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(54) **IMPACT MECHANISM FOR A HAMMER DRILL**

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B25D 11/10 (2006.01)

(52) **U.S. Cl.** **173/101**; 173/117; 173/205; 173/217

(58) **Field of Classification Search** 173/48, 173/101, 103, 105, 117, 203, 205, 217, 93.7, 173/109
See application file for complete search history.

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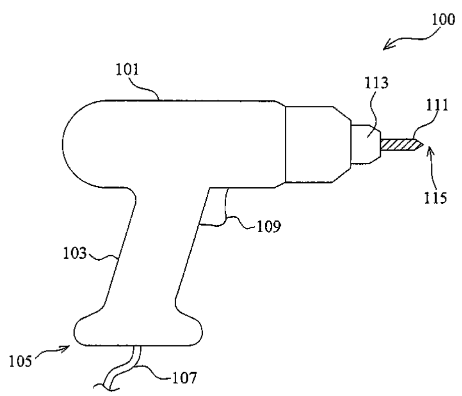
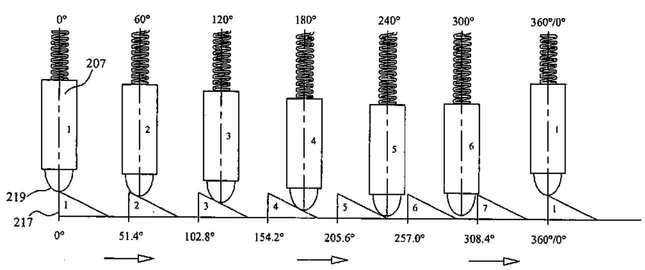
(57) **ABSTRACT**

An impact mechanism for a hammer drill, which has a housing and a drill bit protruding outside the housing, is provided. The mechanism includes firstly an impact platform within the housing; the impact platform is in connection with the drill bit for receiving impact forces and for transferring the impact forces to the drill bit. The mechanism also has a plurality of cams within the housing, and the plurality of cams are angularly spaced apart and arranged about an axis of rotation. The mechanism further includes a plurality of hammers placed within the housing and interactable with both the impact platform and the plurality of cams. The plurality of hammers are angularly spaced apart and arranged about the axis of rotation, and each hammer is capable of reciprocating along the axis for exerting the impact forces on the impact platform. Each of the plurality of cam is driven to interact with each of the plurality of hammers alternatively such that the plurality of hammers are driven to reciprocate along the axis so as to generate the impact forces.

