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Gullich

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[54] **HAMMER DRILLING MACHINE**

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[51] **Int. Cl.** **E21c 1/12**

[58] **Field of Search** 173/13, 48

[56] **References Cited**

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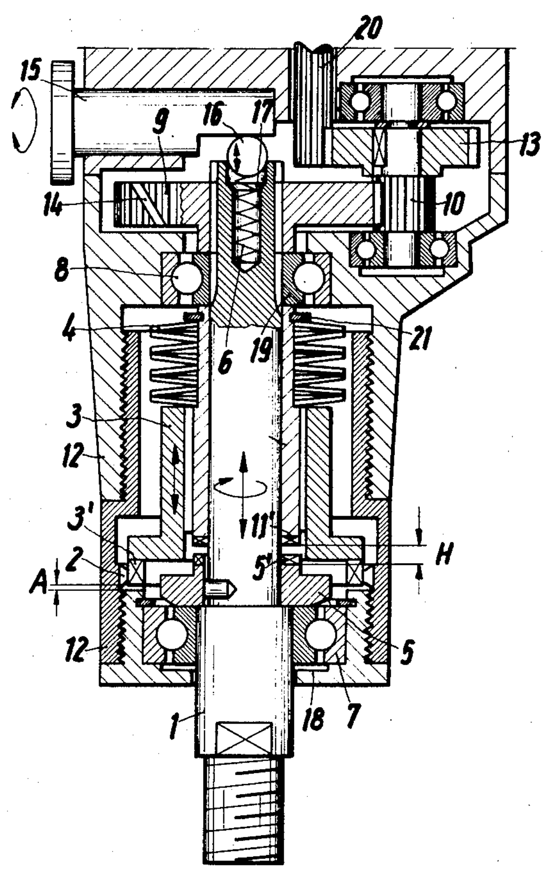
[57] **ABSTRACT**

A hammer drilling machine selectively switchable between pure drilling and hammer drilling modes operates with reduced frictional heat due to the construction of the percussion mechanism. During hammer drilling there is no relative rotation between the plunger and the drilling spindle. The percussion mechanism includes two co-operable cam members, both of which are stationary when the machine is idling, and one of which is connected to the plunger and is set into rotation with the machine in the hammer drilling mode by axial displacement of the drilling spindle.

10 Claims, 2 Drawing Figures



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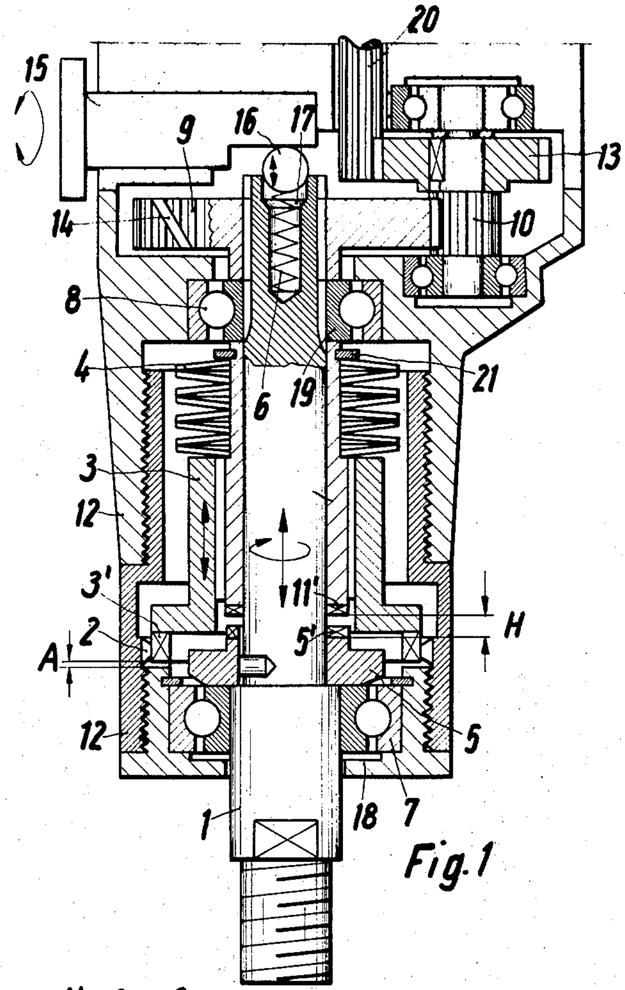
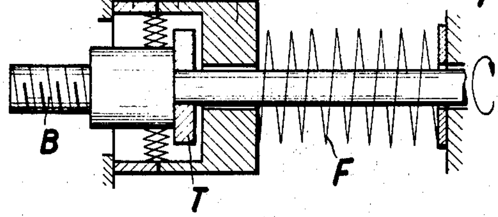


Fig.1

Fig.2



HAMMER DRILLING MACHINE

BACKGROUND TO THE INVENTION

This invention relates to a hammer drilling machine comprising gearing which can be switched between drilling and hammer drilling modes of operation, a drilling spindle which is mounted for limited axial displacement, and a percussion mechanism arranged symmetrically about the drilling spindle, the percussion mechanism comprising a plunger which is subject to the action of spring means and is axially displaceable relative to the drilling spindle, and two co-operable cam members, one of which is connected to the plunger.

