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Inventor(s)	Lang; Günter et al.

Clamping device and workpiece holding device with a clamping device

Abstract

A clamping plate for receiving at least one workpiece clamping device or a workpiece, the clamping plate including: a support surface for the at least one workpiece clamping device or the workpiece, the support surface is penetrated by a plurality of openings for receiving clamping bolts of the at least one workpiece clamping device, clamping slides being arranged in the clamping plate, the clamping slides each project with one end into one of the plurality of openings in a clamping position and are located outside the one of the plurality of openings in a release position, —a clamping wedge, which is movably arranged in the clamping plate and is operatively connected to the clamping slides via at least one of a body formed resiliently yielding in several directions, a hollow body, an annular body, and a hollow cylinder.

Inventors: **Lang; Günter (Wernau, DE), Lang; Philipp (Holzmaden, DE)**

Applicant: **LANG TECHNIK GMBH** (Holzmaden, DE)

Family ID: **1000008763657**

Assignee: **LANG TECHNIK GMBH (Holzmaden, DE)**

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Primary Examiner: Wilson; Lee D

Attorney, Agent or Firm: CANTOR COLBURN LLP

Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS (1) This application is a continuation-in-part application of U.S. Patent Application Ser. No. 17/619,042 filed on Dec. 14, 2021, which is a U.S. National Stage of PCT Application No. PCT/EP2020/066101 filed on Jun. 10, 2020, which claims priority to German Patent Application No. 10 2019 116 262.9 filed on Jun. 14, 2019 and entitled “CLAMPING DEVICE AND WORKPIECE HOLDING DEVICE WITH A CLAMPING DEVICE”, the contents each of which are incorporated herein by reference thereto. (2) This application also claims priority under 35 U.S.C. § 119 to the following German Patent Application No. 20 2022 101 810.3, filed on Apr. 5, 2022, the entire contents of which are incorporated herein by reference thereto.

BACKGROUND
(1) The invention refers to a clamping device for clamping a support body. The support body can comprise a holding device for holding a workpiece. With such clamping devices workpieces held on the support body can be clamped in a machine tool with high position accuracy. Particularly, clamping devices can be present in different machining stations or in different machine tools such that a uniform clamping is allowed in all stations or machine tools.
(2) Such a clamping device is, e.g. known from WO 03/039807 A. The clamping device has a base body having an abutment surface and receptacle holes for clamping bolts of the support body. A clamping body having a clamping end and an operating end is assigned to each receptacle hole. The clamping end of each clamping body can act on a clamping bolt arranged in a receptacle hole and thus clamp the support body on the base body.
(3) In an embodiment of the clamping device known from WO 03/039807 A1 the clamping bodies are arranged in pairs respectively and are moved along a common axis in a movement direction between a clamping position and a release position. All of the clamping bodies are supported in a manner to be movable relative to each other in this movement direction. In other embodiments the clamping bodies are arranged such that their longitudinal axis intersect in a common center point. A common hydraulic cylinder or a common rotor with multiple curved surfaces can act on or can move the clamping bodies.
(4) The known clamping device has proven itself. Starting from the prior art it can be considered as object of the present invention to improve the clamping accuracy and to concurrently guarantee a simple configuration of the clamping device.
(5) The invention also relates to a clamping plate for receiving at least one workpiece clamping device.
(6) DE 101 55 077 B4 describes a clamping device which has a vice. The vice is formed to clamp workpieces, for example, between two jaws that can move against each other. On its lower surface, the vice has clamping bolts by means of which it can be fastened to a clamping plate with repeat accuracy. The clamping plate is also referred to as a “reference plane plate”. The clamping plate has openings into which clamping bolts are held by means of a tightening device arranged in the

clamping plate. The clamping bolts are both pulled axially into the openings and pressed against the opening wall to find a precise contact there. The reference plane plate has three or four openings to accommodate workpiece clamping devices with three or four clamping bolts. The tightening device has slides which are movable radially to the openings and can be actuated via a wedge-slide mechanism by means of a screw.

(7) U.S. Pat. No. 5,167,405 also discloses a workpiece clamping device and an associated clamping plate with slides for tightening clamping bolts which project away from the lower surface of the workpiece clamping device and are received by openings in the clamping plate. The slides are actuated by a central eccentric shaft arranged in the clamping plate.

(8) It is also known from DE 10 2017 122 112 A1 to provide a workpiece clamping device for clamping workpieces, the two clamping jaws of which are individually supported on separate linear guides spaced apart from one another. A threaded spindle mounted centrally in a bearing device engages with both clamping jaws. The two linear guides and the bearing device are in turn mounted on a clamping plate, referred to here as the base plate.

BRIEF SUMMARY

(9) This object is solved by a clamping device as well as a workpiece holding device with a clamping device. Disclosed is a clamping device for clamping of a support body, including: a base body that comprises an abutment surface on a clamping side of the base body, the abutment surface having multiple receptacle holes that open toward the clamping side, the multiple receptacle holes each being configured for location of one of a plurality of clamping bolts of support body; multiple clamping bodies that are linearly movably supported in or on the base body along a longitudinal axis of the base body, the multiple clamping bodies can be moved between a clamping position and a release position by means of an operating device; and wherein longitudinal axes of the multiple clamping bodies define multiple points of intersection with respect to each other.

(10) The clamping device according to the invention is configured for clamping a support body. It has a base body having a clamping side. The base body comprises an abutment surface on the clamping side. The abutment surface is configured to abut against a counter abutment surface of the support body, if the support body is clamped on the base body. The abutment surface can be continuously or can be defined by multiple surface sections arranged distant from one another. The abutment surface is preferably orientated parallel to a plane that is spanned by a first direction and a second direction.

(11) On the clamping side the base body further comprises multiple receptacle holes that are open toward the clamping side. The receptacle holes can open into the abutment surface or can be arranged with distance to the abutment surface. Each receptacle hole is configured to at least partly locate a clamping bolt of the support body therein. Preferably the receptacle holes extend parallel to each other in a direction orthogonal to the abutment surface.

(12) Multiple clamping bodies are arranged in or on the base body. Preferably exactly one clamping body is assigned to each receptacle hole. The clamping bodies are supported in a linearly movable manner along their longitudinal axes. The clamping device has an operating device that is configured to move all of the clamping bodies between a clamping position and a release position. Each clamping body has a clamping end that is assigned to one of the receptacle holes and that projects in the assigned receptacle hole in the clamping position. In the release position each clamping body is farther away from the center axis of the receptacle hole and the clamping end does not project or project less into the receptacle hole than in the clamping position.

(13) The longitudinal axes of the clamping bodies of a common clamping body group define multiple intersection points, particularly at least three and preferably four intersection points. Due to this arrangement of the longitudinal axes of the clamping bodies, such that multiple intersection points are defined, a very accurate positioning can be achieved. Remaining inaccuracies in a rotary degree of freedom around an axis orientated orthogonal to the abutment surface can be eliminated. In the prior art longitudinal axes are either identical or intersect in one single intersection point. If

all of the longitudinal axes intersect in one common point, a positioning inaccuracy around an axis extending through the intersection point of all of the longitudinal axes of the clamping bodies remains depending on the manufacturing accuracy.

(14) The clamping bodies can form multiple clamping body groups. The longitudinal axes of the clamping bodies of a common clamping body group can define one intersection point respectively. In the case of two clamping body groups, for example, a first intersection point and a second intersection point are defined. The first intersection point and the second intersection point are preferably arranged along a straight line extending in a first direction.

(15) The longitudinal axis of a clamping body of one clamping body group preferably defines a third intersection point together with a longitudinal axis of a clamping body of another clamping body group. The longitudinal axes of two other clamping bodies of these clamping body groups can define a fourth intersection point. The third intersection point and the fourth intersection point can be located on a common straight line that is preferably orientated in the second direction.

(16) It is advantageous, if multiple clamping body groups are present having two clamping bodies respectively. For example, a first clamping body group having a first clamping body and a second clamping body can be present as well as a second clamping body group having a third clamping body and a fourth clamping body. It is particularly advantageous, if the longitudinal axis of the clamping bodies define at least four intersection points. Preferably these four intersection points represent the corners of a polygon that particularly has the form of a rhombus.