8 Claims, 4 Drawing Sheets





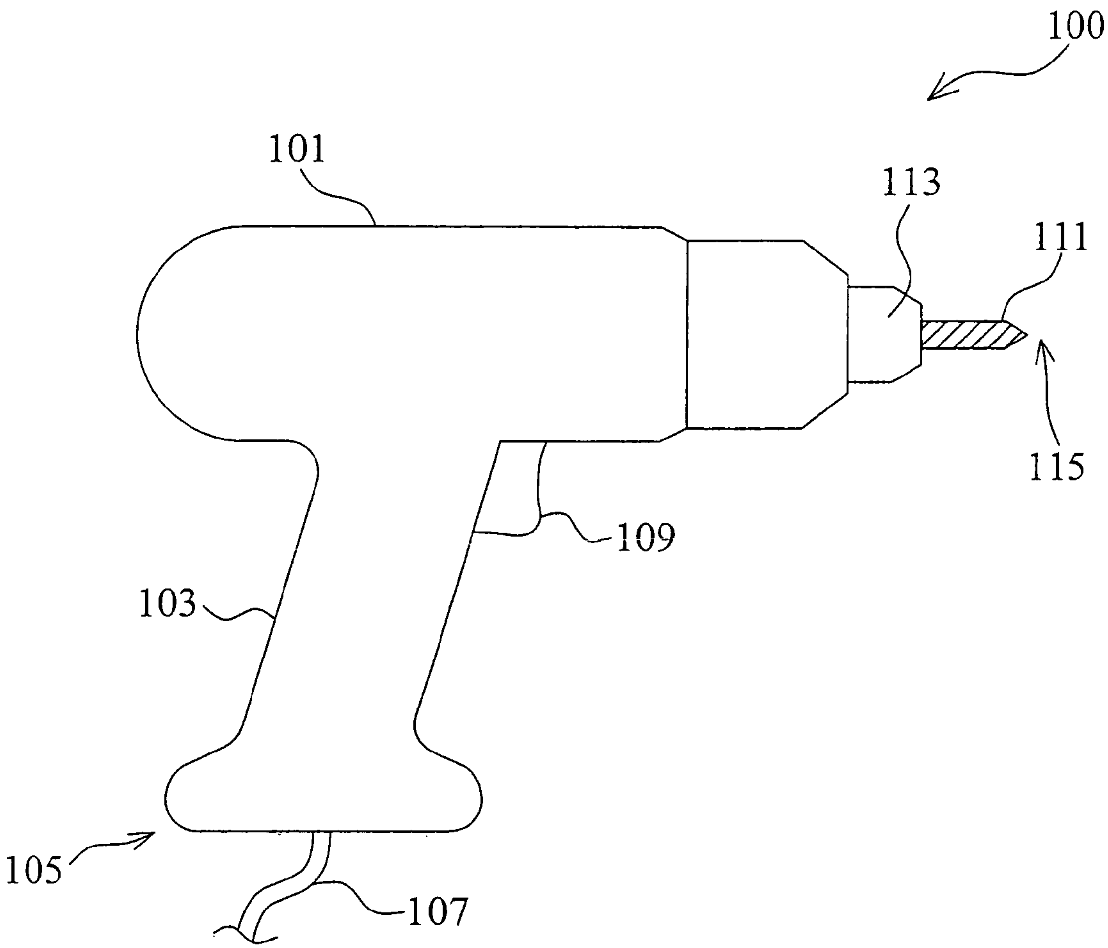
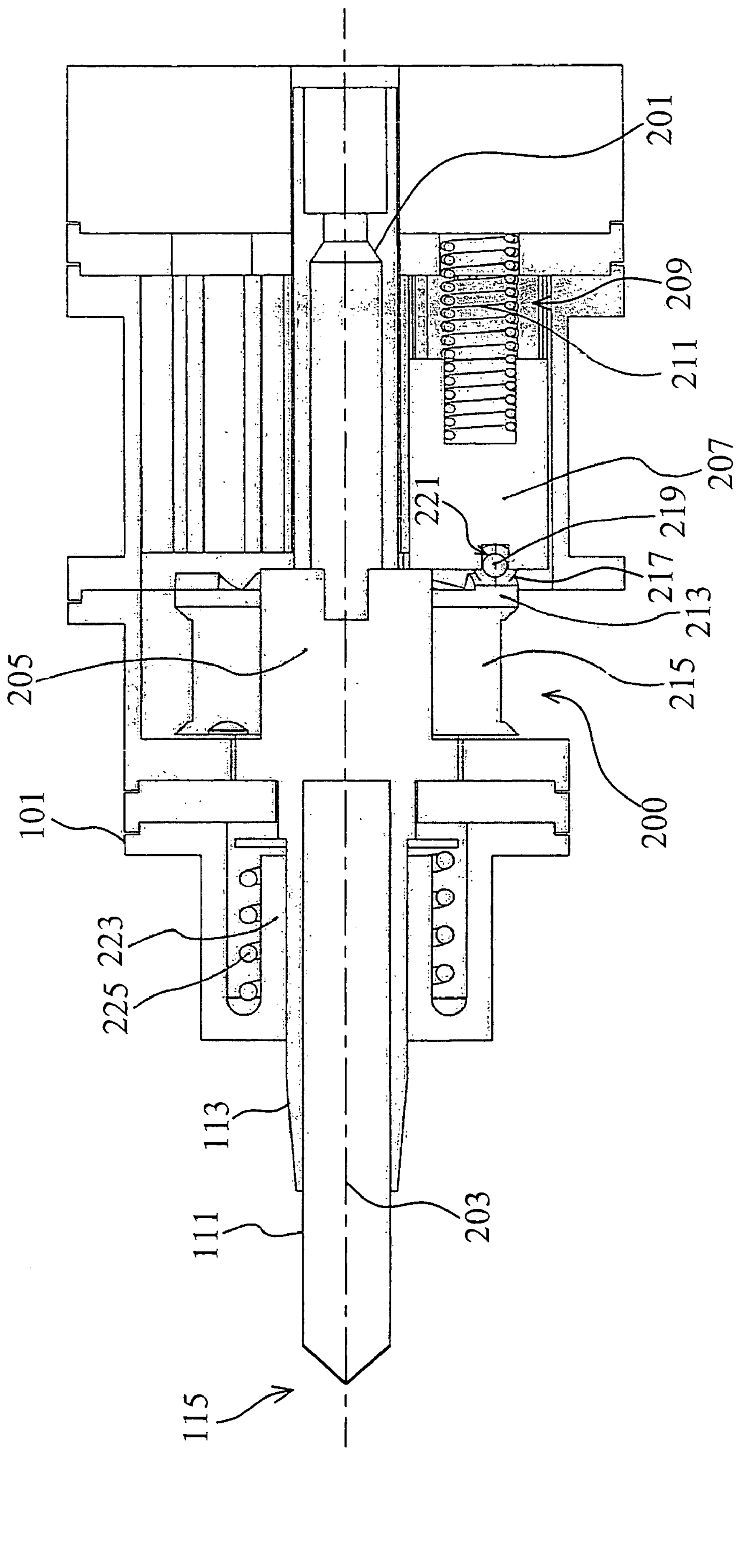


