

Description

State of the Art

The invention relates to a method according to the preamble of the Main Claim.

Receiving plates *per se*, which are suitable for the accurately fitted and precise clamping and securing of workpieces to be machined or for building machinery and in which bores containing insert bushes are disposed at precise grid intervals from one another, are known (DE-OS 22 32 387, publication of the firm VFW-Focker "VAPA-System" and DE-PS 25 57 701 and DE-AS 26 28 155).

In the case of the publications first mentioned (DE-OS 22 32 387, the VFW-Focker publication), the receiving plates are produced in such a way that bores are first generated in the plate at precise intervals in the grid system, and then insert bushes corresponding in diameter to the bores are inserted in the said bores. The bores are produced by numerically controlled processing machines of suitably high quality and accuracy.

In the case of the remaining publications (DE-PS 25 57 701, DE-AS 26 28 155), however, the receiving plates are produced in a completely different manner, in that they adopt the required high precision of the insert bush arrangement in the grid system from a master plate, which is responsible for the positioning of the insert bushes in their bores. In particular, in order to produce receiving plates of this type for the clamping and securing of workpieces to be machined or for building machinery, the procedure is such that bores are placed with normal precision in the starting plate - i.e. without requiring great precision - at the predetermined grid intervals; insert bushes with a smaller diameter than the diameter of the bores are then inserted into the said bores, producing an annular interspace all the way round, and then the intervals between the insert bushes inserted are established with the aid of a master plate, acting as a template gauge, comprising pins or in any case positioning elements at a high-precision grid interval. The master plate, which is present only once, thus confers its intrinsic accuracy by hereditary transmission, as it were, upon the accuracy of the receiving plate produced in each case, namely by introducing a age-hardenable plastics material into the inter-

spaces between the diameter of the bore and the outer diameter of the insert bush, it becomes possible to fix the bushes in the bores after the plastics material has age-hardened, in which case, after the receiving plate is separated from the master plate, the insert bushes will have taken on the highly precise grid interval dimension of the master plate and will retain it.

In the manufacture of receiving plates of this type, the fitting or insert bushes of which are held in the annular space of their receiving bores by a plastics material, the accuracy demanded of the master plate is particularly great, because of course tolerances, even if they are extremely small, must be taken into account in making the transfer to the respective daughter receiving plate, these tolerances necessitating a precision positioning of the fixing pins of the master plate which is even greater than the accuracy required and in fact achieved for the respective receiving plate.

The object of the invention is therefore to produce a master plate of this type which then acts in turn as a template measurement rod for producing high-precision receiving plates in jig construction and in workpiece machining.

This object is attained according to the invention with the characterizing features of the Main Claim, and has the advantage that a degree of precision is achieved in positioning the fitting bores or fitting pins in the grid system which is sufficiently high that, even when precision receiving plates are reproduced by a transfer-like method on the basis of the master plate as a template measurement rod, the receiving plates achieve a standard of accuracy considered unattainable.

The main reason for the high precision of the master plate which the present invention can provide and subsequently confer upon the receiving plates is that, on the basis of perceptions upon which the invention is based, any sort of machining which represents an expenditure of energy must be avoided, since the energy expended inevitably appears in the form of heat in the master plate and/or the receiving plate, where it causes warping which results in tolerances and inaccuracies which are no longer acceptable.

On the basis of this perception, the present invention in principle avoids a chip-producing deformation in the master plate where accuracy must be

achieved. The bores introduced into the master plate act solely as rough reference points for positioning insert bushes, the position of which is determined by measurement, preferably by using so-called end measures which have an absolute zero dimension for the respective spaced relationship.

Since it is impossible to convert a measurement directly into the positional relationship, in accordance with the present invention an intermediate step of a so-called preliminary fixing or intermediate fastening of the precision insert bush loosely in its assigned receiving bore in the master plate is taken, and after all these positions have been fixed absolutely in the predetermined grid interval dimension and confirmed in their accuracy by repeated measurement, the bushes are cast in the receiving bores with the aid of an age-hardenable plastics material.

Further developments of and improvements to the invention form the subjects of the Sub-Claims and are reproduced in the latter and in the following description.

Drawing

Examples of embodiment of the invention are illustrated in the drawing and are explained in greater detail in the following description. In the drawing

- Fig. 1 is a cutaway section, shown highly diagrammatically, of a base plate in a specific machining position for producing the master plate, and
- Fig. 2 is a detailed cutaway section of an insert fitting bush and a fitting pin inserted into a bore in the master plate.

Description of the examples of embodiment

The basic concept of the present invention is the avoidance of any operations representing the expenditure of energy, in the design and arrangement of the insert fitting bushes in the base plate for producing the master plate, which [expenditure of energy] would necessarily be absorbed by the master plate and inevitably converted into heat, which would result in an unacceptable heat-produced warping. This, however, include, not only rough processing

operations such as chip-producing deformation and the like but also even such subtle operations as the tightening of screws for example.

