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<p>(21) International Application Number: PCT/GB90/01116 (22) International Filing Date: 20 July 1990 (20.07.90) (30) Priority data: 8916823.1 22 July 1989 (22.07.89) GB (71) Applicant (for all designated States except US): VERSON HME LIMITED [GB/GB]; Willenhall Road, Darlaston, Wednesbury WS10 8JG (GB). (72) Inventor; and (75) Inventor/Applicant (for US only): MOSELEY, Andrew, Stephen [GB/GB]; 38 Napier Road, Western, Bath BA1 4AW (GB). (74) Agent: FORRESTER KETLEY & CO.; Chamberlain House, Paradise Place, Birmingham B3 3HP (GB).</p>		<p>(81) Designated States: AT (European patent), BE (European patent), CA, CH (European patent), DE (European patent)*, DK (European patent), ES (European patent), FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent), SU, US.</p> <p>Published <i>With international search report.</i></p>
<p>(54) Title: PRESS AND METHOD OF WORKING MATERIAL</p>		
<p>(57) Abstract</p>		
<p>A coining press has a toggle linkage (25) for transmitting motion to a die carrier (19) from a connecting rod (24) driven by a crank (16). As the connecting rod moves in one direction, the die carrier moves in an opposite direction. The toggle linkage includes duplicate links (26, 29) at opposite sides of the crankshaft.</p>		<p>The diagram is a cross-sectional view of a coining press mechanism. At the top, a crankshaft (16) is shown with a connecting rod (24) attached to it. The connecting rod is linked to a die carrier (19) through a toggle linkage (25). This toggle linkage consists of two main links, 26 and 29, which are connected to the crankshaft and the die carrier respectively. The die carrier is positioned above a die (18) which is mounted on a die holder (12). The die holder is supported by a frame (11) which includes a base (10) and a support structure (13). Other components shown include a crank (16), a connecting rod (24), and various pivot points and joints (14, 15, 17, 18, 19, 20, 21, 22, 23, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42). The die carrier (19) is shown in a position where it is about to strike the die (18).</p>

DESIGNATIONS OF "DE"

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Title: "Press and method of working material "

Description of the Invention

From one aspect, the present invention relates to a press which comprises a frame, a crank mounted for turning relative to the frame about a crank axis, a first die carrier guided by the frame for reciprocation along a rectilinear path and means for transmitting motion to the first die carrier from the crank. The invention has been devised primarily for use in a coining press which comprises a second die carrier and a collar within which respective dies mounted on the die carriers engage a workpiece. Generally, the first die carrier is advanced towards the second die carrier to effect the coining operation. The first die carrier is then retracted and the second die carrier is advanced so that the die thereon ejects the workpiece from the collar. The workpieces are fed to and from a position between the dies across a feed surface. It is desirable that the die on the first carrier should be held with its coining face co-planar with the feed surface during feeding of each workpiece onto and from that die.

In GB 1,476,757, there is disclosed a coining press having a toggle linkage for transmitting motion from a crank-driven connecting rod to a first die carrier. The connecting rod moves with simple harmonic motion but this motion is modified by the toggle linkage. Abutments are provided for arresting travel of the first die carrier with a member of the toggle linkage in a direction away from the other die carrier so that the first die will remain in a position with its coining face co-planar with a feed surface, whilst the member of the toggle linkage continues to move away from the other die carrier and then returns. This arrangement provides a satisfactory dwell of the die on the first die carrier but each cycle of operation of the machine involves impact of the member of the toggle linkage with the first die carrier as the clearance between these is eliminated. This contributes to vibration of the machine. A further factor contributing to vibration is the vertical acceleration and deceleration of the first die carrier and of the adjacent

member of the toggle linkage. These components necessarily have a considerable mass.

According to the first aspect of the present invention, there is provided a press comprising a frame, a crank mounted for turning relative to the frame about a crank axis, a first die carrier guided by the frame for reciprocation along a rectilinear path which, if produced, would intersect the crank axis, a linkage for transmitting motion to the first die carrier and a connecting rod for transmitting motion from the crank to the linkage, wherein the linkage is arranged to move the first die carrier in one direction when an end of the connecting rod remote from the crank moves substantially in an opposite direction.