(17) In a preferred embodiment each clamping body has an operating end opposite its clamping end that is assigned to an operating body of the operating device and preferably abuts against this operating body. The at least one operating body of the operating device is preferably supported in a linearly movable manner in the first direction. It is configured to act on the operating ends of multiple clamping bodies of a common clamping body group. Preferably the clamping body group comprises exactly two clamping bodies. Further preferably multiple clamping body groups and particularly exactly two clamping body groups are provided to each of which one operating body is assigned. By displacing of the operating body the clamping bodies of the assigned clamping body group can be displaced as well in order to switch them between the release position and the clamping position. The longitudinal axes of the clamping bodies of a common clamping body group are particularly neither arranged parallel to each other, nor congruent. They stand obliquely to each other and obliquely to the first direction and/or obliquely to the second direction. Particularly two operating bodies are present that are movably supported in first direction.

(18) By means of the operating body, the clamping bodies can be moved between the release position and the clamping position. In the clamping position each clamping body is configured to act on a clamping bolt arranged in a receptacle hole, particularly with a force that comprises force components orthogonal to the abutment surface in the first direction and the second direction.

(19) Due to this oblique orientation of the longitudinal axes of the clamping bodies, a simple possibility is provided to apply the clamping bolts with force components that act in two spatial directions, according to the example in the first direction and the second direction. In doing so, the support body can be exactly positioned relative to the base body in the first direction and the second direction in which the abutment surface extends.

(20) The operating device operates preferably mechanically and is particularly free of fluidic force transmission units. Preferably the coupling between the at least one operating body and the assigned clamping bodies is a coupling that only transmits pressing or thrust forces and thus no coupling that transmits traction forces. This means the operating body can act on the assigned clamping bodies of a common clamping body group in a pushing manner, particularly for switching the clamping bodies in the respective clamping position, but can however transmit no traction force for counter movement. Particularly the operating body is configured to push the assigned clamping bodies from the release position into the clamping position without traction coupling to the clamping bodies that would allow pulling them from the clamping position back into the release

position. Thereby a very simple mechanical configuration of the operating device is obtained.
(21) Due to the mechanical operating device, each clamping body is moved in a path-controlled manner in the respective clamping position. It can be guaranteed that the movement paths of the clamping bodies of a common clamping body group have equal amounts. In addition, it can also be guaranteed that the movement paths of all clamping bodies into the respective clamping position have equal amounts. This increases the precision during clamping. By operating the clamping bodies by means of at least one linearly movable operating body and by providing one or more clamping body groups, the receptacle holes can also be arranged with large distance in the first direction and/or the second direction from each other without problems. The operating device is preferably self-locking. Thereby an unintentional disengaging or releasing of the clamping bodies or movement of the clamping bodies out of their clamping positions is avoided.
(22) Preferably an operating body directly abuts on the operating ends of the clamping bodies of the assigned clamping body group.
(23) The operating device preferably comprises one drive source, e.g. a drive element that can be operated by an operating person or a robot, wherein the drive source can move all of the clamping bodies from a release position into the respective clamping position during operation. For example, a wedge gear coupling exists between this drive source and the clamping bodies.
(24) It is further advantageous, if at least one of the receptacle holes is arranged with distance in the first direction from one of the other receptacle holes and/or at least one of the receptacle holes is arranged with distance in the second direction from one of the other receptacle holes. Preferably the receptacle holes define the corners of a polygon. The number of receptacle holes is preferably an even number. Preferably four receptacle holes are provided.
(25) It is in addition advantageous, if at least one longitudinal axis of a clamping body and particularly all of the longitudinal axes of all of the clamping bodies are orientated obliquely to the first direction and obliquely to the second direction. In doing so, a force can be applied to the clamping bolts via all of the clamping bodies having a force component in the first direction as well as in the second direction.
(26) It is in addition advantageous, if the at least one operating body comprises a front end assigned to the operating ends of the clamping bodies of the assigned clamping body group. On the front end at least one slant is provided that extends obliquely to the first direction and/or to the second direction. Due to this slant, a wedge surface gear coupling can be obtained between the operating body and the clamping bodies being in contact with the operating body. The abutment between the at least one slant and the respective operating end of a clamping body is preferably two-dimensional, but can as an alternative also be line-shaped or point-shaped.
(27) It is advantageous, if the operating device comprises a main body that is configured for acting on the at least one operating body. Particularly the main body is arranged in a displaceable or linear movable manner. Preferably the main body is linearly movably arranged in the second direction.
(28) The main body can have at least one main body surface that extends obliquely to the first direction and/or the second direction. Against this main body surface the at least one operating body can abut preferably two-dimensionally or as an alternative in a line-shaped or point-shaped manner.
(29) Preferably one single main body is provided for operation or displacement of all present operating bodies. The switching movement of all clamping bodies between the release position and the clamping position can be initiated by means of the main body.
(30) The main body, the at least one operating body and the clamping bodies are thus linearly displaceably supported either in the first direction or in the second direction or obliquely to the first direction and the second direction. This operating device can be very simply integrated in a plate-shaped base body and can be realized in a flat and space-saving manner.
(31) The clamping device comprises another inventive aspect that it can be realized independent from the orientation and arrangement of the clamping bodies, the at least one operating body and

the main body described above. Thereby at least one guide channel is provided in the base body, wherein a clamping body is arranged in each guide channel. The at least one operating body and/or the main body can be arranged in addition also in one further guide channel respectively.

(32) Each guide channel has two opposed channel walls facing one another. Preferably the channel walls are formed by opposite groove side walls that are connected with each other inside the base body via a groove bottom. The groove is open opposite the groove bottom and preferably closed by a cover that can be releasably attached on the base body. A guide wall section is present in each channel wall. The clamping body or the operating body or the main body abuts only against the guide channel in the area of the two opposite guide channel walls and is apart therefrom arranged with distance to the channel walls. Preferably also a distance exists between the bottom and/or the cover and the body arranged in the guide channel, i.e. the clamping body or the operating body or the main body. In doing so, the friction between the guide channel and the body respectively displaceably arranged therein can be adjusted in a defined manner or minimized. Preferably the contour of the guide channel matches the outer contour of the body (i.e. clamping body or operating body or main body) displaceably supported therein only in the areas of the guide wall sections. Outside of the guide wall sections the guide channel can have an arbitrary contour and the channel walls can be orientated parallel to each other outside the guide wall sections, for example, and can extend parallel to a common center plane that extends along the center of the guide channel respectively.

(33) Preferably the guide wall sections can be configured in a trough-shaped manner. The concave-curved trough can have a radius matching the outer radius of an outer surface area of the movably supported clamping body or operating body or main body.

(34) Preferably the clamping bodies and/or operating body and/or main body have a cylindrical section between their opposite ends that abuts against the guide wall sections.

(35) In all embodiments of the clamping device described above it can be advantageous, if a biasing arrangement is present. The biasing arrangement can bias or urge the clamping bodies in their respective release positions. In their initial position in which they are not subject to an action of an operating body the clamping bodies are therefore in their release position. Preferably the biasing arrangement has one biasing element and particularly exactly one biasing element for each clamping body group. In a preferred embodiment the biasing element is supported directly on the clamping bodies of the clamping body group and is particularly not directly attached to the base body or supported on the base body. In an embodiment the biasing element effects a traction force between the clamping bodies of the clamping body group toward the respective operating body. For example, the biasing element can be a tension spring. Particularly the operating device is, apart therefrom, free of biasing elements that exclusively engage on the clamping bodies or are arranged on the clamping bodies.

