

Sept. 19, 1939.

G. S. FORICHON

2,173,583

PRESS AND METHOD OF PRESSING

Filed May 22, 1936

6 Sheets-Sheet 1

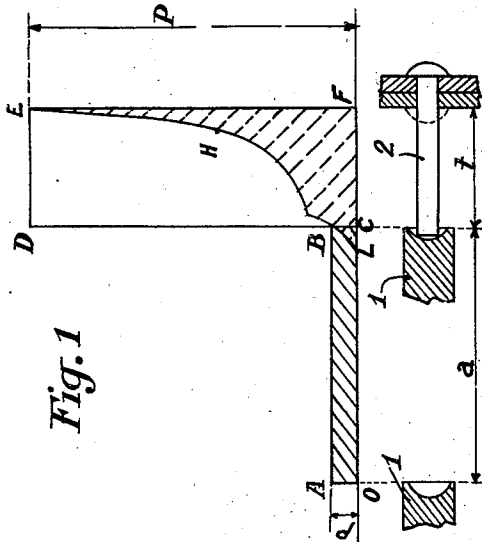


Fig. 1

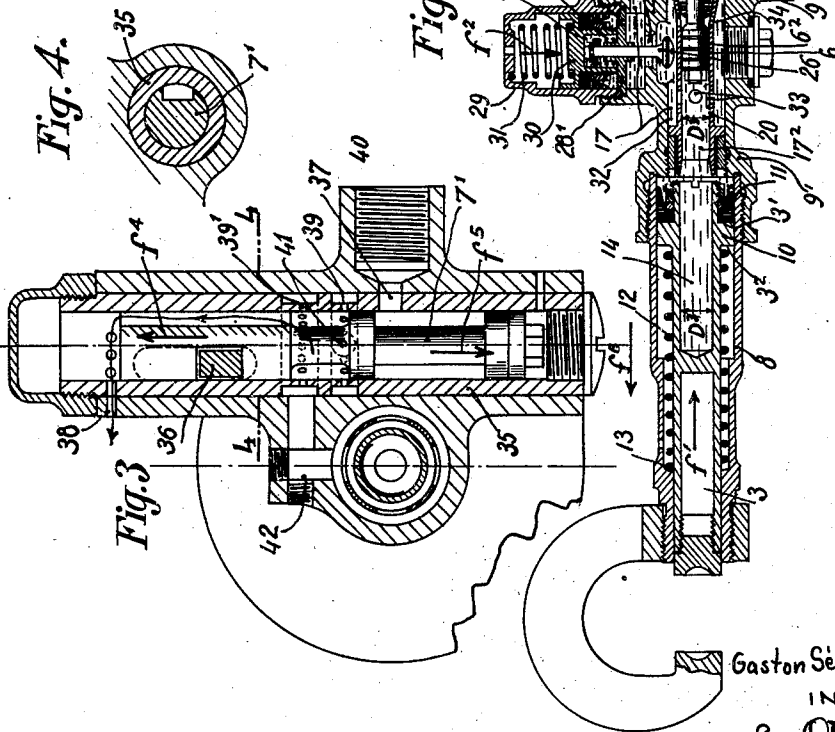


Fig. 2

Fig. 3

Fig. 4.

Gaston Sébastien Forichon
INVENTOR

INVENTOR

By O. H. Munk
his ATT'Y.

Sept. 19, 1939.

G. S. FORICHON

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6 Sheets-Sheet 2

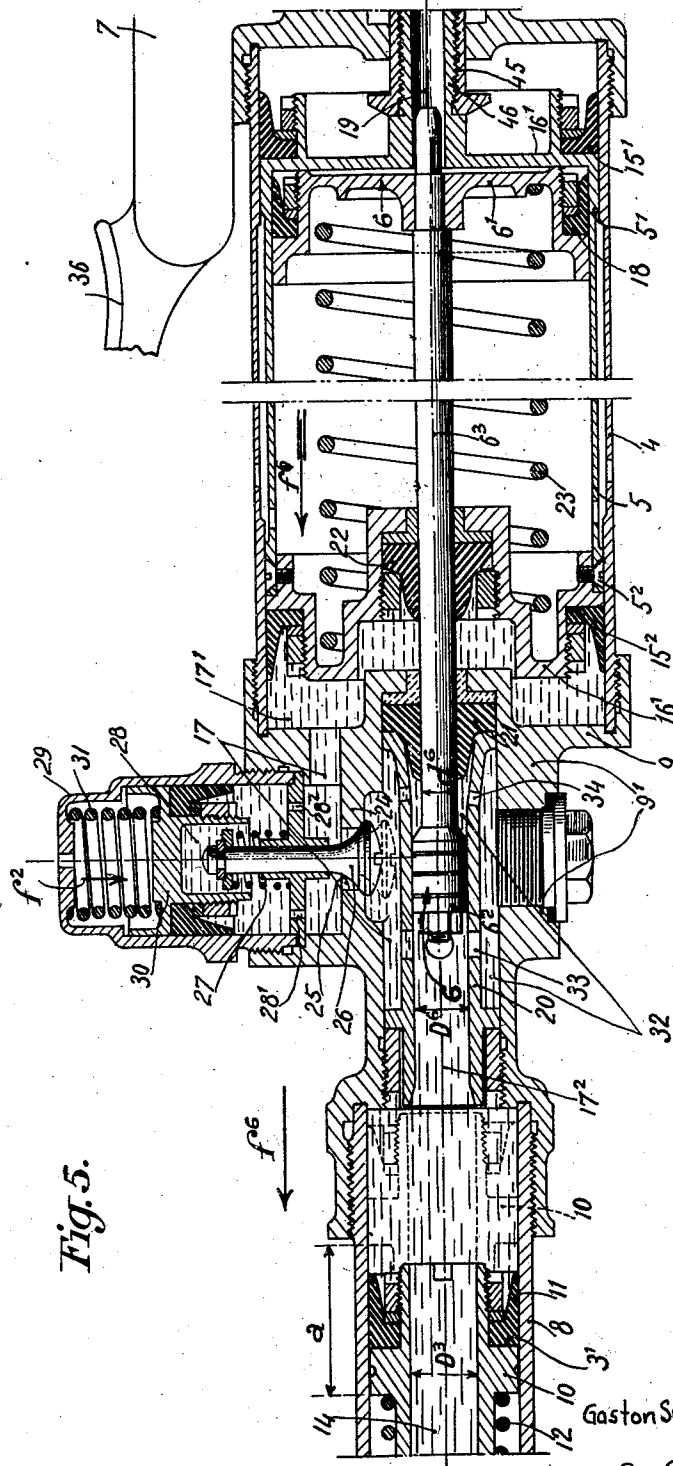


Fig. 5.

