VARIABLE STROKE DROP HAMMER MECHANISM

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This invention relates to drop hammers of the mechanically driven type wherein the hammer is lifted by frictional drive and released to drop by gravity for striking its blow.

Hence, in hammers of this character, the practice has been to lift the ram to a fixed height through the medium of a lift board connected to the ram and frictionally engaged by suitable driven rolls, the friction rolls disengaging the board at the maximum lift of the ram and permitting the ram to drop by gravity to impart its blow to the workpiece.

In such structures, suitable friction brakes operate for holding the ram in suspended condition, are released from the lift board, upon depressing a foot treadle, or upon operation of a suitable lever, and remain in released condition until the treadle or lever is returned to its starting position, whereupon the brakes again become operative for holding the ram.

In such prior machines it also has been customary to effect engagement of the friction rolls and the brakes with the lift board through the medium of heavy lever and rod mechanisms in which the frictional force applied is directly provided by the weight and inertia of the levers and rods themselves.

One serious objection to such prior structures is the fact that the stroke of the ram is fixed and can only be varied by stopping the machine and readjusting some of the working parts. Such adjustment requires partial disassembly with a consequent loss of time and, of course, is impractical in those instances wherein the same workpiece is to be subjected to a series of successive blows of different intensity.

One of the principal objects of the present invention, therefore, is to provide a hammer of this general character in which the stroke of the ram may be controlled and varied instantly by the operator through the medium of a convenient and readily operable differential lever mechanism.

A more specific object is to control the differential lever mechanism by the usual operating treadle.

Another object is to operate the friction rolls by pneumatic means which, in turn, are operated by comparatively light levers as a result of which a more rapid engagement and release of the rolls and lift board and consequently more accurate control of the ram stroke are provided.

Another object of the invention is to provide means whereby the wear of certain of the working parts may be compensated by readily made adjustments, so that the useful life of such parts and of the entire apparatus is greatly increased.

Another object is to render the operation of the apparatus by the operator more simple, thereby insuring greater accuracy and uniformity of the finished piece.

Other objects and advantages will become apparent from the following specification wherein reference is made to the drawings, in which:

Fig. 1 is a front elevation of a drop hammer embodying the principles of the present invention;

Fig. 2 is a vertical sectional view taken on the plane indicated by the line 2—2 of Fig. 1;

Fig. 3 is a diagrammatic illustration of the control mechanism viewed opposite from Fig. 2, 15 parts of the apparatus being removed for clearness of illustration;

Fig. 4 is a fragmentary, enlarged illustration of part of the operating mechanism illustrated in Fig. 3, showing the position of the mechanism when the hammer is suspended in inoperative condition;

Fig. 5 is a perspective view of the mechanism illustrated in Fig. 4, in the same operating position;

Fig. 6 is a view similar to Fig. 4, illustrating the mechanism when the ram is released for maximum stroke and prior to appreciable downward movement of the ram;

Fig. 7 is a view similar to Fig. 6, showing the mechanism immediately after the ram has completed its downward stroke;

Fig. 8 is a view corresponding to Fig. 7, but with the mechanism set to effect release of the ram at less than full stroke;

Figs. 9 and 10 are respectively fragmentary sectional views taken on planes indicated by lines 9—9 and 10—10 of Fig. 1.

Referring to Fig. 1, the hammer comprises a base frame or anvil 4 which is surrounded by rigid upright columns 2, bridged at the top by a rigid lifter frame 3. The anvil, columns and frame are rigidly secured together to form a sturdy, reinforced structure.

Carried on the inner faces of the columns 2 are upright V-guides 4 which form the slideway for the ram 5 and guide it into accurate alignment with the particular stationary die which is carried in the die holder 6 of the apparatus. Connected to the ram 5 is a suitable lifting board 7 which, in the form illustrated, comprises a rigid steel rod of substantially square cross section, as more fully described in my co-pending application Serial No. 73,506, filed April 9, 1936. The rod 7 extends upwardly through the lifter frame in
position for engagement by suitable friction lift rolls 8 and 9, respectively. The roll 8 is rotatably mounted on the frame 3 in fixed position except for provision made for adjustment to compensate for wear and the like. The complementary roll 9 is rotatably mounted on the frame 3 and is movable laterally into engagement with the lift board or rod 7 so as to face the lift board or rod into contact with both the rolls 8 and 9 with sufficient pressure for frictionally lifting the ram. In the form illustrated, both the rolls 8 and 9 are continuously driven, the roll 8 being driven in a counterclockwise direction, and the roll 9 in a clockwise direction. Suitable pneumatic mechanism and spring retracting mechanism are provided for moving the roll 9 into and out of operating position, respectively, as will later be described.

