United States Patent [19]

Baumer et al.

[11] **3,709,477**

[45] **Jan. 9, 1973**

[54] **MECHANISM FOR SWINGING A TAPHOLE GUN**

[75] Inventors: **Albrecht Baumer**, Kreuztal-Eichen; **Karl-Heinz Schussler**, Siegen, both of Germany

[73] Assignee: **Dango & Dienenthal Kommanditgesellschaft**, Dieger, Germany

[22] Filed: **July 16, 1971**

[21] Appl. No.: **163,275**

[52] **U.S. Cl.** **266/42**

[51] **Int. Cl.** **C21b 7/12**

[58] **Field of Search** 266/42

[56] **References Cited**

UNITED STATES PATENTS

3,190,629 6/1965 Draper 266/42

Primary Examiner—Gerald A. Dost

Attorney—David Toren et al.

[57] **ABSTRACT**

A taphole gun is mounted on a pivoted boom which is swung by means of a hydraulic ram arranged in such a way that the arc of swing is at least 180°. For this purpose a double-acting hydraulic ram is provided having a piston rod which acts on the pivoted boom at a point situated eccentrically with respect to the pivot axis of the boom and the ram has a hydraulic control device which reverses the direction of action of the ram during the swinging of the boom between a working position of the gun at one end of the arc of swing and a withdrawn position at the other end of the arc of swing when the ram passes through a dead-center position. The hydraulic control device preferably comprises a four-path three-position control valve and a switching device which, as the ram reaches its dead-center position, switches the control valve over into a position in which a forward and a return thrust cylinder chamber, one on each side of the piston of the ram, are both connected to a return line for the hydraulic fluid so that as the ram passes through its dead-center position, the piston of the ram is able to move freely in its cylinder so that the movement of the boom as the ram passes through its dead-center position is not impeded.

13 Claims, 5 Drawing Figures

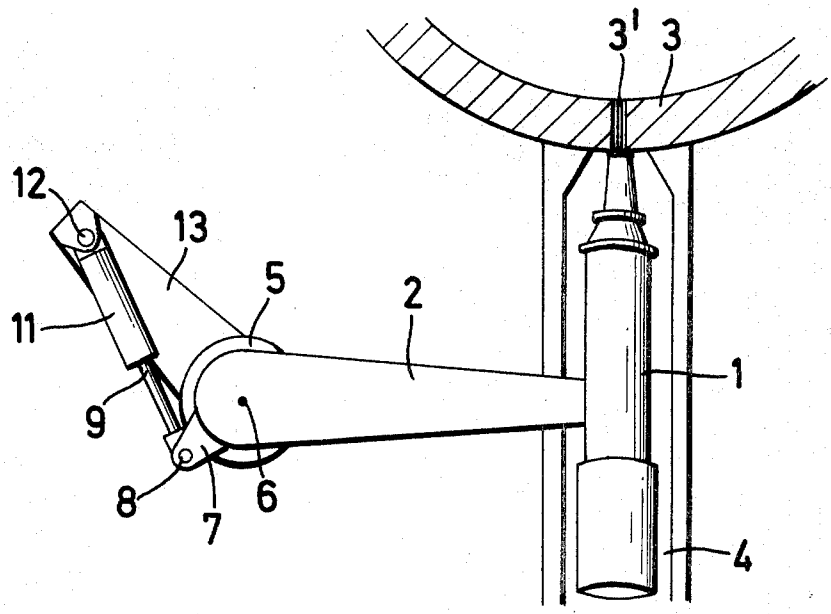
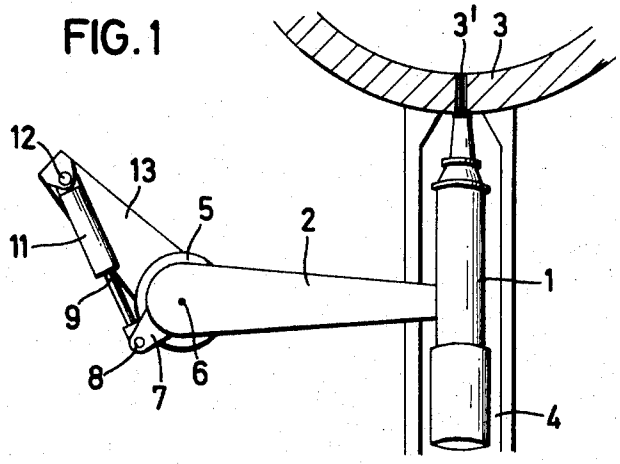