Figure 1


201
209
211
207
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219
217
213
215
205
200
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113
111
203
115

Figure 2

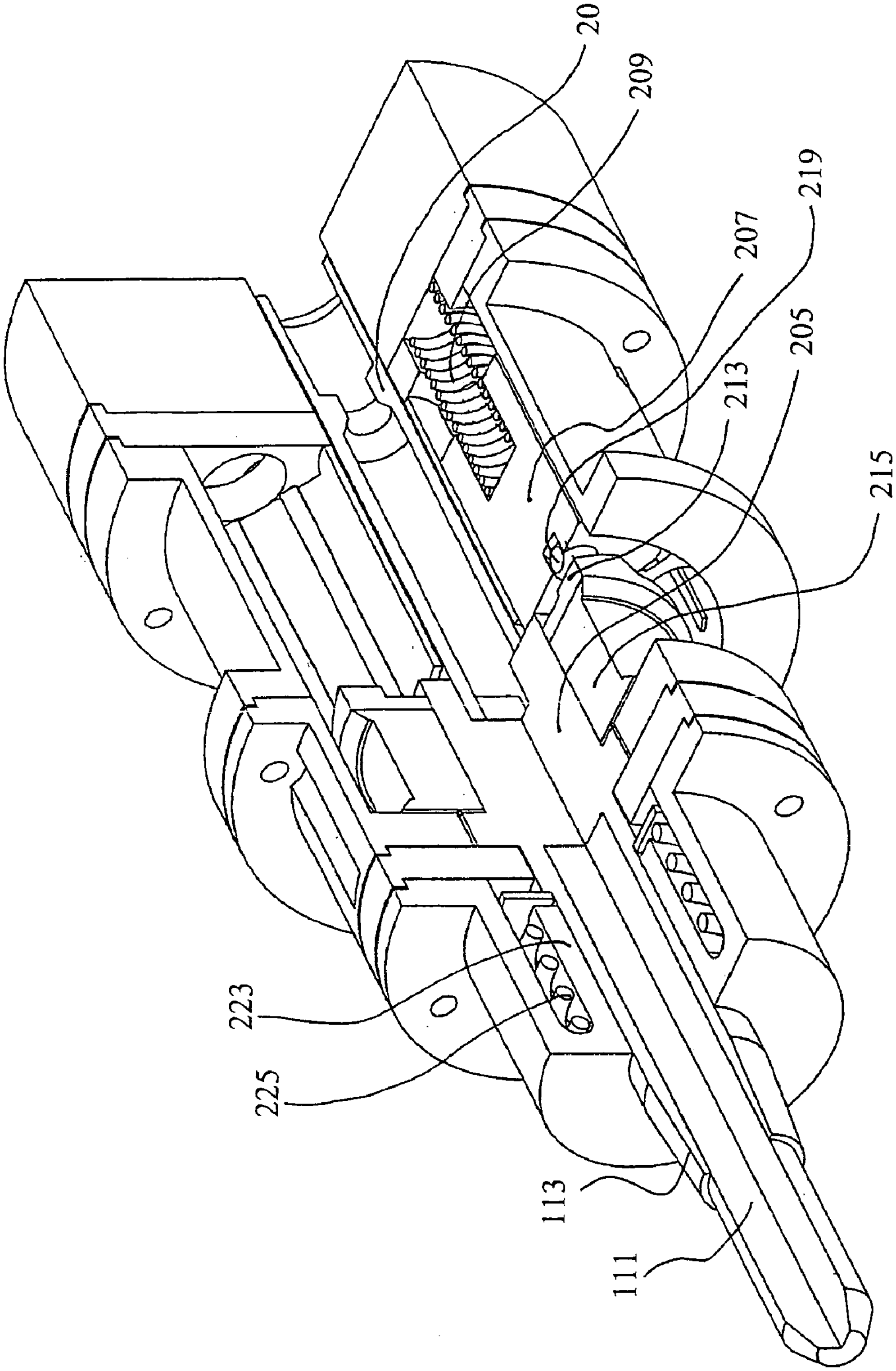

Figure 3

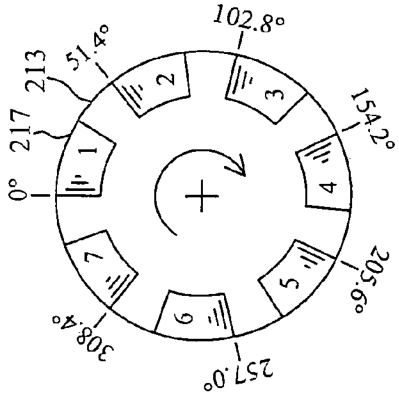

Figure 4

