④ United States Patent [15] 3,638,466
Calmes [45] Feb. 1, 1972

[54] **RECOIL DEVICE FOR A ROTARY FORGING MILL**

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[22] Filed: **June 19, 1969**

[21] Appl. No.: **834,832**

[30] **Foreign Application Priority Data**

June 20, 1968 Germany......................P 17 52 603.3

[52] **U.S. Cl.**......................................**72/208,** 72/419, 72/453
[51] **Int. Cl.** **B21j 9/12**
[58] **Field of Search** 72/453, 209, 208, 419; 92/134, 92/85

[56] **References Cited**

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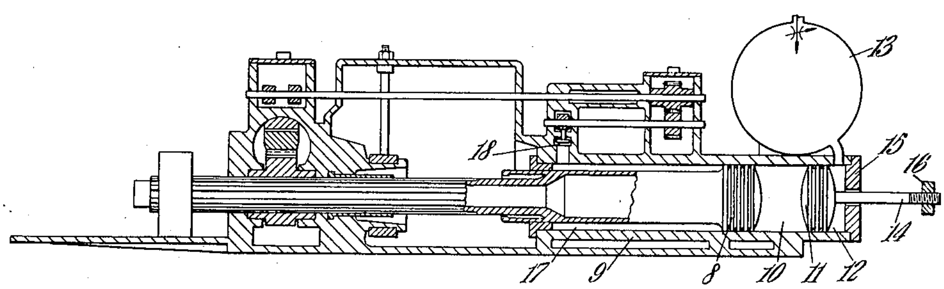
[57] **ABSTRACT**

Operating a rotary forging mill with a gas recoil device by compressing the recoil gas to a limit pressure and then keeping the recoil gas at approximately the same pressure as the recoil piston continues its rearward travel.

6 Claims, 6 Drawing Figures



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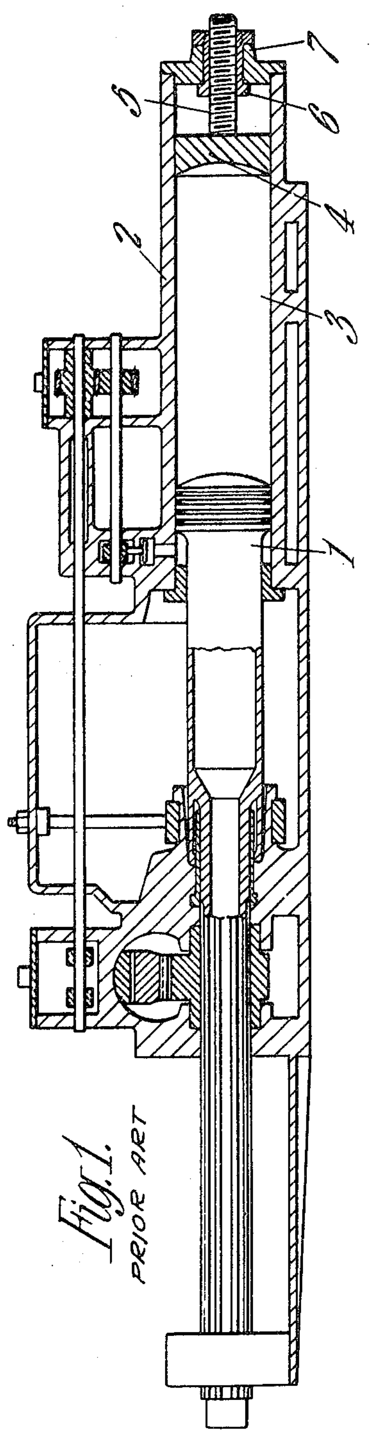

