Oct. 13, 1970 J. MARCOVITCH 3,533,260

ROLLING OF METAL BILLETS

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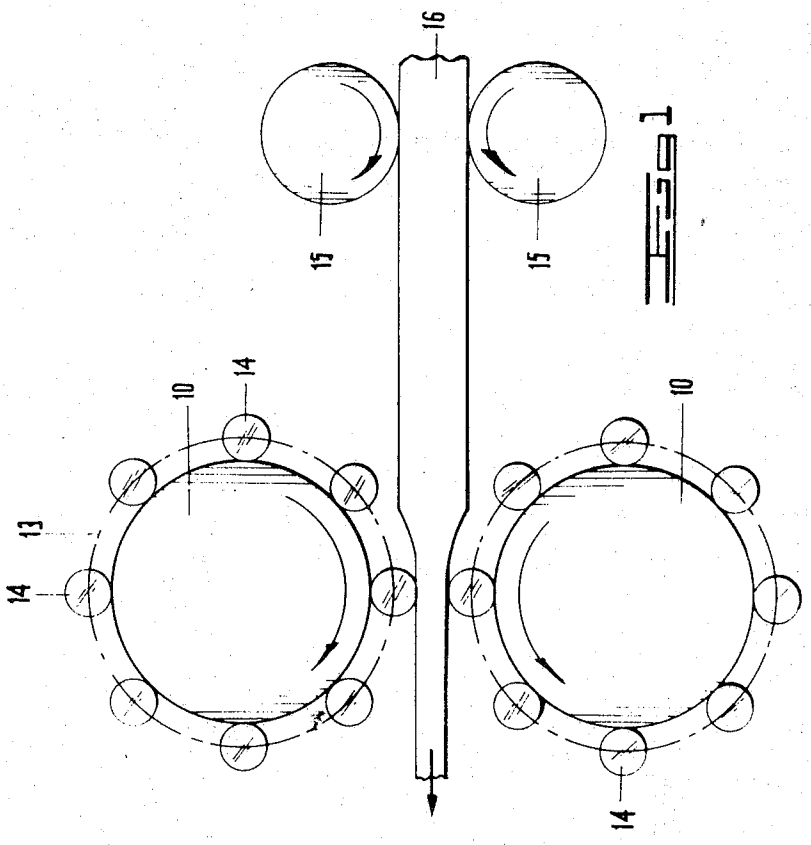

Fig 1

INVENTOR

JACOB MARCOVITCH

By Young & Thompson

ATTYS.

