A common manually operated member is provided in a drilling machines for selectively effecting percussion drilling and rotary drilling, and also rotation of the tool holder shaft at two different speeds during either operation. First and second control means, including cams, connect the manually operated member, such as a turnable knob or sleeve, with a striking mechanism by which the tool holder shaft can be reciprocated, and with a shiftable transmission.
Fig. 6

INVENTORS
Monteir MURR
Alfred HETTICH
Reinhard HAHNER
Reinhold STRÖEZEL
Max BÜRKLIN

BY
their ATTORNEY
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VARIABLE SPEED PERCUSSION DRILLING MACHINE

BACKGROUND OF THE INVENTION

The present invention relates to percussion drilling machine in which the striking mechanism can be rendered ineffective so that rotary drilling can be carried out. It is known to provide machines of this type with a change speed gear, requiring two manually operated control means for the striking mechanism and for the change speed transmission, respectively. Additional controls are required so that known drilling machines have at least five control members which have to be manually operated, causing confusion for an unskilled operator.

SUMMARY OF THE INVENTION

It is one object of the invention to overcome this disadvantage of known percussion drilling machines, and to provide a percussion drilling machine in which a single manually operated member is provided for selecting percussion drilling operations and rotary drilling operations at different speeds.

Another object of the invention is to provide a compact and reliably operating apparatus serving this purpose.

Another object of the invention is to provide a percussion drilling machine in which a single knob effects during turning for one revolution, percussion drilling at two different speeds, and rotary drilling at two different speeds.

With these objects in view, a drilling machine according to the invention comprises a drive shaft; a tool holder shaft; transmission means connecting the drive shaft with the tool holder shaft and having at least two stages for rotating the tool holder shaft at different speeds; a striking mechanism having an operative position for reciprocating the tool holder shaft in axial direction, and an inoperative position in which the tool holder shaft only rotates, the striking mechanism being moved to the operative position when the tool holder shaft is pressed against a workpiece; first control means including actuating cams connected with the transmission means for shifting the same between the two stages; second control means connected with the striking mechanism for shifting the same between the inoperative and operative positions when the tool holder shaft is pressed against a workpiece; and common manually operated means connected with the first and second control means for simultaneously operating the same so that the tool holder shaft rotates at different speeds while performing percussion drilling and rotary drilling operations.

In one embodiment of the invention, the manually operated means includes a sleeve rotatable and axially movable on a housing, and a first control means include circumferential axially effective first actuating cam means on the sleeve for shifting the transmission means between the two stages, while the second control means include circumferential axially effective second actuating cam means on the sleeve for moving the striking mechanism between the inoperative and operative positions.

The transmission means includes a shifting member controlled by the actuating cam means of the first control means, and being preferably constructed as a transmission shaft. In one embodiment of the invention, the transmission shaft is pressed by a spring in axial direction against the cam means on the sleeve, and in another embodiment of the invention, the transmission shaft has an annular groove engaged by a cam plate on the sleeve.

In other embodiments of the invention, the manually operated member is a knob, and the first and second control means are interconnected at the ratio 2 : 1 so that the machine can operate at two different speeds during percussion drilling, as well as during rotary drilling. The manually operated member may be a turnable knob having a prismatic stem serving as a cam for controlling the striking mechanism, and an eccentric pin controlling the transmission means. In another embodiment, interconnecting meshing gears connect the manually operated knob and its prismatic portion, with a rotary control means including the eccentric pin.

In both embodiments the eccentric pin projects into an annular groove in a transmission shaft whose axial shifting effects coupling of the same with two gears rotated at different speeds from a drive shaft.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a side elevation, partially in section, illustrating a first embodiment of the drilling machine according to the invention;

FIG. 2 is a fragmentary sectional view illustrating a modification of the drilling machine as shown in FIG. 1;

FIG. 3 is a vertical sectional view illustrating another embodiment of the invention;

FIG. 4 is a fragmentary plan view of the embodiment of FIG. 3, with the manually operated knob and a cover plate omitted;

FIGS. 5a-5e are diagrammatic views illustrating schematically four positions of the first control means, and four positions of the second control means, corresponding to four positions of the manually operated knob in FIG. 4;