It will be understood that the centre of gravity of the connecting rod moves along a curved path. However, in a press in accordance with the first aspect of the invention, this path is so arranged that this path extends generally in a direction of movement of the first die carrier. Movement of the connecting rod in a direction which is substantially opposite to that in which the first die carrier is moving reduces the effect of acceleration of the first die carrier, in particular the vibration which results from acceleration of the first die carrier.

It will be appreciated that the problem of vibration becomes more severe as the operating speed of a press is increased. The present invention enables a press to be operated at a higher speed than can a comparable press as disclosed in GB 1,476,757.

The linkage of a press embodying the first aspect of the present invention preferably includes a pair of corresponding links between which the crank axis lies. The preferred linkage is so arranged that these links move towards and away from the crank axis in unison. If the links have substantially the same mass and are arranged in a corresponding manner, the forces required to produce this movement will balance.

According to a second aspect of the invention, there is provided a method of working material between a pair of dies wherein movement is transmitted to a first of the dies from a rotating crank via a connecting rod and linkage and wherein, as the first die moves in one

direction towards the other die, an end portion of the connecting rod remote from the crank moves in a substantially opposite direction.

In the preferred method, there is no lost motion as occurs in operation of the press described in GB 1,476,757.

An example of a press embodying the first aspect of the invention and which is used in a method according to the second aspect will now be described, with reference to the accompanying drawings, wherein:-

FIGURE 1 is a diagrammatic representation of the press, as viewed in a direction along a crank axis of the press, and with a part of a frame of the press omitted,

FIGURE 2 shows a diagrammatic representation of the press, as viewed in a direction towards the crank axis and with certain parts shown in cross-section in a plane containing the crank axis, and;

FIGURE 3 is a graphical representation of the motion of a movable die carrier of the press during one cycle of operation.

The press shown in the drawings comprises a frame which includes a bed 11, a cross-head 13 disposed above the bed and pillars 12 connecting the cross-head with the bed. A crank shaft 14 is supported for rotation relative to the frame about a horizontal crank axis 15 by means of suitable bearings. In the example illustrated, there is provided a pair of bearings and the crank 16 is disposed between the bearings.

On one end portion of the crank shaft 14, there is provided a brake and means for transmitting drive to the crank shaft from an electric motor or other prime mover (not shown). A flywheel also may be mounted on the crank shaft. The brake, flywheel and transmission means may be constructed and arranged in a known manner.

There is incorporated in the frame 10 guide means 18 for guiding a first die carrier 19 which, in the example illustrated, is a lower die carrier, for reciprocation relative to the frame along a rectilinear, vertical path which, if produced, would intersect the crank axis 15. In

the example illustrated in the drawings, the die carrier 19 is disposed above the crank shaft 14.

Above the die carrier 19, there is mounted in the frame 10 an upper die carrier 20 which is also guided for reciprocation along a rectilinear, vertical path. For reciprocating the upper die carrier 20, there is mounted on or in the cross head 13 ejector drive means 21 which is connected with the crank shaft 14 by a belt and pulley drive 22. The ejector drive means and the upper die carrier may be constructed and arranged in a known manner.

The press includes a feed surface 23, across which workpieces can be fed to and from a position between respective dies mounted on the die carriers 19 and 20. Feed means is provided for feeding the workpieces across the feed surface 23. The feed means may be a dial plate or other known feed means and provision may be made for transmitting drive in a known manner from the crankshaft 14 to the feed means. There is supported in a position spaced above the feed surface 23 by a distance slightly greater than the thickness of workpieces intended to be worked in the press a collar 24 or ring die.

For transmitting motion from the crank 16 to the lower die carrier 19, there is provided a combination of a connecting rod 24 and a toggle linkage 25. During rotation of the crank shaft 14 at substantially constant speed, the connecting rod 24 executes simple harmonic motion. This motion is modified by the toggle linkage 25 so that the lower die carrier 19 does not execute simple harmonic motion. During a part of each cycle, the lower die carrier dwells in a position such that a coining surface of a die mounted on the lower die carrier is substantially flush with the feed surface 23. Whilst the coining surface of the lower die is flush with this surface, a workpiece which has been coined is moved from the lower die and a workpiece blank is moved into a position directly above the lower die.