(36) A workpiece holding device according to the invention comprises a clamping device according to one of the embodiments described above. In addition, a support body having a holding side and an attachment side is provided. The attachment side is preferably facing away from the holding side or provided opposite to the holding side on the support body. For example, the support body can be configured as support plate. On the attachment side a counter abutment surface is provided. The counter abutment surface is configured to abut against the abutment surface of the base body, if the connection between the support body and the clamping device is established. Multiple clamping bolts project from the support body on the attachment side. Preferably the clamping bolts extend parallel to each other. The number of clamping bolts correspond particularly to the number of receptacle holes. If the connection is established, one clamping bolt projects into one receptacle hole respectively. The arrangement pattern or the distances between the clamping bolts therefore correspond to the arrangement pattern or the distances between the receptacle holes.

(37) Particularly each clamping bolt has an impingement surface that can be provided by a cone shell surface, for example. The at least one impingement surface extends obliquely to the extension

direction of the respective clamping bolt. If the clamping bolt is arranged in the assigned receptacle hole, the impingement surface extends obliquely to the first direction and obliquely to the second direction and obliquely to the extension direction of the clamping bolt. If the assigned clamping body acts on the impingement surface during clamping of the support body on the base body, force components are created in all three spatial directions. The counter abutment surface is pulled against the abutment surface orthogonal to the first direction and orthogonal to the second direction. Concurrently, the clamping bolt is pushed in the first direction and the second direction by the clamping body. The clamping bolts are thus subject to a traction force parallel to their extension direction and are concurrently pushed away from each other in the first direction and the second direction, such that a precise positioning and orientation of the support body on the base body occurs.

(38) An object of the present disclosure is to have all clamping slides act on the clamping bolts with essentially the same forces.

(39) Disclosed is a clamping plate for receiving at least one workpiece clamping device or a workpiece, the clamping plate including: a support surface for the at least one workpiece clamping device or the workpiece, the support surface is penetrated by a plurality of openings for receiving clamping bolts of the at least one workpiece clamping device, clamping slides being arranged in the clamping plate, the clamping slides each project with one end into one of the plurality of openings in a clamping position and are located outside the one of the plurality of openings in a release position, a clamping wedge, which is movably arranged in the clamping plate and is operatively connected to the clamping slides via at least one spring means.

(40) The clamping plate according to the present disclosure serves to receive at least one workpiece clamping device, for example in the form of a vice which has a flat base surface from which a plurality of clamping bolts project away. The clamping plate according to the present disclosure can also be used for directly receiving a workpiece to whose base surface clamping bolts have been attached in a preparatory operation. The following description of the clamping plate and the workpiece clamping device to be mounted with it applies equally to clamping plates which directly receive a workpiece provided with clamping bolts.

(41) The clamping plate has a support surface for this or a similar workpiece clamping device, with several openings being provided in the support surface for receiving the clamping bolts of the workpiece clamping device. A tightening device is provided in the clamping plate, which serves to fix and position the clamping bolts in the openings. For this purpose, the tightening device has several clamping slides, whereby, at least preferably, exactly one clamping slide is assigned to each opening. The clamping slides are each movable radially relative to their openings between a clamping position and a release position. In the clamping position, they are located with a preferably wedge-shaped end inside the opening, while in a release position they are located completely outside the opening. The clamping slides are configured to press the clamping bolts against the opposite bore wall, which is preferably formed as a reference surface. As a result of the wedge shape of the end of the clamping slide that enters the opening, the clamping bolt is simultaneously pulled down in the axial direction so that the lower surface of the workpiece clamping device is pressed against the support surface of the clamping plate.

(42) A clamping wedge being also a part of the tightening device and used to actuate the clamping slides of the tightening device is arranged in the clamping plate so that it can move, preferably linearly, and to which the clamping slides are operationally connected via at least one spring means. The spring means is preferably a hard spring which transmits the necessary actuating force for the clamping slide from the clamping wedge to the clamping slide when deformed by a few hundredths of a millimeter. Preferably, the spring is a non-linear spring with a digressive characteristic.

(43) The spring means is used to transmit the actuating force from the clamping wedge to the clamping slide. Each clamping slide can be assigned a spring acting much more weakly in the

opposite direction, by means of which the clamping slide is preloaded to its release position. This makes it easier to release the workpiece clamping device from the clamping plate.
(44) The clamping wedge preferably has clamping surfaces arranged diametrically opposite each other, the distance between which varies along its direction of movement. The surfaces can be flat surfaces or curved surfaces. The clamping wedge serves to urge two force transmission elements away from each other when it is moved in the clamping direction. The force transmission elements can be formed by the spring means by means of which the clamping force is transmitted from the clamping wedge to the clamping slides.
(45) The spring means can be formed as a body resilient in several radial directions. Preferably, it is resilient in the longitudinal directions of the two clamping slides in contact with it and also in the direction away from the wedge (radially to the clamping rod). The body forming the spring means can, for example, be a hollow body, in particular an annular body such as a hollow cylinder or other rotationally symmetrical body. The axis of symmetry of this body is preferably oriented transverse to its displacement and force transmission direction.
(46) This can have a constant or also varying wall thickness. Further preferably, a stop means is provided in the spring means, which can preferably be formed as a rigid body, for example as a bolt or also a ball. The stop means is arranged with clearance in the spring means, whereby the spring means and the stop means can, for example, jointly define an annular gap. The width of this annular gap is preferably large enough for the spring means to have sufficient spring travel for its function. The spring travel is preferably greater than the tolerance to be compensated. On the other hand, the gap width is preferably so small that the spring means finds firm contact with the stop means before it is overloaded.
(47) The stop means, i.e. a bolt for example, can be arranged stationary in the clamping plate. Alternatively, the bolt can be arranged movably, for example floating, in the clamping plate.
(48) During clamping, the corresponding clamping bolts are subjected to a clamping force which comprises both an axial component, which pulls the clamping bolt into the opening, and a radial component, as a result of which the clamping bolt laterally resiliently contacts a point on the bore wall locally. By simultaneously actuating the tightening devices for all clamping bolts, it is ensured that the clamping bolts are tightened at the same time and the workpiece clamping device is thus positioned in the desired position.
(49) Several such clamping plates can also be provided and arranged in a fixed spatial relationship to one another in a machine tool. Such an arrangement comprises at least two clamping plates according to the present disclosure with their own tightening devices. These have actuating rods coupled to one another or a common actuating rod. By this measure, the tightening devices of two or more clamping plates can be actuated together and simultaneously from one operating position.
(50) If the tightening devices are actuated in series, incorrect positioning could otherwise occur. In any case, however, the concept according to the present disclosure saves operating effort and makes it possible to actuate several clamping plates from one side. This is particularly advantageous when mounting the clamping plates in enclosed working areas of machine tools where access to the clamping devices is restricted, for example, is only possible from one side.
(51) In a preferred embodiment, the common actuating rod or the two actuating rods in contact with each other directly or with the aid of an intermediate piece are arranged in the clamping plates so as to be axially movable. The tightening and loosening of the tightening devices are then effected by axial movement of the actuating rod(s).
(52) The actuating rods, which are in direct contact with each other at the end faces or with the interposition of an intermediate piece and are thus coupled in terms of movement, are preferably arranged in alignment with each other. In this way, the actuating movement of an actuating rod of one clamping plate is transmitted to the actuating rod of another clamping plate.
(53) Each clamping plate preferably has a through opening in which the actuating rod is axially movably arranged. The through opening is preferably arranged parallel to a flat upper surface

