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GB 2273904 A US 4638870 A

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(54) **Hand tool safety device**

(57) A hand tool, such as a drill, has a detection device 46 for detecting an uncontrolled operating situation, for instance the locking of the tool 27 in a workpiece 28 with the resultant sudden rotation of the machine housing 12, and a locking device 30, suitable for locking a drive train 16,17,18,19,20,22,23 of the hand tool, the locking device consisting of a locking element 31 and a locking tooth system 32. In response to locking of the tool in the workpiece, the detection device generates an electric tripping signal which may trigger the locking device, such that the locking element engages the locking tooth system thus locking the drive train. Preferably, in normal use the locking element is held disengaged from the tooth system by a locking pin 38 such that on production of the tripping signal of the detection device, the locking pin is attracted by electromagnetic means 41 thus releasing the locking element for engagement with the tooth system.

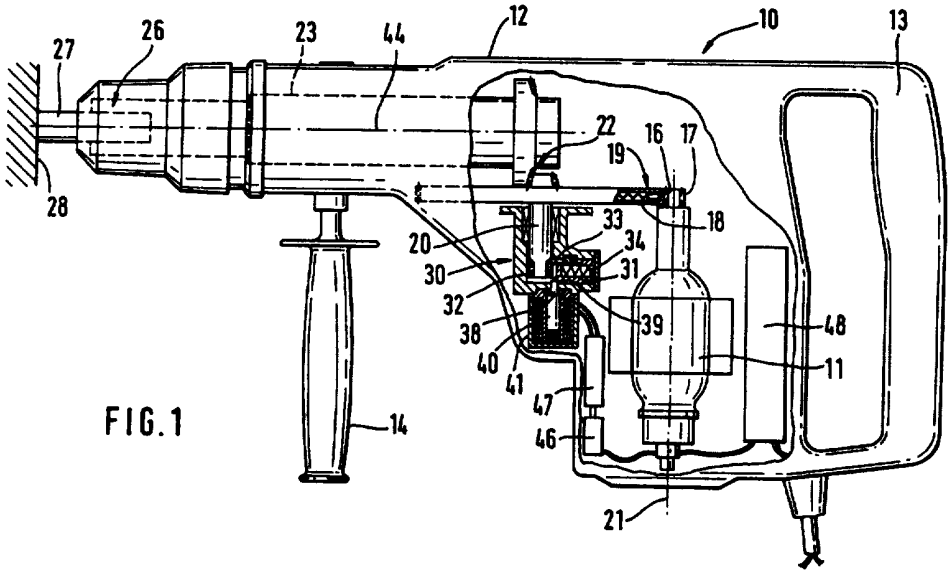

FIG.1

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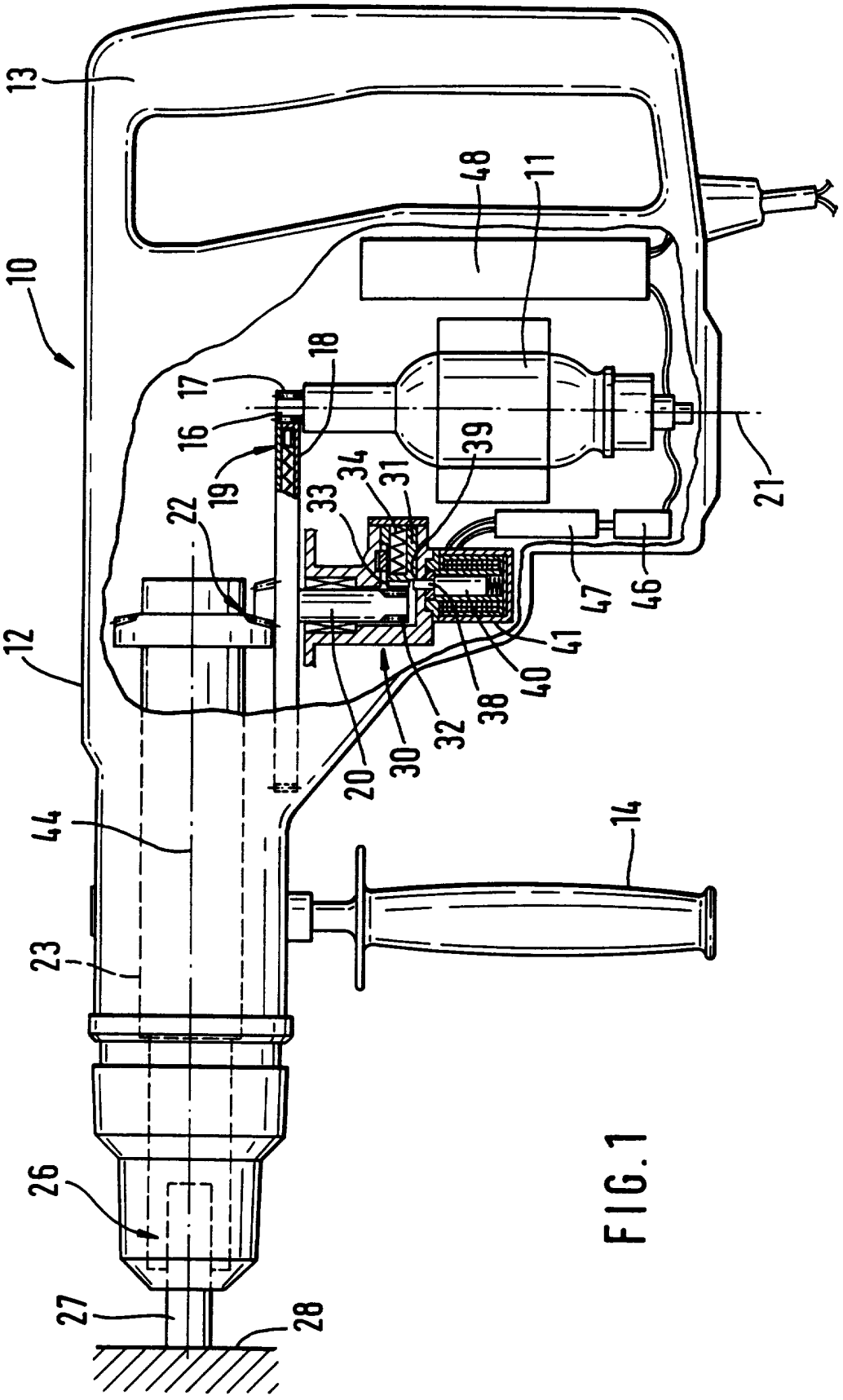
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FIG. 1

