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AbstractMachine tool

There is disclosed a machine tool for machining bores having a large axial length and a boring tool especially suited for a machine tool of this kind in which a boring bar holding at least one tool lip is supported by a steady adapted to be connected to the boring bar 28 via a coupling 48. By the steady the radial excursion of the boring bar during the machining process is reduced to a minimum.

Description**MACHINE TOOL**

The invention relates to a machine tool for machining recesses, for instance bores having a large axial length in accordance with the preamble of claim 1 and a tool especially suited for a machine tool of this kind.

Machine tools of this kind are used in series production of case components, for instance of crank/gear cases. By the term machine tool the respectively used machining stations, such as, for instance, transfer units, fine-boring units, special machines, horizontal boring machines or machining centers are understood by which the machining of the cases is effected. An important field of use of such machines is, for example, the machining of crankshaft bearing bores of a bearing channel for supporting the crankshaft or, correspondingly, of a camshaft. Such bearing channels include a plurality of bearing bore sections spaced apart from one another which are formed by case webs. In a four-cylinder engine the crankshaft usually runs fivefold on bearings so that five such bearing bore sections are arranged to be coaxially one behind the other. In dependence on the size of the crankshaft such bearing bores extend over a considerable axial length so that relatively high demands in terms of manufacture are made for forming the bore.

For machining such bearing bores usually so-called "line bore systems" are employed in which a boring bar is introduced from one side into the bore of the bearing. In the following description the plurality of bore sections spaced apart from one another is understood by the bore of a bearing. The boring bar supports a plurality of tool lips spaced apart from one another, wherein each tool lip is

assigned to one of the bearing bore sections so that after introduction of the boring bars into the bore of the bearing all bearing bore sections can be machined simultaneously by one feed motion. In order to avoid radial excursions, the end portion of the boring bar guided through the bore sections is supported in a guide bearing, i.e. both end portions of the boring bar run on bearings. For machining the bore section the boring bar and the guide bearings are first aligned, the case is lifted off, the aligned boring bar is inserted into the bore sections, the case is lowered and chucked. After the subsequent machining another aligning step is taken, the case is chucked off and lifted off and the boring bar is removed. This tool has a relatively complex structure, because for each bore section at least one tool lip has to be formed at the boring bar. Moreover a compensation of dimensional variations is very difficult, because a separate compensating means would have to be assigned to each tool lip.

Moreover also systems are known in which merely at an end portion the boring bar supports a premachining cutting edge and a subsequent machining cutting edge so that the bearing bore sections are machined one after the other seen in the feeding direction.

When using such tools and machine tools it has turned out that, in the case of long bores of a bearing and the related necessity to design the boring bar also to have a corresponding length, during the feed motion considerable forces act upon the boring bar in radial direction, which forces guide the same in radial direction and thus have to be taken into consideration during machining. A compensation of these forces requires a considerable expenditure in terms of manufacture so that the desired accuracy during manufacturing the bearing bores frequently can be observed only with difficulties or after a subsequent treatment by a further tool.

In contrast to that, the object underlying the invention is to provide a machine tool and a boring tool especially suited for a machine tool of that kind in which a high dimensional accuracy of the workpieces to be manufactured is ensured with a minimum expenditure in terms of apparatuses.

This object is achieved, in respect of the machine tool, by the features of claim 1 and, in respect of the tool, by the features of claim 9.

The radial excursion of the boring bar vis-à-vis a freely protruding boring bar can be considerably reduced by the measure to support the boring bar by a steady. By the considerable reduction of the radial excursion of the boring bar and thus of the tool lips supported on the boring bar the bearing bore sections of a bearing channel of a crank case, for instance, can be machined with a substantially higher accuracy. The connection of the boring bar with the steady is effected, according to the invention, via an appropriate coupling which may be a conventional chucking device for rotating tools, for instance. Alternatively, the coupling may also be effected by a threaded engagement of the adjacent end portions of the steady and the boring bar.

It is particularly advantageous, if the steady is driven by a spindle so that the speed of the steady can be adapted to the speed of the boring bar before coupling. The threaded engagement may be effected, for instance, by adjusting a predetermined difference in speed, while in the case of a coupling via a known chucking device the steady and the boring bar are driven synchronously at the same speed.

Despite the support via the steady deviations from the desired setting values, which may be caused, for instance, by wear of the lip, lip tolerance, adjusting error or by variations of measure due to changes in temperature of the machine, may nevertheless occur during manufacture. Therefore it is especially advantageous, if the cutting tool and the machine tool are designed with a feed system permitting an adjustment of the cutting edge during machining. A feed system of this kind is described in detail, for example, in a German prior application (Application No. P19712238) of the applicant which is explicitly referred to herewith and whose content also has to be deemed to be part of the disclosure of the present application.

A possibility of designing a feed system of this kind consists in that a cutting tool is fixed via a bending clamp holder to the boring bar and the bending clamp holder can be deflected in radial direction by means of an operating shaft and a control surface formed thereon so as to compensate the errors occurring or else to carry out particular changes in diameter of the bores to be formed in response to the axial length of the bore. Such variations in diameter may be necessary, for instance, in concave, convex or tapered bores or when introducing recesses etc.

For inserting the tool lips into the bearing channel they either have to be brought to a dimension smaller than specified via the feed system or else the relative position between the bearing channel and the boring tool (boring bar, steady) has to be varied such that an insertion is made possible without the lips colliding with the bore walls. This may be effected, for example, by lifting or lowering the crankcase, which requires a considerable expenditure of work. In accordance with the invention, this drawback is eliminated in that the boring tool itself is

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received in the machine tool to be movable in radial direction.

In the case of a first alternative, this is achieved by the fact that the work spindle for the boring bar and the spindle for the steady are supported by eccentric spindles so that the aforementioned radial adjustment to a dimension smaller than specified can be performed by the same. In this case also the feed motion can be effected by a corresponding control of the eccentric spindles so that a separate feed system could be dispensed with. This can be additionally provided as an alternative, of course, to make up for manufacturing errors during machining.

As an alternative to the provision of eccentric spindles, each of the work spindle and, where appropriate, also the spindle for the steady can be supported on a feed unit including a cross slide rest so that at least the boring bar is movable in radial direction for inserting the tool into the bearing channel.

An especially compact machine tool is obtained, when the boring bar (and possibly the steady) is provided with cutting tools so that the axial length of the boring tool is

the coupling is arranged approximately in the center of the bearing channel (seen in axial direction).

Alternatively to that, the cutting tools may also be formed solely at the boring bar, of course, so that the boring bar passes through the entire bearing channel

Figure 4 is a schematic representation of the boring tool of the machine tool of Fig. 3,

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On both sides of the workpiece carrier 8 guides 1