Gaston Sébastien Forichon
INVENTOR
By *Otto H. Frank*
his ATTY.

Sept. 19, 1939.

G. S. FORICHON

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Fig. 6.

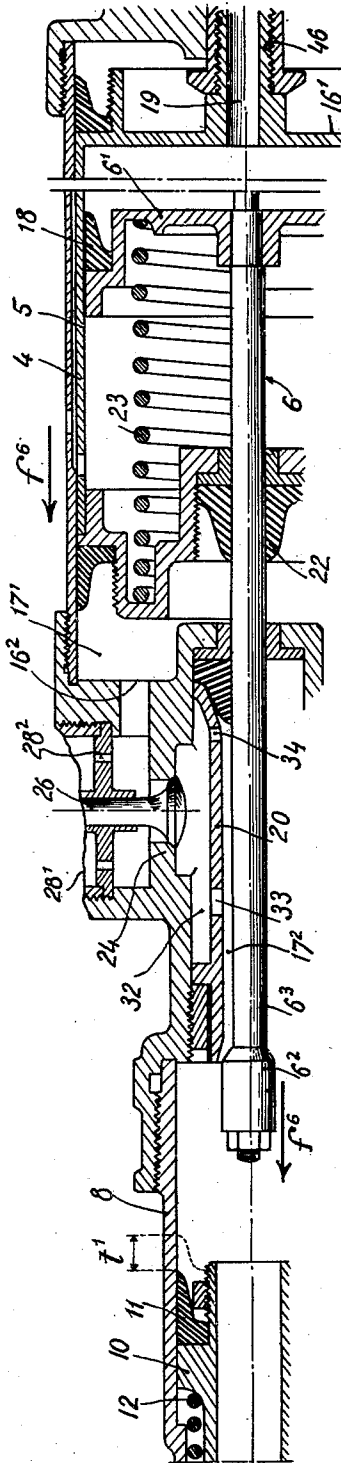
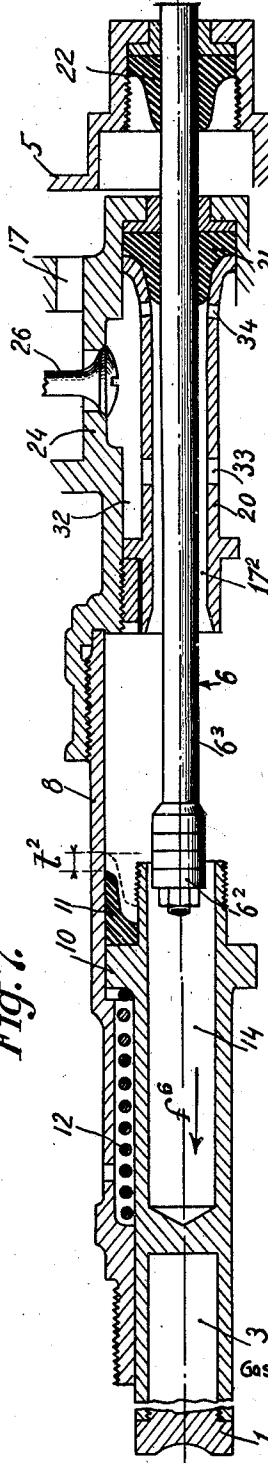


Fig. 7.



Gaston Sébastien Forichon
INVENTOR:

By *Oldhunk*
his ATTY.

Sept. 19, 1939.

G. S. FORICHON
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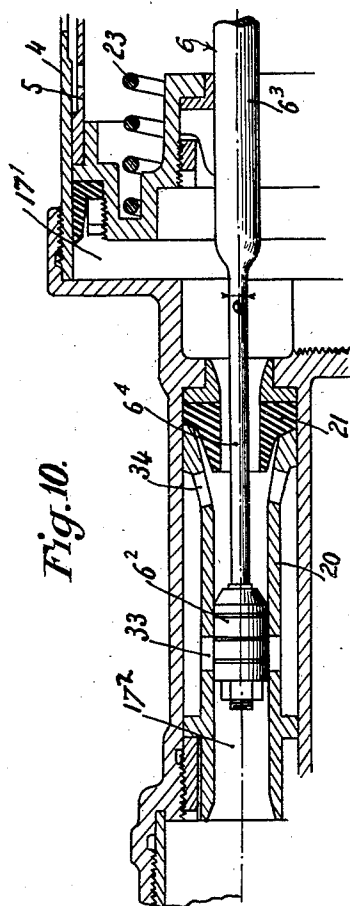


Fig. 10.

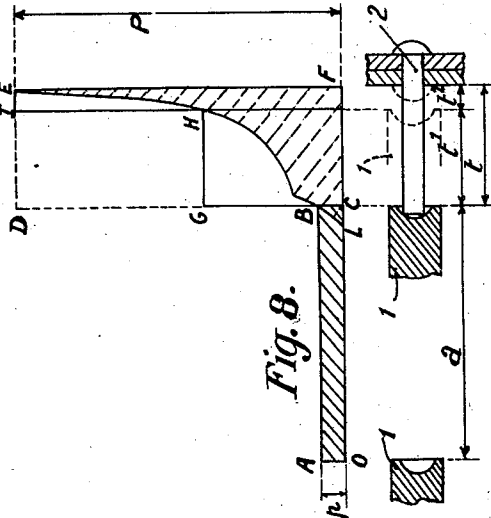


Fig. 8.