DESCRIPTION OF THE PRIOR ART

In the building and construction industries, for working on rock or stone, there are used both heavy jack hammers and drill hammers, generally operated by compressed air, and also lighter and smaller hammer drilling machines. These latter are designed for electrical operation and are equipped with comparatively weak mechanical percussion mechanisms, which, as also with percussion drilling machines, do not begin automatically to hammer in the idling state, i.e., when the machine is not set against the stone, but only after drilling begins when pressure is exerted on the machine in the direction of drilling. The percussion mechanism of these hammer drilling machines operates substantially without recoil until the feed or the pressure of the machine against the stone in the direction of drilling ends.

In one known machine of this kind, a plunger is axially oscillatable directly on an axially movable drilling spindle under the effect of the force of a spring, in such a way that a cam ring or toothed disc rigidly screwed to the plunger co-operates with a cam ring or toothed disc of the drilling spindle. The latter is displaced on setting the machine against the stone or on feeding axially in the direction of the interior of the gear housing, so that coupling teeth on the plunger are brought into engagement with coupling teeth fixedly arranged in the housing and the plunger is secured against rotation. The toothed discs and springs thereby allow the plunger to hammer upon the drilling spindle with a predetermined rhythm. When the machine is idling, the spring acts so that the toothed discs perform no rotation relative to one another and the plunger is then rotated together with the drilling spindle. This co-rotation of the plunger and the toothed discs coupling it to the drilling spindle also takes place during pure drilling with the drill, in which mode the axial movement of the drilling spindle is blocked. The primary disadvantage of this known machine is that in the hammer drilling mode which loads the machine to the greatest degree, additional frictional heat is produced by the drilling spindle rotating in the plunger and behaving as a guide for it at the same time.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a hammer drilling machine of the kind first mentioned above in which the frictional heat losses are limited to a minimum and in which also the electric power input requirements can be kept small.

In accordance with the invention there is provided a hammer drilling machine comprising gearing which can be switched selectively between drilling and hammer drilling modes of operation, a drilling spindle which is mounted for limited axial displacement, and a percussion mechanism arranged symmetrically about the drilling spindle, said percussion mechanism comprising a plunger which is subject to the action of spring means and is axially displaceable relative to the drilling spindle, and two co-operable cam members, one of which is connected to the plunger, wherein both cam members remain stationary when the machine is idling and wherein said cam member connected to the plunger is arranged to be set into rotation with the machine in the hammer drilling mode by axial displacement of the drilling spindle. For the invention, it is important that both cam members remain still on idling and that when operating in the hammer drilling mode only the cam member connected to the plunger is rotated upon setting the machine against the stone or on advancing the machine. Thus, during hammer drilling, there is no relative rotation between the plunger and the drilling spindle and thus no corresponding frictional losses. The power capacity of the driving motor can also be reduced, since when idling, when operating in the hammer drilling mode, and during pure rotational drilling, the plunger does not need to be enclosed or to be correspondingly accelerated.

In a preferred embodiment of the invention, said cam member connected to the plunger is coupled to the drilling spindle with the machine in the hammer drilling mode through the plunger. The other cam member co-operating with this cam member can therefore be fixedly arranged so that the construction of the percussion gearing is very simple.

Preferably, the plunger is arranged to be axially displaceable but non-rotatable on a coupling sleeve which is mounted for rotation and limited axial movement on the drilling spindle, said sleeve having at its one end coupling means for engagement with coupling means on the drilling spindle and supporting at its other end said spring means which is arranged to be stressed by axial movement of the plunger.

The coupling sleeve thus carries the oscillatable plunger, so that the sliding friction originating from the oscillatory movement is transferred to the coupling sleeve and does not have an effect on the upper surface of the drilling spindle, as is the case with the known hammer drilling machines. Sliding friction forces between the drilling spindle and the coupling sleeve only occur when the latter is stationary during idling in the hammer drilling mode or during pure drilling operations. The plunger spring means effecting the hammering movements of the plunger in conjunction with the cam members is supported by the coupling sleeve in such a way that, in addition to the sliding friction originating from the oscillation of the plunger, no further sliding friction arises due to the spring means, but on the contrary the sliding friction in the hammer drilling mode rather remains limited to the sliding surfaces guiding the plunger and the bearings supporting the drilling spindle, apart from the sliding friction of the cam members.

