of the transfer means in respective alternative embodiments;

Figure 14 is a pneumatic-hydraulic system chart;

Figures 15 ~ 23 show a first alternative embodiment of the present invention, of which

Figure 15 is a plan view of a pallet-setting device;

Figure 16 is a partial pneumatic-hydraulic system chart of the pallet-setting device;

Figure 17 is a side view of the pallet-setting device and the work-clamp pallet set thereon;

Figure 18 is a partly broken away vertical sectional side view of the work-clamp pallet;

Figure 19 is a horizontal sectional plan view of a shut-off valve and an actuator for detecting hydraulic pressure fall;

Figure 20 is a side view of the shut-off valve;

Figure 21 is a sectional view taken along the line A-A in *Figure 19*;

Figure 22 is a sectional view taken along the line B-B in *Figure 19*;

Figure 23 is a horizontal sectional plan view of a spring-type accumulator;

Figures 24 ~ 27 show a second alternative embodiment of the present invention, of which

Figure 24 is a plan view of the pallet-setting device;

Figure 25 is a front view of the pallet-setting device;

Figure 26 is a vertical sectional side view of the pallet-setting device and a positioning device;

Figure 27 is a partial side view of the pallet-setting device showing a modified movable pawl means of the positioning device;

Figure 28 is a side view of a locating and clamping apparatus in the quoted prior art and a work member

supporting fixture clamped thereon, and

Figure 29 is a perspective view of the locating and clamping apparatus shown in *Figure 28*.

Referring to Figures 1 ~ 13, described below is the principal embodiment of the present invention.

As shown in Figures 1 and 2, a rotary pallet-changing table 2 for changing work-clamp pallets 3 is placed in front of a work table of a vertical machine tool 1 and after setting works 4 on the work-clamp pallet 3 at a work-changing station X thereon, a rotary bed 2a of the pallet-changing table 2 is turned 180° on carrying castors 3 to shift the work-clamp pallet 3 to a work-clamp pallet changing station Y and from there the work-clamp pallet 3 is transferred rolling on transfer rails 39A and 39 onto the work table 5.

The apparatus for positioning and clamping a work-clamp pallet for machine tools claimed in the present application is for positioning and clamping in place the work-clamp pallet 3 transferred onto the work table 5 of the machine tool 1 and consists of the work-clamp pallet and a pallet-setting device 6.

The work-clamp pallet 3 is of the following makeup. As shown in *Figure 3*, a standard frame extending on the lateral center of a work-clamping face on the topside of the pallet's base block 7 is fixedly secured thereto and on both longitudinal sides of the standard frame 9 are arranged clamping frames 11 across each work accommodating space 10 therefrom with its position adjustable longitudinally.

Each clamping frame 11 is provided with work-clamping devices 14 each thereof opposed to each of a plurality of unit work positioning faces 13 on the front and rear sides of the standard frame 9, and a work 4 is clamped or unclamped as each clamping block 15 is driven toward or away from each unit work-positioning face 13. A gate-shaped work-positioning member 13a is disengageably engaged in each mating groove in the topside of the standard frame 9.

As shown in Figures 11 and 14, the clamping drive means of the work-clamping device 14 is a hydraulic cylinder 16 in the clamping frame 11, to which hydraulic oil is supplied with a hydraulic pressure outlet of hydraulic pressure supply device (not shown) connected to a hydraulic pressure inlet/outlet 18 of a shut-off valve 17 through the shut-off valve 17, an oil path 20 in the base block 7, a hydraulic hose 21 and another oil path 20 in the clamping frame 11.

After clamping of the works 4, the oil path 20 is shut down by the shut-off valve 17, the oil pressure outlet 19 is disconnected from the oil pressure inlet/outlet 18 and in this state the work-clamp pallet 3 alone can be transferred and the works 4 clamped thereon can be machined. The shut-off valve 17 is the same as that shown in the first alternative embodiment.