formed on the clamping plate. The clamping movement of the actuating rod can thus be introduced into the actuating rod from one of the side surfaces of the clamping plate.
(54) Preferably, the through opening has an anchoring structure at its two ends, which is formed by an internal thread, for example. This is suitable for receiving and anchoring a spring means to preload the actuating rod in one direction, preferably in the release direction. At the other end of the through opening, an adjusting means, for example in the form of a screw, can be provided on the internal thread or other anchoring structure. By turning the screw, the actuating rod can be moved axially and thus tightening or loosening of the tightening device can be effected.
(55) The actuating rod preferably has a wedge structure engages with at least one slide belonging to the tightening device. The wedge structure can be formed by an inclined surface formed on the actuating rod itself or also by an inclined surface provided on a wedge which is held on the actuating rod in an axially non-displaceable manner. The inclined surface is inclined against the longitudinal direction of the actuating rod.
(56) The slide engages with at least one, preferably two clamping slides, each of which is assigned to one of the openings and arranged radially to it. In the clamping position, the clamping slide projects into the opening. In the release position, it is retracted from the opening. Preferably, a spring means is provided which preloads the clamping slide radially outwards with respect to the opening. The slide and the clamping slide preferably form a reduction gear, i.e. a stroke of the slide is translated into a stroke of the clamping slide that is at most as great as the stroke of the slide. Preferably, at least the actuating rod, the slide and the clamping slide form a reduction gear.
(57) The slide and the clamping slides are preferably arranged in pockets of trapezoidal, rectangular or square cross-section, which are closed on one flat side of the clamping plate by one or more covers. This not only has manufacturing advantages, but also the additional benefit that the clamping plates can be provided with a continuous actuating rod which can be inserted into the aligned through-holes for assembly. The actuating rod can be inserted by first removing at least the slides from the clamping devices. After the actuating rod has been inserted, the slides can be inserted into their pockets and secured therein by fitting the cover.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) Advantageous embodiments of the invention are derived from the dependent claims, the description and the drawings. In the following preferred embodiments of the invention are described in detail based on the attached drawings. The drawings show:
(2) FIG. **1** a schematic side view of an embodiment of a workpiece holding device comprising a support plate having a holding device for a workpiece, as well as a clamping device for the support plate,
(3) FIG. **2** a sectional illustration of a part of the clamping device of FIG. **1** showing a clamping body and an assigned receptacle hole with a clamping bolt arranged therein, wherein the clamping body is in a release position,
(4) FIG. **3** the illustration of FIG. **2**, wherein the clamping body is in a clamping position,
(5) FIG. **4** a schematic illustration of the clamping device of FIG. **1** in a section transverse through the receptacle holes,
(6) FIG. **5** a schematic illustration of the force components introduced from a clamping body into a clamping bolt in a first direction and a second direction,
(7) FIG. **6** a schematic illustration of the orientation of the longitudinal axes of the clamping bodies and the definition of multiple intersection points by the longitudinal axes of the clamping bodies and
(8) FIG. **7** a schematic illustration in part of the base body and the clamping device of FIGS. **1** and

4 in a cross-section through a guide channel for a clamping body.
(9) FIG. **8**A illustrates a simplified perspective view of a workpiece clamping device and an associated clamping plate,
(10) FIG. **9** illustrates a vertical section of the workpiece clamping device and the clamping plate,
(11) FIG. **10** illustrates a tightening device of the clamping plates shown in FIGS. **1** and **2** in a schematic representation,
(12) FIG. **11** illustrates a clamping plate with several opening groups,
(13) FIG. **12** illustrates an arrangement consisting of several clamping plates, each with several opening groups.

DETAILED DESCRIPTION

(14) FIG. **1** schematically shows an embodiment of a workpiece holding device **10** having a clamping device **11** and a support body **12**. The support body **12** has a holding side **13** and an attachment side **14** facing away from the holding side **13**. The support body **12** can be configured as support plate, wherein the holding side **13** and the attachment side **14** are formed by opposite sides of the support plate. The support body **12** comprises a holding device **15** for holding a workpiece **16** on the holding side **13**. The holding device **15** can comprise clamping jaws **17**, for example, in order to hold the workpiece **16** in a clamping manner on the support body **12**.
(15) On the attachment side **14** the support body **12** has multiple clamping bolts **18** that project from the support body **12**. In the embodiment the clamping bolts **18** are orientated parallel to one another and extend in an axial direction A with reference to the support body **12**. Each clamping bolt **18** can comprise at least one cylindrical section. At an end distant to the support body **12** each clamping bolt **18** has a chamfer or a conically tapering end section **19**. Thereby the introduction of the clamping bolt **18** in an assigned receptacle hole **20** of the clamping device **11** is simplified. On the free end each clamping bolt **18** can have a face cavity **21** in the face.
(16) In addition each clamping bolt **18** comprises at least one impingement surface **22**. The impingement surface **22** extends obliquely inclined to the axial direction A. In the illustrated embodiment each clamping bolt **18** has exactly one impingement surface **22** that is formed by the outer surface of a conical section **23** of clamping bolt **18**. The conical section **23** expands in axial direction A away from the support body **12** toward the free end of clamping bolt **18**. The conical section **23** is arranged with distance to the support body **12** and the end section **19** according to the example. A tapering section **24** of clamping bolt **18** can be provided between conical section **23** and support body **12**. The tapering section **24** can also be formed by the outer surface of a cone. A cylindrical section can be provided between tapering section **24** and conical section **23**. As an alternative, tapering section **24** and conical section **23** can also directly transition into one another. Thereby a constriction is formed on clamping bolt **18** with distance from end section **19** and with distance from support body **12**.
(17) The clamping device **11** has a base body **28**. The base body **28** has an abutment surface **30** on a clamping side **29**. The abutment surface **30** is configured to abut against a counter abutment surface **31** provided on the support body **12**, if support body **12** is arranged or clamped by means of the clamping bolts **18** on the clamping device **11** or base body **28**. Preferably the abutment surface **30** extends in a plane that is spanned by a first direction x and a second direction y. The first direction x and second direction y are related to a coordinate system of clamping device **11** or base body **28**. In this coordinate system the third direction z is orientated orthogonal to the first direction x and second direction y. If the connection between support body **12** and clamping device **11** is established, clamping bolts **18** approximately extend in third direction z.
(18) Counter abutment surface **31** extends preferably in a plane orientated orthogonal to axial direction A. Abutment surface **30** and counter abutment surface **31** are configured for two-dimensional abutment against one another. As an alternative to this configuration it is also possible to configure base body **28** and/or support body **12** in a manner such that instead of a two-dimensional abutment, a line-like or point-shaped contact is formed on several locations and for

example at least one or exactly three contact locations arranged with distance to one another, if the connection between support body **12** and clamping device **11** is established. The abutment surface **30** or the counter abutment surface **31** could comprise, for example, three convex, particularly dome-shaped elevations against which the respective other surface (i.e. counter abutment surface **31** or abutment surface **30**) abuts in a point-shaped manner.
(19) For each present clamping bolt **18** one assigned receptacle hole **20** is provided in the base body **28** that is open toward the clamping side **29**. In the embodiment the receptacle holes **20** open out into the abutment surface **30**. The receptacle holes **20** are configured as blind holes in the embodiment and are closed on the bottom side of base body **28** opposite the clamping side **29** by means of one hole bottom **32** respectively. As an option, an elastically deformable element **33** is arranged on the hole bottom **32** projecting into the receptacle hole and applying a force in the third direction z onto an assigned clamping bolt **18**, if clamping bolt **18** is completely arranged in receptacle hole **20** and counter abutment surface **31** abuts against abutment surface **30**. The force in the third direction z can be created by elastical deformation of element **33**. The elastically deformable element **33** can thereby engage into the face cavity **21** of the assigned clamping bolt **18**. Due to this force, release of the clamping connection between support body **12** and clamping device **11** can be simplified.
(20) In the embodiment clamping device **11** has four receptacle holes **20**. The receptacle holes **20** form corner points of a rectangle according to the example (FIGS. **4** and **6**). Accordingly, four clamping bolts **18** are provided on support body **12**, the arrangement and distance of which corresponds to the arrangement and distance of the receptacle holes **20**.
(21) Clamping device **11** has multiple clamping bodies **36** that are arranged in a linearly movable manner on and according to the example, in base body **28**. Each clamping body **36** is movably supported in a guided manner in a guide channel **37**. The guide channels **37** are introduced into base body **28**, preferably by milling. Each guide channel **37** for a clamping body **36** opens out into a receptacle hole **20**.
(22) In the embodiment the guide channels **37** are groove-shaped and have two opposite channel walls **38** that are connected with one another via a channel bottom **39** (FIG. **7**). On the side opposite the channel bottom **39** the guide channel **37** is open to the clamping side **29** and according to the example, closed by means of a cover **40**. Cover **40** is arranged such that it does not project beyond the plane in third direction z in which the abutment surface **30** or counter abutment surface **31** extends, if the connection with support body **12** is established. Preferably the outer surface of cover **40** accessible on the clamping side **29** is arranged with distance to abutment surface **30**. As an alternative to this, outer surface of cover **40** accessible from the clamping side **29** can form a section of the abutment surface **30**. Cover **40** is preferably arranged in a cover holding cavity **41** adjoining the clamping side **29**. The cover holding cavity **41** forms a depression or cavity in base body **28** and comprises support surfaces for cover **40** in order to be able to attach cover **40** on base body **28**, for example by means of a screw connection.
(23) Each channel wall **38** has a guide wall section **42**. Outside of the respective guide wall section **42** the channel wall **38** extends in a plane, according to the example, that is orientated parallel to the third direction z in the embodiment. Preferably a contact between clamping body **36** and channel wall **38** does not exist outside of the respective guide wall section **42**. Preferably no contact exists between clamping body **36** and channel bottom **39** and/or cover **40** outside of guide wall sections **42**.
(24) The guide wall sections **42** are configured in a trough-shaped manner according to the embodiment. Accordingly, the areas of the guided clamping body **36** in abutment with the guide wall sections **42** are curved in a convex manner. With view onto channel wall **38**, each guide wall section **42** can be curved in a concave manner with a radius corresponding to the outer radius of a cylindrical or in part cylindrical section of clamping body **36**. By means of the two opposite guide wall sections **42**, clamping body **36** can thus be movably arranged in a guided manner inside guide