Oct. 13, 1970 J. MARCOVITCH 3,533,260

ROLLING OF METAL BILLETS

Filed Aug. 14, 1967 6 Sheets-Sheet 2

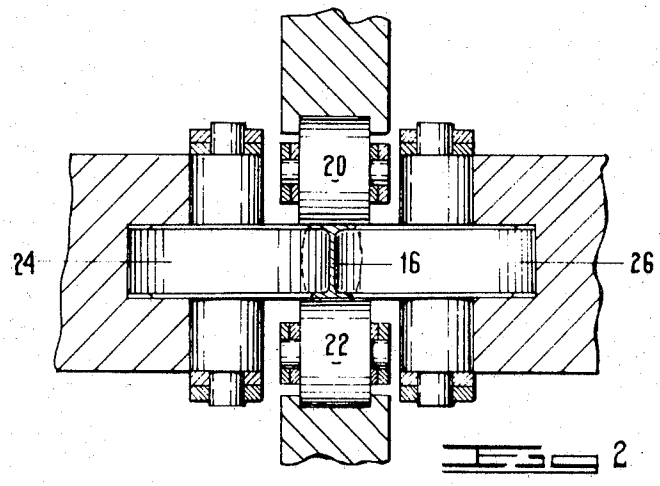

FIG 2

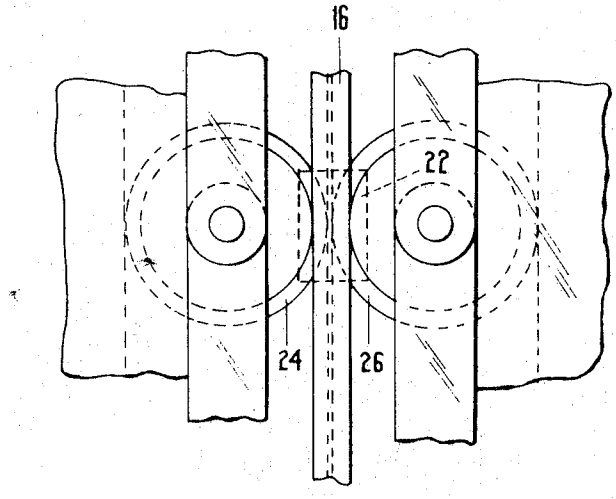

FIG 3

INVENTOR

JACOB MARCOVITCH

BY Young + Thompson

ATTYS.

Oct. 13, 1970 J. MARCOVITCH 3,533,260

ROLLING OF METAL BILLETS

Filed Aug. 14, 1967 6 Sheets-Sheet 3

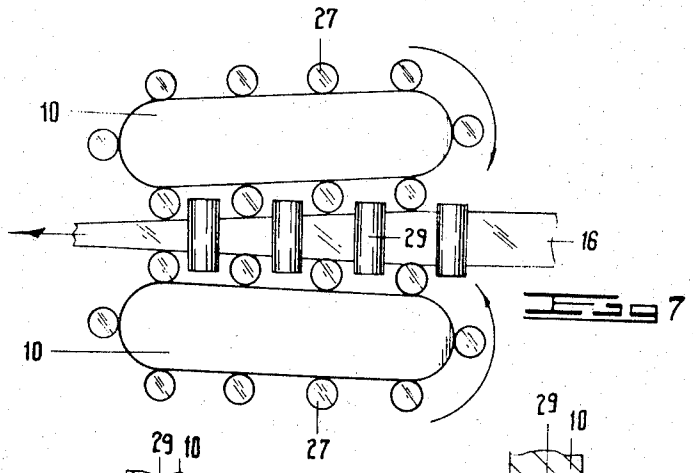

Fig 7

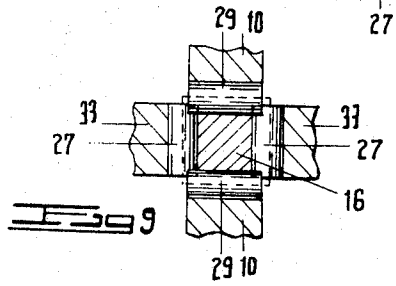

Fig 9

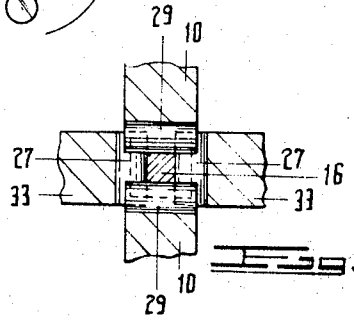

Fig 10

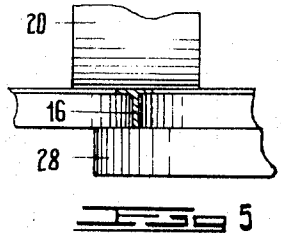

Fig 5

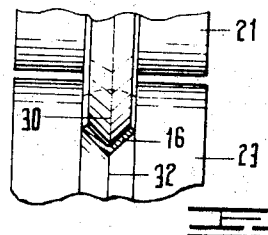

Fig 6

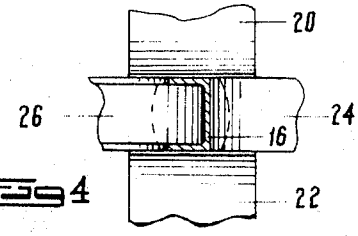

Fig 4

INVENTOR

JACOB MARCOVITCH

BY Young + Thompson

ATTYS.

