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METHODS AND DEVICES FOR SHAPING PIECES

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2 Sheets-Sheet 1

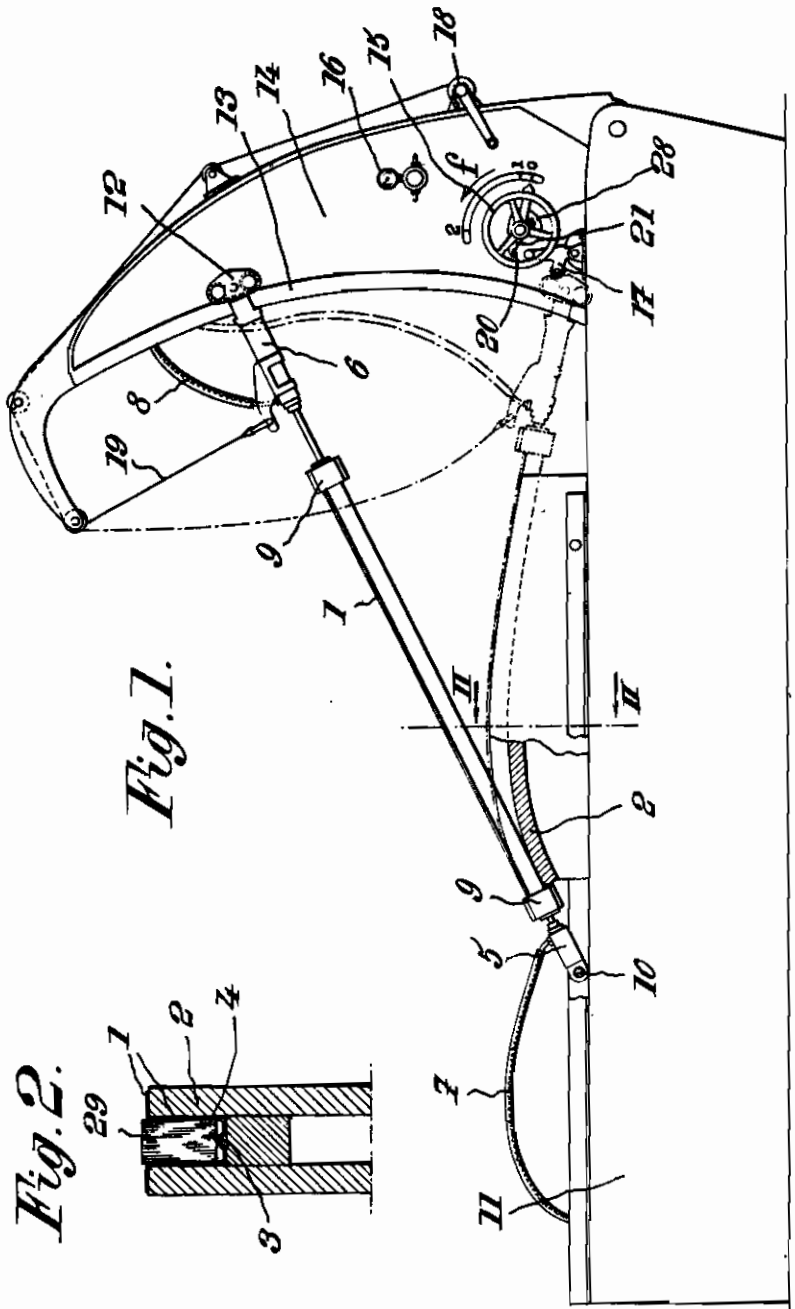

Fig. 1.

Fig. 2.