channel **37** in the guide wall sections **42**.
(25) The guide wall sections **42** are preferably directly formed by an area or the material of base body **28**.
(26) It is noted here that the arrangement of clamping body **36** in guide channels **37**, as described above based on FIG. **7**, can be realized independent from other configuration features of clamping device **11**.
(27) In the embodiment illustrated here exactly one clamping body **36** is assigned to each present receptacle hole **20** (FIG. **4**). The provided clamping body **36** form multiple clamping body groups, wherein in the embodiment a first clamping body group **50** and a second clamping body group **51** are present. Each clamping body group **50**, **51** has exactly two clamping bodies **36** in the embodiment. A first clamping body **36***a* and a second clamping body **36***b* are part of first clamping body group **50** and a third clamping body **36***c* and a fourth clamping body **36***d* are part of the second clamping body group **51**. First clamping body **36***a* has a first longitudinal axis L**1** and is movably arranged in the assigned guide channel **37** along its first longitudinal axis L**1**. Second clamping body **36***b* has a second longitudinal axis L**2** and is movably supported in the assigned guide channel **37** along the second longitudinal axis L**2**. Third clamping body **36***c* has a third longitudinal axis L**3** and is movably supported in the assigned guide channel **37** along the third longitudinal axis L**3**. Fourth clamping body **36***d* has a fourth longitudinal axis L**4** and is movably supported in the assigned guide channel **37** along the fourth longitudinal axis L**4**. If in the following longitudinal axis L of a clamping body **36** is mentioned, this means the respective longitudinal axis L**1** or L**2** or L**3** or L**4** of first or second or third or fourth clamping body.
(28) Each clamping body **36** can be moved between a release position F (FIGS. **1** and **2**) and a clamping position S (FIGS. **3-5**) by means of an operating device **52** of clamping device **11**. In the clamping position S the clamping body **36** engages in the assigned receptacle hole **20** and can act on a clamping bolt **18** arranged there in order to immovably clamp support body **12** with workpiece **16** on base body **28** of clamping device **11**. For this each clamping body **36** has a clamping end **53** assigned to the receptacle hole **20** in the embodiment. The clamping body **36** has a clamping surface **54** extending obliquely to the longitudinal axis L of clamping body **36** in the clamping end **53**. The clamping surface **54** is in addition inclined with regard to a third direction z and extends preferably parallel to the second direction y. Clamping surface **54** can have approximately the same inclination with regard to third direction z as impingement surface **22** with regard to axial direction A. In doing so, a two-dimensional or line-shaped contact can be established between clamping surface **54** of clamping body **36** and impingement surface **22** of clamping bolt **18**.
(29) As apparent from FIG. **3**, by means of the surfaces **22**, **54** orientated obliquely to third direction z, a traction force FZ can be created on clamping bolt **18** that in turn provides for pressing of abutment surface **30** and counter abutment surface **31** against one another. Therefore, a very precise positioning of support body **12** on base body **28** of clamping device **11** in this third direction z is guaranteed.
(30) It is also apparent from FIGS. **4** and **5** that clamping body **36** in addition applies a longitudinal force FL onto the assigned clamping bolt **18** in the clamping position S that is orientated along or parallel to the respective longitudinal axis L. As illustrated in FIG. **4**, all of the longitudinal axes L, i.e. first longitudinal axis L**1**, second longitudinal axis L**2**, third longitudinal axis L**3** and fourth longitudinal axis L**4** extend obliquely inclined with regard to first direction x and second direction y respectively. In doing so, longitudinal force FL comprises a first force component FX in first direction x and a second force component FY in second direction y (FIG. **5**). Thus, each clamping bolt **18** is subject to a traction force FZ in third direction z, as well as a first force component FX in first direction x and a second force component FY in second direction y, due to the engagement of a clamping body **36** being in clamping position S. Clamping bolts **18** are thus urged away from each other in first direction x, as well as in second direction y, if the clamping bodies **36** are in the clamping position S. Thereby a very accurate positioning of support body **12** with workpiece **16** in

first direction x and second direction y on base body **28** of clamping device **11** is guaranteed.
(31) The positioning is further improved and more accurate in that the longitudinal axes L of clamping bodies **36** define multiple points of intersection arranged with distance from one another, as schematically illustrated in FIG. **6**. First longitudinal axis L**1** of clamping body **36***a* and second longitudinal axis L**2** of clamping body **36***b*, that both belong to first clamping body group **50**, form a first intersection point P**1**. Third longitudinal axis L**3** of third clamping body **36***c* and fourth longitudinal axis L**4** of fourth clamping body **36***d* that both belong to the second clamping body group **51** define a second intersection point P**2**. In the embodiment described here the first intersection point P**1** and the second intersection point P**2** are arranged on a common first straight line G**1** extending parallel to the first direction x.
(32) In the embodiment first longitudinal axis L**1** of first clamping body **36***a* and third longitudinal axis L**3** of third clamping body **36***c* define a third intersection point P**3**. Second longitudinal axis L**2** of second clamping body **36***b* and fourth longitudinal axis L**4** of fourth clamping body **36***d* define a fourth intersection point P**4**. Third intersection point P**3** and fourth intersection point P**4** are thus defined by longitudinal axes L**1** and L**3** or L**2** and L**4** that are part of clamping bodies **36***a* and **36***c* or **36***b* and **36***d* of different clamping body groups **50** or **51**. According to the example, third intersection point P**3** and fourth intersection point P**4** are arranged on a common second straight line G**2** extending in the second direction y.
(33) In the embodiment the four intersection points P**1** to P**4** form the corner points of a rhombus in a plane parallel to the abutment surface **30**. The distance between the first intersection point P**1** and the second intersection point P**2** is preferably different from the distance between the third intersection point P**3** and fourth intersection point P**4**.
(34) In the embodiment the two straight lines G**1** and G**2** intersect in a center point that also is the intersection point of the straight lines that connect the receptacle holes **20**.
(35) Due to the definition of multiple intersection points P**1** to P**4** by longitudinal axes L**1** to L**4** of clamping bodies **36**, also a rotational degree of freedom around an axis extending in third direction z is very well eliminated and the positioning accuracy of support body **12** relative to base body **28** is further increased.
(36) The arrangement and orientation of the longitudinal axes L of clamping body **36** and the definition of intersection points P**1** to P**4** can be realized independent from other configurations of a clamping device **11** or workpiece holding device **10**.
(37) An embodiment of the operating device **52** is illustrated in FIG. **4**. The operating device **52** has preferably one single drive source in order to switch all of the clamping bodies **36** between the release position F and the clamping position S. Thus, all of the clamping bodies **36** are in the release position F, if one of the clamping bodies **36** is in the release position F and vice versa all of the clamping bodies **36** are in the clamping position S, if one of the clamping bodies **36** is in the clamping position S. In the embodiment an operating screw **57** serves as a drive source that is rotatably supported in a nut **58**. The nut **58** is seated in a torque-proof manner on base body **28**. By rotation of the operating screw **57**, the operating screw **57** can thus be displaced along its rotation axis that extends in second direction y in the embodiment. By means of the operating screw **57**, a main body **59** being in abutment therewith can be displaced linearly parallel to its extension and according to the example, in second direction y. Thereby an abutment contact exists between main body **59** and operating screw **57**.
(38) The operating screw **57** can be rotated by means of a tool, for example. The tool can be handled by an operating person. The tool can also be provided on a robot arm or another machine device.
(39) On its end opposite the operating screw **57** the main body **59** has at least one and in the embodiment two main body surfaces **60** orientated obliquely to the second direction y and obliquely to the first direction x. The main body tapers in a wedge-shaped manner toward its end due to the two main body surfaces. The main body surfaces **60** are respectively configured as