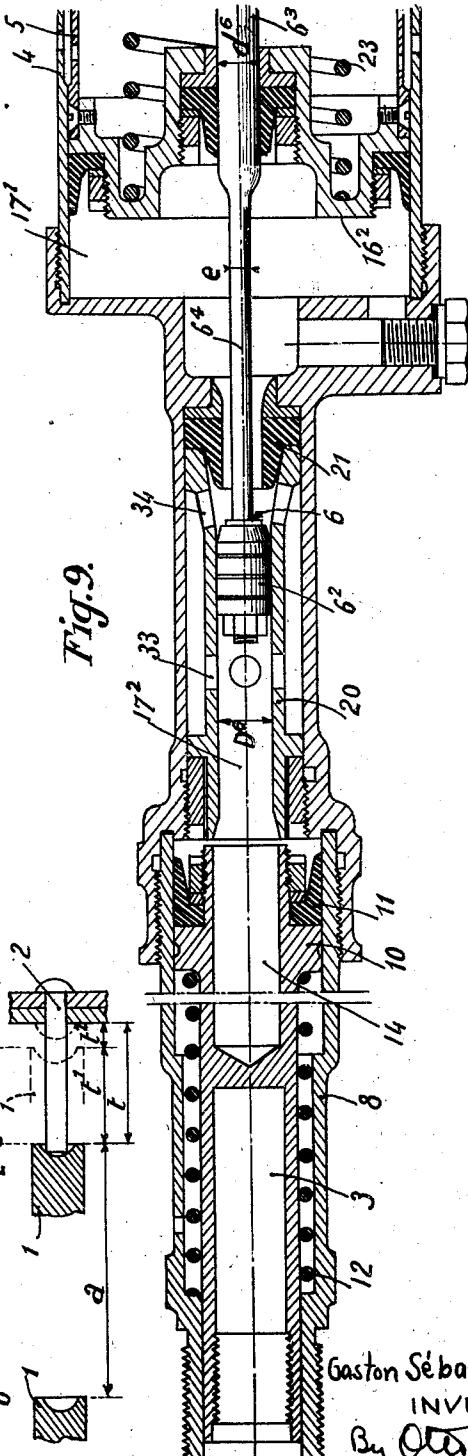


Fig. 9.

Gaston Sébastien Forichon
INVENTOR
By *O. O. O. O.*
his ATT'Y.

Sept. 19, 1939.

G. S. FORICHON

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Fig. 11.

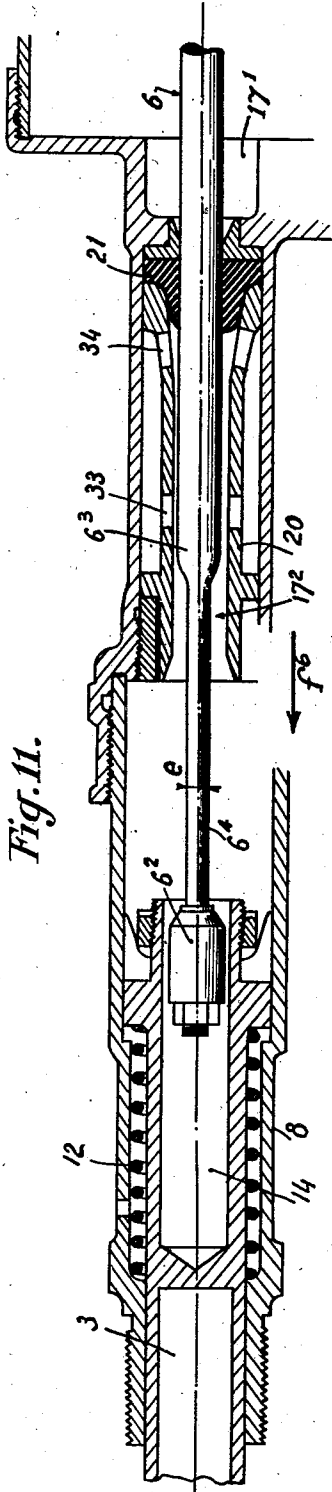
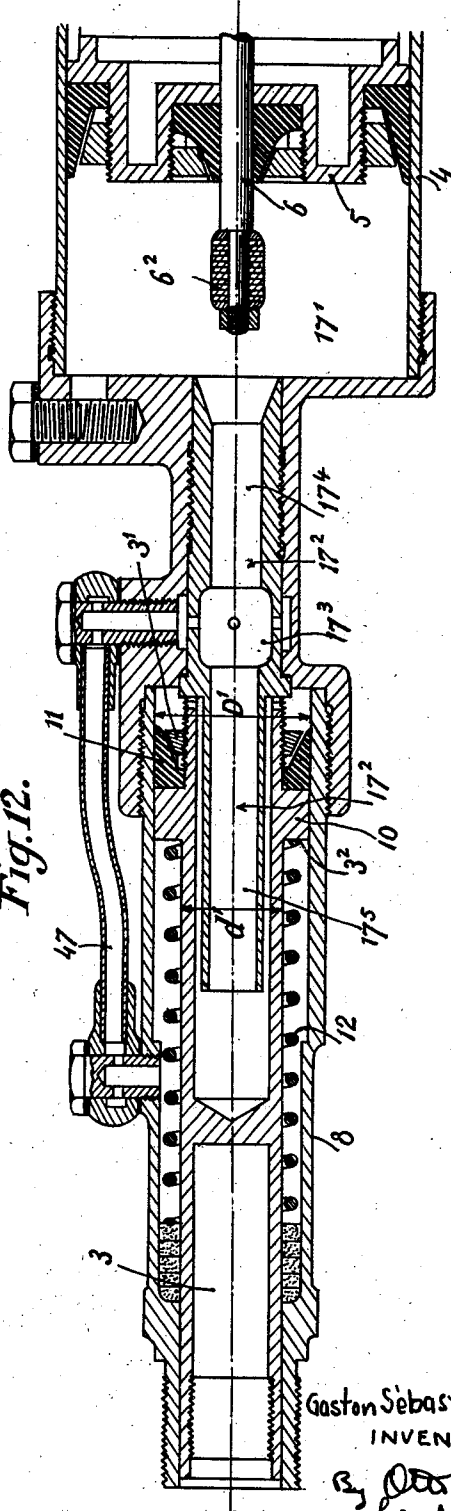


Fig. 12.