Oct. 13, 1970 J. MARCOVITCH 3,533,260

ROLLING OF METAL BILLETS

Filed Aug. 14, 1967 6 Sheets-Sheet 4

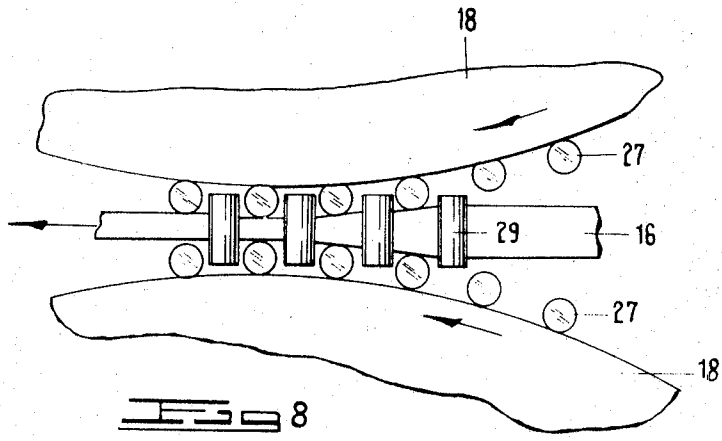

Fig 8

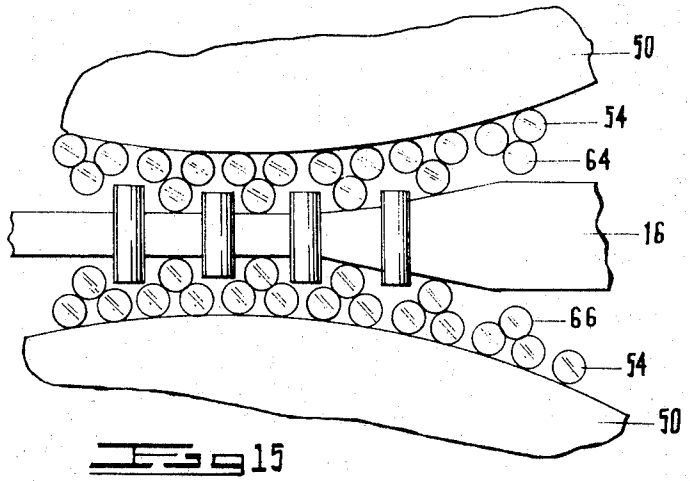

Fig 15

INVENTOR

JACOB MARCOVITCH

By Young & Thompson

ATTYS.