FIG. 6 is a fragmentary vertical sectional view illustrating another embodiment of the invention; and

FIGS. 7a-7e are diagrammatic views illustrating four positions of the manually operated knob of FIG. 6, and corresponding four positions of the first and second control means.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIG. 1, the drilling machine illustrated in the same has a handle 1 which is attached by screws, not shown, to a motor housing 2, in which an electric motor, not shown in FIG. 1, but shown in FIG. 3, is provided. A main housing 3 is secured to the motor housing 2, and has a cylindrical opening 4 at the front end. A manually operated sleeve is mounted in opening 4 for turning and axial movement, and surrounds a tool holder shaft 6 whose front end projects from sleeve 5.
A partitioning wall 7 divides the main housing 3 into a transmission housing portion 8, and a striking mechanism housing portion 9.

The drive motor drives a pinion 10 located in the transmission housing portion 8 which drives through intermediate gears and an intermediate shaft, not shown, two gears 11 and 12 which have inner coupling teeth 13 by which they are slidably mounted on a cylindrical portion 14 of a transmission shaft 15. A coupling pin 14 transversely passes through the cylindrical portion 14 of transmission shaft 15, projecting at both ends thereof from the same, and either couples gear 11, or gear 12, with transmission shaft 15 by engaging the inner coupling teeth of the respective gear. In an intermediate position in which no coupling teeth are provided in adjacent regions of gears 11 and 12, the transmission shaft 15 is not driven. When transmission shaft 15 is shifted between two axial positions, it is driven at different speeds, and in an intermediate axial position, transmission shaft 15 is not driven at all from the drive pinion 10.

Transmission shaft 15 has a portion 16 which is guided in a bearing bushing 17 in a supporting sleeve 18 of motor housing 2. Shaft portion 16 has a blind bore 21 in which a ball 22 and a spring 20 are located. Spring 20 abuts a steel disc 19 in bore 21 and urges ball 22 against the bottom of the bore 25 so that transmission shaft 15 is urged to move forwardly in axial direction.

A pinion portion 23 is provided in front of the cylindrical portion 14 on transmission shaft 15, and meshes with a gear 24 secured to the tool holder shaft 6. Transmission shaft 15 has a journal portion 25 guided in a bearing bushing 26 which is mounted on a supporting portion of main housing 3. The transmission shaft 15 has an end portion 27 which is located in a bore 28 of main housing 3. Gears 11 and 12 are secured against axial movement by a steel disc abutting a sleeve portion 28' of the housing, and on the other side by a steel disc abutting the sleeve portion 18 of the housing. Consequently, axial shifting of transmission shaft 15 effects no axial displacement of gears 11 and 12.

Another tubular support portion 31 of the housing mounts a journal portion 33 of tool holder shaft 6 in a bearing bushing 32. The tool holder shaft 6 is continued by a cylindrical portion 34 of greater diameter on which gear 24 is fixed. A steel disc 35 secures gear 24 in abutment with the partitioning wall 7.

A striking mechanism by which tool holder shaft 6 is axially reciprocated during rotation, includes first displacement means 38 on a disc 38 which is fixedly secured to partitioning wall 7 of the housing. The tool holder shaft 6 passes through an opening 36' provided in partitioning wall 7 and in disc 36. Disc 36 has a circumferential collar 37 with a forwardly facing axially effective circumferential cam track cooperating with the rear end of sleeve 5 which is correspondingly shaped. The displacement means 38 include projecting and recessed portions, and corresponding projecting and recessed portions 39 are provided on the rear face of a member 40 which is screwed onto a threaded portion of tool holder spindle 6 and abuts a shoulder formed by shaft portion 41 of greater diameter. The projections and recesses of the first and second displacement means 38 and 39 cause reciprocation of the tool holder shaft 6 when the same is rotated in an operative position of the striking mechanism in which the first and second displacement means 38 and 39 engage each other due to the action of spring means 43.