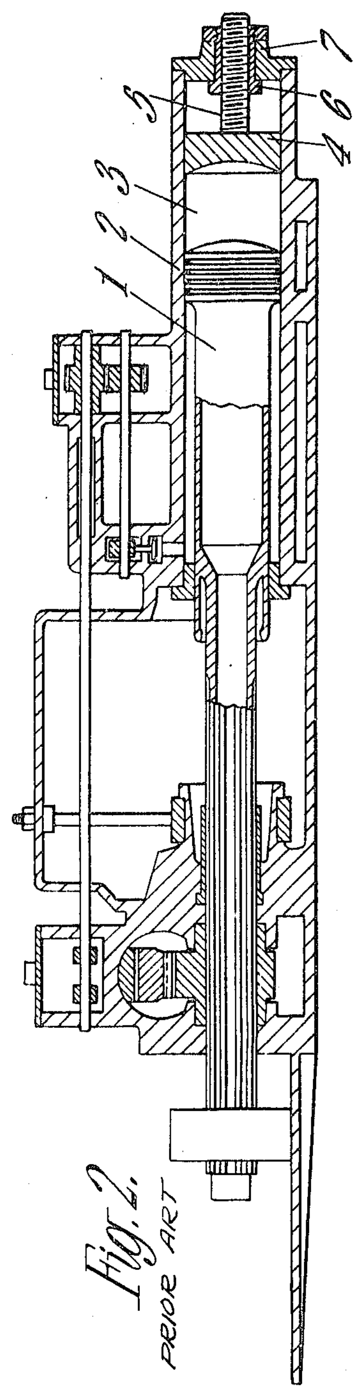

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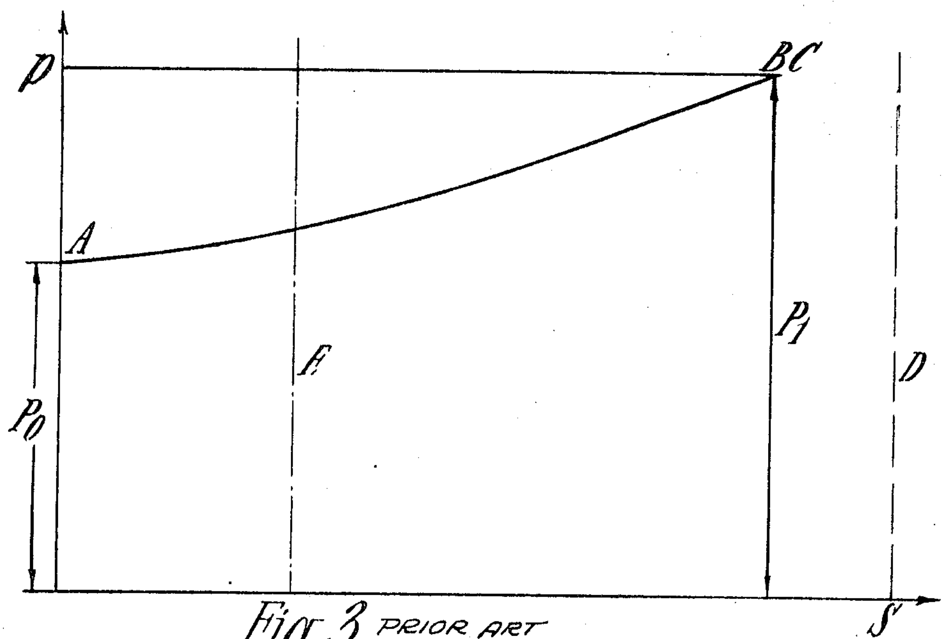
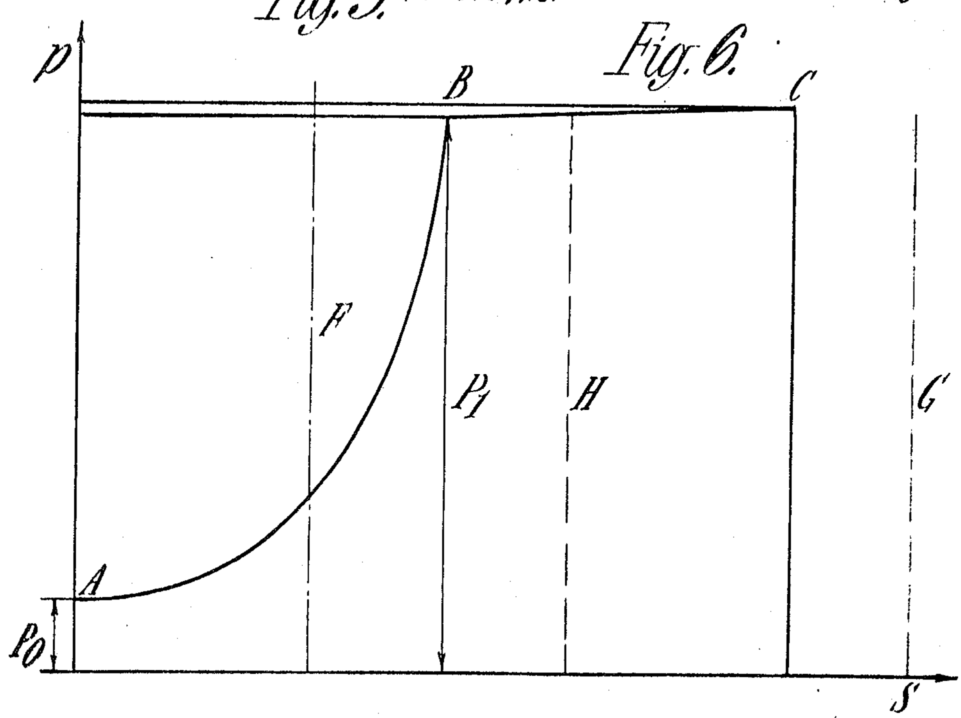