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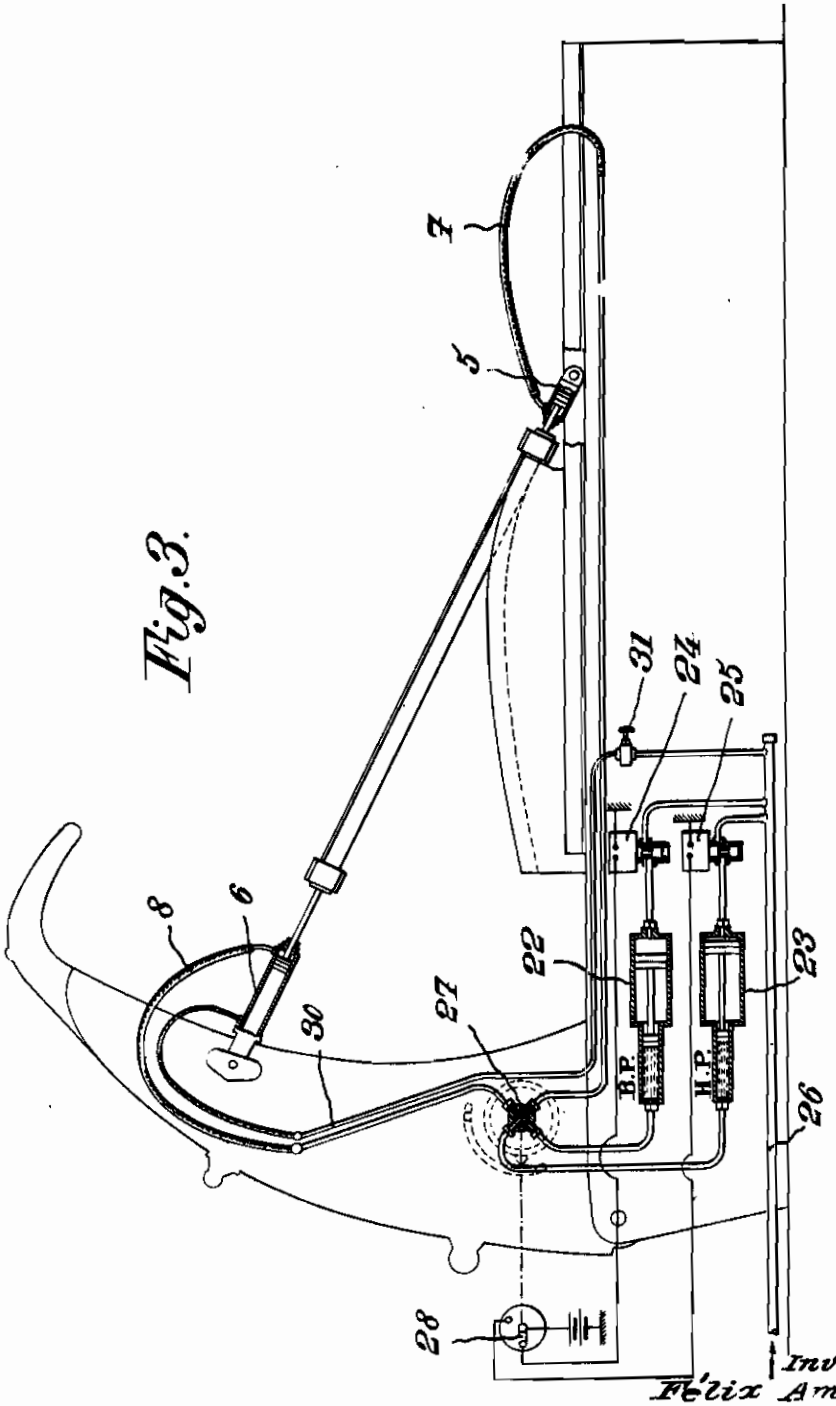
Fig. 3.



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METHODS AND DEVICES FOR SHAPING PIECES

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The present invention relates to methods and devices for shaping pieces, especially metal pieces by causing them to conform to shaping members or suitable curved pieces.

The chief object of the present invention is to provide a method and device of the type above referred to which is capable of meeting the requirements of practice, especially concerning the finish of the articles obtained and the rapidity of work.

The essential feature of the present invention consists in subjecting the pieces to be treated, in the course of their shaping, to a given tension or stretching, preferably close to their elastic limit.

According to another feature of the present invention, when it is desired to conform a surface to the shape of another surface, for instance to conform a sectional iron to be bent to a shaping piece, I guide the piece to be bent by means of a carriage or another analogous system capable of moving along a path such, and of exerting between said piece and these guiding means forces such, that said carriage automatically tends, under the effect of these forces, to move in the direction which corresponds to the bending of the piece.

Other features of the present invention will result from the following detailed description of some specific embodiments thereof.

Preferred embodiments of the present invention will be hereinafter described, with reference to the accompanying drawings, given merely by way of example.