Oct. 13, 1970 J. MARCOVITCH 3,533,260

ROLLING OF METAL BILLETS

Filed Aug. 14, 1967 6 Sheets-Sheet 5

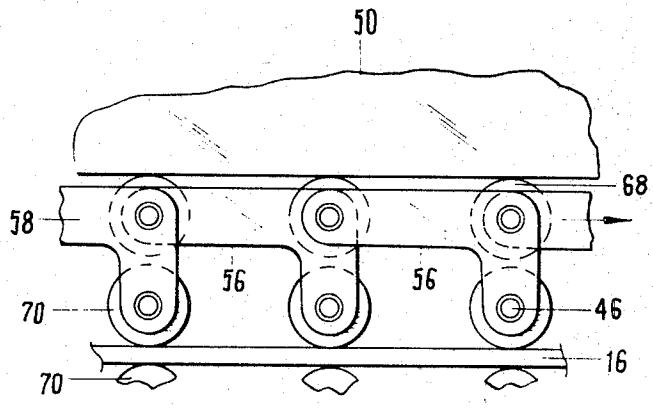

Fig 16

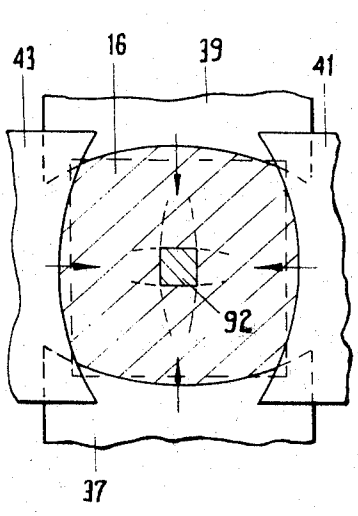

Fig 12

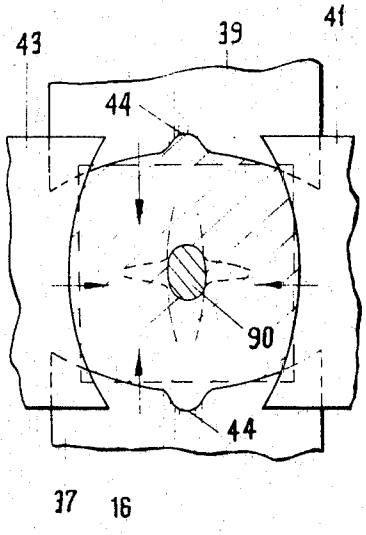

Fig 11

INVENTOR

JACOB MARCOVITCH

BY Young & Thompson

ATTYS.

Oct. 13, 1970 J. MARCOVITCH 3,533,260

ROLLING OF METAL BILLETS

Filed Aug. 14, 1967 6 Sheets-Sheet 6

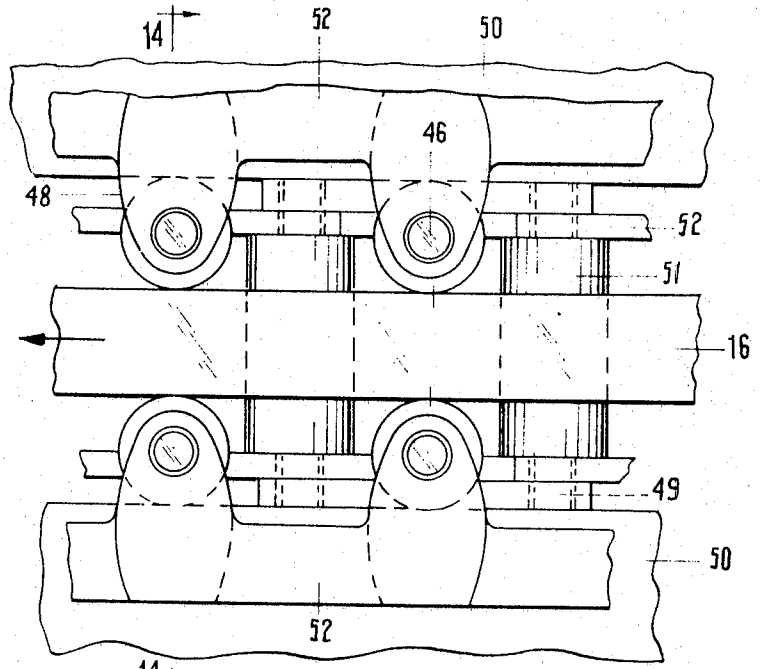

Fig 13

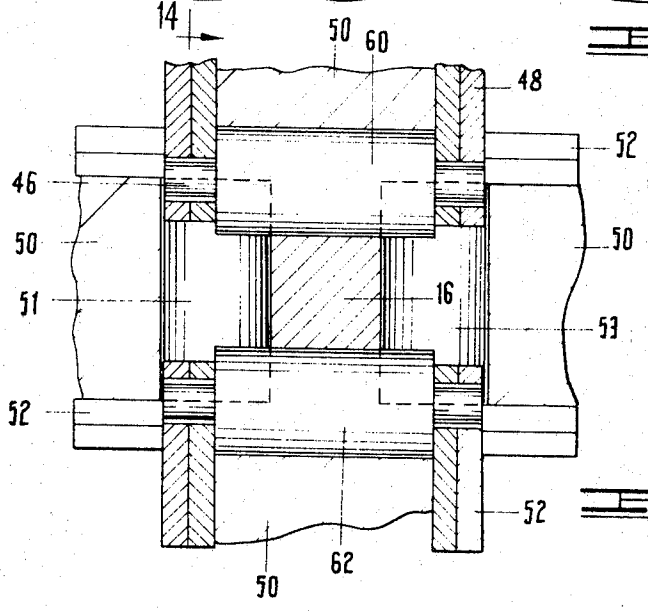

Fig 14

INVENTOR
JACOB MARCOVITCH
BY Young & Thompson
ATTYS.