Fig. 3. PRIOR ART

Fig. 6.



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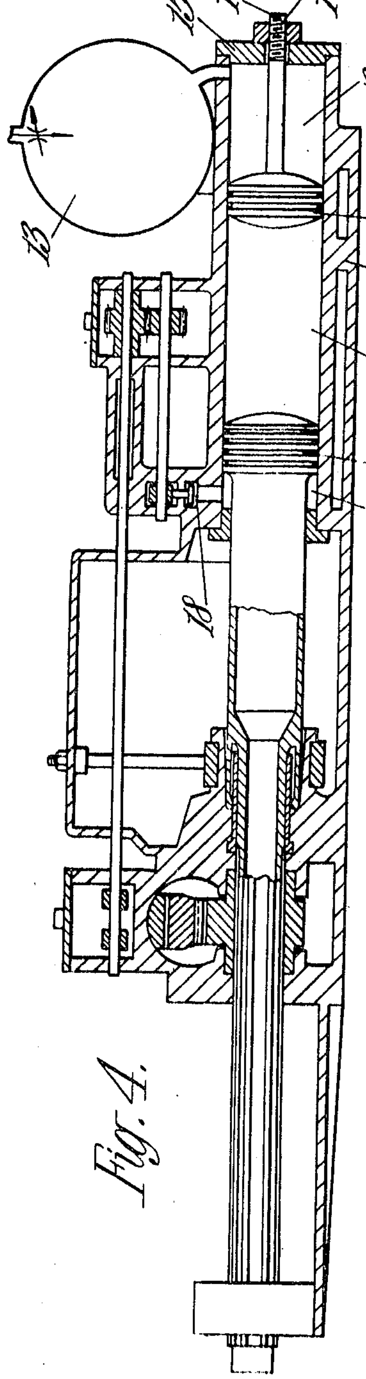

Fig. 4.

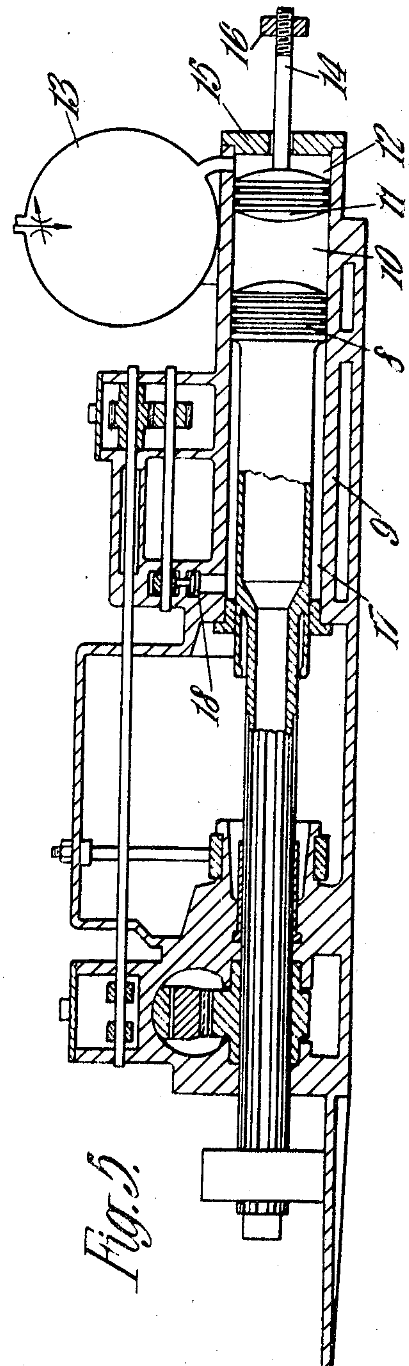

Fig. 5.