Investigations have in fact revealed that merely tightening screws with an appropriate expenditure of force produces such heat-produced warping as to cause errors to accumulate in the end result in the master plate which may amount to as much as 2/10 mm from the insert fitting bushes at one end of the plate to the other.

The basic concept of the present invention is therefore that the insert fitting bushes in their roughly pre-drilled receiving bores first have their final precision position determined by measurement, and then fixing them in the measured position by careful preliminary fixing, and subsequently finally fixing them by the introduction of a pourable material, beginning for instance at the rear side of the base plate, and by the age-hardening thereof.

In detail, the following procedure takes place, in which case, for the sake of better comprehension, numerical dimensions will be provided and the performance of the present invention will be explained in detail, but it will be understood that neither these dimensions nor individual detailed steps thereby restrict the invention.

In a starting base plate 1, preliminary bores 2, which are drilled with the normal precision attainable for example by appropriate multiple drilling machines, even in a numerically controlled implementation, are formed in the specified grid interval dimension corresponding to the desired coordinate intervals, in which case, of course, polar coordinates or any other conceivable coordinate dimension is also possible here. In this connexion, the diameter of these preliminary bores is selected to be substantially larger than the diameter of the insert fitting bushes to be subsequently inserted into these preliminary bores. For the sake of better comprehension, the following data can be provided as a numerical example of embodiment, this only applying of course to one desired embodiment of the grid interval dimension and of the coordinate network used. The preliminary bores 2 are at a distance of approximately 80 mm from one another, measured from centre to centre in each case, and the diameter of the preliminary bores 2 amounts to 40 mm for example.

Insert fitting bushes are introduced into these preliminary bores, the said insert fitting bushes generally having means for being pre-fixed in the preliminary bore, i.e. for being secured to the receiving plate in a suitable manner, after their precise position has been measured. This securing is not the final form of fixing the insert fitting bushes, but merely serves to impart to them a positional relationship with respect to the receiving plate which is firm enough that an age-hardenable plastics material can be introduced into an annular space or interspace between the outer diameter of the bush and the inner diameter of the preliminary bore and can then be age-hardened.

In the case of the example of embodiment illustrated in the drawing, the means for the preliminary fixing comprise an angle flange on the end face of the insert bush, which is as a whole designated 3 in Fig. 2; the outer edge flange is provided with the reference numeral 4. If the numerical dimensions indicated above are extrapolated, the outer diameter of the actual bush part 5 may amount to 37 mm, while the flange, which has a thickness of 12 mm for example, has a diameter of 60 mm.

The manufacture of an insert fitting bush of this type with a bush part 5 and a flange 4 is first performed as follows: The bore in the insert fitting bush is honed to completion with a diameter in this case of 24 mm, i.e. it is machined to its absolutely final form, and the insert fitting bush 3 is subsequently placed on a mandrel - this is not shown in the drawings, because such operations are obvious to the person skilled in the art - and then the outer diameter and in particular the flange are machined relative to the inner bore 6 of the bush. This fine finishing or final machining of the flange is carried out in order that the flange will extend absolutely centrally with respect to the inner bore 6 of the insertible fitting bush 3 and in order to attain in this way an axial orientation of the flange contact face on the base plate 1 that is accurate with respect to the fitting bore 6 of the insert fitting bush 3. In fact it is the flange 4 which according to a preferred example of embodiment is used for pre-fixing the respective insert fitting bush 3 after measurement has been carried out and before the final fixing.

To this end, each flange is provided with a predetermined number of bores, preferably countersunk bores 7, distributed about its periphery, which receive the securing means in the form of screws, which in the example of

embodiment are countersunk screws 8. On account of the embodiment of countersunk bores 7, the screws 8, which are hexagon-socket screws, can be countersunk so that they do not project beyond the surface of the flange. The flange rests with its lower annular face on the counter surface of the receiving plate 1. For receiving the screws 8 as they are screwed in, the receiving plate is provided with threaded bores 9 adjacent the preliminary bores 2 and corresponding to the distribution of the countersunk bores in the respective annular flange 4 of the insert fitting bushes, so that it is possible to secure the insert fitting bushes on the receiving plate 1 by screwing the screws 8 into the countersunk bores 7 on the annular flange 4. It will be understood and should be mentioned at this point, that the seat of the screws 8 in their countersunk bores 7 of the flange 4 is constructed with sufficient play, with respect to the shank of the screw as well, that before the screws 8 are tightened the respective insert fitting bush will be capable of adjustment and displacement which is sufficient in any desired horizontal direction.

The next manufacturing step is that a first row of insert fitting bushes is inserted into the respective receiving bores 2 in the base plate 1 and the screws for example are then screwed loosely into their threaded bores 8 in the base plate in such a way that the fitting bushes are held to a certain extent.