FIG. 1



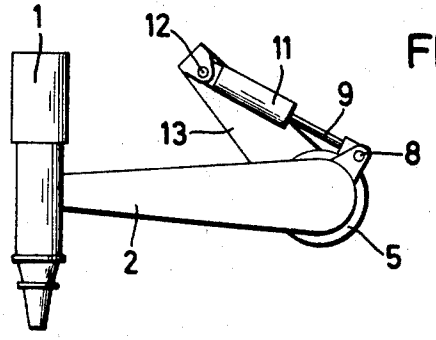


FIG. 2

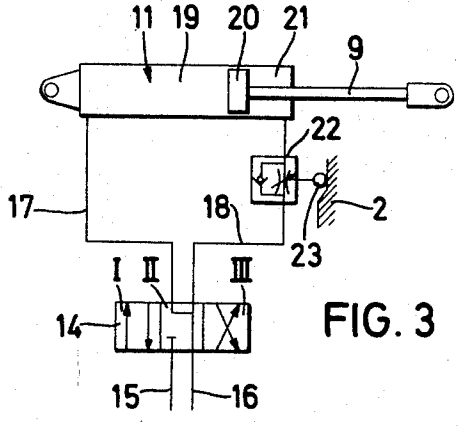


FIG. 3

INVENTORS
ALBRECHT BRÜNER
KARL-HEINZ SCHÜBLER
BY Toren and McCready
ATTORNEYS

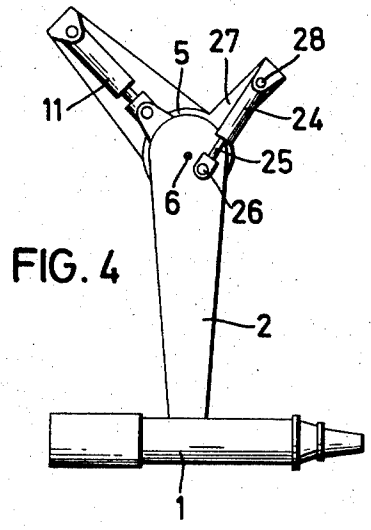
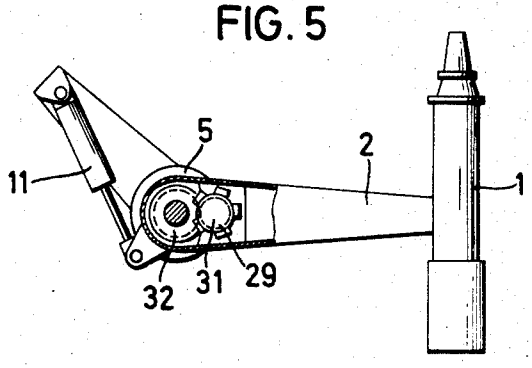


FIG. 4

FIG. 5



INVENTORS
ALBRECHT BAUNER
KARL-HEINZ SCHÜBLER
BY
Toren and McGeady
ATTORNEYS

MECHANISM FOR SWINGING A TAPHOLE GUN

This invention relates to swinging mechanisms for apparatus which has to be swung between a working position and a withdrawn position, for example for taphole guns which are mounted on pivoted booms and are used for plugging tapholes of furnaces.

Taphole guns are used for plugging the tapholes of reducing furnaces and melting furnaces, particularly blast furnaces used in the production of pig iron. The taphole gun injects a quantity of a sealing compound into the taphole. During this process of injection the taphole gun must be thrust powerfully against the outer wall of the furnace in a working position, the applied thrust being sustained until the sealing compound has hardened thus securely plugging the taphole.