United States Patent Office

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3,533,260

ROLLING OF METAL BILLETS

Jacob Marcovitch, Johannesburg, Transvaal, Republic of South Africa, assignor to Rotary Profile Anstalt, Vaduz, Liechtenstein

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Claims priority, application Republic of South Africa, Aug. 22, 1966, 66/5,031
Int. Cl. B21b 1/42
U.S. Cl. 72—190 10 Claims

ABSTRACT OF THE DISCLOSURE

In a rolling mill, the throat in which the billet is entrained is defined by series of rollers, the throat being circumferentially continuous and diminishing in cross-section along its length, at least one wall of the throat being provided by an endless line of small work rollers arranged to follow each other in a closed orbit.

This invention relates to the rolling of metal billets, for the production of strip, plate, bar, rod and so on, of any cross-sectional shape.

In conventional rolling mills, the billet is passed through a throat defined between two juxtaposed rollers. The geometry of a pair of juxtaposed rollers is such that only a small reduction in thickness can be achieved because of the rapid convergence of the throat between the rollers. Increasing the roller diameters in order to produce a more gradual convergence merely serves to increase the areas of contact between the rollers and the billet which impracticably increases the forces induced between the rollers.

The only remedy for this is to subject the billet to a number of operations progressively to thin it. A number of pairs of juxtaposed rollers is provided and the billet is passed through the rain. This is obviously wasteful of money, space and time, especially since the roller contours must usually be tailor-made to the product and a change of product necessitates a change of rollers. There is also the drawback that, when the rollers have become unserviceable through wear, their replacement or reconditioning is a major undertaking.

There is another, and perhaps more serious, drawback and that is that the reduction of the billet in the desired direction is always associated with an unwanted lateral spread. The train of rollers must be so designed to prevent the widening of the ribbon during all the stages of the reduction.

Attempts have been made to overcome some of these problems by providing a rolling mill in which a number of planetary work rollers, spaced around and supported on a backing surface, are used to roll the billet. Generally the backing surface is a large roller. Two large rollers define a throat, with the work rollers in effect lining it.

The reduction of the billet in such systems takes place, not by direct contact with the billet of the throat walls, as in conventional practice, but by contact with the juxtaposed work rollers. The construction provides, in effect, a line of convergent throats of progressively decreasing dimension, contained within a larger and longer throat.

The degree of reduction imposed on the billet is dictated, not by the passage of the billet through any one of the several throats defined by the work rollers, but by the single larger throat which contains the work rollers. The reduction produced is therefore considerably more than is possible with a single pass through the conventional rollers, and this is achieved by elongating the throat without impracticably increasing the induced forces.

The object of this invention is to provide a rolling technique, which has the advantages of the planetary system and at the same time limits lateral spread of the workpiece.

According to the invention, a mill to roll a metal billet to obtain large reduction of cross-sectional area in one pass consists of series of rollers, each series defining a wall of an elongated throat diminishing in cross-sectional area from one end to the other, at least one series consisting of an endless line of small work rollers arranged to follow one after another in a closed orbit; means holding the rollers spaced apart, and means to cause the endless line of rollers to move around the orbit.

Retaining means for the rollers may conveniently be a cage or chain or the like in which the ends or shafts of the rollers are journalled, and the apparatus may include means to draw the retaining means through the throat.

Usually, there is no force feeding means to pass the billet into and through the throat, the mill being designed for the work rollers to perform this function.