The toggle linkage 25 comprises a first link 26 and a second link 27 which are pivotally connected to each other adjacent to first ends of these links for relative movement about a pivot axis 32. The first link 26 is also pivotally connected with the first die carrier 19. The

second link 27 is pivotally connected adjacent to its end remote from the link 26 with the frame 10 for movement relative to the frame about a pivot axis 33 which is fixed with respect to the frame.

Means is provided for transmitting motion from the connecting rod 24 to the links 26 and 27. In the example illustrated, this means comprises a third link 28 connected adjacent to one of its ends with the first and second links for pivoting relative thereto about the pivot axis 32 and connected adjacent to its opposite end with the connecting rod 24 for pivoting relative thereto about a pivot axis 34.

The frame 10 incorporates guide means 35 for guiding that end portion of the connecting rod 24 which is adjacent to the pivot axis 34 along a rectilinear path, the centre line 36 of which coincides with the centre line of the path of travel of the lower die carrier 19 and which passes through the centres of respective coining faces of the dies. When the crank shaft 14 turns, the axis 34 is reciprocated along this path and the axis 32 is moved towards and away from the path. Accordingly, the upper end portion of the link 26 is caused to move upwardly and downwardly by rotation of the shaft. It would be within the scope of the invention to pivotally connect the link 26 adjacent to its upper end directly with the lower die carrier 19. In this case, the pivot connection would be intersected by the centre line 36.

In the example illustrated, the toggle linkage comprises fourth, fifth and sixth links 29, 30 and 31 which correspond respectively to the first, second and third links but which are disposed at a side of the centreline 36 opposite to that at which the first, second and third links are disposed. The first and fourth links may be pivotally connected with the lower die carrier 19 for movement relative thereto about a common pivot axis which lies on the centreline 36. In the example illustrated, there is provided a beam 37 which is interposed between the lower die carrier, on the one hand, and the links 27 and 29, on the other hand.

At a mid-portion of the beam 37, the beam is connected with the lower die carrier 19 for pivoting relative thereto about a pivot axis 38 which intersects the centreline 36. Since the lower die carrier is guided by the frame for reciprocation along a path parallel to the

centreline 36, the axis 38 is constrained also to move along the centreline 36 and always intersects that centreline. The first link 26 is connected adjacent to its upper end with the beam 37 adjacent to one end of the beam for relative pivoting about a pivot axis 39. The fourth link 29 is connected adjacent to its upper end with the beam adjacent to an opposite end of the beam for relative pivoting about a pivot axis 40.

The fourth link 29 is pivotally connected adjacent to its lower end with the fifth link 30 and the sixth link 31 for relative pivoting of these links about a pivot axis 41. Adjacent to an end remote from the pivot axis 41, the fifth link 30 is connected with the frame 10 for pivoting about a pivot axis 42 which is fixed with respect to the frame. Adjacent to an end portion of the sixth link 31 which is remote from the pivot axis 41, this link is connected with the third link 28 and with the connecting rod 24 for pivoting relative thereto about the pivot axis 34. The pivot axes 32, 33, 34 and 38 to 42 are all parallel to the crank axis 15 and are distributed around that axis.

The linkage 25 is represented in Figure 1 in the condition which corresponds to a T.D.C. position of the crank 16 and a B.D.C. position of the lower die carrier 19. In this configuration of the linkage, the third and sixth links 28 and 31 are substantially co-linear. The pivot axes 32, 34 and 41 may lie on a rectilinear line which is perpendicular to the centreline 36. As the crankshaft 14 turns and the crank 16 descends, the connecting rod 24 and the pivot axis 34 descend along the centreline 36. This causes the links 28 and 31 to depart from a co-linear relation, so drawing towards the centreline 36 the pivot axes 32 and 41. This tends to move the links 26 and 27 from the mutually inclined configuration illustrated in Figure 1 towards a co-linear relation and also tends to move the links 29 and 30 from the mutually inclined relation illustrated in Figure 1 towards a co-linear relation. According, the beam 37 and the lower die carrier 19 are driven upwardly whilst the connecting rod is driven downwardly. The vertical movement of the centre of gravity of the lower die carrier, the linkage 25, the connecting rod 24 and the crank 16, considered collectively, is through a relatively

small distance, as compared with the vertical movement of this centre of gravity which would occur in a case where, as disclosed in GB 1,476,757, the connecting rod moves in a direction which is primarily at right angles to the direction of movement of the tool carrier. It will be appreciated that the centre of gravity of the connecting rod 24 moves along a curved path which departs somewhat from the centreline 36 and that the centre of gravity of the crank 16 moves along a circular path. Accordingly, the movement of the crank, connecting rod and links 28 and 31 does not compensate precisely for the movement of the lower die carrier 19 and the beam 37. Counterweights (not shown) may be provided on the crankshaft 14 to balance the mass of the crank 16 and, possibly, partially to counter balance the mass of the connecting rod 24. Such arrangements of counterweights in association with a crank shaft are well known.