Fig. 1 is an elevational view of a machine for bending sectional irons in accordance with the method of the invention, this machine itself being made according to the invention;

Fig. 2 is a sectional view on an enlarged scale on the line II—II of Fig. 1;

Fig. 3 is a partial diagrammatic back view corresponding to Figs. 1 and 2.

In the following description with reference to the drawings, it will be supposed that the invention is applied to the bending and shaping of sheet iron pieces intended, for instance, for use in aeronautical construction.

It is already known, for shaping such pieces, to start from elements or irons of suitable section, either rectilinear or already curved, which are adapted in any suitable manner on shaping elements.

One of the difficulties that are met with is to ensure a perfect contact of the metal at all points with the shaping element. As a matter of fact, some portions of the piece to be treated tend to form undulations or folds.

In order to obviate these drawbacks, and also to obtain further advantages which will appear hereinafter, I proceed in such manner, according to the present invention, that the pieces are subjected, in the course of their shaping, to a suitable tension or stretching, which may be, but is not necessarily, close to the elastic limit of the metal of which said pieces are made.

According to the present invention, this tension may be applied in a single operation during the whole time of the shaping operation, while the piece is being brought into contact with the surfaces of the bent element, or this tension may be applied only during a portion of this operation, especially at the end thereof, after the piece to be treated has already been brought into contact with the bent element and there remains only to perfect the bending of said piece.

Or, according to a preferred embodiment of the invention, the tension or stretching is applied in several successive steps, and this, if need be, in correspondence with different values of the tension; for instance the method includes the utilization of relatively low tension f during the period of time for which the piece is brought into contact with the shaping element, then, after this contact has been established, the piece is subjected to a higher tension F (which is for instance, in the case above considered, close to the elastic limit, while the first value f averages F/10 or more).

Of course, the tension or stretching may be applied in a different manner.

Concerning now the apparatus to be provided for carrying out the method above specified, it can be devised in many different ways.

However, it seems advantageous to have recourse, for the construction of this apparatus, to another feature of the invention according to which, in order to cause the piece to be treated to conform to the shape of the curved element, use is made of the tension applied to said piece, this tension serving, in combination with suitable guiding means, automatically to produce the desired displacements or deformations.

Supposing, for instance, that it is desired to bend a sectional iron 1 to the shape of a curvilinear element 2, for example with a view to obtaining a rib element for an airplane wing, said sectional iron having, in particular, in the known manner, a U-shaped section with a groove 3 along which it can be sawed into two parts, and shaping member 2 having inner shaping surfaces 4 which

correspond to those of said sectional iron, I proceed as follows:

Concerning first the means for exerting the desired tension or stretching on the sectional iron, I preferably make use of pneumatic or hydraulic means. In particular, if a certain pneumatic pressure is available, it is advantageous, especially if two elementary operations are to take place at tensions *f* and F, to have this pressure acting on hydropneumatic relays, in such manner as to have, at will, either of two hydraulic pressures *p* and P, it being understood that it is possible to act on the pneumatic pressure through pressure relieving means.

The hydraulic or other pressure that is obtained is then caused to act:

a. either only at one of the ends of the sectional iron, the other end of said piece being secured in any suitable manner; or

b. at least during the second step of the process, at both ends in such manner as to obtain, by balancing the frictional stresses on the curved element, a suitable balancing of the tensions over the whole length of the piece.

In the embodiment of Fig. 1, I have shown two receivers, for instance of the hydraulic type, **5** and **6**, which receive fluid under pressure through flexible conduits **7** and **9** and are connected to the sectional iron through jaws **8** of any suitable type holding the ends of said sectional iron **1**.

Concerning now the means for bringing the sectional iron into intimate contact with the corresponding shaping piece, through the application of the pressure, they are, for instance, advantageously made as follows:

One of the receivers, **5** for instance, is pivotally secured at **10** to the frame **11** of the machine;

The other receiver is carried by a carriage **12** capable of moving along a guiding path element **13** arranged in such manner that the application the pressure tends to cause said carriage to move forward along said path in the desired direction. In order to obtain this result, the tangent to the guiding path should make, with the direction of the effort exerted by the pressure, an angle different from 90°, which angle will be calculated in a suitable manner as a function of said pressure (this obliquity corresponding, for instance, to a gradient of, say 10%).

The guiding rail **13** is, for instance, carried, by a support **14** which may also carry means for controlling the pressure such as **15**, a pressure gauge **16**, and so on.