A ball bearing 42 having annular grooves for the balls is mounted on cylindrical shaft portion 41 for longitudinal axial movement. The inner ring of ball bearing 42 abuts dished springs 43 and a steel disc 44 which abuts a shoulder formed by a shaft portion 45. In the other axial direction, the outer ring of ball bearing 42 abuts a shoulder 46 of manually operated sleeve 5. Due to the pressure of springs 43, the sleeve 5 is urged to the right as viewed in FIG. 1 to a position in which the rearward rim of sleeve 5 abuts the cam tracks on the front face of collar 37 of member 36 which is fixed to the housing and has displacement means 38 on its front face. A felt packing 48 is provided in the opening 47 of manually operated sleeve 5 and is in sealing contact with the outer surface of shaft portion 45.

Sleeve 5 has on part of its circumference, a collar 49 whose rearward end face has an axially effective cam track 15 engaged by the end of transmission shaft 15 due to the action of spring 20.

When the drive motor is started, it drives through pinion 10 and an intermediate shaft, not shown, gears 11 and 12 which rotate at different speeds on transmission shaft 15. In the illustrated position, gear 11 is coupled by coupling pin 14a with transmission shaft 15 which consequently rotates at the higher speed and drives through pinion portion 23, gear 24 and thereby the tool holder shaft 6.

When the machine is moved toward a workpiece so that a drill held at the end of tool holder shaft 6 is pressed against the workpiece, tool holder shaft 6 is displaced rearwardly against the action of springs 43 together with member 40 and displacement ridges and recesses 39 until the displacement means 39 cooperate with the corresponding displacement means 38 which are stationary so that the tool holder shaft 6 is forced to reciprocate in axial direction while being rotated by gears 23, 24, resulting in percussion drilling by the tool at the high speeds determined by the operative gear 11.

When sleeve 5 is now manually turned, the circumferential axially engaging cam tracks on collar 37 and on the rear end face of sleeve 5 effect an axial displacement of sleeve 5 in forward direction together with ball bearing 42 so that shaft 6 is forwardly held in a position in which the displacement means 38 and 39 are spaced when the tool is pressed against the workpiece, and spring 43 is compressed. The striking mechanism 36, 38, 39, 40 is then inoperative, and shaft 6 rotates with the drill without performing a reciprocating motion.

The other cam track 50 on collar 49 of sleeve 5 influences at the same time the position of transmission shaft 15 since it permits the spring 20 to shift transmission shaft 15 more or less toward the front, depending on the angular position of sleeve 5 and its cam track 50. When transmission shaft 15 moves far enough to the left as viewed in FIG. 1, the coupling pin 14a connects gear 12 instead of gear 11 with the transmission shaft 15 so that the speed of the transmission shaft 15, and of the tool holder shaft 6 is reduced. In one position of transmission shaft 15, gear 11, and in the other position of transmission shaft 15, gear 12 is effective to cause tool holder shaft 6 to rotate faster or slower. In the in-
termediate position of the transmission shaft in which coupling pin 14a does not engage the inner teeth of gears 11 and 12, the transmission shaft 15 and tool holder shaft 6 do not rotate and the machine idles.

The embodiment of FIG. 2 corresponds to the embodiment of FIG. 1, with the difference that the transmission shaft 15' is not urged by a spring toward the front, as is the case in the embodiment of FIG. 1. Shaft 15' is mounted in a bearing 16', and has an extended front portion projecting out of the housing front wall. The projecting free end portion of shaft 15' has an annular groove 51, engaged by an axially efecting cam plate 52 secured to a collar portion 49' of the manually operated sleeve 5'. Consequently, by turning sleeve 5', transmission shaft 15' is positively shifted in forward or rearward axial directions for engagement of the coupling pin with the inner teeth of gears 11 or 12. The operation of the modification of FIG. 2 is the same as described for FIG. 1.

The drilling machine according to the embodiment shown in FIG. 3 and FIG. 4, has a handle 101, a motor housing 102, a main housing 103, and a striking mechanism housing 104. Motor shaft 105 drives a pinion 107 mounted in a ball bearing 106 in the housing. Pinion 107 drives through intermediate shafts, not shown, gears 108 and 109 which have inner coupling teeth 110 sliding on transmission shaft 111 which is mounted at its rear end in the housing 103, and at its front end in the striking mechanism housing 104 for rotation and axial movement.