In order to retain the ram in lifted idle position, conventional brake mechanism is mounted on the frame 3 in position for engaging and disengaging the board or rod 7, the brake mechanism being provided with suitable brake shoes 10 and 11 positioned for direct engagement with and release from the board or rod 7.

In the form illustrated, the shoe 10 is fixed in a given adjusted position, and the shoe 11 is movable for effecting the engagement and release. The brake mechanism later to be described in detail, is operated by suitable resilient operating and pneumatic release means, both the resilient operating means and the pneumatic release means being controlled by a conventional foot treadle.

In the structure thus provided, the rolls 8 and 9 are engaged with the rod 7 by the pneumatic pressure mechanism and are released by suitable spring or other resilient return means. The brake mechanism, on the contrary, is rendered engaged by its associated spring or resilient operating mechanism and is released by its pneumatic pressure mechanism so that in case of failure of the source of pneumatic pressure the brakes will be engaged concurrently with the release of the rolls 8 and 9.

An alternative construction however, for effecting a similar operation can be obtained by the use of double acting cylinders equipped with suitable valving mechanisms instead of springs.

In the structure illustrated in Fig. 1, the ram is in normal idle position, the brake mechanism being engaged with the rod 7 and the rolls 8 and 9 being in released condition, and the ram is in position at the beginning of the initial downward stroke.

In order to effect re-engagement of the rolls 8 and 9 with the rod 7 after the ram completes its downward stroke, a ram operated mechanism is provided for effecting re-engagement of the rolls and the rod, this mechanism comprising a cam surface 12 on the ram 5 in position for engagement with a retractable pin 13 for moving the pin in one direction, resilient return means being provided for returning the pin into the path of the cam surface 12. The pin 13 is provided with an abutment surface 14 on which rests the lower end of an operating rod 15. The rod 15, in turn, is connected to a valve-operating mechanism which controls a valve for the admission of pneumatic pressure to the pneumatic pressure mechanism which effects re-engagement of the rolls with the rod 7. The rod 15 is so cooperated with the control mechanism that when it is in lifted or raised position and resting on the abutment surface 14, the rolls are disengaged from the rod or board 7. When the rod 15 has been released by the surface 14, it drops downwardly and effects the re-engagement of the rolls with the board 7 for lifting the ram and repeating the stroke. To vary the position of reengagement of the rolls with the board 7, a manually adjustable device is provided.

As illustrated in Fig. 1, the rod 15 is guided at its lower end and operative in a block 14, which block is mounted on a slide surface, as indicated at 15, for reciprocally sliding along a central portion of a vertically disposed cam surface 24, at its upper end, adjacent the slot 23, which upon vertical movement of the rod 19,
imparts a rocking motion to a pivotally mounted arm 25 by engagement with a cam roller 26 which is yieldably held in engagement with the cam surface 24 by a suitable spring, as illustrated. 

The arm 25 is pivoted to a housing 27 of a pneumatic valve, better illustrated in Figs. 4 to 8, inclusive, and has two valve stems 29 and 30 which project from one face of the valve housing toward the arm 25.

Suitable air conducting tubes 31, 32, 33 are operatively connected to the valve which is so arranged that by depression of the hand or foot control, as shown in Fig. 6, air from any suitable source is admitted through the tube 31 to the tube 32 which opens into an air cylinder 35. Within the cylinder 36 is a piston 37 carrying a rod 38 which is adapted to lift a brake lever 38 when air is admitted through the tube 32 into the cylinder 35, thus causing the release of engagement of the brake shoe 41 with the board 7. This movement of the piston 36 compresses a coil spring so that, upon exhausting the air from the cylinder 35, the piston 35 and lever 35 are restored to normal position in which the brake shoes are active.