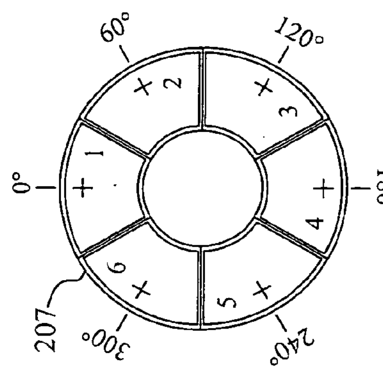

Figure 5

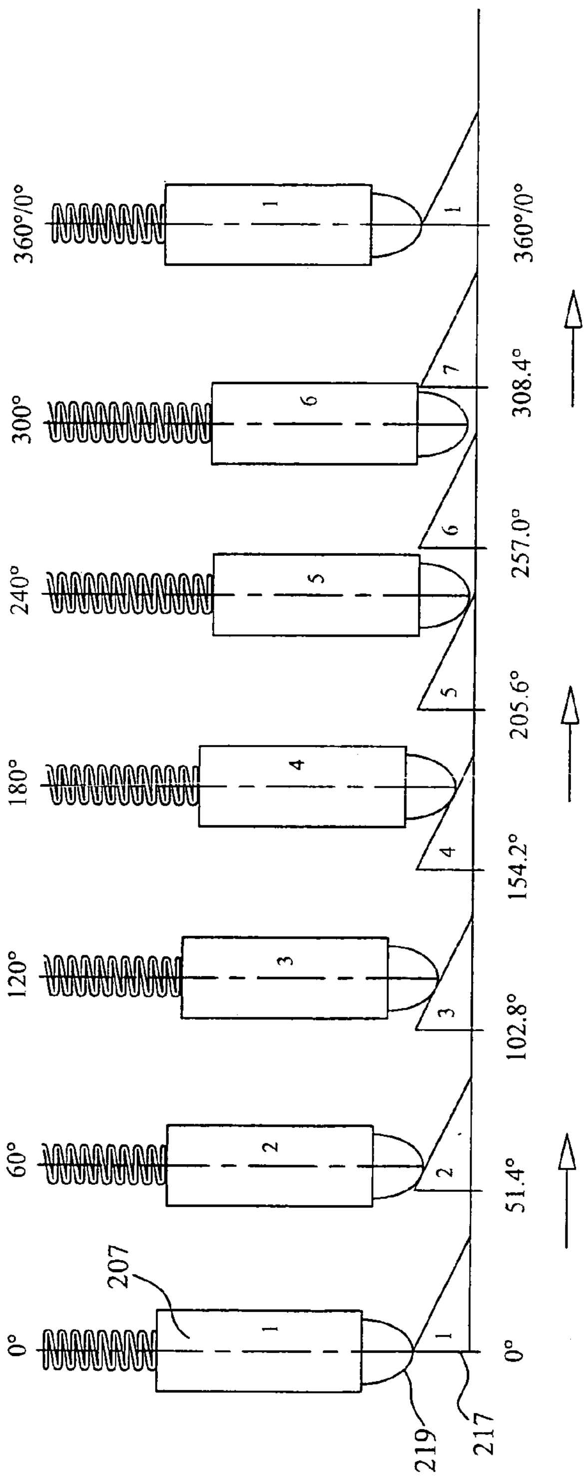

Figure 6

IMPACT MECHANISM FOR A HAMMER DRILL

BACKGROUND

1. Field of the Invention

The present invention relates to hammer drills, and more particularly, to an impact mechanism for a hammer drill.