After the plugging process has been completed the taphole gun is usually swung away from the furnace into a withdrawn position some distance away from the taphole. A number of different swing mountings have been devised for this purpose. In existing swinging mechanisms for this purpose the taphole gun is fixed to the end of a boom which is pivoted on a stationary frame, which, in use, is situated to one side of the taphole. Due to the increasing sizes of modern furnaces the swinging mechanisms have to satisfy increasing demands. The sealing compounds used develop a greater hardness than those used previously, and consequently a greater thrust has to be applied to the taphole gun. A greater torque therefore has to be applied to the pivoted boom, that is to say the mechanism for swinging the pivoted boom has to be more powerful. In modern furnace operations motor vehicles, for example shovel loaders have to be able to move freely along the furnace wall in the vicinity of the taphole and consequently the stationary pivot point around which the boom swings has to be situated a considerable distance away from the taphole. The boom therefore has to be longer and the drive of the swinging mechanism for swinging the boom has to be capable of providing a greater torque. In order to move the taphole gun into the withdrawn position as far away as possible from the taphole the boom should be able to swing through an arc of substantially 180° and if possible even a little more. A further requirement is that the entire taphole gun including the swinging mechanism must be of a restricted constructional height. This restricted height is necessary because the working platforms of modern blast furnaces, necessary for maintenance of the tuyere systems of the furnaces, extend continuously around the furnace in the vicinity of the taphole. The taphole gun has to operate entirely under the working platform.

Previous swinging mechanisms for taphole guns do not satisfy all these requirements. Although some of the known mechanisms do satisfy some of the requirements, none of them satisfy all the requirements, in many cases not even approximately. In particular it is difficult to apply a sufficiently high torque to the pivoted boom. The drive of the mechanism usually takes the form of an electric motor driving through reduction gearing. A drive arranged in this way is necessarily bulky and does not leave enough working space between the swinging mechanism and the taphole. A hydraulic or other fluid pressure-operated ram drive would appear to be appropriate, but a difficulty arises due to the desired arc of swing which should be substantially 180° or more. A fluid pressure-operated ram can usually provide an arc of swing no greater than approximately 110°.

The object of the present invention is to provide a swinging mechanism for apparatus which has to be swung back and forth between a working position and a withdrawn position of rest, for example for a taphole gun for use in plugging the tapholes of furnaces, the mechanism being not only simple and inexpensive in construction but also being capable of satisfying fully all the requirements of modern blast furnace operation, particularly with regard to a high swinging torque, a wide arc of swing and the very compact arrangement.

To this end, according to this invention, a swinging mechanism for such apparatus includes a pivoted boom, a double-acting fluid pressure-operated ram having a piston rod which acts on the pivoted boom at a point situated eccentrically with respect to the pivot axis of the boom, and a fluid pressure control device which reverses the direction of action of the ram during the swinging of the boom between the working position and the withdrawn position when the ram passes through a dead-center position.

The arrangement in accordance with the invention of the fluid pressure, preferably hydraulically operated, ram and the hydraulic control system allows the available hydraulic thrust to be fully utilized, and provides an arc of swing of substantially 180° with the shortest possible piston stroke. The mechanism in accordance with the invention provides, when incorporated by a taphole gun, a very high thrust applied to the taphole gun during the taphole plugging process and also allows the gun to be moved to a withdrawn position comparatively far away from the taphole in the furnace.

In one form of the invention the fluid pressure control device comprises a four-path three-position control valve, and a switching device which, as the ram reaches its dead-center position, switches the control valve over into a position in which a forward and a return thrust cylinder chamber, one on each side of the piston of the ram, are both connected to a return line for the pressure fluid. This allows the pivoted boom to swing around through the dead-center position of the ram propelled by the momentum of the considerable masses involved, the parts being free to move, in particular the piston being free to slide in the cylinder of the ram due to the automatic switching over of the control valve into a position in which both cylinder chambers are connected to the return line, allowing the piston to slide without hindrance. Consequently the pivoted boom swings around easily through the dead-center of the ram without any risk of it being brought to a standstill.

The mechanism may with advantage be arranged so that the hydraulic or other fluid pressure control device includes a further switching device which, directly after the ram has passed through its dead-center position, switches the control valve over into a position in which the forward thrust cylinder chamber is connected to a fluid pressure line and the return thrust cylinder chamber is connected to the return line. Consequently as soon as the ram has passed dead-center hydraulic or other fluid pressure is applied in the forward thrust chamber of the cylinder, swinging the boom around to its final position.

Under certain circumstances it can however be an advantage to provide an auxiliary drive for the pivoted boom, in addition to the main hydraulic or other fluid pressure-operated ram. This has the advantage that should the boom for one reason or another come to rest with the ram in its dead-center position, the auxiliary drive nevertheless remains operative and can drive the boom round positively through the dead-center position. The fluid pressure control systems for the main ram and the auxiliary drive, when this is fluid pressure-operated, are coordinated so that torque is applied continuously to the boom all the way around the arc of swing, without any interruption near the dead-center position of the ram.