As transfer means 22 of the work-clamp pallet 3 are provided right and left castor-type transfer means 22 set in square-sectioned grooves 23 in the underside of the base block 7. Normally, a U-sectioned member 24 carrying castors is urged downwardly by compression springs 26 to be in the

rolling position and the tread of each castor 25 is projected beyond the underside of the base block 7 so that the work-clamp pallet 3 is movable on the castors 25 rolling on the transfer rails 39 and 39A.

5 When the work-clamp pallet 3 is pulled down by the clamping devices 36, the U-sectioned member 24 is lifted against the springs 26 to be in the stopping position. Reference numeral 27 denotes a retainer preventing the U-sectioned member 24 from falling out.

10 Each U-sectioned member 24 is provided with a plurality of castors 25 so that the work-clamp pallet 3 is smoothly movable even if there is a gap between the pallet-changing table 2 and the pallet-setting device 6.

15 The vertical sides of the longitudinal center T-sectioned groove in the underside of the base block 7 constitute the transfer guide faces 29 to guide the work-clamp pallet 3 as it is transferred against lateral shifting. In this T-sectioned groove a guide rail 30 on the pallet-changing table 2 and/or a guide rail 31 of the pallet-setting device 6 are engaged freely slidable therein for the work-clamp pallet 3 to be longitudinally guided thereby.

25 Further, there are provided a lateral pair of positioning means 34 in the underside of the base plate 7 for engaging the work-clamp pallet 3 by engaging plugs 33 of positioning devices 32 of the pallet-setting device.

30 3 longitudinal T-sectioned grooves provided on the left and right and at the center of the underside of the base block 7 are clamping means 28 for clamping the base block 7 by clamping devices 36 onto supporting blocks 35.

35 As the work-clamp pallet 3 is transferred into or out of the place released clamping arms 37 are engaged loosely in the clamping means 28 to allow moving of the work-clamp pallet 3, and when the work-clamp pallet 3 is to be clamped, the clamping arms 37 are lowered into the clamping position for the base block 7 to be clamped level on the supporting blocks 35.

40 The clamp-setting device 6 provided on the work table 5 of the machine tool 1 is, as shown in Figure 3, composed of a bed plate 38, a lateral pair of --left and right-- transfer rails 39 and center guide rails 31 set on the top side of the base plate 38, 6 pairs of supporting blocks 35, a pair of positioning devices 32, 6 pairs of clamping devices 36 and stoppers 40.

50 In this embodiment, the base plate 38 is made of steel plate separate from the work table 5 by means of erection bolts 41. This allows the apparatus of the invention to be readily applicable to standard as well as existing machine tools 1.

55 Of course, it is also possible to form this base plate 38 monoblock with the work table 5 but the universal feature of the machine tool 1 is then affected.

60 As shown in Figures 3, 5 and 7, the transfer rails 39 are set on the top side of the base plate 38 one each of the left and right to correspond the transfer means 22 of the work-clamp pallet 3. This transfer rail 39 is made of L-sectioned member and is secured to the base plate 38 by means of bolts etc.

65 This transfer rail 39 has a narrow top track face which is a step higher than the top side of the base

plate 38, hence chips are not easily deposited on it and, if deposited, they can be removed easily. If necessary, scrapers (not shown) may be provided at the front and rear ends of the transfer means 22 for automatic cleaning of the track face.

70 It is advisable to have the transfer rail 39 narrower than the square-sectioned groove 23 of the transfer means 22 to prevent chips from being caught between the transfer rail 39 and the base block 7.

75 As shown in Figures 12 and 13, it is also practical enough to form the transfer rails 39A and 39B to serve concurrently as guiding means.

80 As shown in Figures 3 and 10, the guide rails 31 are set two pieces each on each center supporting block 35 aligned longitudinally, set to extend above the horizontal reference plane containing the top side of each supporting block 35. This guide rail 31 comes into sliding contact with the transfer guide face 29 as the work-clamp pallet 3 is transferred into and out of the place for it to be guided thereby longitudinally.

85 It is advisable to round the front end of foremost guide rail 31 so that it can be engaged smoothly into the mating groove in the underside of the base block 7. The guide rails 31 may as well be formed as a continuous, longitudinal member.

