This invention relates to a method and apparatus for forming strip material, particularly metals, and is especially concerned with a method and apparatus for forming relatively thin metal strips into molding and the like.

The art of forming moldings by shaping strips of metal, the customary procedure is to pass the metal strip between a pair of complementary shaped rollers, one or both of which may be driven, and in this manner the strip is caused to take the cross-sectional configuration desired.

A difficulty that resides in the forming of metal strips in this manner is that the rollers must be very accurately formed to produce the proper sort of product, and each pair of rollers will handle only a certain fairly limited range of thicknesses of metal because any substantial departure from the thickness for which the rollers were designed would bring about improper spacing of the rollers at certain parts across the strip.

The forming of strip metal by rollers in the described manner also imposes a limitation on the amount of forming that can be accomplished, and deeply crowned moldings or those having complex configurations can be formed only with extreme difficulty, due to the amount of movement that must be taken by the metal and the tendency of the metal to flow and buckle when being deeply formed. Furthermore, it is impossible, when utilizing rollers, to exceed a right-angle bend.

Certain types of molding can also be extruded or drawn through forming dies, but this has the disadvantage of tending to score the surface of the metal, and extra finishing operations are involved on moldings made in this manner.

Having the foregoing in mind, it is a primary object of the present invention to provide a method and apparatus for forming metal strips which avoids the drawbacks referred to above.

Another object of this invention is to provide a method and apparatus for forming strip metal material which is capable of handling metal strips of widely varying thicknesses with any change in the apparatus.

A still further object is the provision of a method and apparatus for forming metal strips in which the strips can readily be given deeply crowned shapes.

Still another object of the present invention is the provision of a method and apparatus for forming strip metal material continuously which does not score or mar the surface of the metal, whereby no finishing operations are required, after the metal has been formed.

Another object is the provision of an apparatus for forming strip metal which eliminates the need for having two expensive forming members running together, and also eliminates the need for synchronizing the movements of two forming members.

These and other objects and advantages will become more apparent upon reference to the following description taken in connection with the accompanying drawings, in which:

Figure 1 is a perspective view showing one form which my invention can take;

Figure 2 is an end elevational view looking in from the left side of Figure 1;

Figure 3 is a fragmentary view of an arrangement similar to that shown in Figures 1 and 2;

Figure 4 is a view similar to Figure 1 but showing a modified arrangement according to my invention utilizing a resilient rubber-like sheet in place of a resilient rubber-like forming wheel;

Figure 5 is a sectional view, indicated by line 5—5 on Figure 4;

Figure 6 shows an arrangement like Figure 1, but somewhat modified as to the manner in which working pressure is developed between the forming elements of the apparatus;

Figure 7 is a side view partly in section showing still another modified form which the device according to this invention can take;

Figure 8 is a sectional view indicated by line 8—8 on Figure 7;

Figure 9 is a fragmentary sectional view showing the use of a solid but resilient forming member reinforced with side plates; and

Figure 10 is a view like Figure 9 but shows a forming member having a resilient annular band on the periphery thereof.

Referring to the drawings somewhat more in detail, there is illustrated in Figure 1 a metallic forming die 10 having its upper surface 12 shaped to correspond to the inside surface of the work member that is being formed in the forming apparatus.

A hydraulic ram 14 extending into a cylinder 16 supports die 10 and is adapted for pressing upwardly therebeneath. Positioned vertically above ram 14 and extending transversely to the length of die 10 is a shaft 18 having each end journaled in stationary supports and which rotatably supports a wheel 20 adapted for engaging the upper surface 12 of die 10 directly above ram 14.

Positioned over wheel 20 is a pressure roll 22 mounted in a yoke 24 carried on a ram 26 that extends into a hydraulic cylinder 28.

At this point, it will be appreciated that energization of the hydraulic motors referred to will cause wheel 20 and die 10 to be pressed against each other with a predetermined force, and, inasmuch as only a limited area of wheel 20 will engage the upper surface 12 of die 10, a considerable unit pressure will be developed between the said wheel and die.

Reference now to Figure 3 will reveal that wheel 20 includes an inflated outer annular portion 30 which will conform to the configuration of upper surface 12 of die 10. Accordingly, it will therefore be apparent that a piece of metal or other ductile material, when placed between wheel 20 and die 10, will be formed to the shape of upper surface 12 of die 10 upon energization of the hydraulic motors referred to above.