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RECOIL DEVICE FOR A ROTARY FORGING MILL

This invention relates to a method of operating a recoil device for forming seamless tubes on a rotary forging mill (also called a pilger mill), which device essentially has a recoil cylinder, a recoil piston with a mandrel and a device for braking the forward movement of the piston; a cylinder space behind the piston contains gas, for instance air, for storing the energy for the forward stroke of the piston. The braking device may be in the form of a cone containing liquid, and the recoil device may include a mechanism for turning the mandrel. This invention also relates to a device for carrying out the method.

When using a rotary forging mill to roll a hollow into a tube, the recoil piston is moved back by the working part of the rolls. During this working stroke, the gas contained in the rear cylinder space of the recoil cylinder is compressed. At the end of the working stroke, when the hollow has been released from the working part of the rolls, the compressed gas drives the recoil piston forward so that the hollow and the mandrel are again passed between the rotary forging rolls for a further rolling cycle. During this forward movement, the recoil piston together with the mandrel and the hollow may be turned through say 90° by means of a turning mechanism so that the ridges or flashes caused by the spaces between the edges of the rolls are rolled out during the course of the next rolling cycle. The recoil piston can be braked for example by arranging for the recoil piston to enter the braking cone or funnel of a liquid brake towards the end of the forward stroke.

A limit is set on the compression of the recoil gas in the rear cylinder space of the recoil cylinder, in particular for the following reasons: the rotary forging rolls have a working part which is made up of three sections. The first section, the so-called caliber mouth, grips the hollow. This piece of the rolls is also called the caliber trumpet section and performs the deformation work. The smooth section of the working part is adjacent the caliber mouth, and smoothes the already rolled-out tube. In both these sections, the tube is tightly surrounded by the caliber. In the zone of the third section, the tube is gradually released from the rolls. Up to the present day, the recoil air may however be so strongly compressed that slip can occur between the rolls and the tube while the tube is gripped by the third section. As a result of this, disadvantageous scratches or similar damage can occur on the tube if after a certain period of operation, the faces of the working parts of the rotary forging rolls are no longer completely smooth. A further reason is as follows: the recoil piston, which compresses the recoil air in the recoil cylinder, is moved back from the working part of the rotary forging rolls by way of the mandrel and the hollow. Particularly when rolling thin-walled tubes, transverse cracks can occur in the tube wall if the thin tube wall can no longer transmit the recoil force as a result of the counterpressure of the recoil air being too great.

According to a first aspect of the present invention, there is provided a method of operating a rotary forging mill for forming seamless tubes, the rotary forging mill having a recoil device with a recoil cylinder, a recoil piston in the recoil cylinder, the recoil cylinder defining a space behind the recoil piston, a mandrel connected to the recoil piston, and braking means for braking the forward movement of the piston, in which method, during the working (rearward) stroke of the recoil piston, the gas pressure in said space is compressed to a limit pressure and the gas pressure in said space is subsequently kept approximately constant.

According to a second aspect of this invention, there is provided a recoil device for a rotary forging mill, the recoil device having

- a recoil cylinder,
- a recoil piston in the recoil cylinder, the recoil cylinder defining a space behind the recoil piston, the recoil piston being arranged to have a mandrel connected thereto,
- displaceable means closing said space, the displaceable means being arranged to be displaced when the pressure in said space reached a limit pressure,
- a gas container of substantially larger cubic capacity than the volume of the recoil cylinder swept by the recoil piston, connected to a space behind the displaceable means, and
- braking means for braking the forward movement of the recoil piston.

Using this invention, the potential energy in the recoil air in the rear space of the recoil cylinder is so increased that the force on the recoil piston is not increased substantially above a certain limiting value, and at the same time the travel caused by the inertia of the withdrawn masses (recoil piston, mandrel and hollow) can be decreased while achieving a great forward speed during the return stroke of the piston.

Although it is theoretically feasible to use other means such as a very large relief valve, the displaceable means is preferably a movable closure piston movable in a cylinder (which cylinder is most conveniently the recoil cylinder), the front of the movable closure piston being in communication with said space and the rear of the movable closure piston being in communication with the gas container; in this manner the movable closure piston closes said space and, after said limit pressure is reached in said space, the gas pressure in said space is subsequently kept approximately constant by rearward movement of the movable closure piston. It is not essential to alter the end position of the movable closure piston with every change in the rolling program, though some alteration may be required with some changes.