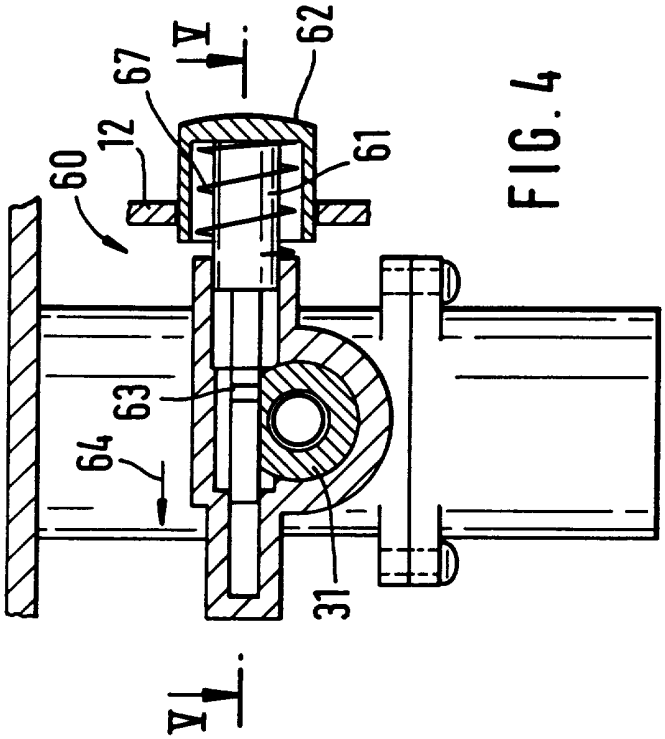

FIG. 4

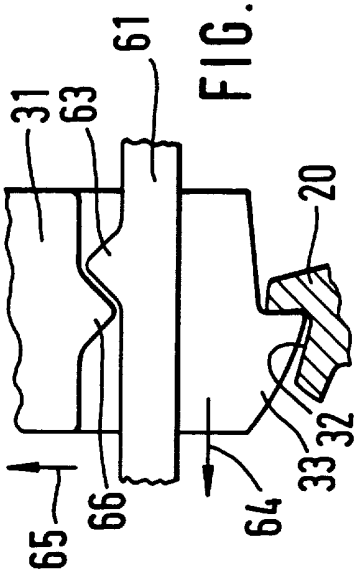

FIG. 5

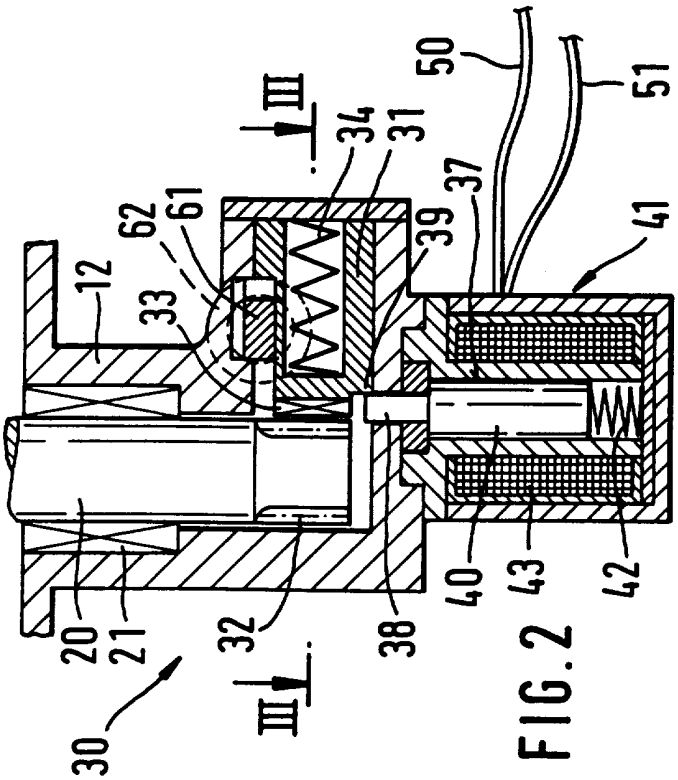

FIG. 2

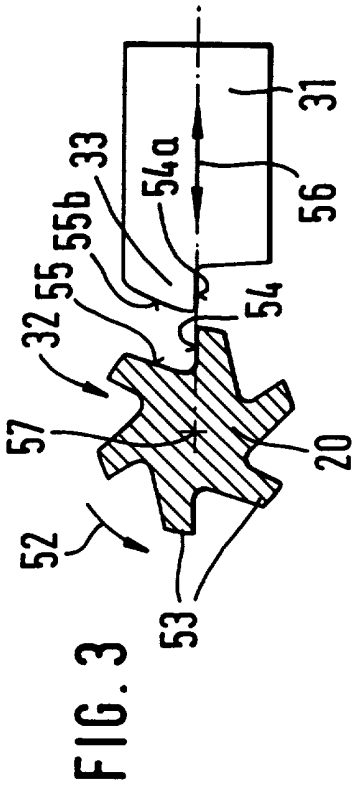

FIG. 3

FIG. 6