It goes without saying, of course, that all the sets of rollers can be profiled to impose any required profile on the advancing billet.

Where large reductions are required in a billet in both the width and height dimensions such as for squares and rounds, two sets of rollers intercalated with each other will be used.

It is pointed out that, if the intercalated rollers are spaced sufficiently apart, the two sets of rollers can be so interpenetrated that the end product can be of very small cross-sectional dimensions.

Several embodiments of the invention are described below with reference to the accompanying drawings, in which:

FIG. 1 is a simplified side view of a planetary rolling mill well known in the art;

FIG. 2 is a fragmentary semi-sectional view laterally across the throat of a mill according to the invention, in which an I-beam is being rolled;

FIG. 3 is a longitudinal view through the portion of the apparatus shown in FIG. 2, certain components being omitted;

FIGS. 4, 5 and 6 are fragmentary views illustrating the action of rollers on billets in mills according to the invention;

FIG. 7 is a semi-schematic view through one form of mill according to the invention, backing members for two series of rollers in the throat being omitted;

FIG. 8 is a fragmentary view, similar to that of FIG. 7, of a second form of mill according to the invention;

FIGS. 9 and 10 are fragmentary cross-sectional views through the throat of a mill such as those shown in FIGS. 7 and 8, illustrating respectively early and late stages of reduction in the mill;

FIGS. 11 and 12 are views similar to those of FIGS. 9 and 10, illustrating the curvature of rollers suitable in the mill of the invention for the production of round rod;

FIG. 13 is a fragmentary detail view illustrating the manner of intercalation of rollers in a mill such as that illustrated in FIG. 7;

FIG. 14 is a section on the line 14—14 of FIG. 13;

FIG. 15 is a fragmentary semi-schematic view of a different form of mill according to the invention; and

FIG. 16 is a fragmentary detail view illustrating the manner of entraining a series of unbacked rollers through a mill according to the invention.

In FIG. 1 there is shown a known planetary mill comprising two backing members 10 in the form of rollers defining between them a throat. Lining the throat are two opposed series of small work rollers 14 which are mount-

ed in cages **13**. The rollers **10** are driven in the direction of the arrows. A billet **16** is offered to the throat and is fed through the throat by feed rolls **15**, to be reduced in thickness by the opposed series of work rollers. This technique is used for rolling strip and nothing is done to prevent lateral spread of the billet.

In the mill of the invention, as in the known mills, the throat through which the billet passes is defined by opposed lines of rollers, but, additionally, there are rollers which define the width of the throat, so that the billet passes through a throat which is circumferentially continuous. For instance, in FIGS. 2 and 4 the rollers **24**, **26** are the equivalent of a pair of opposed rollers **14** of FIG. 1, and as seen in FIGS. 2 and 4, the width of the throat is defined by the side rollers **20**, **22**. The billet **16** is initially of the cross-section shown in dotted line.

In FIG. 5, the roller **22** of FIGS. 2 and 4 is replaced by a flange **28** of the roller which extends beyond the throat to define one wall opposite the roller **20**.

In FIG. 6, the rollers **21**, **33** are contoured themselves to define both the depth and the width of the throat. The roller **21** has an annular protrusion **30** that projects into a groove **32** in the opposed roller **23** and the throat is defined in depth between the end of the protrusion and the base of the groove, and in width by the walls of the groove.

Where the reduction of the billet is in one dimension only, as is the case in FIGS. 2, 3 and 4, the side rollers **24**, **26** are arranged to penetrate into the throat defined between the rollers **20**, **22** and in so doing they reduce the billet. This is apparent from FIG. 2, in which the side rollers **20**, **22** are arranged opposite each other in pairs and the individual throats between the opposed rollers remain the same width throughout. On the other hand, the distances between opposed pairs of the rollers **24**, **26** diminishes from one end of the throat to the other, to roll out the billet to the cross-section of the throat at its termination, for instance an I in FIGS. 2 and 3, a channel in FIG. 4, a T in FIG. 5, and an angle in FIG. 6.