The displacement of the lower die carrier 19 from its B.D.C. position during one cycle is represented in Figure 3 where the displacement of the lower die carrier is plotted against the angular position of the crankshaft 14.

It will be noted that each of the links 26 to 31 and the connecting rod 24 are subjected during operation to tensile and compressive stresses but are not subjected to any bending load. During parts of each cycle of operation, the length of the connecting rod 24 departs from a parallel relation with the centreline 36. Accordingly, tensile and compressive forces in the connecting rod exert on the pivot which defines the pivot axis 34 forces having both a vertical component and a horizontal component. These horizontal components are borne by the guide means 35 and are transmitted directly to the frame.

It will be noted that the first and second links 26 and 27 move in unison respectively with the fourth and fifth links 29 and 30. The horizontal component of acceleration of the pivot axis 32 is exactly equal and opposite to the horizontal component of acceleration of the pivot axis 41. Accordingly, these horizontal components of acceleration do not contribute significantly to vibration of the press.

The linkage 25 illustrated in the accompanying drawings is

arranged for use with a connecting rod 24 which extends from the crank axis 15 in a direction away from the first die carrier 19. This arrangement leads to a relatively compact structure. Alternatively, the connecting rod may be arranged to extend upwardly from the crank. In this case, the third and sixth links would be arranged to drive the pivotal connection between the first and second links away from the pivotal connection between the fourth and fifth links as the connecting rod is driven upwardly, so that the first die carrier would move downwardly during upward movement of the connecting rod. In both this modified arrangement and in the arrangement illustrated in Figure 1, the mass which moves downwardly when the first die carrier moves upwardly is constituted by the crank, connecting rod and by the linkage. These parts are all integral elements of the means for transmitting motion from the crankshaft to the first die carrier. There is not associated with the linkage any counterweight which serves solely to compensate for movement of the mass represented by the first die carrier. It will be appreciated that the driving of such counterweights would detract from the force which could be applied by the first die carrier to the first die, for working the workpiece.

It will be noted that the linkage 25 provides two, corresponding paths for the transmission of force from the connecting rod 24 to the lower die carrier 19. Accordingly, the magnitude of the force transmitted by each link of the linkage 25 is approximately half of that force which would be transmitted by the links of a press having the same duty but only a single pair of links, corresponding to the first and second links 26 and 27 of the illustrated arrangement. Accordingly, the links can be relatively light and the aggregate mass of the linkage 25 is not excessive.

The mass of the connecting rod 24 is considerably less than is the mass of the first die carrier 19. Even the aggregate of the mass of the connecting rod, the mass of the link 28 and the mass of the link 31 and associated parts which move with the axis 34, may be considerably less than the aggregate of the mass of the first die carrier, the beam 37 and other parts which move with the axis 38. The

distance through which the axis 34 moves vertically is considerably greater than is the distance which the axis 38 moves vertically. Accordingly, the movement of the smaller mass represented by the parts which move with the axis 34 is able to compensate for the movement of the larger mass of the parts which move the axis 38.

The centre of mass of the assembly comprising the crank and any associated counterweights, the connecting rod, the linkage 25, the beam 37 and the lower die carrier 19 is maintained almost stationary during each cycle 19 of operation of the press. The position of this centre of mass does not move more than 30 mm and preferably not more than 10 mm.