2. Background of the Invention

When drilling through hard surfaces such as rocks or stone, many times it is desirable to impart a reciprocating motion to the drill bit to facilitate drilling. This hammering motion of the drill bit helps break up the material while the rotating of the drill bit allows the broken up material to be removed from the hole being drilled.

A primary disadvantage associated with existing impact mechanisms for hammer drills is the fact that in order to accomplish a desired high blows per minute (BPM) for efficient hammer drill performance, an undesirable high output speed is required. High BPM can also be achieved by increasing the number of ramps on the impact mechanism. However, an increased number of impact ramps tend to produce a "skipping" effect and efficiency loss due to the smaller area of surface contact for each ramp.

OBJECT OF THE INVENTION

It is, therefore, an object of the present invention to provide an improved impact mechanism for a hammer drill that accomplishes desired high blows per minute (BPM) without requiring an undesirable high output speed, or at least provide the public with a useful choice.

SUMMARY OF THE INVENTION

According to an aspect of the present invention, an impact mechanism for a hammer drill, which has a housing and a drill bit protruding outside the housing, includes firstly an impact platform within the housing. The impact platform is in connection with the drill bit for receiving impact forces and for transferring the impact forces to the drill bit. The mechanism also has a plurality of cams within the housing, and the plurality of cams are angularly spaced apart and arranged about an axis of rotation. The mechanism further includes a plurality of hammers placed within the housing and interactable with both the impact platform and the plurality of cams. The plurality of hammers are angularly spaced apart and arranged about the axis of rotation, and each hammer is capable of reciprocating along the axis for exerting the impact forces on the impact platform. Each of the plurality of cam is driven to interact with each of the plurality of hammers alternatively such that the plurality of hammers are driven to reciprocate along the axis so as to generate the impact forces.

According to another aspect of the present invention, a hammer drill includes

- a housing;
- a drill bit protruding outside the housing; and
- an impact mechanism, including
  - an impact platform within the housing, the impact platform being in connection with the drill bit for receiving impact forces and for transferring the impact forces to the drill bit;
  - a plurality of cams within the housing, the plurality of cams being angularly spaced apart and arranged about an axis of rotation; and
  - a plurality of hammers placed within the housing and interactable with both the impact platform and the plurality of cams, the plurality of hammers being angularly spaced apart and arranged about the axis of rotation, each hammer being capable of reciprocating along the axis for exerting the impact forces on the impact platform,
  - wherein each of the plurality of cam is driven to interact with each of the plurality of hammers alternatively such that the plurality of hammers are driven to reciprocate along the axis so as to generate the impact forces.

Other aspects and advantages of the invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings, which description illustrates by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side elevation view of a hammer drill in which an exemplary embodiment of the present invention can be used;

FIG. **2** is a cross section view of an impact mechanism in accordance with an exemplary embodiment of the present invention, which can be used in the drill of FIG. **1**;

FIG. **3** is an exposed perspective view of the impact mechanism of FIG. **1**;

FIG. **4** is a top plan view of a cam disc, which is a part of the impact mechanism of FIG. **2**;

FIG. **5** is a bottom plan view of a plurality of hammers, which are part of the impact mechanism of FIG. **2**; and

FIG. **6** is a set of side elevation views illustrating various rise and fall cycles of the hammers of FIG. **5**.

DETAILED DESCRIPTION

As shown in FIG. **1**, an exemplary hammer drill **100** includes a housing **101** having a pistol grip handle **103**. The lower end **105** of housing **101** receives an electrical cord **107**. The electrical cord **107** is adapted to be connected to a suitable power source (not shown) that powers a motor (not shown) within the housing **101**. In the case of a battery-powered hammer drill, the electrical cord **107** will be internal and connected to a battery instead. The cord **107** is in circuit with a trigger switch **109** on the handle **103** of housing **101**. Of course, the present invention is equally useful with a battery powered cordless hammer drill. The trigger switch **109** selectively supplies power to the motor. A suitable speed control device (not shown) for controlling motor speed can also be included in a circuit connected to trigger switch **109**, if so desired. A drill bit **111**, protruding outside the housing **101** and held by a drill chuck **113**, can be driven to rotate for drilling through a workpiece (not shown). Furthermore, in the exemplary embodiment, a front end **115** is defined as the end of drill bit **111**, and a front direction is defined as a direction towards the front end.