The auxiliary drive may for example consist of a second double-acting fluid pressure-operated ram which acts on the boom at a point situated eccentrically with respect to the pivotal axis of, and on the opposite side of, the boom, from the first fluid pressure-operated ram. Alternatively however if desired the auxiliary drive may comprise a rotary fluid pressure-operated or electric motor which rotates at a constant speed. A particularly favorable arrangement is one in which the boom is driven through most of its angular movement at constant speed by the motor, and is driven through the remainder of its angular range, including into and out of its working position by the fluid pressure-operated ram. In this case, when the mechanism is incorporated in a taphole gun, the ram may serve just for applying the necessary thrust to the taphole gun when the gun is in its working position, and the necessary traction for extracting the gun from the taphole when the plug has been completed.

Three examples of taphole guns incorporating mechanisms in accordance with the invention are illustrated in the accompanying drawings, in which:

FIG. 1 is a plan view showing a first example in its working position;

FIG. 2 is a plan view showing the first example in its withdrawn position;

FIG. 3 is a hydraulic circuit diagram of a hydraulic control system for the swinging mechanism of the first example;

FIG. 4 is a plan view of a second example; and,

FIG. 5 is a plan view of a third example.

In FIG. 1 a taphole gun 1 is shown in its working position. The gun is thrust by a pivoted boom 2 on which it is mounted against a taphole 3' of a furnace, for example a blast furnace. In this position the taphole gun 1 is situated above a tapping runner 4 of the furnace 3. The boom 2 is pivoted at its end remote from the gun on a stationary frame 5. Fixed to the boom 2 and extending radially outwards with respect to a pivot axis 6 of the boom 2 is a crank arm 7 to which is pivoted by a pivot pin 8 a piston rod 9 of a double-acting hydraulic ram 11. The end cylinder of the ram, remote from the piston rod, is pivoted by a pivot pin 12 to the outer end of a bracket 13 fixed to the stationary frame 5. The pivot pin 12 is therefore stationary. A straight line joining the pivot pin 12 to the pivot axis 6 lies at an angle of approximately 45° to the line of thrust of the gun 1, that is to say to the direction of thrust between the gun and the taphole of the furnace.

In FIG. 2 the gun is in its withdrawn position, the boom 2 having been swung through an angle of substantially 180°. The control circuit for the hydraulic ram 11 which swings the gun is shown in FIG. 3. The hydraulic control system has a four-path three-position control valve 14 connected to a hydraulic pressure line 15 leading to a hydraulic pump (not shown) and to a hydraulic return line 16 connected to a storage tank (also not shown) for hydraulic liquid. The control valve 14 is also connected by a hydraulic line 17 to a forward thrust chamber 19 of the hydraulic ram 11, and by a hydraulic line 18 to a return thrust chamber 21 of the hydraulic ram 11, these two chambers being separated by a piston 20.

The hydraulic line 18 connected to the return thrust chamber 21 contains a non-return valve 22 equipped with a controlled bypass. The bypass is controlled in this example by a cam follower pin 23 which follows a cam surface on the pivoted boom 2. Alternatively the bypass can be controlled electrically in dependence on the angular position of the pivoted boom 2. The control valve 14 has three positions I, II, III. When the valve 14 is in position I, the hydraulic pressure line 15 is connected through the hydraulic line 17 to the forward thrust chamber 19 of the hydraulic ram 11, the return thrust cylinder chamber 21 being connected through the hydraulic line 18 to the return line 16. When the valve 14 is in position II, both the cylinder chambers 19, 21 are connected to the return line 16, the pressure line 15 being blocked. When the valve 14 is in position III, the pressure line 15 is connected to the return thrust chamber 21 and the return line 16 is connected to the forward thrust chamber 19.