abutment surface for one operating body end surface **61** of an operating body **62**. According to the example, the inclination and orientation of the operating body end surface **61** of a respective operating body **62** is orientated parallel to the main body surface **60** against which the operating body end surface **61** abuts. Each operating body end surface **61** is thus orientated obliquely to the first direction x and obliquely to the second direction y. The main body surfaces **60** and the operating body end surfaces **61** are preferably planar surfaces and extend parallel to the third direction z according to the example.

(40) The operating device **52** comprises one operating body **62** for each present clamping body group **50**, **51**. Thus, in the embodiment two separate operating bodies **62** are provided. According to the example, each operating body **62** is linearly displaceably supported. The two operating bodies **62** are linearly displaceably supported in first direction x in the embodiment. As particularly apparent from FIG. **4**, the operating bodies **62** can be arranged along a common axis. On their one end they comprise the operating body end surface **61** and on an opposite front end with view in first direction x they comprise at least one slant **63**. For each clamping body **36** of the assigned clamping body group **50**, **51** one slant **63** is provided. Thus, each operating body **62** has two slants **63** in the embodiment. The slants **63** of an operating body **62** are orientated obliquely to the first direction x and the second direction y respectively and are preferably configured as planar surfaces that extend parallel to the third direction z. Due to the two slants **63**, the operating body **62** tapers in a wedge-shaped manner toward the free end that is assigned to the clamping bodies **36**.

(41) Each clamping body **36** has a clamping body end surface **65** on its operating end **64** opposite the clamping end **53** configured for abutment with the assigned slant **63**. The clamping body end surface **65** is respectively inclined with regard to the first direction x and inclined with regard to the second direction y and is according to the example, orientated parallel to the third direction z and corresponds in its inclination and orientation to the assigned slant **63**.

(42) The operating device **52** thus forms a wedge surface gear between main body **59** and operating body **62**, as well as between operating bodies **62** and clamping bodies **36**. The connection between main body **59** and operating body **62** is exclusively an abutment contact and cannot transmit traction forces. The connection between the operating body **62** and the clamping bodies **36** is an abutment contact and cannot transmit traction forces.

(43) The operating device **52** is configured without fluidic force transmission. It does not contain fluid components such as pistons or cylinders. The operating device **52** operates exclusively mechanically according to the example.

(44) The clamping device **11** has in addition a biasing arrangement **70**. The biasing arrangement **70** is configured to bias or urge clamping bodies **36** in their release position F. For this, clamping bodies **36** can be subject to an elastical force that pulls or pushes clamping bodies **36** along their respective longitudinal axis L away from the assigned receptacle hole **20** toward the release position F.

(45) In the embodiment illustrated here one biasing element **71** of biasing arrangement **70** is assigned to each clamping body group **50**, **51**. Two biasing elements **71** are thus sufficient. In the embodiment the biasing elements **71** are not directly supported on base body **28**, but connect the clamping bodies **36** of a common clamping body group **50** or **51** directly. A first biasing element **71** connects first clamping body **36***a* with second clamping body **36***b* and a second biasing element **71** connects third clamping body **36***c* with fourth clamping body **36***d*. The biasing elements **71** effect a traction force and are attached to the clamping bodies **36** in the area of the operating end. Due to the traction force of biasing elements **71**, the clamping body end surfaces **65** of clamping bodies **36** of a common clamping body group **50** or **51** are urged against the respectively assigned slant **63** of operating body **62** that is assigned to the clamping body group **50** or **51**. This in turn results in that the operating body end surfaces **61** of operating bodies **62** are urged against the respectively assigned main body surface **60** of main body **59** in order to support the force acting on the operating bodies **62** by means of the biasing elements **71**. Main body **59** supports the impinging

force on operating screw **57**. Operating screw **57** supports the force on base body **28** via nut **58**. The thread connection between operating screw **57** and nut **58** is self-locking such that the force applied to the operating screw **57** in second direction y cannot result in that the operating screw **57** moves in second direction y. Between main body **59** and operating body **62** on one hand and between operating body **62** and clamping bodies **36** on the other hand, an abutment contact is continuously established in the embodiment.

(46) As an alternative to the embodiment illustrated in FIG. **4**, a separate biasing element **71** could be assigned to each clamping body **36** that is supported on base body **28**. In the illustrated embodiment the biasing element **71** can be tension springs, e.g. helical springs, that are arranged in cavities of clamping bodies **36** that are open toward the respective operating end **64**. The cavities are not illustrated for sake of clarity in FIG. **4**.

(47) The operating device **52** operates as follows:

(48) In a retracted position of main body **59** the operating bodies **62** are sufficiently close adjacent to one another in first direction x that the clamping bodies **36** being in abutment therewith are urged in the release position F by means of biasing arrangement **70** and release the receptacle holes **20** for insertion of clamping bolts **18**. After arrangement of clamping bolts **18** in the receptacle holes **20**, main body **59** can be moved in second direction y by operating screw **57** and displace the two operating bodies **62** from each other. This in turn results in that the clamping bodies **36** being in abutment against slants **63** are moved along their respective longitudinal axis in the assigned receptacle hole **20** and into the clamping position S. Due to the inclination of screw thread between operating screw **57** and nut **58** the operating device **52** is configured in a self-locking manner. Independent from a force acting on the linearly displaceably supported main body **59** in second direction y, the operating screw **57** remains in its axial position relative to nut **58** and thus maintains clamping position S. This is because an annulation of this clamping position is mechanically blocked by means of the mechanical abutment between clamping bodies **36** against operating bodies **62** and the operating bodies **62** against main body **59**.

(49) Release of the clamping connection is carried out in that operating screw **57** is rotated in release direction, whereby main body **59** can be moved in second direction y, such that approaching of the two operating bodies **62** in first direction x is possible. Main body **59** is at least partly removed out of the interstice between the two operating bodies **62** so-to-speak. In doing so, operating bodies **62** are moved in first direction x toward one another, which is effectuated by the force of the biasing arrangement **70** and according to the example, the two biasing elements **71**. This in turn results in that each clamping body **36** is moved away along its respective longitudinal axis L from the assigned receptacle hole **20** and can take its release position F.

(50) In the release position F clamping bolts **18** are not held on base body **28** by the clamping bodies **36**. The optionally provided elastically deformable elements **33** have the effect that clamping bolts **18** are at least slightly urged out of the receptacle holes **20** in order to simplify removal of support body **12** from clamping device **11**.

(51) With regard to FIG. **7**, the guide of clamping bodies **36** in guide channels **37** has been explained. In addition or as an alternative to this guidance of clamping bodies **36**, also the at least one operating body **62** and/or the main body **59** can be guided in this manner. It is therefore also possible to provide a guide channel **37** for each present operating body **62** or for main body **59** that is provided according to the example, as it has been described and explained for clamping body or clamping bodies **36** based on FIG. **7**.