Gaston Sébastien Forichon
INVENTOR

By *O. Schunk*
his ATT'Y.

Sept. 19, 1939.

G. S. FORICHON

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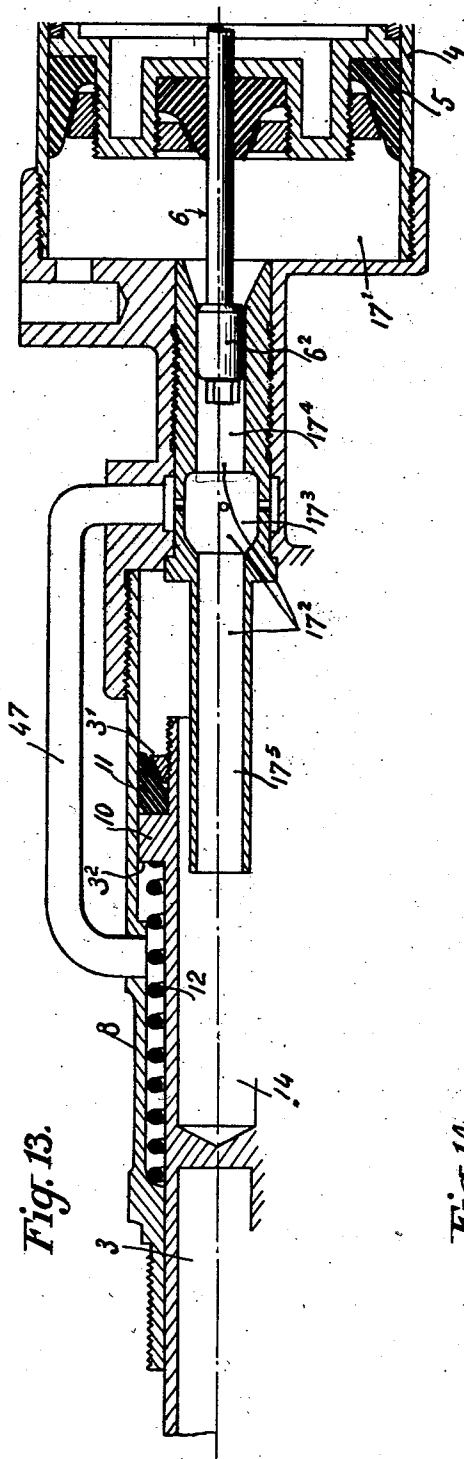


Fig. 13.

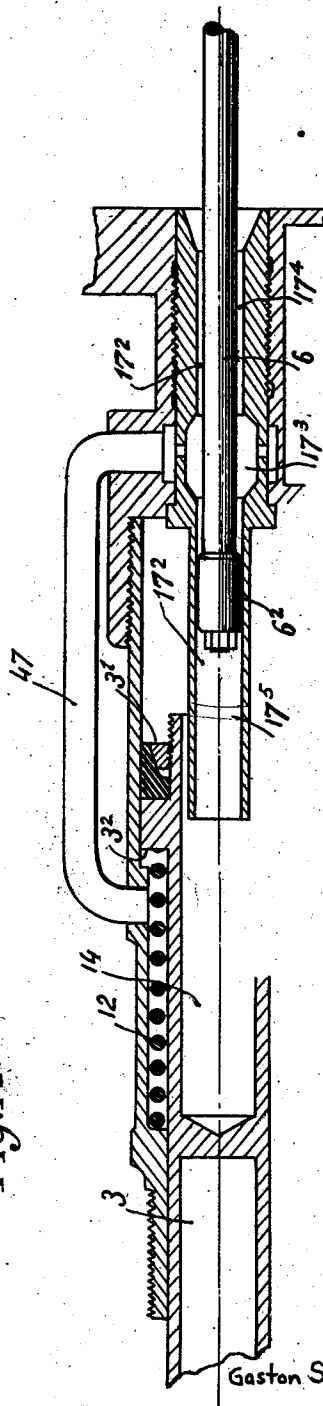


Fig. 14.

Gaston Sébastien Forichon
INVENTOR
By *Ottomund*
his ATT'Y.

UNITED STATES PATENT OFFICE

2,173,583

PRESS AND METHOD OF PRESSING

Gaston Sebastien Forichon, Paris, France

Application May 22, 1936, Serial No. 81,164
In France April 21, 1936

6 Claims. (Cl. 60—54.5)

Presses are already known, in particular riveting presses, in which a movable head carrying the riveting tool, is actuated by means of a fluid on which two pistons are successively operated; an approach piston of low power and a working piston of high power.

One object of the present invention is to reduce to a minimum the losses of energy of the driving medium used in carrying out the work.

A further object is the production of a press which takes care automatically and without control, that the work is executed with pressures of increasing values regardless whether the driving force is increased or not.

Still a further object is to produce a portable press of light weight and reduced size.

Riveting presses according to the present invention are illustrated by way of example in the accompanying drawings, in which:

Fig. 1 is a diagram showing the development of the different forces in a riveting press.

Figure 2 is an axial section of the assembly of a press according to the invention.

Figure 3 is a section along the line 3—3 of Figure 2.