Gears 108 and 109 which have laterally abutting hubs, are laterally supported by a steel disc 112 abutting a sleeve 113 of the housing, and by a steel disc 114 abutting a sleeve portion 115 of the housing 104. Transmission shaft 111 has a transverse bore 116 in which two balls 117 are guided which are pressed apart by a spring 118 so as to engage the inner teeth 110 of the gears 108 and 109 which have slanted faces 119 in the abutting region of the gears. Depending on the axial position of transmission shaft 111, balls 117 connect one or the other of gears 108, 109, for rotation with shaft 111. The slanted starting faces 119 serve the purpose of facilitating the entering of the balls into the gaps of the inner coupling teeth, and to make possible an intermediate position of transmission shaft 11 in which the balls 117 engage and couple none of the two gears, so that the machine idles. Transmission shaft 111 has near its rear end, an annular groove 120 which is engaged by a shifting member not shown in FIG. 3. A gear ring 121 is provided at the front end of transmission shaft 111 which meshes with a gear 122 secured by threads to the tool holder shaft 127. The striking mechanism housing 124 has an opening in front into which a bearing block 124 is fixedly inserted which carries a bearing bushing 125 and a ring 126. In bearing bushing 125, the large diameter portion 128 of the tool holder shaft 127 is rotatably and axially shaftably mounted. Rearwardly adjacent thread portion 129 secures gear 122 abutting a shoulder formed by shaft portion 128. Gear 122 has on its rear face, projecting and recessed displacement means 130, cooperating with corresponding displacement means 131. In the operative position of the striking mechanism, the displacement means 130 and 131 engage each other during rotation of shaft 127 so that the same is axially reciprocated for percussion drilling, while when the displacement means 130, 131 are spaced, tool holder shaft 127 rotates without axial displacement. Displacement means 131 are provided on a disc 132 and are preferably integral with the same. Disc 132 is secured on a wall 133 of the striking mechanism housing 104 by screws, not shown.

The tool holder shaft 127 passes through an opening 134 in disc 132 and partitioning wall 133, and abuts with gear 122 through a pressure spring 135 onto a thrust needle bearing 136 and a bearing bushing 137 which is guided in a sleeve portion 138 of the housing. The rear end face of shaft 127 cooperates with a prismatic portion 139 so that shaft 127 can be shifted forward from the illustrated position to a position in which the displacement means 130, 131 do not engage each other. The prismatic member 139 has four planar faces, and is mounted eccentrically to the turning axis of a manually operated member 141, which has the form of a knob embedded in the housing wall in a corresponding recess. The upward and outward projecting portion of the prismatic actuating member 139 carries a gear 140, and above the same the knob 141. A cover plate 141' is arranged between gear 140 and the knob 141, and covers the interior of the housing. An arresting ball 142' which is mounted in a recess on knob 141, cooperates with four recesses in the cover plate 141 for arresting the knob in four angular positions.

As shown in FIG. 4, a gear 140 meshes with gear 142, which is connected for rotation with a second actuating member 143 having an eccentric pin 144 engaging the annular groove 120 in the transmission shaft 111. Since gear 140 has twice as many teeth as the gear 142, a quarter turn of the first actuating means 139, corresponds to half a revolution of the second actuating member 143. In this manner, the result is obtained by turning knob 141, percussion drilling can be carried out at two different speeds, and also rotary drilling can also be carried out at two rotary speeds.

As schematically shown in FIG. 5, the first actuating member 139 has two positions 1 and 2 in which the first and second displacement means 130, 131 engage each other, and two positions 3 and 4 in which the displacement means are separated.

When the actuating member 139 is in one of the two positions in which the displacement means cooperate for obtaining percussion drilling, the second actuating member 143, 144 assumes two positions in which the eccentric pin 144 is in two diametrically opposite positions for shifting transmission shaft 111 between the two positions of the same corresponding to two different gear stages. In the positions 3 and 4 of FIG. 5 in which the first actuating member 139 holds the displacement means 130, 131 spaced, also two different speeds are obtained by pin 144 displacing transmission shaft 111.