Pivotally mounted by a pin 39 on the U-shaped lever 20, at a point intermediate the extreme ends, is a return lever 40 to which is secured the rod 18 connected to the bell crank 16. The lever 40 is provided with an arm 41 which is adapted to engage a rocker arm 42. The rocker arm 43 is pivotally mounted on a valve housing 44. On the rocker arm 43, near one end, is a ledge 45, or other suitable abutment, in position for engagement by the arm 41 for rocking the end of the arm 43 adjacent the ledge 44 downwardly and thereby lifting the opposite end to raise the rod 15. As herebefore described, when the rod 15 is lifted a predetermined distance, the retractor pin 13 retains the rod in the raised position.

The valve 44 is provided with valve stems 46 and 47, positioned on opposite sides of the pivotal axis of the rocker arm 43. The arm 43 carries adjustable abutments 48 and 49 which are adapted to engage stems 46 and 47, respectively, for operating the same.

For pneumatically moving the roll 9 into active position, a pneumatic mechanism, as herebefore mentioned, is provided. This mechanism comprises air conducting tubes 50, 51 and 52 which are operatively connected to the valve 44, the tubes and valve being so related that depression of the valve stem 45 causes air from a suitable pressure source to pass through the tube 50 and into the tube 51 and therethrough into an air cylinder 54, preferably mounted on the top of the lift frame 3. The cylinder 54 is fitted with a piston 55 having a connecting rod 56 which is operatively connected to eccentric bearing housings 50 and 51.

The roll 9 has a drive shaft 58 by which it is rotatably supported on the frame 3, the shaft 58 being carried in a rotatable eccentric bearing housing 59. The axis of the shaft is eccentric to and below the level of the axis of the bearing housing 59. Thus by operation of the piston, the eccentric bearing housing 59 is rotated about its own axis in a clockwise direction and swings the eccentric or axis of the roll 9 toward the lift rod or board 7 and effects engagement of the roll and lift rod.

For restoring the eccentric bearing housing 59 to its original position, the arms 58 are connected by eye bolts 62 to suitable compression springs 63 which are compressed consequent upon this operation of the piston and which, upon expanding, effect upward movement of the arm 66. This movement rotates the eccentric bearing housing 59 in a counterclockwise direction, causing disengagement of the lift roll 9 from the rod 7.

For the purpose of the present invention, the drive roll 9 may be rotatably mounted in an eccentric bearing housing 69, corresponding to the housing 65 of the stem 25, for example, as shown in Figs. 6, 8 and 11.

The roll 9 is adjustable only for purposes of compensating for wear and during normal operation is retained in a fixed position such that it very lightly engages the lift rod 7. Consequently the bearing housing 69 is maintained in adjusted position by means of a stationary connecting rod or other suitable means adequately secured thereto and to one of the columns 2 as illustrated, or some other portion of the frame of the apparatus.

Herebefore the roll has been entirely under the control of a bell crank and retracting pin, such as the crank 16 and pin 13 of the present invention, and their cooperating cam surfaces, so as to be continuously lifted to the full stroke and there released. This action continued until the brakes were applied for arresting the fall of the ram near the full stroke position so as to prevent it from contacting with the retracting pin. Accordingly, for operating the brakes, a suitable foot treadle, such as is customary in drop hammers of this character, was provided, the sole purpose of the treadle being to release and apply the brakes. In these pressure structures, depression of the treadle released the brakes and upon return of the treadle to its normal upward position, the brakes were reapplied.

As mentioned in the objects, one of the principal advantages of the present invention is the utilization of the treadle, not only for operating the brakes as herebefore, but also for the purposes of varying the point of release of the rolls 9 and 9 from the rod 7, and consequently the length of stroke, of the ram. The manner in which this is accomplished is most clearly illustrated in Figs. 4 to 8 inclusive.

A treadle 68 is provided and is connected by means of a suitable connecting rod 71 and rocker arm 72 to the push rod 73 herebefore described so that upon depression of the treadle the rod 19 is raised, and upon return of the treadle to its upward position, as indicated by the dotted line in Fig. 3, the push rod 19 is lowered.