In FIGS. **2** and **3**, an exemplary impact mechanism embodiment **200** of the present invention is placed inside the housing **101** and firstly has a rotational shaft **201** in connection with the motor (not shown) at one end either directly or through a gear train (not shown) as generally understood. At the other end, the shaft **201** is connected to the drill bit **111**, and thereby the drill bit **111** can be driven to rotate about an axis **203** for the drilling purpose.

An impact platform **205**, mounted co-axially with the rotational shaft **201** in the exemplary embodiment, is placed inside the housing **101** and behind the drill bit **111**. The impact platform **205** receives impact forces and further transmits such forces to the drill bit **111** for drilling purposes.

A plurality of angularly spaced apart hammers **207** is placed inside the housing **101** and behind the impact platform **205** for striking on the platform **205** alternatively to exert an impact force thereon individually. The hammers **207** are arranged to circle the axis **203**, and each hammer **207** may reciprocate parallel to the axis **203** within a longitudinal chamber **209**. Furthermore, a plurality of compression springs **211** are provided inside the chambers **209**, and each is connected to the backside of its respective hammer **207** and biases the hammer **207** towards the impact platform **205** for exerting the impact force.

A cam disc **213**, secured atop a ring **215**, is co-axially mounted with the impact platform **205**, with a plurality angularly spaced apart cams **217** mounted thereon. Thus, as the platform **205** rotates with the rotating shaft **201**, the cam disc **213** also rotates such that each cam **217** sequentially interacts with the hammers **207**. As a result, each hammer **207** is raised and then falls due to the spring force to strike on the platform **205** individually.

A plurality of steel balls **219** is provided, with each being rotatably retained in a hole **221** at an end of its respect hammer **207** between the hammer **207** and the cam disc **213** for reducing friction forces therebetween.

The impact platform **205** and the drill chuck **113** are held by a bearing **223** to the housing **101** but are allowed to rotate and move forward and backward freely. The positions of the impact platform **205** and the drill chuck **113** are held back by a spring **225** such that as the impact forces are exerted on the platform **205**, the drill chuck **113** and the drill bit **111** will shock forward producing a chiseling action before being held back to their original positions by the spring **225**. The spring **225** eliminates the need for holding the platform **205** back to receive the impact by forcing the drill bit hard against the surface to be drilled as compared to conventional designs. This brings more convenience to the user in that conventionally, a large force is generally required by the user to press the drill against the surface to be drilled for the impact ramps to be effective.

Furthermore, this forward shock action produced by the hammers **207** happens at two position of the rise and fall cycle of the hammers **207**; firstly when the cam **217** on the cam disc **213** becomes in contact with the steel ball **221** producing an upward shock of the hammer **207**, and the counteraction of such shock on the cam disc **213** is transmitted as an forward shock through the cam disc **213** to the chuck **113** that holds the drill bit **111**; the second position is when a hammer **207** strikes on the impact platform **205**, which transmits the impact energy as a forward chiseling action to the drill bit **111**.

The design of the impact platform **205**, the cam disc **213**, the ring **215** and the hammers **207** is such that when a hammer **207** strikes on the impact platform **205** while none of the cams **217** is in contact with the steel ball **219** of this hammer **207**, there is a sufficient clearance between the steel ball **219** and both this hammer **207** and the cam disc **205** to allow no contact therebetween. This allows this particular hammer **207** to strike on the platform **205**.