The features disclosed in the foregoing description, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

CLAIMS:-

1. A press comprising a frame, a crank mounted for turning relative to the frame about a crank axis, a first die carrier guided by the frame for reciprocation along a rectilinear path which, if produced, would intersect the crank axis, a linkage for transmitting motion to the first die carrier and a connecting rod for transmitting motion from the crank to the linkage, wherein the linkage is arranged to move the first die carrier in one direction when a portion of the connecting rod which is remote from the crank moves substantially in an opposite direction.
2. A press according to Claim 1 wherein the connecting rod extends from the crank in a direction away from the first die carrier.
3. A press according to Claim 1 or Claim 2 wherein the linkage comprises first and second links pivotally connected to each other adjacent to first ends of those links, wherein a second end of the first link is pivotally connected with the first die carrier and wherein a second end of the second link is pivotally connected with the frame.
4. A press according to Claim 1 or Claim 2 wherein the linkage includes a pair of corresponding links and the crank axis lies between the corresponding links.
5. A press according to Claim 4 wherein the linkage comprises a further pair of corresponding links, the links of one of said pairs are connected with the frame for pivoting relative thereto about respective axes, the links of the other of said pairs are connected with the first die carrier for pivoting relative thereto about respective pivot axes which move with the second die carrier relative to the frame, each link of the one pair is pivotally connected with a respective link of the other pair and wherein there is provided means for transmitting drive from the connecting rod to the links of both pairs.

6. A press according to Claim 1 or Claim 2 wherein the linkage includes first, second and third links connected together adjacent to respective first ends for relative pivoting about a pivot axis which is parallel to the crank axis, the linkage further includes fourth, fifth and sixth links which are connected together adjacent to respective first ends for relative pivoting about a further pivot axis which is parallel to the crank axis, wherein the third and sixth links are pivotally connected to each other and to the connecting rod adjacent to second ends of the third and sixth links, wherein the second and fifth links are pivotally connected with the frame adjacent to second ends of the second and fifth links and wherein the first and fourth links are pivotally connected with the first die carrier adjacent to second ends of the first and fourth links.

7. A press according to Claim 6 wherein the linkage further comprises a beam, opposite end portions of the beam are pivotally connected with respective ones of the first and fourth links adjacent to the second ends thereof and a mid-portion of the beam is pivotally connected with the first die carrier.

8. A press according to Claim 3 wherein the linkage comprises a further pair of links which are pivotally connected to each other adjacent to respective first ends of the further pair of links, one link of the further pair is pivotally connected with the first die carrier and corresponds to said first link and the other link of the further pair is pivotally connected with the frame and corresponds to said second link.

9. A press comprising a frame, a first die carrier guided by the frame for reciprocation along a rectilinear path, a crank mounted for turning relative to the frame about a crank axis and a linkage for converting the simple harmonic motion produced by rotation of the crank at uniform speed to a converted the motion which is other than simple harmonic motion and applying the converted motion to the first die

carrier, wherein the linkage is arranged to move a substantial mass in one direction when the first die carrier is moved in an opposite direction.

10. A method of working material between a pair of dies wherein a crank is rotated at substantially uniform speed and reciprocates a first member with simple harmonic motion, the motion of the first member is converted to a converted motion other than simple harmonic motion and the converted motion is applied to one of the dies to reciprocate the one die, wherein movement of the mass of the one die and of parts which reciprocate with the one die in one direction is substantially compensated for by movement of a further mass in a substantially opposite direction.

11. A method of working material between a pair of dies wherein movement is transmitted to a first of the dies from a rotating crank via a connecting rod and a linkage and wherein, as the first die moves in one direction towards the other die, the centre of gravity of the connecting rod moves away from the other die.

12. A method according to Claim 11 wherein there is no substantial movement of the centre of gravity of the linkage in a direction transverse to said one direction.

13. A press comprising a die carrier, a crank shaft and means substantially as herein described with reference to the accompanying drawings for transmitting motion from the crank shaft to the carrier.