Figure 4 is a transverse section along the line 4—4 of Figure 3.

Figures 5 to 7 are axial sections showing the successive positions of the members of the said press during a riveting operation.

Figure 8 is a diagram representing the work done by the press above mentioned.

Figure 9 is a partial axial section of a press according to a modification of Figure 2.

Figures 10 and 11 are two partial axial sections showing successive positions of members of the said press.

Figure 12 is a partial axial section of another press according to the invention.

Figures 13 and 14 are two partial axial sections showing successive positions of members of the same press.

In a riveting press the riveting operation is carried out in two phases (Fig. 1): an approach phase corresponding to the path a of the tool or snap head die 1, and a working phase corresponding to the path of the said snap head die 1, i. e. to the setting of the rivet 2.

The approach stroke a of the snap head die 1 is effected by a low driving force p so that the corresponding work $p \times a$ is represented by the area OABC.

The working stroke t of the spare head 1 can be accomplished by the development of a driving

force P which grows in proportion to the advancement of the working stroke t .

However, in the actually known riveting presses, the pressure per square inch applied to the spare head remains substantially constant during the entire working stroke, whereby it becomes necessary to develop a driving force which in the beginning of the working stroke considerably exceeds the necessary force. The result is a considerable loss of energy. The driving force spent in the working stroke of the known devices is represented by the area CDEF, whereas the useful working stroke only requires the development of a force corresponding substantially to the force of resistance represented by the area LBHEF.

The processes according to the present invention renders it possible to develop pressure forces which grow progressively and relative to the advancement of the work, so that the diagram of the pressure forces is assimilated to that of the useful work and the loss of energy in the execution of the work is considerably reduced.

The riveting press shown in Figures 2-7 comprises the following principal members:— a riveting tool 1 integral with a moveable working head 3, a transmission cylinder 4, an approach piston 5, a working piston 6, a control member such as a distributor 7 for the operating fluid.

The movable head 3 is slidably mounted in a cylinder receiver 8, which is screwed on an extension 9¹ of the bottom 9 of the transmission cylinder 4.

The said movable head 3 is provided with a shoulder 10 which forms a piston and one of the faces 3¹ of which receives a packed joint 11 ensuring a fluid-tight seal in one direction between said movable head and its cylinder 8. The other face 3² of the said piston serves as an abutment for a spring 12 which, bearing on a shoulder 13 of the cylinder 8, constantly urges the movable head 3 in the direction of its return stroke f ¹.

Finally the movable head 3 presents an axial cavity 14 of diameter D^3 .

The transmission cylinder 4 receives the approach piston 5 which is constituted by a cylindrical body with sliding surfaces 5¹ 5² and a fluid tight joint 15¹ 15².

7 denotes a distribution valve for a pressure fluid, such as compressed air. The valve 7 permits the compressed air, which may be delivered by a reservoir of any known type (not shown) to enter through an inlet duct 40, one end of a duct 41. The other end of the duct 41 terminates at a point close to the face 16¹ of the approach

piston, which face thus receives the pressure of the compressed air, while the other face 16² of the said approach piston 5 is in contact with the transmission liquid; the said liquid is contained in a chamber 17 formed by an extension 17¹ of the principal cylinder 4 and by the axial space 17² provided in the extension 9¹ of the bottom of the cylinder 9. The extension 17¹ thus acts to supply the feed.

The working piston 6 comprises a plurality of elements each one of which plays a predetermined part in the operation: a driving piston 6¹ with a fluid tight joint 18 is slidably mounted in the approach piston 5 which forms a cylinder for this purpose; the said piston 6¹ directly receives the pressure of the operating fluid through the duct 19; the working piston proper 6² of diameter D⁶ which is less than D³, slides in a cylinder 20 centered in the chamber 17 containing the transmission liquid; a rod 6³ forming a plunger piston of diameter d⁶ less than D⁶ connects the piston 6¹ to the working piston proper 6². The said rod 6³ passes through two joints 21, 22 one of the joints 21 being provided in the bottom 9 of the principal cylinder 4 and the other joint 22 being provided in the face 16² of the approach piston 5.

A spiral spring 23 bearing on the inside part of the face 16² of the approach piston 5 constantly urges the working piston 6 in the direction *f*¹ of its return stroke.

The chamber 17 containing the transmission liquid comprises a partition 24 which divides the said chamber 17 into two parts 17¹ 17², an upstream part 17¹ constituting the transmission chamber proper and a downstream part 17² relative to the flow of the liquid during the working stroke of the members of the press. The downstream part 17² forms a single working chamber of uniform cross-section interposed between the transmission chamber 17¹ and the cylinder receiver 8.

The partition 24 comprises an orifice 25 controlled by a valve 26 of which the spring 27 constantly urges the said valve against the orifice 25. Further the front part 17¹ of the chamber 17 communicates permanently through ports 28¹ 28² with an auxiliary chamber 28 limited by a cylindrical body 29, in which moves a piston 30 which is constantly urged in the direction *f*² by a spring 31.

At the end of the stroke in the direction *f*² the piston 30 comes to abut on the valve spindle 26 which then puts the two parts 17¹ 17² of the chamber 17 in communication with each other.

An annular space 32 is provided between the inside wall of the chamber 17 and the cylinder 20 of the working piston proper 6². This annular space 32 which also surrounds the spindle 6³ at its exit from the joint 21 communicates with the front feed chamber 17¹ through the orifice provided with valves 26.

Ports 33, 34 put the annular space 32 in communication with the inside of the cylinder 20 of the working piston 6².

The distributor 7 is essentially characterized by a balanced slide valve 7¹ which slides in a casing 35 and which is actuated externally by means of a lever 36. The said slide valve 7¹ controls the ports 37, 38, 39, 39¹. The ports 39 and 39¹ are put into communication successively with an inlet air duct 40. A duct 41 puts the ports 39 into communication with the face 16¹ of the approach piston 5, a connecting duct 42 making the face 18¹ of the working piston 6¹ communicate with the ports 39¹ in the direction *f*³.