90 In an alternative embodiment the guide rails 31 may be provided along both left and right edges of the base plate 38 so as to be in sliding contact with the transfer guide faces 29 on the left and right sides of the work-clamp pallet 3.

95 The supporting blocks 35 in a total of 3 longitudinal pairs on the left and right sides and at the center of the base plate 38 are provided with their top side constituting a horizontal reference plane higher than the top side of the base plate 38.

100 Each supporting block 35 is recessed about its center in the form of a shallow groove to make its top supporting face as small as possible to minimize the risk of chips depositing thereon and it is so arranged, as will be described later in greater detail, that the foreign objects possibly deposited on each supporting block 35 are blown off by the compressed air jetted out of air outlets 42. At the rear end of the rearmost supporting block 35 is formed a projecting stopper 40 to check the work-clamp pallet 3 for rough positioning thereof.

110 As shown in Figures 3 and 9, the positioning device 32 is plug means 43 consisting of air cylinders arranged on the base plate 38 on the left and right sides as far away from the center. The piston rod of each air cylinder whose upper end portion constitutes the plug 33 is arranged to be shiftable between the positioning position in which the plug 33 is projected above the horizontal reference plane and the waiting position with the plug 33 retracted.

120 It is so arranged that with the work-clamp pallet 3 stopped at the predetermined position the plug 33 is shifted from the waiting position to the positioning position so as to be engaged in the positioning means 34 of the base block 7 for highly precise positioning of the base block 7 longitudinally as well as laterally.

125 To enable clamping of the work-clamp pallet 3 after secure engagement of the plug 33 in the positioning means 34, required is a means for
130

detection of the engagement of the plug 33 in the positioning means 34.

For that, as shown in Figure 9, a stop valve 45 interlocked with a piston 44 of the air cylinder is provided between an air supply channel 46 and a pneumatic pressure channel for detection 47 and it is so interlocked that the stop valve 45 is closed when the piston 44 is at the waiting position and opened when it is at the positioning position.

The clamping device 36 is disposed at the center of each supporting block 35 and the clamping arm 37 connected with a piston 49 of a hydraulic cylinder 48 formed in the supporting block 35 projects from the supporting block 35 above the horizontal reference plane so as to be loosely engaged in the clamping means 28 of the work-clamp pallet 3.

When hydraulic oil is supplied to an oil path 51 of a hydraulic oil room 50 of the hydraulic cylinder 48, the clamping arm 37 is shifted from the unclamping position to the clamping position for the base block 7 to be clamped onto the supporting blocks 35.

When hydraulic oil is drained, the clamping arm 37 is shifted to the unclamping position by a spring 52.

The clamping blocks 35 are arranged close by each clamping arm 37 on both left and right sides thereof lest the clamping means 28 should be deformed by the clamping force.

Further, in order to ensure against chips being caught between each supporting block 35 and the base block 7, there are arranged outlets 42 in the topside of the supporting block 35 for the compressed air from an air supply channel 53 in the base plate 38 to be jetted out therethrough for blowing off the chips deposited on the supporting block 35 as shown in Figures 7 and 10.

When the base block 7 is clamped on the supporting blocks 35 to be in contact therewith, the pneumatic pressure in the air supply channel 53 rises, hence clamping of the base block 7 on all supporting blocks 35 in gap-free contact therewith can be confirmed through detection of this rise in pneumatic pressure.

Referring now to Figure 14, described below is the pneumatic-hydraulic pressure system of the positioning device 32 and the clamping device 36.

The hydraulic pressure generated by a hydraulic pressure supply device 54 of the machine tool 1 or the pallet-changing table 2 is supplied to the clamping device 36 through a shut-off of direction switching type 55.

When the air supply channel 46 is also switched by a direction switching valve 56, compressed air is supplied to the plug means 43 for the plug 33 to be actuated and further through the stop valve 45 opened by the plug 33 to the pneumatic pressure channel for detection 47 and the condition is displayed by a pneumatic pressure indicator lamp 57. By this proper actuation of the positioning device 32 can be confirmed.

Further, compressed air is supplied since before actuation of the clamping device 36 to the air supply channel 53 with a direction switching valve 58 switched accordingly for it to be jetted out through the air outlets 42 in the topside of the supporting block 35.