The drilling spindle preferably includes a striker plate which carries the drilling spindle coupling means and transfers the hammer blows of the plunger to the spindle. This means that with heavy loadings the striker plate may be changed without renewal of the drilling spindle also being necessary at the same time.

The other said cam member is preferably carried by a lock nut connected into a housing for the precussion mechanism. The cam member and lock nut may be formed as one part, and the additional expense of fitting a separate cam member is then not necessary.

The drilling spindle is preferably mounted in two roller bearings, the inner race ring of the motor-side roller bearing supporting the rotatable coupling sleeve of the drilling spindle in the hammer drilling mode against the force of the plunger sping means. In this way the axial forces arising when operating in the hammer drilling mode can be transferred in a simple way through the coupling sleeve to the inner race ring of this roller bearing. The percussion gearing is fitted as a built-up unit into the gear housing and is preferably screwed into the housing.

According to a further preferred feature of the invention, the end of the drilling spindle to which the rotary driving force is imparted carries an axially displaceable driving gear wheel which preferably has an inclined tooth periphery urging it in the feed direction. In this way, not only is the hammer action of the machine increased and the input power requirement of the machine reduced for a given hammer effect, since the plunger does not need to be accelerated for every strike against the drilling spindle, but also the overall length of the machine is reduced, since it needs a shorter drilling spindle stroke, because the gear wheel remains arranged in the feed direction as far as possible with all strokes of the spindle.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the invention may be more fully understood a preferred embodiment of hammer drilling machine in accordance therewith will now be described by way of example and with reference to the accompanying drawing, in which:

FIG. 1 is a longitudinal sectional view through the whole gear system of the hammer drilling machine;

FIG. 2 is a schematic sketch illustrating the principle of the percussion gearing.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in FIG. 2 the percussion mechanism of the hammer drilling machine consists essentially of components grouped symmetrically about a drilling spindle B. These components comprise a first cam ring N, an opposing cam ring G rigidly connected to a plunger S, and a spring F which throws the plunger S against a stroker plate T by the action of the spreading of the two cam rings on rotation of the one relative to the other, e.g. by relative rotation of two sets of ratchet teeth sliding on one another, stressing the spring, whereafter the closing of the cam rings upon further relative rotation causes the spring to be unloaded and the plunger to be thrown forward.

The drilling spindle 1 in FIG. 1 is so mounted, as indicated by the arrows of movement, that it is both rotatable as well as displaceable to a limited degree in an axial direction. It is supported by two roller bearings 7, 8, the first of which is arranged in an end lock nut 18 of the gear housing 12 and the second of which is arranged in a gear housing flange separating the percussion gearing from the rotary gearing. The axial movement of the drilling spindle 1 can be blocked by means of a control pin 15 which is rotatably mounted in the machine housing in such a way that a ball 16 positioned at the end of the drilling spindle can be pressed by the pin against the drilling spindle counter to the force of a spring 6 seated in the spindle. The rotation of the drilling spindle is effected through a motor drive shaft 20 which drives a gear wheel 13 and thence a rotatably mounted counter shaft 10, the latter driving a toothed gear wheel 9 which is axially displaceable on the drilling spindle. The inclined teeth 14 of the gear wheel 9 ensure that on turning the drilling spindle in a clockwise direction the gear wheel runs constantly in the feed direction against the inner roller bearing 8.

The drilling spindle 1 carries a striker plate 5 adjacent to the outer roller bearing 7. This striker plate is rigidly connected to the drilling spindle and is provided with coupling teeth 5' on its axially inner face. Between the striker plate 5 and the inner race ring 19 of the axially inner roller bearing 8, a coupling sleeve 11 is rotatably arranged on the drilling spindle and co-axial therewith, the sleeve 11 having coupling teeth 11' at its outer end adjacent to the coupling teeth 5'. This coupling sleeve 11 supports in a non-rotatable but axially displaceable manner a plunger 3 and a plunger spring 4. The latter presses at one end against a circlip or snap ring 21 of the coupling sleeve 11 adjacent to the inner roller bearing 8, and at the other end against the plunger 3, which at its end remote from the spring 4 has a counter-pressur cam ring 3' non-rotatably connected to it. This counter-pressure cam ring 3' engages with axial play A with a further cam ring 2 which is supported by the lock nut 18. The cam rings are preferably formed integrally with the components which support them or are machined directly from them. The construction then works well with just two roller bearings in spite of the movable parts of the percussion gearing.