This fact is illustrated by referring to the present invention for a continuous forming of metal strips by feeding a metal strip, as at 32, along the upper surface 12 of die 10 and under wheel 20 while the said wheel and die are pressed against each other by their respective hydraulic motors and by rotation of wheel 20 and the simultaneous movement of metal strip 32, the said strip takes on the form of the upper surface of die 10 and passes from the forming apparatus in a continuous strip as a formed molding or the like.

In Figure 1 the molding is merely concave in cross-
section, whereas in Figure 3 there is illustrated an arrangement whereby the molding is provided with a relatively narrow face depression along its length. It will be obvious that a great variety of shapes can be formed according to this invention so long as the cross-sectional form of the molding is continuous along its entire length and is not interrupted by any transversely extending configuration.

In normal operation, the upper surface of metal strip 32, which is the surface engaged by the periphery of wheel 20, is the finished surface, and it will be evident that there will be no scoring or marring of this surface in any way whatsoever. The underside of metal strip 32 slides along die 10, but, inasmuch as this is the reversed side of the strip, whatever slight scoring there may be thereof is of no importance.

If, for any reason, it should occur that the face of the strip being formed that slides along the die is to be the finished or exposed surface, means can be provided for preventing scoring thereof, as, for example, by the interposing of a thin sheet of plastic materials, such as celophane or the like, between the metal strip and the die.

It would also be possible within the scope of this invention to provide a formed roller for die 10 running against the resilient wheel 20, and in this manner neither side of the metal strip being formed would be scored.

In Figures 4 and 5, I show an arrangement wherein die 40, and which is supported by hydraulic motor 42, is adapted for cooperation with a stationarily mounted formed metallic roller 44 by virtue of the interposing therebetween of a resilient rubber-like strip 46. Strip 46 acts in the manner illustrated in Figure 3, and pressures the metal strip being formed about the forming surface of die 40. By utilizing the Figures 4 and 5 arrangement, a few simply shaped rollers 44 can be utilized with great many different types of dies, and the metal strip in every case will be formed in exact conformity with the shape of the die, on account of the rubber-like sheet or strip 46.

In Figure 6 there is illustrated an arrangement similar to the Figures 1 and 2 construction, but wherein only a single hydraulic motor 50 is required for urging die 52 upwardly against the periphery of resilient wheel 54. This is accomplished by connecting the cylinder 56 of the motor with the shaft 58 in which wheel 54 is mounted by the strain rods 60. With the arrangement shown, the upward thrust exerted on die member 52 by ram 62 is opposed by a substantially equal and opposite tension in strain rods 60 that eliminates the necessity of the additional pressure roller and hydraulic motor for urging the wheel downwardly.

In Figures 7 and 8 I illustrate a still further modification in which the wheel 64 has its resilient outer portion 66 confined between the side plates 68 of the wheel, and then still further confined about the periphery of the wheel that is not in engagement with the surface of metal strip 70 that passes around the said wheel and over a plurality of stationarily mounted idler sprockets or rollers 74. In the Figure 7 arrangement, the wheel can be pressed against the die member 76, or the said die member can be pressed upwardly against the wheel and the resilient annular portion 66 of the said wheel between the die member, thus forcing the metal to the desired shape. The provision of chain 72 permits the resilient outer part 66 of wheel 64 to be made somewhat more flexible and resilient than is the case with the previous modifications referred to, and in this manner at least thin metal strips can be formed so as to have a relatively complex cross-sectional contour.

In Figure 9 there is illustrated an arrangement similar to the Figures 7 and 8 construction, except that the resilient outer portion of the forming wheel is constructed of solid rubber or rubber-like material and having sufficient resiliency to conform to the shaped upper surface 80 of die member 82. The resilient annular outer part of the forming wheel is preferably confined in the side plates 84 so that a high working pressure can be maintained on the metal strip 86 that is being shaped.