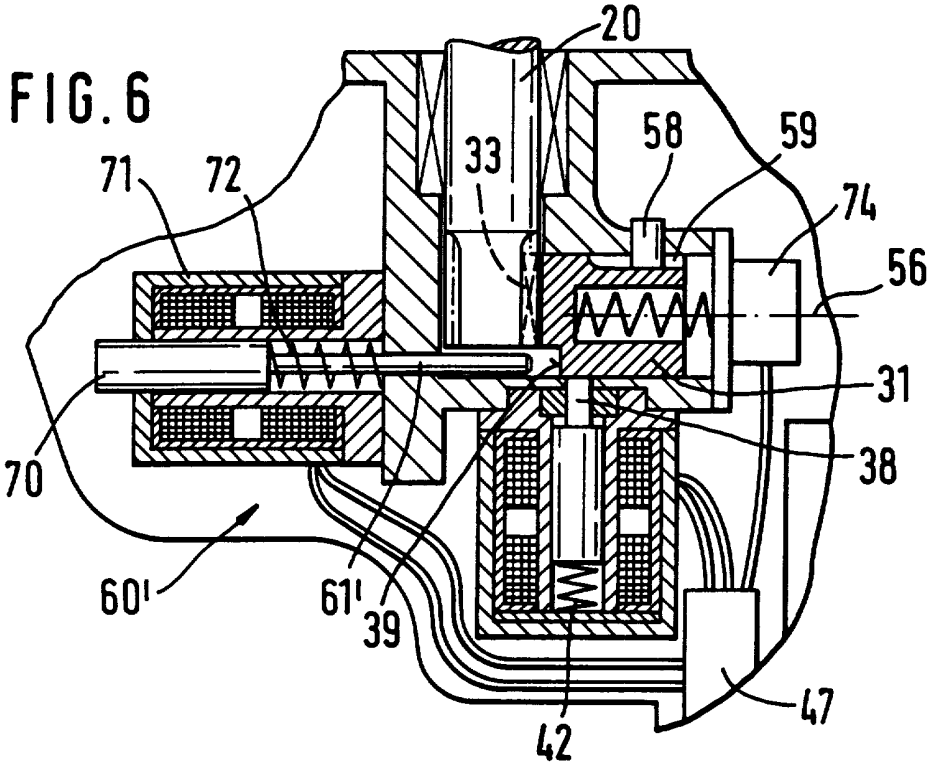
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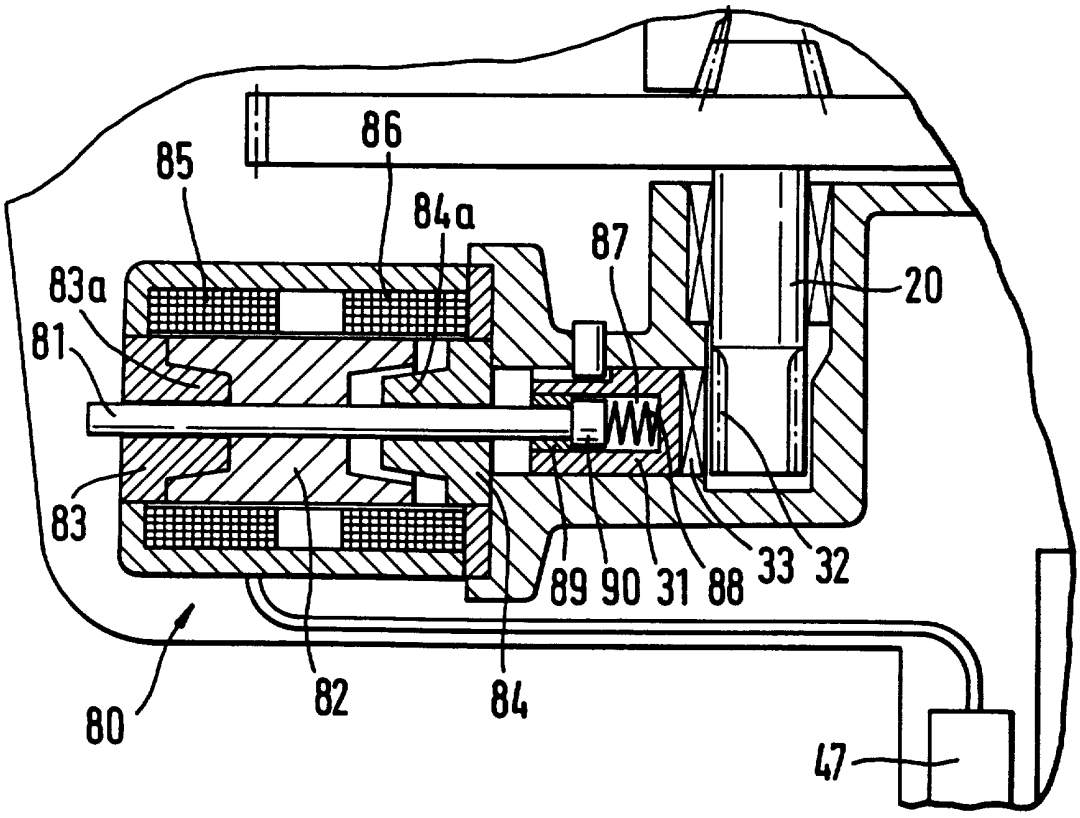
FIG. 7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Hand machine tool