14. Any novel feature or novel combination of features disclosed herein or in the accompanying drawings.

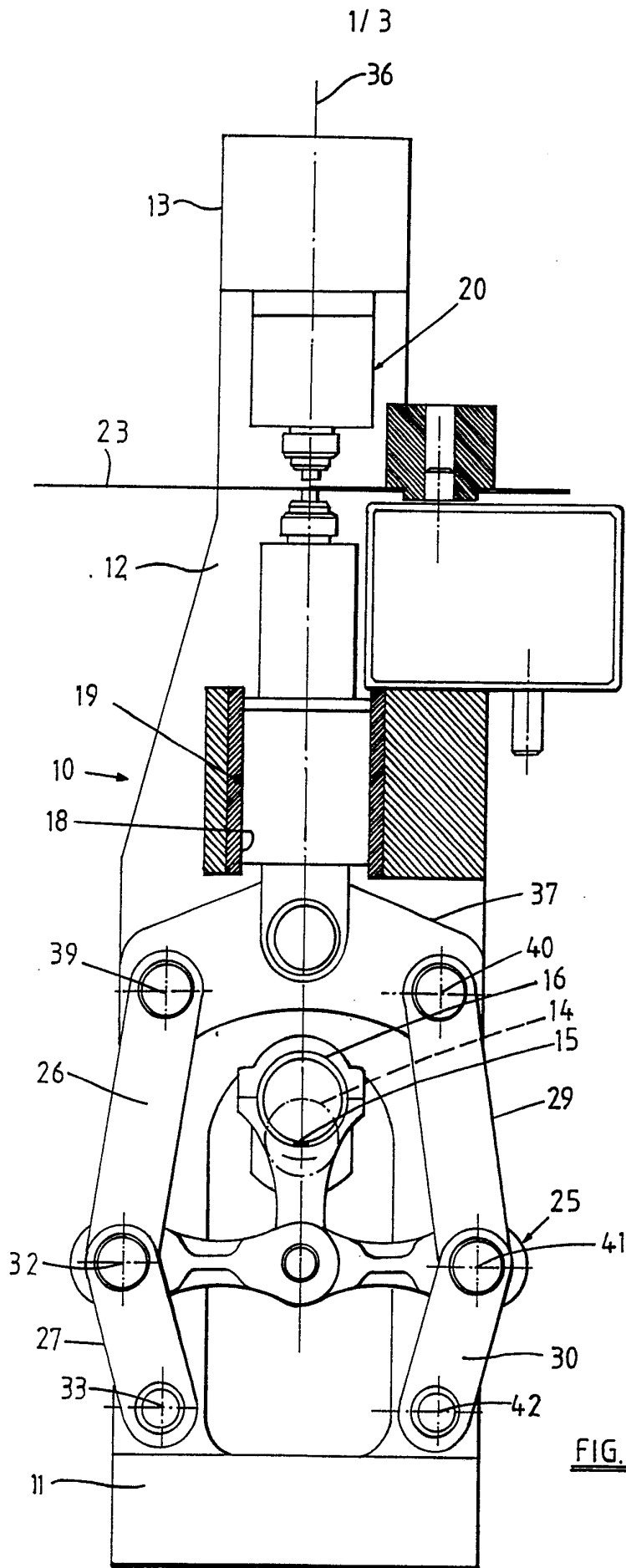


FIG. 1

TIMING DIAGRAM

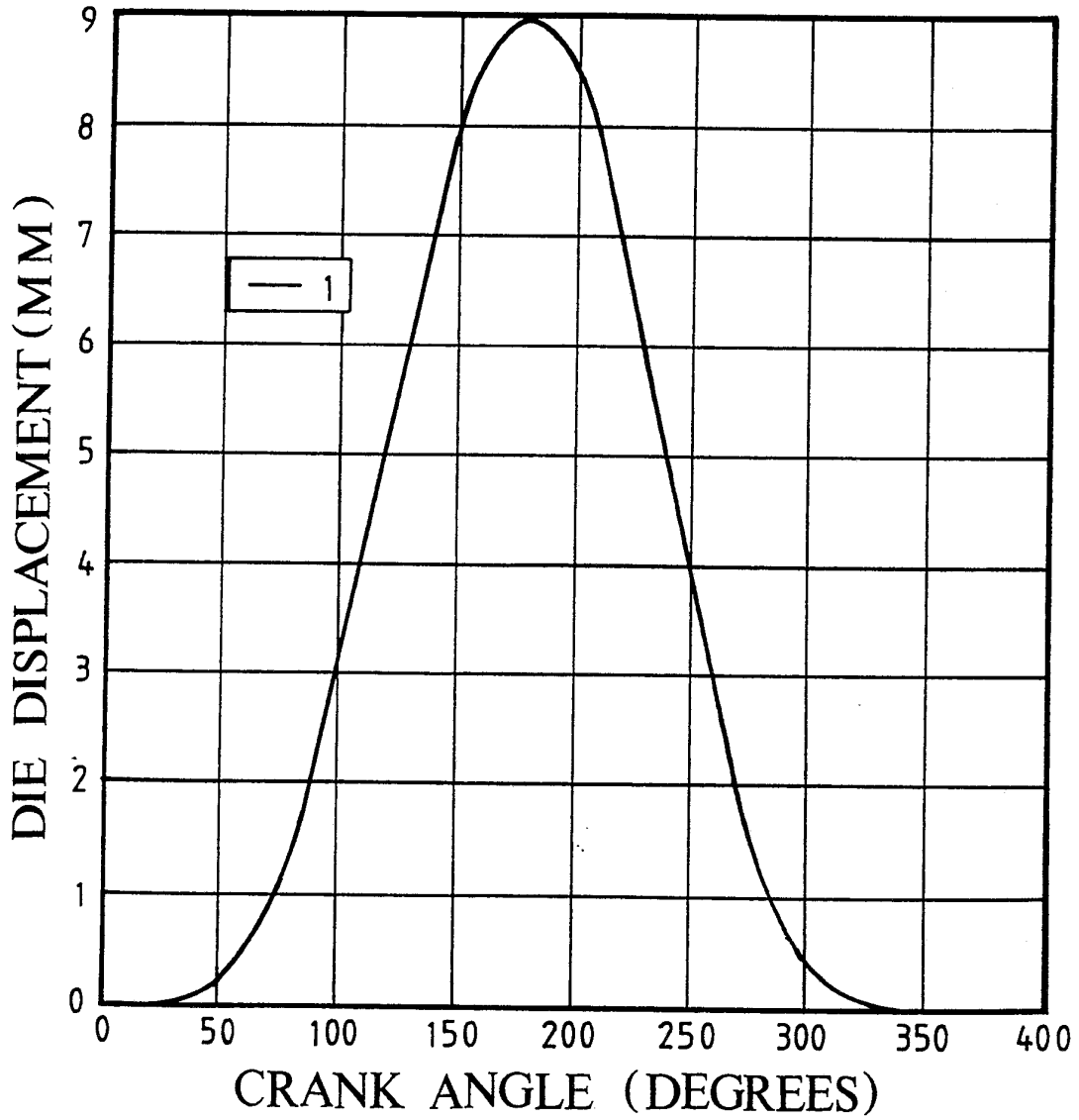
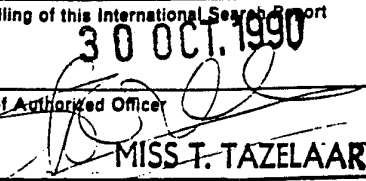


FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No **PCT/GB 90/01116**

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC ⁵ : B 30 B 1/14, B 44 B 5/00		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
IPC ⁵	B 44 B 5/00, B 30 B 1/00, F 16 H 21/00, B 21 J 9/00	
Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched ⁸		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹		
Category ⁹	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
X	US, A, 3661008 (RICHARDSON) 9 May 1972 see claim 1; figure 1 --	1, 2, 3, 9, 11
A	CH, A, 354331 (J. BOBST & FILS S.A.) 30 June 1961 see claim; figure 2 --	4
A	FR, A, 1431926 (FORGES ET ACIÉRIES DU SAUT DU TARN) 7 February 1966 see page 2, lines 58-59; page 3, lines 1-2; figure 2 --	5
A	US, A, 1801575 (SEABURY) 21 April 1931 see claim 1; figures --	1
A	US, A, 2269758 (NORONHA) 13 January 1942 see claim 4; figures --	1
A	GB, A, 1476757 (GRABENER MASCHINENFABRIK) 16 June 1977 see claims 5,6; figure 1 (cited in the application)	1
<p>¹⁰ Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&" document member of the same patent family</p>		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search 9th October 1990	Date of Mailing of this International Search Report 30 OCT. 1990	
International Searching Authority EUROPEAN PATENT OFFICE	Signature of Authorized Officer  MISS T. TAZELAAR	

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO.**

GB 9001116

SA 38618

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 25/10/90. The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 3661008	09-05-72	None	
CH-A- 354331		None	
FR-A- 1431926		None	
US-A- 1801575		None	
US-A- 2269758		None	
GB-A- 1476757	16-06-77	DE-A, C 2346810 JP-A- 50077972 US-A- 3910096	27-03-75 25-06-75 07-10-75