When the lever 36 is depressed the valve 7¹ slides in the direction of the arrow *f*⁴. In this way the valve 7¹ opens the orifices 39 so that the compressed air can pass from the inlet duct 40 through the port 37 to the channel 41, which terminates in the bottom of cylinder 4 (Fig. 4). The compressed air conducted into this cylinder acts upon the face 16¹ of the approach piston 5 to move it in the direction *f*⁶.

The valve 7¹ continuing its course in the direction *f*⁴ finally opens the orifices 39¹ (Fig. 3), so that the compressed air can stream into the channels 42 and 44 and from there in the direction *f*³ through the tube 46 onto the face 18¹ of the working piston 6¹.

It will be understood that in this construction the distributor 7 constitutes the equivalent of a driving device in so far as this distributor controls the action of the pressure fluid on the approach piston 5 and on the working piston 6.

Finally, the said press is completed by a handle 43 of which an axial hole 44 extends the duct 42 for the admission of compressed air to the piston 6¹; the said handle 43 also permits adjustment of the initial position of the approach piston 5 due to a screw threaded part 45 in which is screwed a screw threaded extension 46 of the said approach piston 5.

This press operates in the following manner:

(a) *Approach stroke*.—Compressed air is admitted on to the face 16¹ of the approach piston 5, thereby producing a displacement of the said piston 5 in the direction *f*⁶ (Figures 2 and 5).

The approach piston 5 drives the transmission liquid which then flows through the orifices or ports 25, 33 and displaces the movable head 3 in the direction *f*⁶.

During the said displacement of the approach piston 5, the pressure of the transmission liquid increases, thereby raising the piston 30. The valve 26 is thus freed so that at the end of the stroke of the approach piston 5, after the pressures on both sides of the orifices 25 have been stabilized the said valve 26 becomes reclosed under the action of its spring 27.

When the approach piston 5 is at the end of its stroke, the movable head 3 becomes displaced by the amount (a) (approach stroke; Fig. 5).

(b) *Working stroke*.—Compressed air continues to be admitted on the piston 6¹, the said air no longer driving the approach piston 5, which has arrived at the end of its stroke but displacing the piston 6¹ in the direction *f*⁶ (Figures 5 and 6).

At the beginning of the stroke of the said piston 6¹, the working piston 6² closes the ports 33 and slides in its cylinder 20 thereby driving the transmission liquid into the cylinder 8 of the movable head 3 which thus becomes displaced during the first part of the working stroke by a further amount *t*¹ (Figure 6) corresponding to the beginning of the riveting operation (Figure 8).

During the first part of the working stroke, piston 6² closes the ports 33 in the cylinder 20 and then creates a depression in its rear and simultaneously in the annular space 32 and chamber 17. Consequently the valve 26 opens under the pressure of the liquid in chamber 17¹, whereby the depression which tends to develop at the right side of piston 6², is compensated.

The communication between the chamber 17 and the chamber 17¹ is ensured during the return stroke by the action of spring 31 lifting valve 26 from its seat.

The working piston 6², 6³ has a stroke greater

than the length of the working cylinder 20. As soon as the working piston 6² leaves its cylinder 20 (Figure 6), the displacement of the movable head 3 is no longer ensured by the said piston 6², but by the rod 6³ of the said piston which then forms a working plunger piston. At this instant the pressures between the annular space 32 and the cylinder 8 of the movable head 3 become stabilized so that the pressure in this annular space 32 increases, thereby causing closure of the valve 26 (Figure 6) assisted by its spring 27.

The transmission liquid then becomes totally enclosed in the working chamber formed by the chamber 17² and the cylinder 8; consequently the movable head 3 becomes displaced by an amount t^2 under the action of the pressure due to the penetration of the rod 6³ forming the plunger piston in the working chamber 17². The displacement t^2 of the movable head corresponds to the termination of the riveting operation (Figures 7 and 8).

Since the section of the rod 6³ is smaller than that of the piston 6² the force which acts on the movable head 3 during the portion of the stroke t^2 is greater than the force which acts on the said movable head 3 during the portion of the stroke t^1 .

It has been specified that the diameter D⁶ of the working piston 6² is smaller than the diameter D³ of the cylinder 8. During the first part of the working stroke the large section 6² of the working piston 6 becomes displaced in the working cylinder 20 forming a joint with it, while during the second part of the working stroke, the smaller section 6³ of the working piston 6 moves freely in the working cylinder 20 and in the chamber 14 of the movable head 3, thereby producing the high pressure necessary towards the end of the working operation.

To sum up, the working piston which after the action of the approach piston 5 operates on the transmission liquid in order to create the working pressure, operates successively through several sections of different magnitudes, to each one of which there corresponds a different working pressure.

According to the invention a process is therefore put into operation for the working of a metal under the action of a driving force such as the pressure of compressed air and of a liquid operating at constant volume, which process is characterized by the feature that a force of constant pressure is developed in order to ensure the approach of a working tool and then forces are developed with successive pressures of different values during the working operation. This permits the pressure force diagram and the useful working diagram of the metal to be rendered as identical as possible and consequently permits the loss of energy in the execution of the working operation to be reduced to the minimum.

In order to return all parts of the device to their inoperative positions the lever 36 of the distributor 7 is released, whereupon the valve 7¹ connects the ducts 41 and 42 (Fig. 3) with the atmosphere through duct 38, and the action of the compressed driving medium on the approach piston 5 (face 16¹) and the working piston 6 (face 18¹) ceases. The working piston 6 is returned in a direction opposite to f^6 by means of its return spring 23. The working head which is no longer subject to the force of the driving liquid returns in the direction f^1 by means of its return spring 12 and presses the liquid contained in chamber 14 towards chamber 17²

and 17¹, whereby the approach piston 5 is returned into its inoperative position in a direction opposite to f^6 . The communication between the chambers 17² and 17¹ is secured by the valve 26 which is kept open by the bottom of the regulating piston 30. The return spring 31 of the piston 30 exerts a pressure in the direction f^2 superior to that of the return spring 27 of valve 26.