In Figure 10 there is shown a construction similar to the one described in Figure 9, but, instead of the resilient portion 88 of the forming wheel 90 being confined between side plates, the said rubber-like material includes a plurality of transversely extending flaments, such as wire, cable, textile materials, or fibers, which inhibits expansion of the said member laterally while retaining a high degree of resilience of the said member radially. The portion 88 of the forming wheel will thus conform to the configuration of die member 92 and a relatively high working pressure can be maintained, but without the necessity of any side plates for preventing excessive bulging or even rupturing of the resilient portion 88.

From the foregoing, it will be seen that this invention provides for a new and novel method and apparatus for forming strip metals with the process being characterized by requiring only inexpensive tools and a minimum number of tools, being rapid in operation, and being capable of producing an end product that requires no further finishing operation.

It will be understood that this invention is susceptible to modification in order to adapt it to different usages and conditions, and, accordingly, it is desired to comprehend and all modifications within this invention as may fall within the scope of the appended claims.

I claim:

1. In an apparatus for forming strip material; a shaped forming shoe substantially straight so that a strip can be moved lengthwise thereof, a stationarily mounted wheel adjacent the forming shoe adapted for engagement with the face of the strip opposite the shoe, means for urging said wheel and shoe against each other thereof to exert forming pressure on a strip therebetween, said wheel being provided with a hollow resilient annular peripheral portion containing fluid under pressure, and means for effecting pressure engagement with the periphery of said wheel at a point spaced from the point of engagement of the strip by the wheel for increasing the pressure of the wheel on the strip.

2. In an apparatus for forming strip material; forming shoe for slidably receiving a strip to be formed, a stationarily mounted wheel having a hollow resilient periphery containing fluid under pressure and adapted for engaging one face of the strip for pressing it against said forming shoe, hydraulic motor means for urging said shoe toward said wheel to develop pressure on a strip therebetween, an auxiliary roller bearing on the periphery of said wheel opposite the point of engagement thereof with said strip, and hydraulic motor means for urging said auxiliary roller into pressure engagement with said wheel.

3. In an apparatus for forming strip material; a forming shoe for slidably receiving a strip to be formed, a stationarily mounted wheel having a hollow resilient periphery adapted for engaging one face of the strip for pressing it against said forming shoe, hydraulic motor means for urging said wheel and shoe toward each other thereof to develop forming pressure on a strip therebetween, an auxiliary roller bearing on the periphery of said wheel opposite the point of engagement thereof with said strip, and hydraulic motor means for urging said auxiliary roller into pressure engagement with said wheel.

4. In an apparatus for forming strip material; a shaped forming shoe substantially straight so that a strip can be moved lengthwise thereof, a stationarily mounted wheel adjacent the forming shoe adapted for engagement with the face of the strip opposite the shoe, means for pressing said wheel and shoe against each other to exert forming pressure on a strip therebetween, said wheel being provided with a hollow resilient annular peripheral portion containing fluid under pressure, a flexible inextensible member passing around the periphery of said
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wheel while exposing that portion of the wheel that bears on said strip, said inextensible member being in the form of an endless band, and idler members supporting said endless band so the band will confine the resilient peripheral portion of the wheel when it is under pressure so that all the deformation of the said resilient peripheral portion of the wheel takes place where it is in engagement with the strip being formed.

5. The method of forming strip material continuously against a stationary straight forming shoe which comprises rotating a wheel adjacent the forming shoe having a resilient peripheral portion, pressing the wheel and forming shoe toward each other while feeding the said strip therebetween, and confining the resilient peripheral portion of the said wheel about substantially the entire part of the wheel which is not in engagement with the strip being formed.

6. The method of forming strip material continuously against a stationary straight forming shoe which comprises the steps of positioning strip material on the forming shoe, pressing the forming shoe against a wheel having a resilient peripheral portion, rotating the wheel and moving the strip between the wheel and the forming shoe, and confining the resilient peripheral portion of the wheel about at least a part of the wheel which is not in engagement with the strip being formed.

8. The method of forming strip material continuously against a stationary straight forming shoe which comprises the steps of positioning strip material upon the forming shoe, pressing the forming shoe against a wheel having a resilient peripheral portion, rotating the wheel and moving the strip between the wheel and the forming shoe, and confining the resilient peripheral portion of the wheel about substantially the entire part of the wheel which is not in engagement with the strip being formed.

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