Particularly during the starting or pointing period, the rearward movement of the recoil piston may be assisted by subjecting the forward side of the recoil piston to increased gas pressure, preferably by introducing a compressed gas into the forward space in the recoil cylinder. For this purpose, inlet and outlet valve means may be provided for passing compressed gas into or releasing compressed gas from the space defined by the recoil cylinder in front of the recoil piston. By the compression of the recoil air which is achieved in this manner, the starting or pointing period can be carried out with large forward speeds of the recoil piston, and hence at high speeds of rotation of the rotary forging rolls.

Said limit pressure in the space behind the recoil piston is preferably adjustable, and means may be provided for controlling the initial pressure in the gas container to a predetermined, adjustable value.

This invention extends to a rotary forging mill including the recoil device of the second aspect of the invention.

The invention will be further described, by way of example, with reference to the accompanying schematic drawings, in which:

FIG. 1 is a longitudinal section through an earlier recoil device for a rotary forging mill;

FIG. 2 is a longitudinal section corresponding to FIG. 1, showing the recoil device in another position during its working stroke;

FIG. 3 is a graph of the compression curve during the working stroke of the recoil device of FIGS. 1 and 2;

FIG. 4 is a longitudinal section through a recoil device in accordance with the invention, shown at the beginning of its working stroke;

FIG. 5 is a longitudinal section through the recoil device of FIG. 4, shown at the end of its working stroke; and

FIG. 6 is a graph of the compression curve during the working stroke of the recoil device of FIGS. 4 and 5.

The earlier recoil device of FIGS. 1 and 2 has a recoil piston 1 and a recoil cylinder 2. The rear space 3 of the recoil cylinder 2 is closed by an end closure 4 which is carried by a threaded spindle 5. According to the diameter of the tube to be rolled, the cubic capacity of the rear space 3 can be altered by adjusting the end closure 4 whose threaded spindle 5 can turn in a nut 6 carried by a cylinder end cover 7.

FIG. 3 is a graph of the compression curve for the recoil air in the rear space 3. The initial pressure of the air in the rear space 3 is indicated as P_0.

This pressure P_0 occurs in the position of the recoil piston shown in FIG. 1. During the movement of the recoil piston 1 in the working stroke, the recoil air in the rear cylinder space 3 is compressed up to a pressure P_1 along the compression curve A, B, C. The line D indicates the position of the end closure 4 and the line E indicates the position of the fluid brake of the recoil device.

Using the recoil device of FIGS. 1 and 2, it is indeed possible to roll a large range of tube diameters with the same recoil device by adjusting the cubic capacity of the space 3 to the required length of working stroke. However, as the roll diameter becomes smaller as a result of the pilger rolls being turned, and with every alteration of the rolling program, the end closure 4 must be adjusted. This adjustment takes some time before the correct position is found. Furthermore, the recoil device and the tube can be considerably damaged if the readjustment of the end closure 4 is forgotten when changing from a small to a large working stroke.

FIGS. 4 and 5 show a recoil device constructed according to the invention. The recoil piston 8 moves in a recoil cylinder 9. A movable piston closure 11 is mounted in the rear space of the recoil cylinder 9. By this arrangement, a further space 12 is provided, connected by means of a duct with an air container 13 whose cubic capacity is considerably larger than the maximum capacity of the space 12. The pressure in the air container 13, and thus the pressure in the space 12, can be adjusted to the value required at any time, for instance by means of a compressor.

The forward space 17 of the recoil cylinder 9 is in communication with an inlet valve 18 and an outlet valve (not shown). A compressed gas is passed through the inlet valve 18 to the front of the recoil piston 8 in order to assist the rearward movement of the recoil piston 8, particularly during the pointing or starting period. The outlet valve serves to exhaust the compressed gas during the ensuing forward stroke. FIG. 5 shows the rearmost position of the recoil piston 8. After reaching an adjustable limit pressure in the rear space 10 as a result of the compression of the recoil air in the rear space 10, the movable piston closure 11 moves rearwards out of the position shown in FIG. 4 with the same speed as the recoil piston 8. It is possible to equalize the pressure on the forward and rear sides of the movable piston closure 11 because of the cubic capacity of the air container 13 is considerably larger than the space 12. In this way, the compressed air can have a large potential energy which is available for great acceleration of the whole mandrel during the subsequent forward stroke.