(52) The invention refers to a clamping device **11** and is configured for releasably clamping a support body **12** on which a workpiece **16** can be arranged. The clamping device **11** has a base body **28** with receptacle holes **20** for location of one clamping bolt **18** of support body **12** respectively. Each clamping body **36** is linearly movable along its longitudinal axis L between a clamping position S and a release position F. The movement from the release position F into the clamping position S and/or vice versa from the clamping position S into the release position F can

be carried out by means of an operating device **52**. Each clamping body **36** has a clamping end **53** that projects into an assigned receptacle hole **20** in the clamping position S. The longitudinal axes of clamping bodies **36** define multiple points of intersection in a common projection plane parallel to which the longitudinal axes L extend. In a preferred embodiment at least three or four points of intersections are defined. Particularly four clamping bodies **36** with respectively one longitudinal axis L can be provided, wherein four points of intersections are defined in that two of the provided longitudinal axes L**1**, L**2** or L**3**, L**4** or L**1**, L**3** or L**2**, L**4** intersect in each case.
(53) Referring now to FIGS. **8**A-**12** an embodiment of the present disclosure is illustrated.
(54) FIG. **8**A illustrates a device **110** for holding a workpiece clamping device **111** or for directly holding a workpiece. The device **110** comprises at least one clamping plate **112**, which can be arranged in a machine tool, for example, in order to support the workpiece clamping device **111** in a predetermined nominal position. Optionally, one or more further clamping plates **113**, **123**, **123′** (FIG. **11**, FIG. **12**) may be provided. The clamping plates **112**, **113**, **123**, **123′** can be of substantially the same design as one another, so that the following description of the clamping plate **112** applies correspondingly to the clamping plate **113** and in a transferred manner also to the multi-nested clamping plates **123**, **23′**.
(55) The clamping plate **112** has several, for example four, openings **114**, **115**, **116**, **117**, which serve to receive clamping bolts **118** of the workpiece clamping device **111** or a workpiece. FIG. **9** shows an example of such a clamping bolt **118** engaging in the opening **114**. Several clamping bolts project away from the lower surface of the guide body **119**, the arrangement of which corresponds to the arrangement of the openings **114** to **117**.
(56) The workpiece clamping device **111** has a guide body **119** on which at least one or two clamping jaws **120**, **121** are movably mounted in order to grip and firmly hold a workpiece between them.
(57) FIG. **10** illustrates the clamping plate **112** and its tightening device **124**. This comprises an actuating rod **125** arranged axially displaceably in a through bore **127** passing through the clamping plate **112** parallel to its upper surface **126**. The actuating rod **125** is, for example, a round rod which, for actuating the tightening device, has two opposing lateral recesses or which supports a wedge **136** with two inclined surfaces **128**, **129**. Alternatively, the inclined surfaces **128**, **129** may be formed directly on the actuating rod **125**, as illustrated in FIG. **12**. The inclined surfaces can be formed as flat wedge surfaces. However, it is also possible to form the inclined surfaces **128**, **129** as curved surfaces, as can be seen from FIGS. **11** and **12**.
(58) The wedge **136** is operatively connected to clamping slides **132**, **133**, **134**, **135** via spring means **130**, **131** to urge them apart. The spring means **131**, **132** are arranged on both sides of the wedge **136** and are in contact with its inclined surfaces **128**, **129** on the one hand and with end surfaces of the clamping slides **131-135** on the other. The spring means **130**, **131** are movable in pockets of the clamping plate **112** transversely to the actuating rod **125**.
(59) The spring means **130**, **131** are preferably of identical design. In the above example, they are formed by hollow bodies, e.g. in the form of circular rings of hollow cylindrical shape which spring in the radial direction. They are preferably made of steel and can spring in the radial direction by a few hundredths of a millimeter without being damaged. A somewhat larger spring stroke of one or a few 10ths of a millimeter may also be provided. The spring means **130**, **131** may have a cylindrical outer surface. Alternatively, if the wedge **136** is formed as a rotary member, they may have a double-curved outer surface.
(60) Each annular spring means **130**, **131** encloses an inner space in which a stop means **130′**, **131′** is arranged. These stop means are formed, for example, by cylindrical bolts which are arranged in the respective spring means **130**, **131** with a clearance of preferably a few tenths of a millimeter. The stop means **130′**, **131′** can be arranged in the clamping plate **112** in a fixed position or also movable in radial direction in order not to hinder a movement of the respective spring means **130**, **131** as a whole, but only to limit its radial deformation.

(61) The clamping slides **132** to **135** are each individually assigned to the openings **114** to **117**. The clamping slide **132** is located in a channel in which it can move radially to the opening **114** in such a way that it either projects into the opening **114** in a clamping position or stands outside it in a release position. The same applies to the opening **115** and the clamping slide **133**, the opening **116** and the clamping slide **134** as well as the opening **117** and the clamping slide **135**. The clamping slides **132**, and **134** as well as the clamping slides **133** and **135** are each connected in pairs to one another by a tension spring **137**, **138** or are preloaded to their rest position outside the respective opening **114** to **117** by another spring means, not illustrated.
(62) With their ends facing away from the openings **114** to **117**, the clamping slides **132** to **135** are in contact with, for example, the cylindrical outer surface of the respective spring means **130**, **131**. This forms a sliding gear in which a displacement of the actuating rod **125** in FIG. **10** upwards forces the spring means **130**, **131** apart, whereby the spring means **130**, **131** in turn force the clamping slides **132**, **134** or **133**, **135** apart, so that their ends penetrate the bores **114** to **117**. FIG. **9** illustrates this using the example of the slide **132**, the opening-side end of which then moves into the hole **114** and penetrates there into a groove of the clamping bolt **118** with a trapezoidal cross section. Thereby, by interaction of the end of the clamping slide **132** with one of the groove flanks, the clamping bolt **118** is drawn vertically into the opening **114**, whereby the base surface of the guide body **119** is attracted to the upper surface **126**. In addition, the clamping bolt **118** undergoes a slight lateral elastic deformation so that its head **118***a* bears against the bore wall of the opening **114** at a point opposite the clamping slide **132**. This spreads the clamping bolts in the openings **114** to **117** away from each other, causing the guide body **119** to find its desired position, i.e. its zero position.
(63) The movement of the actuating rod is transmitted to the clamping slides **132** to **135** by the spring means **130**, **131**. The wedge **136**, the spring means **130**, **131** and the clamping slide form a reduction gear. In other words, the distance covered by each clamping slide **132** to **135** during clamping is at most as great as the distance covered by the actuating rod **125**, but preferably less. This is achieved by appropriate inclination of the clamping surfaces **128**, **129** and by appropriate adjustment of the wedge angle between the end faces of the clamping slides **131**/**134**, **133**/**135**, which rest against the respective spring means **120**, **121**.
(64) The through opening of the clamping plate **112** has an internal thread **139**, **140** on each side. An abutment **141** is fixed in the internal thread **139**, for example in the form of a screw, which is supported on the end face of the actuating rod **125** via a compression spring **142**. An actuating screw, which is screwed into the internal thread **140**, engages the other end face of the actuating rod **125**. By turning the actuating screw **143**, the axial position of the actuating rod **125** can be adjusted specifically in order to actuate the clamping slides **132** to **135** by means of the wedge **136** and via the spring means **130**, **131**.
(65) The clamping plate described in this respect works as follows:
(66) To connect the workpiece clamping device **111** to the clamping plate **112**, the workpiece clamping device **112** is first placed on the clamping plate **112** in such a way that the clamping bolts **118** move into the openings **114**, **115**, **116**, **117** and the guide body **119** (or a workpiece provided directly with pins **118**) rests on the upper surface **126**. Initially, the clamping slides **132** to **135** are in the release position. To tighten the workpiece clamping device **111**, the screw **143** is now actuated in such a way that the wedge **136** forces the spring means **130**, **131** apart, which in turn force the clamping slides **132** to **135** apart so that they move into the tightening position according to FIG. **9** and tighten the clamping bolts **118**. The spring means **130**, **131** compensate for any tolerances of the clamping bolts **118** and also of the clamping slides **132** to **135**, which are guided in their channels with little clearance. The spring means **130**, **131** distribute the force emanating from the wedge **136** largely evenly over all the clamping slides **132** to **135**. This is further assisted if the wedge **136** is held with some lateral clearance on the actuating rod **125**. For this purpose, the actuating rod may have a reduced-diameter or flattened section over which the wedge **136** engages.