Background art

The invention proceeds from a hand machine tool according to the preamble of claim 1. Such a hand machine tool is already known (DE 43 00 021 A1), the drive spindle of which is abruptly locked in the event of the machine housing accidentally starting to rotate. To trigger the locking process, a mass piece is used, which is guided displaceably in the machine housing and in the locking situation releases a locking element for engagement into a tooth system of the drive spindle. The drawback of said solution is that the mass piece is constantly exposed to vibration caused by operation and is moreover subject to a gravitational influence which is dependent on the operating position, with the result that in unfavourable operating positions only a relatively imprecise and delayed triggering of the locking device is possible.

Advantages of the invention

In contrast, the hand machine tool according to the invention having the characterizing features of claim 1 has the advantage that a triggering of the locking device which is virtually instantaneous and free of undesired disturbing influences is guaranteed.

By virtue of the measures described in the sub-claims, advantageous developments and improvements of the hand machine tool indicated in claim 1 are possible.

Drawings

Three embodiments of the invention are illustrated in the

drawings and described in detail below. Of the drawings, Figure 1 shows a longitudinal section through a drill according to a first embodiment, Figure 2 a section through a locking device of the drill, Figure 3 a section according to line III-III in Figure 2, Figure 4 a cross section through the locking device, Figure 5 a section according to line V-V in Figure 4, Figure 6 a longitudinal section through a locking device according to a second embodiment and Figure 7 a longitudinal section through a locking device according to a third embodiment.

Description of the embodiments

In Figure 1, a drill 10 is shown as an example of a hand machine tool. The drill 10 has an electric drive motor 11, which is housed inside a machine housing 12. The drive motor 11 has a motor shaft 16, which is rotatable about a motor axis 21. A handle 13 and an auxiliary handle 14 are attached to the machine housing 12.

A drive torque to be supplied by the drive motor 11 is transmissible from a pinion 17, which is seated on the motor shaft 16, to a gear wheel 18 and from the gear wheel via an overload clutch 19 to an intermediate shaft 20. The intermediate shaft 20 lying substantially parallel to the motor axis 21 is connected, in terms of transmission, by a bevel gearing 22 to a drilling spindle 23. The drilling spindle 23 is provided at one end with a tool holder 26 for a drilling tool 27, which is used to machine a workpiece 28. The parts - motor shaft 16, pinion 17, gear wheel 18, overload clutch 19, intermediate shaft 20 and drilling spindle 23, form a drive train for driving the tool holder 26 and the tool 27 held therein in a rotational manner. The machine housing 12 and the drilling spindle 23 may additionally receive an impact mechanism (not shown in detail), thereby enabling the drill 10 to be used as a hammer drill or a drilling hammer.

A locking device 30 for the drive train of the drill 10 is disposed in the machine housing 12. The locking device 30 comprises a locking element 31 which is guided axially relative to the machine housing 12. The locking element 31 is provided at one end with a locking tooth 33, which may engage into a corresponding locking tooth system 32 in the intermediate shaft 20. The locking element 31 is loaded by a spring 34 in the direction of the locking tooth system 32.

A locking pin 38, which is displaceable approximately at right angles to the direction of displacement of the locking element 31, engages behind a shoulder projection 39 of the locking element 31 and serves as a stop for the locking element 31 so that the locking tooth 33 remains disengaged from the locking tooth system 32. The locking pin 38 is provided with a cylindrical extension 37, which forms an armature 40 of an electromagnet 41.

During operation of the drill 10, the drill is held by the operator at the handle 13 and optionally additionally at the auxiliary handle 14. During operation, the operator has to counteract a torque which is applied at the tool 27 and is effective around a drilling spindle axis 44. If during drilling the tool 27 becomes stuck in the workpiece 28, the drill 10 experiences a sudden acceleration about the drilling spindle axis 44, as a result of which the drill 10 may be hurled out of the operator's hand, potentially causing injury to the operator or damage to the drill 10.

Such an uncontrolled locking situation is detected by a sensor 46. The sensor 46 is designed, for example, as an acceleration sensor. The signal produced by the sensor 46 is monitored in an evaluation device 47. When a specific threshold value is exceeded, the evaluation device 47 activates the electromagnet 41, with the result that its armature 40 is attracted counter to the spring force 42. The locking pin 38 is therefore moved out of the shoulder

projection 39 and the locking element 31 is released for engagement into the locking tooth system 32.

As a result of the positive engagement of the locking tooth 33 into the locking tooth system 32, the drive train is abruptly locked relative to the machine housing 12. At the same time, the drive motor 11 may be switched off by means of a motor controller 48. In any case, an excess driving torque is reduced by the overload clutch 19, which may also take the form of a disconnect-type clutch.

The locking device 30 is shown in greater detail in Figure 2. This shows the intermediate shaft 20, which is supported by means of a bearing 21 so as to be rotatable relative to the machine housing 12. Situated at one end in the intermediate shaft 20 is the locking tooth system 33, into which the locking element 31 may engage with its locking tooth 31. The spring 34 moves the locking element 31 so that its shoulder projection 39 is applied against the locking pin 38. The locking pin 38 is loaded in the direction of its locking position by a pressure spring 42. The armature 40 is partially enclosed by a winding 43. After the winding 43 is energized via connections 50, 51, the armature 40 is axially attracted counter to the action of the spring 42.

Figure 3 shows the locking tooth system 32 of the intermediate shaft 20 in greater detail. The locking tooth system 32 comprises six teeth 53 which are directed radially outwards and inclined in direction of rotation 52. The teeth 53 have a substantially radially directed locking face 54 and a free face 55. The corresponding locking tooth 33 of the locking element 31 is provided with a corresponding locking face 54a and a corresponding free face 55b. The locking face 54a of the locking tooth 33 is directed substantially parallel to an axis of displacement 56 of the locking element 31 lying substantially at right angles to an axis of rotation 57 of the intermediate shaft 20. By virtue of said right-angled

arrangement of direction of displacement 56 and axis of rotation 57, a fast-action engagement without unwanted latching-over of the locking tooth 33 into the locking tooth system 32 is possible.

Figure 4 shows a resetting device 60 for the locking element 31. The resetting device 60 comprises a longitudinally displaceable resetting slide 61, which at one end is firmly connected to an operating head 62. The operating head 62 protrudes from the machine housing 12 and is therefore operable externally by the operator of the drill 10. The resetting slide 61 is provided with a resetting cam 63 which extends substantially at right angles to the operating direction of the resetting slide 61 and substantially in the resetting direction of the locking element 31.

When the locking tooth 33 of the locking element 31 is meshed with the locking tooth system 32, the locking element 31 is resettable by pressing in the operating head 62 and hence by longitudinally displacing the resetting slide 61. Upon operation of the resetting slide 61 in operating direction 64, the resetting cam 63 comes in contact with a corresponding cam 66 formed on the locking element 31 (Figure 5). Upon further operation of the resetting slide 61, the cams 63, 66 slide past one another, the locking element 31 being displaced in resetting direction 65 counter to the action of the spring 34 and the locking tooth 33 disengaging completely from the locking tooth system 32. The height of the cams 63, 66 is so selected that the locking pin 38 may engage once more behind the shoulder projection 39 and the locking element 31 is applied once more against the locking pin 38. The resetting slide 61 is simultaneously set by means of a restoring spring 67 back into its starting position shown in Figure 4. The locking device 30 of the drill 20 is then ready once more for further triggering.

The second embodiment shown in a cutout manner in Figure 6 differs from the first embodiment only in terms of the resetting device 60. Parts which are identical or act in an identical manner are denoted by the same reference numerals, this similarly being the case for the third embodiment which follows.

The drill 10 shown in Figure 6 is provided with an automatic resetting device 60'. The resetting device 60' has a resetting slide 61' which lies paraxially relative to the axis of displacement 56 of the locking element 31. The resetting slide 61' is connected to an armature 70 of an electromagnet 71. The electromagnet 71 takes the form of an annular magnet which concentrically surrounds the armature 70. The armature 70 is preloaded by a spring 72 in the direction of displacement of the locking element 31 and pressed into an axial position of lower magnetic overlap. As soon as the electromagnet 71 is energized, the armature 70 is attracted counter to the spring 72. The resetting slide 61' then moves counter to the direction of engagement of the locking element 31 towards said locking element and pushes its locking tooth 33 out of the locking tooth system 32. In so doing, the locking element 31 is displaced until the locking pin 38, as a result of the action of the spring 42, may engage behind the shoulder projection 39 of the locking element 31. The locking device 30 is then moved back into its starting position. For reasons of clarity, in Figure 6 the resetting slide 61' and the locking pin 38 are shown in one plane although they actually lie in different planes so as not to impede one another.

A pin 58 engages into a longitudinal groove 59 in the locking element 31 and prevents the locking tooth 33 from rotating relative to the locking tooth system 32, with the result that a locking engagement is always possible. The anti-rotation device may also be realized in some other way, e.g. by means of a four-edged construction of the locking element 31. A

position sensor 74 monitors the set position of the locking element 31. As soon as the locking element 31 is in its starting position, this is detected by the position sensor 74 and the electromagnet 71 is disconnected by the evaluation device 47 so that the spring 72 pushes the resetting slide 61' back into its starting position. The position sensor 74 may also be used to monitor the locking position of the locking element 31, in which case upon attainment of the locking position a disconnect signal produced by the position sensor disconnects the drive motor 11.

In the third embodiment shown in Figure 7, the two electromagnets 41, 71 of Figure 6 are replaced by a single solenoid actuator 80. A separate resetting device 65, 65' is therefore not required. The solenoid actuator 80 comprises two frontally opposed permanent magnets 83, 84 having conical overlap projections 83a, 84b, between which an armature 82 is displaceably supported. The overlap projections 83a, 84a each form an opposite end position for the armature 82. The armature 82 is moreover surrounded by two annular coils 85, 86 which, when energized, move the armature 82 from one end position into the other or back again. When the coils 85, 86 are de-energized, one of the two oppositely-directed forces of attraction of the permanent magnets 83, 84 is always predominant so that two stable end positions are provided for the armature 82.

The locking element 31 is provided at its rear with a location opening 87 for receiving an armature rod 81 which is connected to the armature 82. The armature rod 81 engages with axial play into the location opening 87. A pressure spring 88 is disposed between armature rod 81 and locking element 31 and presses the locking element 31 away from the armature rod 81 and towards the locking tooth system 32. The locking element 31 is axially secured by means of an inner ring 89 which cooperates with an annular collar 90 on the armature rod 81.

In Figure 7, the armature rod 81 with locking element 31 is situated in its disengaged end position. Through energization of the electromagnets 85, 86 the armature 82 may, for locking the intermediate shaft 20, be moved into its opposite end position situated closer to the intermediate shaft 20. During said process, the pressure spring 88 ensures that the armature 82, regardless of the depth of penetration of the locking tooth 33 into the locking tooth system 32, always reaches its end position in which it develops the maximum retention force.

Claims

1. Hand machine tool, in particular a drill or hammer drill or drilling hammer, having a machine housing (12), having a drive motor (11) housed in the machine housing (12), having a drive train (16, 17, 18, 19, 20, 22, 23) connecting the drive motor (11) to a tool holder (26) for the rotary drive of a tool (27) insertable into the tool holder (26), having a detection device (46) for detecting an uncontrolled operating situation of the hand machine tool, in particular for detecting locking of the tool (27) in a workpiece (28) with resultant sudden rotation of the machine housing (12), having a locking device (30) for the drive train (16, 17, 18, 19, 20, 22, 23) of the hand machine tool which may be triggered by the detection device (46), the locking device (30) comprising a locking element (31) which is movably supported in the machine housing (12), may positively engage in the event of rotation of the drive train (17, 18, 19, 20, 22, 23) into a locking tooth system (32) disposed in the drive train (17, 18, 19, 20, 22, 23) and then locks the drive train (16, 17, 18, 19, 20, 22, 23) against rotation relative to the machine housing (12), characterized in that the detection device (46) is designed to produce an electric tripping signal in the uncontrolled operating situation, that the locking device (30) may be triggered by the electric tripping signal, in which case the locking element (31) is engageable into the locking tooth system (32) directly or indirectly by means of an electromagnet (41) operable by the tripping signal.