When the taphole gun 1 is in its working position, as shown in FIG. 1, the control valve 14 is in position I. Hydraulic liquid flows under pressure through the lines 15 and 17 into the forward thrust chamber 19, thrusting the taphole gun 1 firmly up against the taphole 3' of the furnace 3. When it is desired to swing the gun into its withdrawn position the procedure is as follows: The control valve 14 is put into position III. Hydraulic pressure acting in the return thrust chamber 21 retracts the piston 20, the piston rod 9 pulling on the pin 8 so that the boom 2 swings clockwise as seen in FIGS. 1 and 2. Before the hydraulic ram 11 reaches its dead-center position a control device (not shown), for example a programmed electric switch, shifts the control valve 14 into position II. This connects the two chambers 19, 21 to the hydraulic return line 16, allowing the piston 20 and piston rod 9 to move freely in the hydraulic cylinder 11.

This hydraulic control system allows the pivoted boom 2 to continue its swinging movement, propelled by the momentum of the considerable masses involved, past the dead-center position into a position beyond dead-center. Shortly after dead-center has been passed, a further control device (also not shown) switches the control valve 14 over to position I with the result that hydraulic pressure in the forward thrust chamber 19 continues to swing the boom 2 until it reaches its withdrawn position as shown in FIG. 2.

The taphole gun is swung from its withdrawn position into its working position by a reversed sequence of control actions, that is to say the control valve 14 is switched from position I first into position II and then into position III. The controlled bypass non-return valve 22 serves to absorb kinetic energy at the end of

the swinging movement into the withdrawn position of rest, that is to say to provide a buffering effect. This is obtained by suitably arranging the cam surface which acts on the cam follower pin 23. However if desired a terminal damping device (not shown) installed in the hydraulic cylinder 11 can be used instead of the valve 22.

The example shown in FIG. 4 incorporates an arrangement for getting over dead-center difficulties, that is to say for bringing the pivoted boom 2 into motion again if it comes to a standstill with the hydraulic ram 11 at dead-center. An auxiliary double-acting hydraulic ram 24 has a piston rod 25 which acts on a pivot pin 26 fixed to the boom 2 at a position eccentric with respect to the pivot axis 6 of the boom. The auxiliary hydraulic ram 24 is pivoted at its other end to a pivot pin 28 fixed to the outer end of a second bracket 27 fixed to the stationary frame 5. The auxiliary ram 24 is controlled by a control valve (not shown) similar in construction to the control valve 14 of the hydraulic ram 11. The auxiliary ram 24 is capable of swinging the boom 2 in either direction. The two hydraulic rams 11 and 24 are controlled in such a way that a torque is constantly applied to the boom 2 throughout the swinging movement.

The example shown in FIG. 5 incorporates a different arrangement for moving the boom through dead-center. In this example an auxiliary drive for swinging the boom 2 is in the form of a rotary hydraulic motor 29 installed inside the boom 2 and driving a pinion 31 which meshes with a second pinion 32 fixed to the stationary frame 5. The rotary hydraulic motor 29 is controlled by a control valve similar in construction to the control valve 14 used for controlling the ram 11. In this example the hydraulic ram 11 may be used merely for applying the final thrust when the taphole gun 1 engages with the taphole 3', and for subsequently disengaging the gun from the taphole when it is desired to swing it away into its withdrawn position. The hydraulic ram 11 is therefore operative only over a limited angular travel of the boom 2, when the gun is near the taphole, the hydraulic ram 11 being made operative by switching the control valve 14 into positions I and III. When the hydraulic ram 11 is operating the rotary motor 29 is connected through both its hydraulic connections to the return line 16, allowing the rotary motor 29 to rotate freely.

Furthermore, in contrast to the Example shown in FIGS. 1 to 3, the hydraulic pressure line or the return line may contain a flow control valve allowing the rate of flow of hydraulic liquid to the hydraulic motor 29 to be controlled in dependence on the position of the boom, or controlled in such a way that the angular velocity of the boom 2 remains constant. Alternatively the hydraulic liquid can be supplied by a control pump equipped with control devices which allow the rate of flow of the hydraulic liquid to be controlled so as to keep the angular velocity of the boom constant.

The rotary hydraulic motor 29 need not necessarily be enclosed in the boom 2. The motor can for example be fixed to the stationary frame 5, the motor driving the boom 2 through external pinions. On the other hand if desired the rotary motor 29, the ram 11 and the auxiliary ram 24 can all be controlled pneumatically. Finally the auxiliary rotary motor can if desired be an electric motor driving through a hydraulically, pneumatically or electrically controlled clutch. The swinging mechanism in accordance with the invention is also particularly suitable for application to a taphole drilling machine, in which case the pivoted boom supports a drilling device equipped with one or two driven drills.