In the exemplary embodiment, the number of cams **217** is one more than the number of hammers **207**. Specifically, an example of 6 radially positioned hammers **207** and a cam disc **213** with 7 cams **217** are used to demonstrate the principle as shown in FIGS. **4** and **5**. When the cam disc **213** rotates, each hammer **207** will be at a different state of the rise and fall cycle as shown in FIG. **6**. For each rotation of

51.4 degrees of the cam disc **213**, each of the 6 hammers **207** will complete a rise and fall cycle but at a different phase. Therefore, the impact platform **205** will receive 6 hammer strikes within the 51.4 degrees of rotation of the cam disc **213** but at equal time slots apart. Consequently, during that 51.4 degrees ($1/7^{th}$ of a rotation) rotation of the cam disc **213**, there will be 6 cam hits, one at each of the 6 hammers in order to raise them respectively. Summing all these together, for one complete revolution of the cam disc **213**, there will be all together 6×7=42 rise and fall cycles of the hammers **207** where each cycle produces a hammer against cam contact pulse at the cam disc **213**, and an impact pulse at the impact platform **205** generated by the hammer strikes. These two pulses, one at the cam disc **213** due to the counteraction caused by the interaction between the cams and the hammers and the other at the impact platform **205**, are both transmitted to the impact platform **205** and then to the drill bit **111** as a forward shock to produce a maximum total of 84 shocks at the drill bit **111** per revolution of the cam disc **213**. Hence, for the design of in which the cam disc **213** and ring **215** are fixedly mounted to the impact platform **205**, there can be 84 blows per revolution of the drill bit **111**. However, it is understood that if the cam disc **213** rotates at a relatively slow speed, the counteraction on the came disc **213** may not be significant enough such that a blow actually occurs at this position. In such a case, there will be 6×7=42 blows caused by the hammers **207** striking on the platform **205**.

In addition, the interaction between the hammers and the cams happen in a sequential manner such that each rise and fall cycle of each hammer overlaps with the interactions of the other hammers and cams hence allowing more time for the rise and fall hammer to acquire more momentum for a bigger impact and minimizing the skipping problem at high rotation speed of the cam disc.

Various alternatives can be made to the exemplary embodiment as generally understood by the people in the art. For example, the design also caters for cases where the BPM is required to be independent of the rotation speed of the drill bit **111**. In this case, the ring **215** can be a pulley which allows to rotate freely from impact platform **205**, and is driven by an externally driven belt (not shown) so that the speed and direction of rotation of the cam disc **213** can be independent of the drill bit **111**. In addition, the ring **215** together with the cam disc **213** can be detached from the impact platform **205** and be driven (rotate) by a belt (not shown) independently.

What is claimed is:

1. An impact mechanism for a hammer drill, the hammer drill having a housing, the impact mechanism comprising

an impact platform inside the housing, the impact platform being in connection with a drill bit for receiving impact forces and for transferring the impact forces to the drill bit;

a plurality of cams placed inside the housing; and

a plurality of hammers located inside the housing, each hammer being capable of reciprocation for exerting an impact force on the impact platform,

wherein each of the cams is driven to interact with each of the hammers alternately such that the plurality of hammers are driven to reciprocate so as to generate the impact forces to the impact platform,

both the plurality of cams and the plurality of hammers being angularly spaced apart and arranged about an axis of rotation,

a cam disc rotatable about the axis of rotation and with the plurality of cams disposed on the cam disc, wherein rotation of the cam disc drives each of the cams to interact with each of the hammers sequentially, and

the plurality of cams and the plurality of hammers configured such that each of at least some of the hammers being in interaction with one of the cams at a different state of a rise or fall cycle.

2. The mechanism of claim **1**, further comprising at least one spring within the housing for biasing the plurality of hammers towards the platform such that at least one of the plurality of hammers is driven towards the impact platform for generating an impact force when the at least one of the plurality of hammers is not in interaction with any of the plurality of cams.

3. The mechanism of claim **1**, wherein the hammers and the cams interact in a sequential manner such that each rise and fall cycle of one of the hammers overlaps with the interactions between at least part of the other hammers and cams for providing said hammer with a longer rise and fall cycle to acquire a higher momentum.

4. The mechanism of claim **1**, wherein the cam disc is connected to the platform such that the interaction between at least one of the plurality of hammers and its respective cam is transformed to the platform as an impact force.

5. The mechanism of claim **1**, wherein n number of cams and m number of hammers are provided, and wherein the mechanism can exert up to n*m*2 number of impacts on the impact platform during a complete rotation of the cam disc.

6. The mechanism of claim **5**, wherein n and m are unequal.

7. The mechanism of claim **5**, wherein n=m+1.

8. The mechanism of claim **1**, further comprising a spring provided inside the housing for biasing the platform in a direction away from the drill bit to receive the impact forces from the hammers.

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