FIG. 6 shows a graph of the compression curve which can be obtained with the recoil device of FIGS. 4 and 5, the position of the fluid brake and the end position of the movable piston closure 11 being the same as the position of the fluid brake and of the fixed end closure 4 shown in FIG. 3, thus giving a comparison between the two compression curves. In FIG. 6, the line F indicates the position of the fluid brake and the line G indicates the end position of the movable piston closure 11. In addition, line H in FIG. 6 indicates the initial position of the movable piston closure 11. The initial pressure of the recoil air in the rear space 10 of the recoil cylinder 9 is indicated as P_0. During the working stroke, the compression curve AB rises more steeply than the compression curve shown in FIG. 3 and after a considerably shorter movement of the recoil piston 8, reaches a permitted limiting pressure P_1 because the rear space 10 is made smaller by the position of the movable piston closure 11 shown in FIG. 4. On reaching the adjustable limiting pressure P_1, which is determined by the pressure in the air container 13 and the pressure in the space 12, the piston closure 11 moves rearwards at the same speed as the recoil piston 8 because, as a result of the large air container 13, practically no further compression occurs in the space 12. This part of the working stroke is shown by the curve BC, which here indicates a slight increases in pressure in the rear cylinder space 10 of the recoil cylinder 9 because the air container 13 is not infinitely large.

The forward position of the movable piston closure 11 is in general the same for all rolling programs. If it is however necessary to make the compression curve AB somewhat steeper or somewhat flatter, the forward position of the movable piston closure 11 can be altered. For this purpose, the movable piston closure 11 has a stroke-limiting rod 14 which passes through a central bore in a recoil cylinder closure cover 15 and outside carries an adjustable nut 16; by turning the nut 16, the forward position of the movable piston closure 11 can be adjusted.

The advantage of the construction shown is that high rolling speeds of rotation can be achieved without the pressure of the recoil air at the end of the working stroke becoming so great that there is a danger of the tube slipping in the third caliber part (the end of the working part) of the pilger roll or of the tube tearing when rolling out thin-walled tubes. The speed of rotation of rolls having a caliber of 250 mm. diameter can for instance be increased from about 68 to about 112 r.p.m., that is to say by about 65 percent. In this manner, the rolling efficiency is not only increased, but the rolled tubes have a considerably better quality and a higher temperature on leaving the mill and a greater length. This furthermore has a beneficial effect on tooling costs and on steel yield.

In addition, a comparison of the two compression curves of FIGS. 3 and 4 shows that during the forward stroke, when the compression curves run in the opposite direction, a considerably smaller amount of braking work is required with the device of FIGS. 4 and 5 than with the device of FIGS. 1 and 2.

I claim:

1. A method of operating a rotary forging mill for forming seamless tubes, the rotary forging mill having a recoil device with a recoil cylinder, a recoil piston in the recoil cylinder, the recoil cylinder defining a space behind the recoil piston, a closure piston in said space, a mandrel connected to the recoil piston, and braking means for braking the forward movement of the piston, the method comprising compressing the gas in said space between said pistons to a limit pressure by means of the recoil piston during part of its rearward working stroke, and then moving the closure piston rearwardly by means of said compressed gas at approximately the same speed as the recoil piston during the remainder of said working stroke to maintain the gas pressure in said space approximately constant.

2. A method as claimed in claim 1, wherein the rearward movement of the recoil piston is assisted by subjecting the forward side of the recoil piston to increased gas pressure.

3. A recoil device for a rotary forging mill, the recoil device having a recoil cylinder, a recoil position in the recoil cylinder, the recoil cylinder defining a space behind the recoil piston, the recoil piston being arranged to have a mandrel connected thereto, displaceable means closing said space, the displaceable means being arranged to be displaced when the pressure in said space reaches a limit pressure, a gas container of substantially larger cubic capacity than the volume of the recoil cylinder swept by the recoil piston, connected to a space behind the displaceable means, and braking means for braking the forward movement of the recoil piston.

4. A recoil device as claimed in claim 3, wherein the displaceable means is a movable closure piston movable in a cylinder, the front of the movable closure piston being in communication with said space and the rear of the movable closure piston being in communication with the gas container.

5. A recoil device as claimed in claim 3, wherein means are provided for controlling the initial pressure in the gas container to a predetermined, adjustable value.

6. A recoil device as claimed in claim 3, wherein inlet and outlet valve means are provided for passing compressed gas into ro releasing compressed gas from the space defined by the recoil cylinder in front of the recoil piston.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,638,466 Dated February 1, 1972

Inventor(s) Jean-Paul Calmes

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Claim 3, line 2, change "position" to --piston--.

Signed and sealed this 30th day of May 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents