June 12, 1928. 1,672,885

R. GOLDSCHMIDT

MECHANICAL HAMMER

Filed June 17, 1925

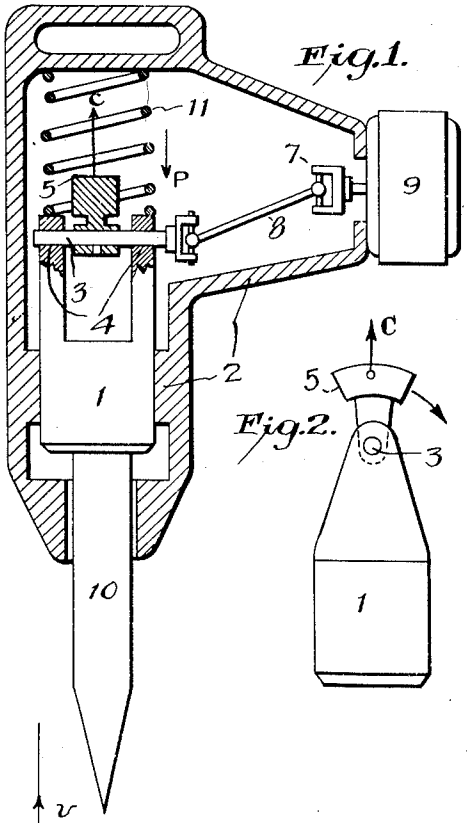


Fig.1.

Fig.2.

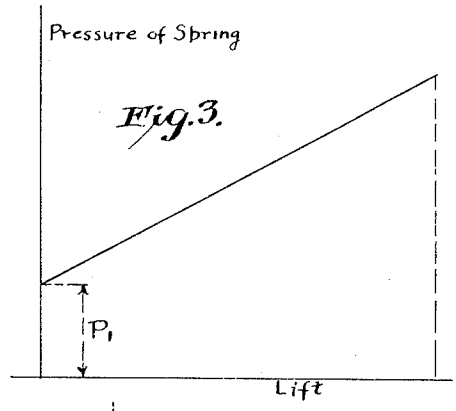


Fig.3.

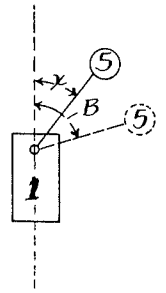


Fig.4.

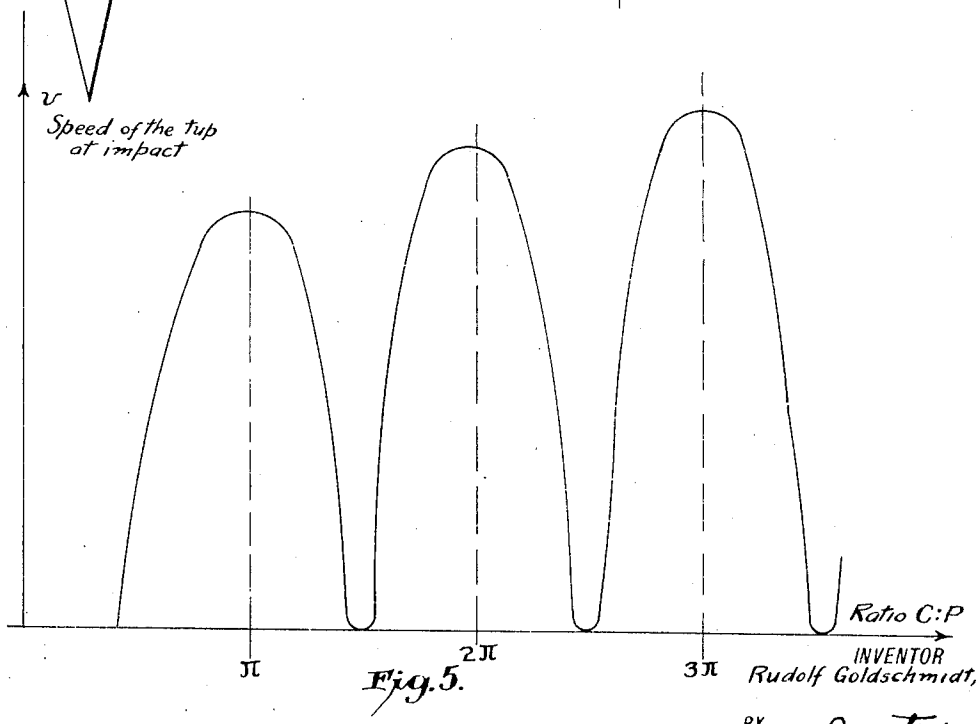


Fig.5.

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UNITED STATES PATENT OFFICE.

RUDOLF GOLDSCHMIDT, OF CHARLOTTENBURG, GERMANY.

MECHANICAL HAMMER.

Application filed June 17, 1925. Serial No. 37,858.

My invention has special relation to mechanical hammers and more particularly to those of the type set forth in my United States Letters Patent No. 1,386,329, issued August 2, 1921, wherein is disclosed a very efficient way of converting rotary motion into hammer action. The method comprises attaching to the hammer or tup one or more flyweights that are driven from a motor, and at the same time exercising a unidirectional force on the hammer preferably by the pressure of a spring. The rotating flyweights develop centrifugal force imparting reciprocatory motion upon the tup, the unidirectional force causing the hammer to deliver a stroke in a certain direction. I have discovered that certain definite relations exist between the centrifugal force with a variable direction and the unidirectional force of the spring. The foregoing relations are the subject of this patent application.

In order that the invention may be more readily understood, reference is made the attached drawings, wherein:

Figure 1 shows a vertical section through a simple form of hammer;

Figs. 2, 3, 4 and 5 are diagrammatic views and curves relating to the design and working of the hammer.

The design of hammer shown as an example in Figs. 1 and 2 is not the most practical type, but is a simple form, and appears to be best for explaining the conditions being dealt with in this application.

In Figs. 1 and 2, 1 is the hammer or the tup which moves up and down and delivers the stroke upon the tool or anvil 10. 3 is a shaft which rotates in the bearings 4 in the tup and which is driven by the motor 9 through the medium of two clutches 6 and 7 and the flexible shaft 8. An eccentric flyweight 5 is fixed on the shaft 3. The described arrangement of drive has been chosen to allow maintenance of the rotation during the reciprocatory movement of the tup 1. The tup is enclosed in the casing 2. A spring 11 is inserted between the upper portion of the casing and the tup.

Through the rotation of the flyweight 5 a centrifugal force C is exercised upon the tup 1, the direction of C varying according to the position of the flyweight 5. However, only the components of C in the direction of the movement of the tup 1 is of importance at the present time. In this construction of the hammer a component at right angles to the movement of the tup would tend to cause a lateral shaking of the hammer and the casing. The casing may be fixed to a foundation or be so heavy that the vibrations become negligible, or the lateral motion may be compensated for. As described in previous patents, particularly my United States Letters Patent No. 1,386,329, issued August 2, 1921, these undesired forces can be compensated for.

The spring 11 exercises a unidirectional force P upon the tup in the direction of its stroke. It is important that the spring exercise this unidirectional force in every stage of the reciprocatory motion of the tup and in whatever position the hammer may be operating. That is to say the tool and hammer may be operated in an upward position, at which time the mass of the tup and the action of gravity would be acting against the spring. If a sufficient blow is to be maintained in this position, the spring should have an initial tension or pressure P_1, at least equal to the weight of the tup 1 including the flyweight 5. Accordingly, the spring will exercise a force upon the tup at all times, even at the moment of impact with the tool 10. Therefore, it will be understood that P is the average pressure for the time of one working cycle, i. e., from one time of impact to the next time of impact.

When the tup 1 is moving upwardly under the action of the flyweights, the spring 11 is compressed, and its pressure increased directly proportional to the amount of the lift, as will be apparent from the diagram in Figure 3.

The ratio between the centrifugal force C of the flyweight 5 and the average pressure P of the spring 11 may be determined from the following formula derived with respect to the trigonometric functions of the angles between the center line of the flyweight and the line of tup motion at moments of impact and lift:

$$v=\frac{C}{M.w}\left[\sin B-\sin x-\frac{P}{C}(B-d)\right]$$

Wherein v may be designated as the speed of the tup at the moment of the impact; x the angle between the center line of the flyweight at the moment of the impact (Figure

4) and the line designating the tup motion; M the total reciprocatory mass of the tup; and w the angular velocity of the flyweight. B is the angle between the line designating the tup motion and the center line of the flyweight at the moment the tup is lifted. From a study of this formula it will be seen that the highest speed of v will be obtained if the two angles, x and B are equal, i. e., if the new cycle begins immediately after one is completed. The parts may be so proportioned by having the centrifugal force C equal to π times the average pressure of the spring P.

With this ratio of forces the tup will deliver one effective blow or stroke for each revolution of the flyweight. As the ratio of P times C becomes smaller, the stroke will become weaker and at 1:1, $5.\pi$ is practically zero.

It has been discovered that if the pressure of the spring relative to the centrifugal force is still more reduced, an effective stroke is again delivered at the ratio

$$\frac{P \times C}{1 \times 2\pi},$$

but under these conditions only one effective stroke or blow is delivered for each two revolutions of the flyweight. Similarly, one blow may be obtained for each three revolutions of the flyweight if the ratio of the spring pressure to the centrifugal force is arranged as $P:C=1:3\pi$ etc.

Figure 5 sets forth a curve of working conditions, the abscissæ being the ratio C x P and the ordinate is the speed v of the tup when completing a blow. It will be noted that these curves have distinct peaks for a spring and weight in coaction similar to the well known resonance curves and therefore, a certain tolerance in the ratio C x P is permissible. It has been discovered that for most practical purposes this tolerance may be

$$+\frac{\pi}{4} \text{ and } -\frac{\pi}{3}.$$

I claim:

1. In a mechanical hammer, the combination with a casing, a tup within the casing having a flyweight journaled thereon and means for rotating said flyweight, of a spring inserted between the casing and the end of said tup, and concentrically disposed about said flyweight, said spring exercising an initial pressure corresponding to a force greater than the weight of the tup.

2. In a mechanical hammer, the combination with a casing, a tup within said casing, means for reciprocating said tup, and a spring for exercising pressure upon the top of said tup, said spring having an initial compression pressure corresponding to a force greater than the weight of the tup and exercising a mean pressure during a cycle of operation with a tolerance of

$$+\frac{\pi}{4} \text{ and } -\frac{\pi}{3}.$$

3. In a mechanical hammer the combination with a casing, a reciprocatory tup within said casing for actuating a tool exterior of said casing, a coil spring member disposed between the inner end of said tup and said casing, a flyweight journaled on the inner end of said tup and substantially enclosed by said coil spring member, means for rotatively driving said flyweight whereby said flyweight describes a circular path within the confines of said coil spring member for delivering successively forces to said tool.

In testimony whereof I affix my signature.

RUDOLF GOLDSCHMIDT.