2. Hand machine tool according to claim 1, characterized in that formed on one end of the locking element (31) is a locking tooth (33) which may be brought into engagement with the locking tooth system (32) and that the locking element (31) is radially displaceable relative to the locking tooth system (32) so that the locking tooth (33) may be engaged and disengaged through displacement of the locking element (31).

3. Hand machine tool according to claim 2, characterized in that the locking tooth system (32) comprises a plurality of teeth (53), which each have in the one direction of rotation a locking face (54) and in the other direction of rotation a free face (55), the locking face (54) being directed substantially radially outwards and the free face (55) being inclined more tangentially thereto.

4. Hand machine tool according to one of the preceding claims, characterized in that the locking tooth system (32) is disposed on an intermediate shaft (20) of the drive train (16, 17, 18, 19, 20, 22, 23).

5. Hand machine tool according to claim 4, characterized in that provided at the drive end in front of the intermediate shaft (20) is a disconnect-type clutch (19) which, in dependence upon the detection device (46) and/or after engagement of the locking element (31) into the locking tooth system (32), automatically separates an output-end part of the drive train (20, 22, 23) from the drive motor (11).

6. Hand machine tool according to one of the preceding claims, characterized in that the locking element (31) is preloaded in engagement direction by a spring (34) and that a locking pin (38) of the electromagnet (41) which is movable into the displacement path of the locking element (31) is provided, which may be brought into

engagement with a shoulder projection (39) of the locking element (31) so that the locking element (31) may then be held disengaged from the locking tooth system (32) by the locking pin (38), and that the locking pin (38) for release of the locking element (31) is operable in dependence upon the electric tripping signal of the detection device (46).

7. Hand machine tool according to claim 6, characterized in that the locking pin (38) is preloaded by a spring (42) in the direction of the position of engagement with the locking element (31).

8. Hand machine tool according to one of claims 6 or 7, characterized in that a resetting device (60, 60') is provided for resetting the locking element (31) from its locking position into its starting position.

9. Hand machine tool according to claim 8, characterized in that the resetting device (60) comprises a manually operable resetting slide (61), which is provided with a resetting cam (63) and extends substantially at right angles to the operating direction of the resetting device (60) in the resetting direction (65) of the locking element (31) and cooperates with a corresponding projection (66) formed on the locking element (31).

10. Hand machine tool according to claim 8, characterized in that the resetting device (60') comprises an electromagnet (71) for operating the resetting slide (61).

11. Hand machine tool according to claims 1 to 5, characterized in that the locking element (31) may be engaged and disengaged directly by means of a solenoid actuator (80).

12. Hand machine tool according to claim 11, characterized in that the solenoid actuator (8) has two end positions which are stable in the de-energized state.

13. Hand machine tool according to claim 12, characterized in that the end positions are produced by permanent magnets (83, 84) and the solenoid actuator (80) comprises an armature (82), which is connected to the actuator (31) and is adjustable back and forth between the end positions by means of energized coils (85, 86).

14. Hand machine tool according to one of claims 11 to 13, characterized in that a spring (88) is disposed between armature (82) and locking tooth (33).

15. Any of the hand machine tools substantially as herein described with reference to the accompanying drawings.

The Patent Office

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Application No: GB 9621591.8 **Examiner:** Gavin Dale
Claims searched: 1-15 **Date of search:** 25 November 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): B3C; B4C

Int Cl (Ed.6): B23B 45/02; B25D 17/10; B25F 5/00

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
Y	GB 2273904A	(ROBERT BOSCH GMBH) See Fig 2	1
Y	US 4638870	(HILTI) See column 2 lines 6-14 and column 4 lines 28-31	1

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.