We claim:

1. In an apparatus including a boom, means pivotally mounting said boom for swinging movement between a working position and a withdrawn position and means for swinging said boom between said positions, the improvement wherein said swinging means includes a double-acting fluid pressure-operated ram, said ram including a cylinder, a piston in said cylinder, and a piston rod extending from said piston out of said cylinder, means pivoting said piston rod to said boom at a point situated eccentrically with respect to a pivot axis of said boom and fluid pressure control means operatively connected to said ram for reversing the direction of action of said ram during the swinging of said boom between said working position and said withdrawn position as said ram passes through a dead-center position.

2. Apparatus as claimed in claim 1, wherein said fluid pressure control means includes a four-path three-position control valve, a fluid pressure return line, a switching device and means operatively connecting said switching device to said control means whereby as said ram reaches said dead-center position, said switching device switches said control valve into a position wherein chambers defined within said cylinder of said ram on both sides of said piston are both connected to said return line.

3. Apparatus as claimed in claim 2, further comprising a fluid pressure supply line and wherein said fluid pressure control means further includes an additional switching device and means operatively connecting said further switching device to said valve whereby, directly after said ram has passed through said dead-center position, said further switching device switches said control valve over into a position in which said chamber in said cylinder on one side of said piston is connected to said fluid pressure supply line and the other of said chambers is connected to said return line.

4. Apparatus as claimed in claim 2, further comprising buffering means for absorbing the kinetic energy of said boom as said boom approaches said withdrawn position, said buffering means including a controlled by-pass non-return valve means in said return line and means controlling said by-pass valve means in dependence upon the angular position of said boom.

5. Apparatus as claimed in claim 1, further comprising a fluid pressure supply line and a fluid pressure return line connected to said ram and flow control valve means in said fluid pressure supply line or said return line, said flow control valve means controlling the rate of flow of fluid to or from said ram in dependence on the angular position of said boom whereby the angular velocity of said boom in its movement between said working and said withdrawn positions is maintained substantially constant.

6. Apparatus as claimed in claim 1, further comprising a hydraulic pump, means connecting said pump to said ram and means controlling the output of said pump in dependence upon the angular position of said boom

whereby the angular velocity of said boom between said working and said withdrawn positions is maintained substantially constant.

7. Apparatus as claimed in claim 1, further comprising auxiliary drive means oPeratively connected to said boom for swinging said boom.

8. Apparatus as claimed in claim 7, wherein said auxiliary drive means includes an additional double-acting fluid-pressure-operated ram and means operatively connecting said ram to said boom at a point situated eccentrically with respect to said pivotal axis of said boom and on the opposite side of said boom from the first mentioned fluid pressure-operated ram.

9. Apparatus as claimed in claim 7, wherein said auxiliary drive means includes a rotary fluid pressure-operated or electric motor which rotates at constant speed and means operatively connecting said motor to said boom.

10. Apparatus as claimed in claim 9, further comprising a stationary frame supporting said means pivotally mounting said boom, said motor being mounted on said boom and said means operatively connecting said motor to said boom including a first pinion driven by said motor and a second pinion fixed to said stationary frame, said first pinion meshing with said second pinion.

11. Apparatus as claimed in claim 9, further comprising a stationary frame supporting said means pivotally mounting said boom, means mounting said motor on said frame, a first pinion mounted on and rotated by said motor and a second pinion mounted on said boom, said first pinion meshing with said second pinion.

12. Apparatus as claimed in claim 9, including means for swinging said boom through a major part of said movement between said working and said withdrawn positions by said motor and means for driving said boom through a remaining part of said movement by said fluid pressure-operated ram.

13. In a taphole gun including a boom, means mounting said gun on said boom, means pivotally mounting said boom for swinging movement of said gun between a working position and a withdrawn position and means for swinging said boom and said gun between said positions, the improvement wherein said swinging means includes a double-acting fluid pressure-operated ram, said ram including a cylinder, a piston in said cylinder and a piston rod extending from said piston out of said cylinder, means pivoting said piston rod to said boom at a point situated eccentrically with respect to a pivot axis of said boom and fluid pressure control means operatively connected to said ram for reversing the direction of action of said ram during the swinging of said boom and said gun between said working position and said withdrawn position as said ram passes through a dead-center position.

* * * * *