Referring now to Fig. 6, when the operating treadle 70 has moved downwardly as far as possible, the rod 19 has caused the lever 20 to move upwardly about its pivot 21. The upward movement of the lever 20 causes the common pivot 39 of the lever 40 and arm 41, which is carried on the lever 20, to move upwardly proportionally. This operation lifts the arm 41 from the ledge 45. From Fig. 6 it will be seen that substantial clearance results between the arm 41 and the ledge 45. As soon as the rod 19 is thus lifted, the brake mechanism is released and the ram starts its initial stroke, followed by successive full strokes so long as the treadle is fully depressed.

In Fig. 7, the position of the differential linkage mechanism is shown when the ram is in its downward position with the operating treadle
still in fully depressed position. In this figure, it will be noted that the rocker arm 43 has been moved to depress valve stem 46 which, as described before, causes driving engagement of the roll 9 with the lift rod 7. In the position shown in Fig. 7, the clearance between the ledge 45 and the arm 41, though slightly reduced, is yet of substantial amount.

In order to restore the rocker arm 43 to the position shown in Fig. 8, which causes the release of engagement of the roll 9 with the board 1, the lever 49 and the arm 41 must rock about the pivot 50 on the lever 29 until the arm 41 bears downward on the ledge 45, depressing the ledge 45 and thereby causing the rocker arm 43 to lift the rod 15 sufficiently to allow the pin 13 to be forced outwardly so that the surface 14 is moved under the end of the rod 15. The distance that the arm 41 travels in order to rock the lever 43 to operate the valve stem 47 for exhausting air from the cylinder 54 and thereby releasing the roll 9, is a function of the distance that the bell crank mechanism 16 travels on the cam surface 17. This distance, in turn, is dependent upon the clearance between the arm 41 and ledge 45. Thus it is apparent that if the clearance between ledge 45 and arm 41 is varied, the point of release of the ram is varied in a direct relation thereto.

This clearance between the ledge 45 and arm 41 is varied in a direct proportional relationship to the depression of the trelde 70 after the trelde has been depressed a predetermined portion of its maximum travel. The amount of depression necessary for initiating this proportional relationship is only sufficient to actuate the arm 25 for releasing the brake mechanism.

By comparing the relative clearance of the arm 41 and the ledge 45 in Figs. 7 and 8, Fig. 7 being the position of the mechanism to effect maximum travel of the ram while Fig. 8 represents the position of the mechanism to effect a shorter travel of the ram, it will be seen in Fig. 8 that the upward movement of the rod 18 and lever 46 for restoring the rocker arm 43 to the position shown in Fig. 6 is considerably less than the distance required from the position shown in Fig. 7.

This reduction variation in the clearance is effected by axial movement of the rod 19 which shifts the attached end of the lever 20 and thereby raises and lowers the pivot 39 of the arm 41. As herefore set forth, this movement of the rod 19 is caused directly by the trelde 70 so that the point of release is directly under the control of the operator at all times.

From the foregoing description it will be seen that I have provided a novel method and means for varying the intensity of each blow produced by means whereby the hammer is in direct relation to the position of the control lever or foot trelde of the machine.

While the present showing is merely an illustrative means for accomplishing this variation, it will be appreciated by those skilled in the art that other modifications may be made without departing from the scope of the invention as set forth in the appended claims.

Having thus described my invention, what I claim is:

1. In a drop hammer of the character described, a ram, a lift member connected to the ram, friction driving rolls movable into and out of operative relation with respect to the member for lifting and releasing the ram, releasing means operatively associated with said frictional lift means for moving said frictional lift means to releasing position consequent upon lifting the ram and for returning said frictional lift means to cause reengagement of the said frictional lift means with the lift member when the ram completes its downward stroke, adjusting means for adjusting the point of release of the release means, brake means engageable and disengageable with respect to the lift member for suspending the ram in lifted condition and for releasing the same, a single travel control means operatively associated with said friction driving rolls for moving said friction driving rolls to release said lift member after the ram has imparted its downward stroke, further means to render operable by the ram for causing release of said friction rolls from said lift member during upward motion of said ram, an operating trelde, a differential linkage mechanism including a lever operated by the trelde; a second lever pivotally mounted on said first-named lever and operatively connected by said further means, a third lever operatively connected to said first means for causing engagement and release of said friction lift rolls relative to said lift member, said second lever having spaced engageable surfaces for actuating said third lever by said second lever, the space between the engageable surfaces being variable and controlled by said trelde whereby cooperation of said engageable surfaces is varied to effect proportional operation of said second and third levers for releasing said ram from various positions of elevation.