When the base block 7 is clamped, the air outlets

42 are closed thereby and the pneumatic pressure in the air supply channel 53 rises. A pressure switch 59 is provided for detection of this rise of pneumatic pressure. Secure clamping of the base block 7 can thus be confirmed.

A valve unit 60 with the switching valves 56 and 58, pneumatic pressure indicator lamp 57, pressure switch 59 etc. incorporated in it is attached to one side of the base plate 38 (Figure 3).

Described below are alternative embodiments in which the above principal embodiment is modified partly.

I. A first alternative embodiment is shown in Figures 15 ~ 23.

During machining of the works 4 clamped on the work-clamp pallet 3 it is necessary to keep the clamping devices 36 actuated but, as the movable table 5 of a large machine tool 1 is supposed to move over a pretty large distance, it is desired to have the hydraulic hoses detached during machining of the works 4.

Hence, in this pallet-setting device 6A a shut-off valve 61 for opening and closing the oil path 51 leading to the hydraulic oil room 50 of the clamping device 36 at one end thereof is provided on a base plate 38A and a hydraulic pressure outlet 63 of the hydraulic pressure supply device is arranged to be disconnectably with a hydraulic pressure inlet/outlet 62 on its primary port side over a self-seal coupling.

The air supply channel 46, pneumatic pressure channel for detection 48 etc. of the plug means 43, too, are arranged to be disconnectably connectable with pneumatic hoses over self-seal couplings. In the base plate 38A there is provided a spring-type accumulator 64 with its pressure accumulating oil room 65 communicating with the hydraulic cylinder 48.

When the work-clamp pallet 3 is replaced and the new pallet is positioned and clamped, the couplings of the hydraulic and pneumatic hoses are connected, and disconnected after clamping of the work-clamp pallet 3. The hydraulic pressures in the clamping devices 36 and the spring-type accumulator 64 then remain perfectly retained by the shut-off valve 61, i.e. by a check valve incorporated therein.

The hydraulic pressure thus retained is kept substantially constant by means of the accumulator 64 even in the event of variation of oil temperature or hydraulic pressure leakage.

As shown by the imaginary (2-dot chain) line in Figure 17, the united body of base block 7 and base plate 38A is subjected to a bending moment resulting from the clamping force of the work-clamping devices 14 to be deformed thereby a maximum of approx. 50 ~ 500 microns.

In order to prevent this deformation, an oil room 66 extending laterally over approximately the overall length of the base plate 38A is provided therein and communicating with the oil path 51.

As shown in the Figure, the hydraulic pressure of the hydraulic oil in this oil room 66 acts extending the base plate 38A longitudinally for the united body of base block 7 and base plate 38A to be subjected to an inverse bending moment cancelling or offsetting the abovementioned bending moment. N.A. in the

figure indicates the neutral axis of the abovementioned united body.

For enhancing the stretching of the base plate 38A, it is advisable to provide 3 ~ 4 oil rooms 66 parallel to one another spaced longitudinally rather than one.

It is, however, also possible to provide an oil room 66A in the base block 7 beneath the neutral axis as shown in Figure 18 for an inverse bending moment to be generated inside a base block 7A.

When deformation of the base block 7A is prevented as mentioned above, the base block 7A of the work-clamp pallet 3 as well as the base plate 38A can be made thinner and lighter in addition to improvement of the machining precision of the works 4 and elimination of adverse influences on the work table 5.

Shown in Figures 19 ~ 22 are the shut-off valve 61 for opening/closing the oil path 51 and an actuator 67 for detection of fall of hydraulic pressure.

Hydraulic oil is supplied from the hydraulic pressure inlet/outlet 62 through a primary port 68, valve chamber 69 and secondary port 70 to the oil path 51 and thence to each clamping device 36. For unclamping a manipulating handle 71 is shifted to turn a cam shaft 72 approx. 60° and thereupon a valve opening rod 74 is caused by its inclined cam face 73 to push a valve core of seating type 75 to open the valve.