The manually operated knob 141 operates simultaneously the actuating means 139 and 144, which are interconnected by the gears 140, 142, at a ratio of 2 : 1. The embodiment illustrated in FIG. 6 has the same parts as the embodiment described with reference to FIG. 3, but instead of two actuating means 139 and 144 interconnected by gears 140, 142, only a single control means 201 is provided which, in addition to the knob 141' includes the prismatic first actuating member 203.
and a fixed actuating member 143' carrying the pin 206 in a position eccentric to the axis of knob 146' and portion 143'. Pin 206 again engages the annular groove 120' of shaft 111, as described with reference to the embodiments of FIGS. 3 and 4.

As schematically shown in FIG. 7, the first actuating portion 203 has four planar faces 202 to 205 which serve for rendering the striking mechanism operative and inoperative, while the pin 206, turning with the same, shifts the transmission shaft 111' between its two positions in which it rotates at different speeds. Since in the embodiment of FIGS. 6 and 7 it is impossible to rotate pin 206 at twice the rotary speed of the prismatic member 203, the foremost and rearmost positions of pin 206 are not used as shifting positions, but, as best seen in FIG. 7, positions displaced 45° in relation to the front and rear end positions. Consequently, also in the embodiment of FIGS. 6 and 7, during the percussion drilling as well as during the rotary drilling, the tool holder shaft can be driven from the transmission shaft at a high speed and at a low speed. Four possible positions are shown in FIG. 7, in the position A percussion drilling is carried out at a low speed, in position B percussion drilling is carried at a high speed, in position C rotary drilling is carried out at a high speed, and in position D, rotary drilling is carried out at a low speed.

It is evident that the setting of the striking mechanism between operative and inoperative positions, and the shifting of the transmission between high speed and low speed stages, by means of a single common manually operated member, such as a sleeve or knob, can also be carried out if the transmission has two differently constructed stages, and the striking mechanism is provided with different displacement means than illustrated in the above disclosed embodiment.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of variable speed percussion drilling machines, differing from the types described above.

While the invention has been illustrated and described as embodied in a drilling machine which can be operated at high speed and low speed not only during percussion operations, but also during rotary drilling operations, while being set to any of these conditions by turning of a single manually operated means between four positions, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims.

We claim:

1. Variable speed percussion drilling machine comprising, in combination, drive shaft means; tool holder shaft means; transmission means connecting said drive shaft means with said tool holder shaft means, and having at least two stages for rotating said tool holder shaft means at different speeds; a striking mechanism having an operative position for reciprocating said tool holder shaft means in axial direction between two positions during rotation of the same, and an inoperative position in which said tool holder shaft means only rotates, said striking mechanism being urged into said operative position when said tool holder shaft means is pressed against a workpiece; first control means connected with said transmission means for shifting the same between said two stages; second control means connected with said striking mechanism for holding the same in said inoperative position when said tool holder shaft means is pressed against a workpiece; and common manually operated means connected with said first and second control means for simultaneously operating the same so that said tool holder shaft means rotates at different speeds while performing percussion drilling and rotary drilling operations.

2. Drilling machine as claimed in claim 1 wherein said manually operated means include a manually operated member and means interconnecting said first and second control means at the ratio 2:1 so that said first control means cycledly shift said transmission means twice between said two stages and said second control means shift said striking mechanism only once between said inoperative and operative positions during the same actuating movement of said manually operated member whereby said tool holder shaft means can be operated at two different speeds during a percussion drilling operation and also during a rotary drilling operation.

3. Drilling machine as claimed in claim 2 wherein said first and second control means include first and second rotary control members, respectively, for shifting said transmission means and for shifting said striking mechanism, respectively; and wherein said interconnecting means include meshing gear means selected so that said first rotary control member makes a half revolution when said second rotary control member makes a quarter revolution.

4. Drilling machine as claimed in claim 2 wherein said second control means include a prismatic second control member secured to said manually operated member eccentric to the axis of rotation of the same, and having a cross section bounded by a plurality of faces operatively connected with said striking mechanism for moving the same once between said inoperative and operative positions during each revolution of said manually operated member; wherein said interconnecting means include an interconnecting member rotatable about an axis; and wherein said first control means include a first control member eccentric to said axis of said interconnecting member and operatively connected with said transmission means for shifting the same twice between said two stages during each revolution of said manually operated member.