In particular Figure 8 shows that the increase in the work obtained with respect to a press that comprises only two operating phases a and t , is equal to the area GDIH.

In the above example, the said method has been applied in particular to the crushing of a rivet 2 joining two plates, the successive pressure forces having increasing values during the working operation. Various modifications may be introduced into the riveting press above described by way of example without thereby departing from the scope of the invention.

In particular in the press shown in Figures 9-11, the two different sections 6², 6³ of the working piston 6 are connected to one another through a part 6⁴ of very small diameter e . In this way in the first part t^1 of the working stroke t , the liquid is conducted from the feed chamber 17¹ behind the section 6² of large diameter D⁶ of the working piston (Figure 10).

The liquid from chamber 17¹ passes freely in the annular space left between the thin portion 6⁴ of the piston rod and the package joint 21, as long as the part 6³ of the piston rod with the diameter d^6 does not engage said joint 21.

In this way a constant filling of the liquid behind the said section 6² is ensured.

Moreover, during the second part of the working stroke, the section 6³ of small diameter of the working piston 6 engages exactly in the joint 21 separating the feed chamber 17¹ from the working chamber 17² (Figure 11).

Before the working stroke t , the ports 33, 34 discharge on both sides of the large section 6² of the working piston (Figure 9). Communication between the feed chamber 17¹ and the movable head 3, is thus ensured, the said head 3 then executing its approach stroke only under the action of the approach piston 5.

Moreover, this arrangement permits the liquid to return to the feed chamber 17¹ after the working stroke.

To sum up, a working stroke is obtained as previously, comprising two phases t^1 , t^2 ; the phase t^2 during which the working head receives an increased force corresponds to the termination of the riveting operation.

The press shown in Figures 12-14, is similar to those previously described with respect to the principal cylinder 4, the approach piston 5, the working piston 6 and the distribution members (not shown).

On the other hand this press differs from the presses above described in the arrangement of the movable head 3 and the working chamber 17² as well as in the method of operation of the approach piston 6 on the movable head 3.

The working chamber 17² comprises two parts 17⁴, 17⁵ of the same diameter connected by a wider part 17³.

A by-pass 47 puts the said wider part 17³ of the working chamber 17² into communication with the cylinder 8 at a part of the said cylinder situated at the rear of the maximum stroke of the movable head.

This press operates in the following manner:

The approach stroke a is obtained as pre-

viously described, the approach piston 5 driving the transmission liquid towards the movable head 3.

As soon as this approach stroke a is completed, the working piston 6² penetrates into the first part 17⁴ of the working chamber 17² (Figure 13) and increases the pressure of the transmission liquid in the said chamber, this pressure being transmitted equally to the two faces 3¹ 3² of the movable head 3 due to the by-pass 47.

The movable head 3 then becomes displaced with a force which arises from the difference between the pressure forces on its face 3¹ of diameter D^1 and on its face 3² of annular section width $D^1 - d^1$.

If p denotes the pressure per unit area, the resultant force f on the movable head 3 is equal to:

$$f = \frac{\pi \bar{D}_1^2}{4} \times p - \left[\frac{\pi \bar{D}_1^2}{4} - \frac{\pi \bar{d}_1^2}{4} \right] p$$

or

$$f = \frac{\pi \bar{d}_1^2}{4} p$$

When the working piston 6² passes the part 17³ of the working chamber (Figure 14) the rear part of the cylinder 8 is put into communication with the part 17⁴ of the working chamber 17² through the by-pass 47. Consequently the pressure on the face 3² of the movable head decreases suddenly and returns to the low value given by the approach piston 5.

The value of this residual pressure of the face 3² on the movable head, can be neglected so that the said movable head is displaced with a force corresponding to the action of the pressure over the whole of the surface of diameter D^1 , or:

$$F = \frac{\pi \bar{D}_1^2}{4} \times p$$

The movable head 3 thus constitutes a differential piston, the opposite faces of which are in communication with the working chamber 17², the larger face 3¹ communicating directly with the said chamber 17², while the smaller face 3² communicates with the said chamber 17² by means of a by-pass 47 which discharges into a region 17³ of the said working chamber separated from the movable head 3 and subjected to low pressure after a certain movement of the working piston 6². Consequently during the first part of the working operation, the pressure produced by the working piston 6² acts in a differential manner on the movable head 3, the displacement of the said movable head being then ensured only by the reduced working section of the said head 3, while during the second part of the working operation the pressure produced by the working piston 6² operates on the whole section of the movable head 3.

In this way a force f is first produced corresponding to the first working phase t^1 , and then an increase force F is produced corresponding to the completion of the said working operation.

In other words during the working operation the movable head 3 presents different working sections D^1 d^1 upon which the pressure of the liquid is exerted, this difference of working section permitting forces of different pressures to be obtained during the working operation.

Moreover, the working piston 6 forms a slide valve distributor and controls the by-pass 47 which makes communication between the smaller face 3² of the movable head 3 and the part of

the working chamber 17² which is subjected to low pressure at the second phase of the working operation.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a press for riveting and similar applications, a transmission cylinder, a chamber containing a transmission liquid and in communication with said transmission cylinder, an approach piston slidably mounted in said transmission cylinder to exert a pressure on the liquid in said transmission chamber, a single working cylinder in communication with said transmission chamber, a working piston arranged for sliding displacement in said working cylinder and having a stroke greater than the length of the latter, said working piston having a plurality of working sections of different diameter to exert pressures of different values on the transmission liquid, the smallest section of said working piston defining an annular space between itself and the working cylinder, means for placing said annular space in communication with said transmission chamber, a driving device to actuate successively the approach piston and the working piston, control means for said driving device to control the successive actuation of the approach piston and the working piston, a cylinder receiver connected with said working chamber, and a movable working head displaceably arranged in said cylinder receiver and subject to the action of the transmission liquid.