Their final positioning is carried out by measurement, more or less in that a first stop strip 10 is placed against a lateral face 1a of the base plate 1, which is cleanly machined and made correspondingly flat, a distance-measuring rod 11 then being contacted by the inside edge 10a of the said first stop strip 1a. This measurement rod 11 represents an absolute zero dimension and it is therefore dimensioned in its width extension A, which in this case is highly accurate, in such a way that fitting pins 13 introduced into the fitting bore 6 in each insert fitting bush 3 of row 12 can be made to strike the measuring face 11a facing them. In the case of the example of embodiment illustrated, therefore, the width A of the measurement rod having the absolute zero dimension of the desired distance must amount to 56 mm, if the fitting pin diameter 13 agrees with the fitting bore diameter 6 and the periphery of the fitting pins strikes the outer face 11a, orientated towards them, of the measurement rod in each case.

It is evident that in this way an extremely highly accurate positioning of the insert fitting bushes is first attained and ensured in the X-direction.

For the final positioning in the Y-coordinate direction (in the case of the example of embodiment illustrated), it is possible, beginning with a first given insert fitting bush, first to secure this bush - in Fig. 1 the fitting bush is designated 3a - with as accurate as possible a central positioning in the sense of a preliminary fixing, by tightening the respective flange screws 8. It should be mentioned once again that this tightening should be carried out with particularly special care and virtually only by hand, and in any event for the subsequent insert fitting bushes, so as to avoid any possible heat-produced warping here. After the first insert fitting bush 3a is then fixed on the base plate 1, a further measurement rod 14 is now used for the purpose of highly accurate positional determination in the Y-coordinate direction, and if the intervals between the insert fitting bushes in the base plate 1 are intended to be equal to one another in all directions, then the said measurement rod 14 has the same thickness A as the measurement rod 11 for the precision positional determination in the X-direction. The measurement rod 14 is then struck on both sides - this measurement rod is likewise provided with an absolute zero dimension in the desired distance interval - by the fitting tangs or fitting pins 13 inserted into the fitting bores 6, and the next insert fitting bush 3b downwards in the plane of the drawing can then likewise be pre-fixed, i.e. it can be secured on the base plate 1 by tightening its flange screws 8.

This procedure is logically continued in a repeated manner until after the first row 12 is finished the second row is begun, in that the measurement rod 11 is now moved into the position 11', in which the outer edge 11b of the measurement rod 11 - which was originally made to strike against the outer strip 10 - in position 11' now strikes from the other side against the fitting pins 13 which have been placed in their fitting bores 6. In this way, by means of the opposite rim edge 11a, the stop position for the fitting pins 13 of the next row of insert fitting bushes is again attained, effecting their highly accurate positioning first in the X-direction and subsequently in succession in the Y-direction, by striking the second measurement rod 14, as already explained.

If the procedure has been followed in this way by locating the respective precision position of the insert bushes by measurement from one side of the base plate 1 to the other and all the bushes have been pre-fixed by means of their flange screws 8, then a measurement is again performed highly accurately in the X- and the Y-directions as well as in the diagonal direction. To this end, measuring rods or measuring surfaces or measuring elements generally having end measures, i.e. zero dimensions, can be used so that the work of location by measurement need be performed merely with stops.

The final manufacturing step is then that the insert fitting bushes held on the base plate 1 by the preliminary fixing which is one merely of non-positive engagement are now fixed in an absolutely positively locking manner, namely with the aid of casting technology which in itself is already known, i.e. an appropriate age-hardening plastics material is introduced into the remaining annular space 15 (Fig. 2) between the external periphery of the bush element 5 and the internal periphery of the preliminary bore 2. This is preferably carried out in such a way that the base plate is turned over and material is poured uniformly into the annular interspaces, care also having to be taken during the manufacturing that the annular interspaces should be as uniform as possible and that an excessive eccentricity of the insert fitting bush in its respective bore should not be permitted; this can also possibly lead to shifts in tolerance in terms of accuracy in this case because of the different age-hardening conditions.

After the age-hardening, the insert fitting bushes are positioned absolutely and highly precisely in the base plate 1, and the master plate which is required for one use is complete.

The rest of the manufacturing process for the receiving plates then takes place in such a way that insert bushes, which are now intended for the respective receiving plate to be produced, are pushed for example onto the fitting pins 13 which have been placed in their fitting bores 6. Then a respective receiving plate, likewise having preliminary bores having a larger diameter than the outer diameter of the further insert bushes pushed onto the fitting pins 13, is placed upon the master plate, and the age-hardenable plastics material is poured into the annular interval formed between the preliminary bores in the receiving plate and the outer diameters of their insert bushes.

Since all this is carried out with highly accurate precision, it is possibly difficult to lift the receiving plate away from the master plate; this separation can therefore be carried out in such a way that the fitting pins 13 are continuously pressed downwards in each case out of the insert bushes in the receiving plate after the age-hardening thereof, so that the receiving plate will separate without constraint from the master plate. The accuracy of the master plate will then have been transferred practically unchanged in the manner of an hereditary law, upon the receiving plate produced in each case. However, this is not the subject of the present invention and is furthermore explained in DE-PS 25 57 101.

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