In this shut-off valve 61 the valve core's seating face is formed as a synthetic resin ring 76 and a valve seat 77 as an annular protrusion, hence hydraulic oil is perfectly shut down. Reference numeral 78 denotes a stop valve for releasing hydraulic pressure.

In the event of a fall of hydraulic pressure in the oil path 51 in the base plate 38A, the actuator for detection of fall of hydraulic pressure 67 is actuated for a limit switch 79 on the work table 5 side to be triggered thereby for indication of the condition.

Reference numeral 80 denotes a rotation limiter and 81 a locking means.

The spring-type accumulator 64 shown in Figure 23 is provided in the base plate 38A with its pressure accumulating oil room 65 connected with the oil path 51 of the clamping device 36.

When hydraulic pressure has started falling, a piston 82 is advanced by the force of a spring 83 and when it starts rising due to rise of the oil temperature, the piston 82 retracts, for abnormal fluctuation of hydraulic pressure to be thus precluded.

II. A second alternative embodiment is shown in Figures 24 ~ 27.

As the positioning device 32 various devices can be used instead of the plug means 43 consisting of a pair of air cylinders.

As the positioning device 32 of a pallet-setting device 6B in this alternative embodiment there are provided checking means 84 at the rear and right-hand end of the base plate 38B, and movable pawl means 85 and 86 at the front end and lefthand end thereof.

The movable pawl means 86 on the front side consists of a movable pawl 87 connected to the piston of the air cylinder arranged to be shiftable between the positioning and the waiting position.

When, with the work-clamp pallet 3 brought in to be checked by the checking means 84, the air cylinder is operated to advance the movable pawl 87, the movable pawl 87 is pushed up by a spring 88 as it advances to come into contact with a positioning means 34A disposed under the front edge of the base block 7 for the work-clamp pallet 3 to be positioned longitudinally thereby.

The movable pawl means 85 at the lefthand end of the base plate 38B consists of an air cylinder with a movable pawl 89 having an inclined face formed in the upper end portion of its piston rod and, when the movable pawl 89 is pushed up, the base block 7 is pushed to the right for the work-clamp pallet 3 to be positioned laterally thereby.

Alternatively as shown in Figure 27 a hydraulic cylinder or air cylinder may be set inclined as the movable pawl means for the base block 7 to be pushed by a movable pawl 90 consisting of its piston rod.

CLAIMS

1. An apparatus for positioning and clamping a work-clamp pallet for machine tools consisting of a work-clamp pallet and a pallet-setting device, wherein

said work-clamp pallet is to be transferred onto and out of a work table of a machine tool with a plurality of works clamped thereon and is composed of a base block, a plurality of work-clamping devices provided thereon and a set of castor-type transfer means provided in the underside thereof, of which said base block has its topside or each of its sides constituting a work-clamping face, has a longitudinal transfer guide face provided on the underside thereof, has longitudinal and lateral positioning means provided at a plurality of points far off said transfer guide face and has clamping means at a plurality of points far off said transfer guide face,

a plurality of said work-clamping devices are arranged in pairs on the work-clamping face of the base block, and

a set of said castor-type transfer means has their individual castors arranged longitudinally as well as on the underside of said base block shiftable between a lower projecting rolling position and an upper retracted stopping position,

said pallet-setting device is for positioning and clamping said work-clamp pallet on said work table of said machine tool and is composed of a base plate and transfer rails, guide rails, supporting blocks, positioning devices and clamping devices, of which said base plate is placed on a movable saddle of said machine tool to be laterally movable,

said transfer rails are set longitudinally raised above the topside of said base plate in at least two, left and right, lines on which moves said work-clamp pallet with its castor-type transfer means.

a plurality of said supporting blocks are fixedly secured to the topside of said base plate at at least four --two longitudinal and two lateral-- points, the topside thereof constituting a horizontal reference plane above the topside of said base plate on which said work-clamp pallet rests level,

said guide rails are linearly arranged longitudinally and are fixed with their topside raised above said horizontal reference plane so as to be in sliding contact with said transfer guide face of said work-clamp pallet for guiding said pallet to ensure against lateral shifting.

a plurality of said positioning devices provided in said base plate are to engage with said positioning means of said work-clamp pallet for longitudinal as well as lateral positioning thereof, and

a plurality of said clamping devices said base plate is also provided with have each of their clamping arms shiftable between said unclamping position and said clamping position and when it is at said unclamping position, said clamping means of said work-clamp pallet is released to allow it to move longitudinally and when it is at the clamping position, the same is engaged for said work-clamp pallet to be clamped on said supporting blocks.