5. Drilling machine as claimed in claim 4 wherein said striking mechanism includes first displacement means secured to said tool holder shaft means and second stationary displacement means; wherein said tool holder shaft means is axially displaceable between a first position in which said first and second displace-
ment means engage each other in said operative position of said striking mechanism, and a second position in which said first and second displacement means are spaced and said striking mechanism is in said inoperative position; wherein said tool holder shaft means is biased to said first position and cooperates with said second control member to be shifted to, and held in said second position.

6. Drilling machine as claimed in claim 5 wherein said transmission means include a transmission shaft connected with said tool holder shaft for rotation, and being shiftable in axial direction between a first position and a second position, two different gears mounted on said transmission shaft and driven from said drive shaft, and coupling means on said transmission shaft for coupling the same with said two gears, respectively, in said first and second positions thereof so that said transmission shaft rotates at different speeds and wherein said transmission shaft has an annular groove engaged by said first control member so that said transmission shaft is shifted by the same between said first and second positions thereof.

7. Drilling machine as claimed in claim 4 wherein said interconnecting member is integral with said first and second control members and has a common axis with said manually operated member; wherein said first control member is a pin on said interconnecting member eccentric to said axis; and wherein said manually operated member, said second control member, said interconnecting member, and said pin turn together about said common axis.

8. Drilling machine as claimed in claim 4 wherein said interconnecting means include at least two meshing interconnecting gears; wherein one of said gears is secured to said manually operated member, and the other gear carries said first control member.

9. Drilling machine as claimed in claim 1 comprising a housing; wherein said tool holder shaft means is mounted in said housing for rotation, and for axial movement; wherein said striking mechanism includes first and second displacement means mounted on said shaft means and on said housing, respectively; wherein said manually operated means include a sleeve mounted on said housing for turning and axial movements; a spring connecting said sleeve with said tool holder shaft means; wherein said second control means include cam means connecting said sleeve with said housing so that when said sleeve is turned to a first position, said sleeve and tool holder shaft means are displaced to a first position in which said first and second displacement means are spaced but can be moved against the action of said spring to an engaging position in which said shaft is reciprocated, while when said sleeve is turned to a second position, said tool holder shaft is moved to a second position in which said first and second displacement means cannot engage each other so that said shaft rotates without reciprocating; wherein said transmission means includes a shifting member for shifting said transmission means between two stages; and wherein said first control means include other cam means connecting said sleeve with said shifting member for shifting said transmission during axial shifting of said tool holder shaft between positions for percussion drilling and rotary drilling at different speeds.

10. Drilling machine as claimed in claim 9 wherein said shifting member of said transmission means is a transmission shaft mounted in said housing for axial movement; wherein said transmission means includes spring means urging said transmission shaft axially in one direction; wherein said sleeve has a collar having said other cam means and being engaged by said transmission shaft under the action of said spring so that turning of said sleeve causes axial displacement of said transmission shaft; wherein said transmission means comprises a coupling means fixed to said transmission shaft, and two gears driven from said drive shaft means and being respectively coupled by said coupling means with said transmission shaft in axially displaced positions of said transmission shaft; and gear means connecting said transmission shaft with said tool holder shaft means.

11. Drilling machine as claimed in claim 9 wherein said shifting member is a transmission shaft mounted in said housing for axial movement; wherein said sleeve has a collar including an axially curved cam plate; wherein said transmission shaft has an annular groove engaged by said cam plate so that turning of said sleeve causes axial displacement of said transmission shaft; wherein said transmission means comprises a coupling means fixed to said transmission shaft, and two gears driven from said drive shaft means and being respectively coupled by said coupling means with said transmission shaft in axially displaced positions of said transmission shaft; and gear means connecting said transmission shaft with said tool holder shaft means.

12. Drilling machine as claimed in claim 1 comprising a housing; wherein said manually operated means include a sleeve rotatable and axially movable on said housing; wherein said first control means include circumferential axially effective first actuating cam means on said sleeve for shifting said transmission means between said two stages; and wherein said second control means include circumferential axially effective second actuating cam means on said sleeve for moving said striking mechanism between said inoperative and operative positions.

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