During standstill, idling and pure drilling, the axial play A is always guaranteed, in order to avoid unnecessary friction, by virtue of the fact that the spring 4 is supported at its two ends directly or indirectly via the seating ring 21 for absorbing the forces on the coupling sleeve 11.

In hammer drilling operations, the drilling spindle 1 is displaced axially into the inside of the gear housing 12 counter to the force of the spring 6 as a result of setting the drilling tool against the stone to be drilled, so that the drilling spindle teeth 5' come into engagement with the teeth 11' on the coupling sleeve 11 and drive them. As a result the plunger 3 is also set into rotation and the cam ring 3' which is rigidly connected to it turns relative to the fixed cam ring 2. By virtue of the relative rotation of the two cam rings, the plunger 3 is axially displaced counter to the force of the spring 4 and thereafter is thrown against the striker plate 5 of the drilling spindle, as the crests of the cam ring disc 3' first displace the plunger axially as far as possible and then fall into the valleys between the crests of the cam ring disc 2. Each time the cams move into the engaged position, the plunger 3 transfers the energy given to it by the spring 4 to the striker plate 5, and thus to the drilling spindle 1 which passes this energy to the drilling tool.

For a compact construction of the percussion gearing and for low power input requirements, it is of significance that the driving gear wheel 9 is axially displaceably mounted on the motor-side end of the drilling spindle. Since as a result the mass of the gear wheel does not need to be accelerated as well as the mass of the drilling spindle by the plunger, the plunger can be kept smaller while achieving the same impact force on a drilling tol. Besides this, the whole machine can be made shorter in respect of the drilling spindle stroke H, since the driving gear wheel **9** runs constantly in the feed direction of the machine against the inner race ring of the roller bearing **8**. A short-period running of the gear wheel **9** on the gear wheel **13** when set for hammer drilling, that is with the drilling tool set against the stone to be drilled, does not cause trouble and is immediately eliminated by the inclined tooth arrangement **14**.

If one wishes the machine to drill without the percussion gearing being able to take effect, the control pin **15** is turned when the machine is switched off or when it is idling so that the spindle ball **16** is pressed against the small pressure of the spring **6** into the drilling spindle at the end adjacent to the roller bearing **8**, so that, on drilling, the spindle is supported by the control pin **15**. The coupling teeth **5'** and **11'** then remain out of engagement, so that the percussion mechanism does not operate.

I claim:

1. A hammer drilling machine comprising gearing which can be switched selectively between drilling and hammer drilling modes of operation, a drilling spindle which is mounted for limited axial displacement, and a percussion mechanism arranged symmetrically about the drilling spindle, said percussion mechanism comprising a plunger which is subject to the action of spring means and is axially displaceable relative to the drilling spindle, and two co-operable cam members, one of which is connected to the plunger, wherein both cam members remain stationary when the machine is idling and wherein said cam member connected to the plunger is arranged to be set into rotation with the machine in the hammer drilling mode by axial displacement of the drilling spindle.

2. A hammer drilling machine according to claim **1**, in which the other of the cam members is permanently fixed in position and is machined into a lock nut connected into a housing for the percussion mechanism.

3. A hammer drilling machine according to claim **1**, in which said cam member connected to the plunger is coupled to the drilling spindle with the machine in the hammer drilling mode through the plunger.

4. A hammer drilling machine according to claim **3**, in which said one cam member is machined directly from the plunger.

5. A hammer drilling machine according to claim **3**, in which the plunger is arranged to be axially displaceable but non-rotatable on a coupling sleeve which is mounted for rotation and limited axial movement on the drilling spindle, said sleeve having at its one end coupling means for engagement with coupling means on the drilling spindle and supporting at its other end said spring means which is arranged to be stressed by axial movement of the plunger.

6. A hammer drilling machine according to claim **5**, in which the coupling sleeve is provided at its said other end with an annular supporting member for said spring means.

7. A hammer drilling machine according to claim **5**, in which the coupling sleeve is supported with the machine in the hammer drilling mode by an inner ring of a driving-end drilling spindle roller bearing against the force of said spring means.

8. A hammer drilling machine according to claim **5**, in which a striker plate transmitting the hammer blows of the plunger to the drilling spindle carries said coupling means on the drilling spindle which is engageable with said coupling means on the sleeve.

9. A hammer drilling machine according to claim **1**, in which the end of the drilling spindle to which the rotary driving force is imparted carries an axially displaceable driving gear wheel.

10. A hammer drilling machine according to claim **9**, in which the driving gear wheel has an inclined tooth periphery urging it in the feed direction.

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