2. An apparatus for positioning and clamping a work-clamp pallet as recited in claim 1, wherein said base plate is formed monoblock with said work table of said machine tool.

3. An apparatus for positioning and clamping a work-clamp pallet as recited in claim 1, wherein said base plate is formed separate from said work table of said machine tool and is removably secured as an auxiliary table to said work table.

4. An apparatus for positioning and clamping a work-clamp pallet as recited in any preceding claim, wherein said positioning device is a plug means consisting of a pair of hydraulic cylinders provided on the topside of said base plate.

5. An apparatus for positioning and clamping a work-clamp pallet as recited in claim 4, wherein air cylinders are used instead of said hydraulic cylinders and the upper end portion of each thereof is formed as a plug and said work-clamp pallet is positioned longitudinally as well as laterally when said plug is engaged in said positioning means provided in the underside of said work-clamp pallet.

6. An apparatus for positioning and clamping a work-clamp pallet as recited in claim 5, wherein said air cylinder is provided with a stop valve arranged to be closed when said plug is at said waiting position and opened when it is at said positioning position and said stop valve is set in said pneumatic pressure channel for detection so as to make completion of positioning detectable.

7. An apparatus for positioning and clamping a work-clamp pallet as recited in any preceding claim, wherein a plurality of air outlets are formed in the topside of said each supporting block and compressed air is supplied thereto from said air supply channel.

8. An apparatus for positioning and clamping a work-clamp pallet as recited in claim 7, wherein close contact of the topside of said supporting block with said work-clamp pallet can be confirmed by detecting a rise of pneumatic pressure in said air supply channel.

9. An apparatus for positioning and clamping a work-clamp pallet as recited in any preceding claim, wherein at least one oil room extending over approximately the overall lateral length of said base

plate is formed inside said base plate so that, with said work-clamp pallet clamped on said supporting blocks, said bending moment the united body of said base block and said base plate is subjected to by said work-clamping device of said work-clamp pallet is cancelled or offset by said inverse bending moment applied to said united body by said hydraulic force of said hydraulic oil filling said oil room.

10. An apparatus for positioning and clamping a work-clamp pallet as recited in any preceding claim, wherein said clamping device is of hydraulic type, said shut-off valve is set at the beginning end of said oil path supplying hydraulic pressure to a hydraulic oil room thereof and discharging it therefrom and, with said hydraulic oil room filled with hydraulic pressure, said oil path can be shut down by means of said shut-off valve.

11. An apparatus for positioning and clamping a work-clamp pallet as recited in claim 10, wherein a spring-type accumulator is provided in said base plate with its pressure accumulating oil room connected to communicate with said oil path so as to ensure against any abnormal fluctuation of hydraulic pressure in said hydraulic oil room.

12. An apparatus for positioning and clamping a work-clamp pallet as recited in any preceding claim, wherein a stopper is provided at the rear end of said base plate projecting above said horizontal reference plane.

13. An apparatus for positioning and clamping a work-clamp pallet as recited in any preceding claim, wherein said supporting blocks are arranged on both left and right sides of said each clamping device.

14. An apparatus for positioning and clamping a work-clamp pallet as recited in any preceding claim, wherein a plurality of said clamping devices are arranged laterally near the longitudinal center of said base plate and supporting blocks are arranged longitudinally before and after said clamping device.

15. A work-clamp pallet for a machine tool and an apparatus for positioning and clamping the pallet, substantially as hereinbefore described with reference to and as illustrated in Figures 1 to 14, or Figures 1 to 14 as modified by Figures 15 to 23, or Figures 1 to 14 as modified by Figures 24 to 27, of the accompanying drawings.