2. In a press for riveting and similar applications, a transmission cylinder, a chamber containing a transmission liquid and in communication with said transmission cylinder, an approach piston slidably mounted in said transmission cylinder to exert a pressure on the liquid in said transmission chamber, a single working cylinder in communication with said transmission chamber, a working piston arranged for sliding displacement in said working cylinder and having a stroke greater than the length of the latter, said working piston comprising two working sections of different diameter, the larger section being arranged at the forward end of said working piston and the smaller section following said larger section, said larger section being adapted upon displacement of the working piston toward the cylinder receiver first to form a packed joint in the working cylinder so as to develop low pressures and thereafter to become ineffective upon moving out of said working cylinder, a driving device to actuate successively the approach piston and the working piston, control means for said driving device to control the successive actuation of the approach piston and the working piston, a cylinder receiver connected to the working cylinder and in alignment therewith for receiving said working piston, and a working head displaceably arranged in said cylinder receiver and subject to the action of the transmission liquid.

3. In a press for riveting and similar applications, a chamber containing a constant volume of transmission liquid, a partition with a passage orifice dividing said transmission chamber into two parts, an upstream part and a downstream part, the latter forming a single working chamber, a valve controlling said passage orifice and opening towards said down stream part of the transmission chamber, a transmission cylinder connected to the upstream part of the transmission chamber, an approach piston slidably

mounted in said transmission cylinder to exert a pressure on the transmission liquid, a single working cylinder mounted in the downstream part of the transmission chamber and in communication therewith, a working piston slidably mounted in the working cylinder and having a stroke exceeding the length of the latter, said working piston comprising two sections of different diameters, the section of larger diameter controlling the communication between the working cylinder and the downstream part of the transmission chamber, and the section of smaller diameter producing an increased pressure in the downstream part of the transmission chamber and closing said valve, when the larger section during displacement of the working piston becomes ineffective upon moving out of the working cylinder, a driving device to actuate successively the approach piston and the working piston, control means for said driving device to control the successive actuation of the approach piston and the working piston, a cylinder receiver connected with said working chamber, and a working head displaceably arranged in said cylinder receiver and subject to the action of the transmission liquid.

4. In a press for riveting and similar applications, a chamber containing a constant volume of transmission liquid, a partition with a passage orifice dividing said transmission chamber into two parts, an upstream part and a downstream part, the latter forming a single working chamber, a valve controlling said passage orifice and opening, towards said downstream part of the transmission chamber, a transmission cylinder connected to the upstream part of the transmission chamber, an approach piston slidably mounted in said transmission cylinder to exert a pressure on the transmission liquid, a single working cylinder mounted in the downstream part of the transmission chamber and in communication therewith, a working piston slidably mounted in the working cylinder and having two sections of different diameters, the section of larger diameter controlling the communication between the working cylinder and the downstream part of the transmission chamber, and the section of smaller diameter defining an annular space between itself and the working cylinder, means for placing said annular space in communication with said transmission chamber, a driving device to actuate successively the approach piston and the working piston, control means for said driving device to control the successive actuation of the approach piston and the working piston, a cylinder receiver connected with said working chamber and a working head displaceably arranged in said cylinder receiver and subject to the action of the transmission liquid.

5. In a press for riveting and similar applications a chamber containing a constant volume of transmission liquid, a partition with a passage orifice dividing said transmission chamber into two parts, an upstream part and a downstream part, the latter forming a single working chamber, a valve controlling said passage orifice and opening towards said downstream part of the transmission chamber, abutment means controlling the position of the valve and controlled by the

liquid in the upstream part of the transmission chamber, a transmission cylinder connected to the upstream part of the transmission chamber, an approach piston slidably mounted in said transmission cylinder to exert a pressure on the transmission liquid, a single working cylinder mounted in the downstream part of said transmission chamber and in communication therewith, a working piston slidably mounted in the working cylinder, said working piston comprising two sections of different diameters, the section of larger diameter controlling the communication between the working cylinder and the downstream part of the transmission chamber and the section of smaller diameter producing an increased pressure in the downstream part of the transmission chamber and closing said valve, when the larger section during displacement of the working piston has become ineffective upon moving out of the working cylinder, a driving device to actuate successively the approach piston and the working piston, control means for said driving device to control the successive actuation of the approach piston and the working piston, a cylinder receiver connected with the working chamber, and a working head displaceably arranged in said cylinder receiver and subject to the action of the transmission liquid.

6. In a press for riveting and similar applications, a chamber containing a constant volume of transmission liquid, a partition with a passage orifice dividing said transmission chamber into two parts, an upstream part and a downstream part, the latter forming a single working chamber, a valve controlling said passage orifice and opening towards said downstream part of the transmission chamber, a control cylinder connected to the upstream part of the transmission chamber, a control piston slidably mounted in said control cylinder and arranged to abut against said valve, a spring urging said control piston against said valve in order to open the latter, a transmission cylinder connected to the upstream part of the transmission chamber, an approach piston slidably mounted in said transmission cylinder to exert a pressure on the transmission liquid, a single working cylinder mounted in the downstream part of the transmission chamber and in communication therewith, a working piston slidably mounted in the working cylinder, said working piston comprising two sections of different diameters, the section of larger diameter controlling the communication between the working cylinder and the downstream part of the transmission chamber and the section of smaller diameter producing an increased pressure in the downstream part of the transmission chamber and closing said valve when the larger section during displacement of the working piston has become ineffective upon moving out of the working cylinder, a driving device to actuate successively the approach piston and the working piston, control means for said driving device to control the successive actuation of the approach piston and the working piston, a cylinder receiver connected with the working chamber, and a working head displaceably arranged in said cylinder receiver and subject to the action of the transmission liquid.

GASTON SEBASTIEN FORICHON.