2. In a drop hammer of the character described, a vertically reciprocable ram, a lift member connected thereto and extending upwardly therefrom, friction driving rolls disposed above the ram and movable into and out of frictional engagement with the lift member for lifting and releasing the ram, respectively, a movably lever for effecting release of the friction driving rolls from the lift member when said movable lever is moved to one position, a ram operated lever operatively associated with the movable lever and operated by the ram as the ram ascends, and means controlled by the operator for changing the operating relationship between the said movable lever and ram operated mechanism, thereby controlling the point of release of the ram by the friction driving means.

3. In a drop hammer of the character described, a vertically reciprocable ram, a lift member connected thereto and extending upwardly therefrom, friction driving rolls disposed above the ram and movable into and out of frictional engagement with the lift member for lifting and releasing the ram, respectively, a rocking lever operable to effect release of the friction driving means from the lift member when said rocking lever is rocked to one position, a ram operated lever movably by the ram as the ram ascends and the rocking lever to the said one position to effect release of the friction driving rolls from the lift member, a manually adjustable trelde for chang-
ing the relative position between the rocking lever and the said ram operated lever and thereby changing the relative position of movement of the friction driving means from the lift member.

5. In a drop hammer of the character described, a vertically reciprocal ram, a lift member connected thereto and extending upwardly therefrom, friction driving means disposed above the ram and movable into and out of frictional engagement with the lift member for lifting and releasing the ram respectively, a release mechanism operative to effect release of the friction driving means from the lift member, said release mechanism including a movable member operative when moved to one position to render the release mechanism active, a ram operated means movable along a single predetermined path of travel by the ram as the ram ascends, an operating lever having an abutment normally spaced from the movable member but engageable therewith when the operating lever is moved by the ram operated means a predetermined distance, said movable member being operative consequent upon said engagement and continued movement of the operating lever by the ram operating means in the same direction to move the movable member for releasing the friction driving means from the lift member, an operating lever for adjusting the initial position of the operating lever to vary the space between the abutment and the movable member whereby actuation of the movable member in response to the ram operated means is adjusted.

6. In a drop hammer of the character described, a vertically reciprocal ram, a lift member connected thereto and extending upwardly therefrom, friction driving means disposed above the ram and movable into and out of frictional engagement with the lift member for lifting and releasing the ram respectively, a release mechanism for releasing the ram, a rocking lever for operating the release means when the rocking lever is rocked to a predetermined position, said rocking lever having an abutment, a second rocking lever having an abutment spaced from the first abutment and engageable with the first abutment consequent upon rocking of said second lever a predetermined distance in one direction and operative upon engagement and continued rocking of the second lever in the same direction to rock the first rocking lever to releasing position, a manual operated mechanism for shifting the second rocking lever to vary the spacing of said abutments and thereby vary the engagement thereof and the start of movement of the rocking lever thereby, ram operated means engageable by the ram and operatively connected to the second lever for operating the same in said direction consequent upon the ascension of the ram, whereby the same cooperation between said ram operated means and the ram effects release of the ram at different positions along its path.

7. In a drop hammer of the character described, a vertically reciprocal ram, a friction lift member extending upwardly therefrom, friction lift means movable into and out of frictional engagement with the lift member for lifting and releasing the ram respectively, mechanism operative for moving said friction lift means into and out of engagement with said member respectively, movable member means operatively connected to said mechanism for controlling said mechanism, said movable means rendering the mechanism operative to release the friction lift means and member when the movable means is in a predetermined position, and to reengage the friction lift means when the movable means is in a different position, a movable ram operated means extending into the path of the ram for engagement and movement by the ram when the ram moves along a predetermined portion of its path on its downward stroke, means yieldably urging said ram operated means into said path, abutment means normally constraining said movable means whereby the movable means may move to said different position for effecting engagement of the friction lift means, and means for adjusting the relative position of said abutment means and movable means in the direction of movement of the abutment means whereby different adjusted amounts of movement of the ram operated means is necessary, a lift member movable means and thereby effect reengagement of the friction lift means in different adjusted relations to the position of the ram.