Advantageously, I further provide means for conjugating the displacements or deformations of the piece to be bent with the control of the pressure, in such manner that the passage from pressure *p* to pressure P can take place only when the piece comes into its bent position on shaping element **2**.

For this purpose, for instance, carriage **12** can come, at the end of its movement, into engagement with a locking member **17**. Said member coacts with the end **20** of a finger **21** carried by the operating wheel **15** of the machine. Normally, locking member **20**, in cooperation with **17**, prevents wheel **15** from being turned in the direction of arrow *f*. When the carriage passes (position shown in dotted lines in Fig. 1) locking member **17** is moved away, and the operating wheel **15** can be turned. I might provide any other equivalent means and, in particular, member **17** might be adapted automatically to produce the shifting from pressure *p* to pressure P.

In Fig. 3, I have shown, by way of example, several means for the control of the pressure applied by the apparatus.

The hydropneumatic relays are shown at **22** (low pressure) and **23** (high pressure). They are supposed to be electrically controlled, through electro-valves **24**, **25**. In one position, these electro-valves, admit into the corresponding cylinder the air from the compressed air main conduit **26** and, in the other position, they connect said cylinder with the exhaust, it being well understood that, instead of this electric eontrol, I might provide any other type of control, for instance a pneumatic control.

The operating wheel, such as **15** (Fig. 1) is adapted simultaneously to control:

a. On the one hand, a three way cock **27** (Fig. 3) which permits, in a first position, of connecting cylinder **6** to the high pressure relay, and, in a second position, to connect both of the cylinders **5** and **6** to the high pressure relay; and,

b. On the other hand, a contactor **28** (Figs. 1 and 3) adapted to bring into play first electrovalve **24** and then electro-valve **25**.

I thus obtain a system which works in the following manner:

At the beginning of a shaping operation, the sectional iron occupies a position such as shown in solid lines by Fig. 1. The relays are then supposed to be in communication with the atmosphere, which corresponds to the zero position (Fig. 1) of wheel **15**.

This wheel **15** is then operated in direction *f* until it comes into position **1**, illustrated by Fig. 1, for which the low pressure is introduced into receiving element **6**, for instance through the action of valve **24** and cock **27**. The component of this pressure in the direction of the rolling track **13** immediately produces the displacement of carriage **12**. Sectional iron **1** is caused to conform to the shape of piece **2**. The reaction at the other end, at **5**, is supposed to be supported, in the embodiment illustrated by the drawing, by the frame of the machine, due to the fact that the jaw **8** on the left hand side is applied against the shaping member **2**, or the frame **11**.

When carriage **12** comes near to the end of its movement, it acts upon locking member **17**. Consequently, finger **21** is unlocked, so that the operator can actuate wheel **15** so as to bring it into position **2**, which causes the high pressure to be admitted to both of the receiving cylinders **5** and **6**.

Finally, when it is found that the deformations of the piece have become definitive, the hand wheel **15** is brought back to the zero position, which stops the action of the pressure.

It is then possible to remove the finished piece.

Means, such as a winch **18** and a cable **19**, may be provided for bringing back carriage **12** to its initial position. Furthermore, a compressed air conduit **30** (Fig. 3), provided with a cock **31**, may also be provided for bringing back the pistons of the receiving cylinders to their initial positions, by discharging the liquid toward relays **22**, **23**.

On the other hand, it should be noted that, in order to avoid the risk of the lips of the sectional iron being moved toward each other, during the stretching operation, I may place between them small spacing members **29** (Fig. 2).

Also, it should be noted that a same carriage **12** and a same receiving system **5**, **6** might coact with a plurality of sectional irons and shaping elements.

These shaping elements 2 might further be made deformable at will in such manner as to permit shapings of all kinds. Likewise, supporting member 14 might be made adjustable.

In any case, it will be readily understood that the method according to the invention has, over existing methods of the same kind, many advantages, and, in particular, the following:

The pieces are obtained without defects, and especially without folds, which are avoided by the stretching of the metal.

It is possible to apply the method to all kinds of pieces (for instance, in aeronautical construction, to sectional irons for making elements of the fuselage, of the wings, and so on).

The operation is quickly effected, since the shaping takes place under the sole action of the tension.

Of course, before and after the shaping, the pieces may be subjected to all suitable thermic operations.

FÉLIX AMIOT.