For example, the wedge **136** may be U-shaped for this purpose to sit on the actuating rod **125** like a rider.

(67) When the tightening device is tightened, the spring means **130**, **131** move radially outwards with respect to the actuating rod **125**. The spring means **130**, **131** thereby entrain the stop means **130′**, **131′** in their interior in the same direction. As the actuating force increases, the spring means **130**, **131** begin to deform slightly from their circular shape in the relaxed state. They can come into contact with the respective stop means **130′**, **131′** at one or more points and can be supported there, so that no further deformation occurs. The spring means **130**, **131** thus have a stroke limitation. The maximum spring travel is defined by the annular gap formed between the respective stop means **130′**, **131′** and the spring means **130**, **131**. The spring force of the spring means **130′**, **131′** can depend non-linearly on the radial deformation. In particular, the spring characteristic can be progressive or digressive.

(68) The embodiment example described above has a tightening device **124** for four openings **114**, **115**, **116**, **117**. However, several such tightening devices **124**, **124′** can also be provided in the clamping plate, as illustrated in the embodiments of FIGS. **11** and **12**. FIG. **11** essentially illustrates a clamping plate **123** with a duplication of the tightening devices and the corresponding openings **114** to **117** and **114′** to **117′**. The above description applies accordingly to the formation of the associated tightening device **124**. It further applies accordingly to the tightening device **124′**, which is actuated by the same actuating rod **125** extended here. The clamping plate **123** can be further enlarged by further doubling of the clamping system, which in turn can be lined up with one another as FIG. **12** illustrates with the aid of the clamping plates **123′**, **123″**. The previous description applies accordingly to the tightening devices, each of which being associated with four clamping openings **114′**, **115′**, **116′**, **117′**.

(69) The clamping plate **112** according to the invention has a tightening device **124** for tightening clamping bolts **118**. The clamping plate **112** has a plurality of clamping openings **114**, **115**, **116**, **117**, with which a tightening device **124** is associated for clamping bolts seated in the openings **114** to **117**. The tightening device **124** comprises clamping slides **132** to **135**, which are movable radially to the respective openings **114** to **117** with little clearance in corresponding channels of the clamping plate **112**. A movably arranged wedge **136**, which acts on the clamping slides **132** to **135** via slightly resilient rollers, rings or other resiliently formed bodies, serves to move the clamping slides **132** to **135**. A stop means **130′**, **131′**, for example in the form of a bolt, which passes through the spring means **130**, **131**, serves to limit the deformation of the corresponding spring means **130** to **131**. The bolt is preferably oriented at right angles to the upper surface **126** serving as a support surface. A gap formed between the spring means and the stop means limits the spring stroke of the spring means. This allows the spring means to compensate for existing manufacturing tolerances or other tolerances in the tightening device or on the clamping bolts on the one hand and to transmit the required clamping forces on the other.

LIST OF REFERENCE SIGNS

(70) **10** workpiece holding device **11** clamping device **12** support body **13** holding side **14** attachment side **15** holding device **16** Workpiece **17** clamping jaw **18** clamping bolt **19** conical end section **20** receptacle hole **21** face cavity **22** impingement surface **23** conical section **24** tapering section **28** base body **29** clamping side **30** abutment surface **31** counter abutment surface **32** hole bottom **33** elastically deformable element **36** clamping body **36***a* first clamping body **36***b* second clamping body **36***c* third clamping body **36***d* fourth clamping body **37** guide channel **38** channel wall **39** channel bottom **40** Cover **41** cover holding cavity **42** guide wall section **43** guide insert **50** first clamping body group **51** second clamping body group **52** operating device **53** clamping end **54** clamping surface **57** operating screw **58** Nut **59** main body **60** main body surface **61** operating body end surface **62** operating body **63** Slant **64** operating end **65** clamping body end surface **70** biasing arrangement **71** biasing element A axial direction F release position FZ traction force FL longitudinal force FX first force component FY second force component G**1** first straight line G**2**

second straight line L**1** first longitudinal axis L**2** second longitudinal axis L**3** third longitudinal axis L**4** fourth longitudinal axis P**1** first intersection point P**2** second intersection point P**3** third intersection point P**4** fourth intersection point S clamping position x first direction y second direction z third direction **110** Device **111** Workpiece clamping device **112**, **113** Clamping plates **114-117** Openings **118** Clamping bolt **119** Guide body **120**, **121** Clamping jaws **123** Clamping plate **124** Tightening device **125** Actuating rod **126** Upper surface **127** Through opening **128**, **129** Inclined surfaces **130**, **131** Spring means **130′**, **131′** Stop means **132-135** Clamping slides **136** Wedge **137**, **138** Spring means **139**, **140** Internal thread/anchoring structure **141** Abutment **142** Compression spring **143** Actuating screw

Claims

1. A clamping plate for receiving at least one workpiece clamping device or a workpiece, the clamping plate comprising: a support surface for the at least one workpiece clamping device or the workpiece, the support surface is penetrated by a plurality of openings for receiving clamping bolts of the at least one workpiece clamping device, clamping slides being arranged in the clamping plate, the clamping slides each project with one end into one of the plurality of openings in a clamping position and are located outside the one of the plurality of openings in a release position, a clamping wedge, which is movably arranged in the clamping plate and is operatively connected to the clamping slides via a hollow body.
2. The clamping plate according to claim 1, wherein the support surface is formed as a flat reference surface.
3. The clamping plate according to claim 1, wherein each of the plurality of openings has a reference surface on its a respective side opposite a respective one of the clamping slides.
4. The clamping plate according to claim 1, wherein each of the clamping slides is preloaded towards the release position.
5. The clamping plate according to claim 1, wherein the clamping wedge has two clamping surfaces arranged diametrically opposite each other, a distance between which is variable along a direction of movement.
6. The clamping plate according to claim 1, wherein the hollow body is a body formed resiliently yielding in several directions.
7. The clamping plate according to claim 1, wherein the hollow body is an annular body.
8. A clamping plate for receiving at least one workpiece clamping device or a workpiece, the clamping plate comprising: a support surface for the at least one workpiece clamping device or the workpiece, the support surface is penetrated by a plurality of openings for receiving clamping bolts of the at least one workpiece clamping device, clamping slides being arranged in the clamping plate, the clamping slides each project with one end into one of the plurality of openings in a clamping position and are located outside the one of the plurality of openings in a release position, a clamping wedge, which is movably arranged in the clamping plate and is operatively connected to the clamping slides via a hollow cylinder.
9. The clamping plate according to claim 1, wherein the hollow body has a constant wall thickness.
10. The clamping plate according to claim 1, wherein a stop means is provided in the hollow body and arranged stationary in the clamping plate.
11. The clamping plate according to claim 10, wherein the shollow body and the stop means are formed to fix an annular gap together.
12. The clamping plate according to claim 2, wherein each of the plurality of openings has a reference surface on a respective side opposite a respective one of the clamping slides.
13. The clamping plate according to claim 12, wherein each of the clamping slides is preloaded towards the release position.
14. The clamping plate according to claim 13, wherein the clamping wedge has two clamping

surfaces arranged diametrically opposite each other, a distance between which is variable along a direction of movement.

15. The clamping plate according to claim 14, wherein the hollow body is a body formed resiliently yielding in several directions.

16. The clamping plate according to claim 11, wherein the stop means is a rigid body.

17. The clamping plate according to claim 11, wherein the stop means is a bolt.

18. The clamping plate according to claim 10, wherein the stop means is a rigid body.

19. The clamping plate according to claim 10, wherein the stop means is a bolt.