8. In a drop hammer of the character described, a vertically reciprocal ram, a friction lift member extending upwardly therefrom, friction lift means movable into and out of frictional engagement with the lift member for lifting and releasing the ram, respectively, mechanism operative for moving said friction lift means into and out of engagement with said member respectively, a rod operatively connected to said mechanism for rendering the mechanism operative to release the friction lift means when the rod is in a lifted position and operative to reengage the friction lift means when the rod is in a lowered position, a pin mounted in fixed position longitudinally of the path of the ram and extending into said path for engagement and movement by the ram when the ram moves along a predetermined portion of its path on its downward stroke, means yieldably urging said pin into said path, an abutment on said pin normally supporting said rod in said lifted position and movable with the pin, when the pin is moved by the ram, to a non-supporting position with respect to said rod, whereby the rod may move downwardly for causing engagement of the friction lift means, and means for adjusting the relative position of said rod and pin abutment in the direction of movement of the pin, whereby different adjusted amounts of movement of the pin are necessary to release said rod and thereby effect re-engagement of the friction lift means in different adjusted relations to the position of the ram.

9. In a drop hammer of the character described, a variable stroke ram connected thereto, friction driving rolls movably into and out of engagement with the lift member for lifting and releasing the ram, respectively, roll operating means for effecting release and engagement of the friction driving rolls with the lift member, ram operated means mounted in a given path regardless of the magnitude of the ram stroke and operated by the ram along said given path when the ram is lifted to a predetermined position, a variable mechanism connected to and operated by the ram operated means for shifting the position of the variable mechanism with respect to the roll operating means whereby to vary the stroke of the ram while the ram operated means moves in said given path of movement regardless of the magnitude of the ram stroke.

10. In a drop hammer of the character described, a ram having a variable stroke, a lift
member connected to the ram, power driven rollers drivingly engageable and disengageable with the lift member for lifting and releasing the ram, respectively, an oscillating lever operatively associated with said power driven rollers for causing driving engagement and disengagement with the lift member and having an area of contact, an adjustable lever having a cooperating area of contact engageable with the oscillating lever at said area of contact, the initial distance between said area of contact and said cooperating area of contact prior to mutual engagement of said areas of contact being variable according to the relative positions of the adjustable lever and the oscillating lever, brake means engageable and disengageable relative to the lift member for frictionally holding the ram in suspended position and for releasing the same respectively, a manual control link associated with the adjustable lever for varying the initial distance between the area of contact and the cooperating area of contact, and a lost motion connection between the control link and the adjustable lever for causing release of said brake means prior to the operation of said adjustable lever.

11. In a drop hammer of the character described, a vertically reciprocable ram, a lift member connected thereto and extending upwardly therefrom, friction driving means disposed above the ram and movable into and out of frictional engagement with the lift member for lifting and releasing the ram, respectively, an oscillating lever mechanism, a variable lost motion connection between the ram operated mechanism and the oscillating lever, said oscillating lever being operated by the ram operated lever mechanism through the variable lost motion connection, said ram operated lever mechanism being moved by the ram as the ram ascends for moving the oscillating lever to release the friction driving means from the lift member, and an operating treadle selectively controlled by the operator for changing the magnitude of the lost motion between the oscillating lever and the ram operated lever mechanism and thereby changing the point of release of the ram by the friction driving means.

12. In a drop hammer of the character described, a vertically reciprocable ram, a lift member connected thereto and extending upwardly therefrom, friction driving means disposed above the ram and movable into and out of frictional engagement with the lift member for lifting and releasing the ram, respectively, a release mechanism operated by the ram as the ram is lifted to effect release of the friction driving means from the lift member, said release mechanism comprising a rocking lever operative when rocked to one position to render the release mechanism inactive, ram operated means moved directly in a single predetermined path by the ram as the ram ascends, a linkage mechanism including an operating lever movable by the ram operated means through an initial predetermined distance into physical engagement with the rocking lever to cause a time delay actuation of said rocking lever by the ram operated means, and upon continued movement of the operating lever by the ram operated means as the ram ascends to rock the rocking lever into said position, after said physical engagement, means controlled by the operator for shifting the said operating lever to vary the initial predetermined distance of movement of the operating lever prior to the physical engagement of the operating lever with the rocking lever, whereby the time delay actuation of the rocking lever by the ram operated means and said operating lever is varied.

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