It is not necessary that all the series of rollers should move in an orbit through the throat. For instance, the series of rollers **20**, **22** that remain the same distance apart through the throat, as in FIGS. 2, 4 and 5, may be rotatable about fixed axes. Furthermore, one of the series of rollers **24**, **26** for instance the rollers **24** of FIG. 4, may also be rotatable about fixed axes. The other series orbits through the throat to reduce the billet.

Where the billet has to be diminished in two dimensions, it is necessary to stagger the series of rollers **20**, **22** and **24**, **26**, so that, as the throat diminishes in both dimensions, the rollers move inwardly to profile the billet without fouling one another. This arrangement is seen in FIGS. 7 to 10. In FIG. 7, the backing members **10** provide the throat which is lined by the small work rollers **27**, **29**.

In FIGS. 9 and 10 it is seen that there are provided backing members **33** mounted at right angles to the backing members **10** of FIGS. 9 and 10 to support the rollers **29** that are intercalated with the rollers **27**.

If the rollers are spaced sufficiently apart in each series, interpenetration can be such that the final cross-section is of very small dimensions.

FIG. 9 is a detail view in cross-section at the beginning of the throat and FIG. 10 is a similar view but at the end of the throat. The diminution of the throat in two dimensions will be observed, and the manner in which the intercalated series of rollers **27**, **29** move inwardly to profile the billet **16**. Despite the displacement of the series **27**, **29** of the rollers, the throat through which the billet **16** passes remains circumferentially continuous in the sense that as the workpiece passes through the throat, its profiling is fully controlled in both depth and width. As an element of the billet passes through the individual throat between two rollers, restraint in the other dimension is momentarily relaxed, but it at once passes between a pair of opposed rollers of the intercalated series, and restraint is restored.

It is, of course, much the same in FIGS. 2 to 5. Here, full restraint in both dimensions is provided as the element of the billet passes between four individual rollers **20**, **22**, **24** and **26**, and all restraint is momentarily removed as it leaves the rollers, but it immediately enters the space between the next set of rollers and is once more controlled.

The effect in both cases is that the throat is in effect circumferentially continuous to control the billet in both the width and the depth dimensions.

It is, of course, not necessary that the rollers be plain cylindrical. For instance, in FIGS. 11 and 12, the rollers **37**, **39**, **41**, **43** which are intercalated because the billet **16** is to be reduced in both dimensions, are concave, and in FIG. 11, two opposed rollers **37**, **39** are circumferentially grooved at **44**, to produce an oval cross-section in the billet. In FIG. 12, the billet is rolled to almost square cross-section. In both cases, the billets are finished to round, by a finishing pass through a conventional mill. The configuration in the centre of the throat in these figures, shown hatched at **90**, **92** illustrates the cross-section of the rod produced in the mill. Its initial cross-section is indicated in dotted lines.

As regards the mounting of the rollers, reference is directed to FIGS. 13 and 14 where suitable mounting means are shown.

In FIGS. 13 and 14, the rollers **51**, **53**, **60** and **62** roll on the backing members **50** (which may be the oblong members **10** of FIG. 7 or the rollers **18** of FIG. 8).

These rollers have pintles **46**, **49** projecting on either side which are journalled in the links **48** of chains **52**. The rollers are thus held spaced apart the correct distance. The side rollers are similarly mounted.

As the billet traverses the throat and is reduced, so does its forward speed increase, and this tends to make the rollers rotate more quickly. As the backing members remain stationary or, if the members are rollers, the peripheral speed remains constant, the increasing speed of rotation of the rollers must be accompanied by increasing slip between the rollers and the backing members as the rollers proceed through the throat. To facilitate this localised slip and to minimise wear of rollers and backing members, further intermediary series of rollers such as in the arrangement of FIG. 15 can be used. Here, the rollers **64**, **66** are backed by series of rollers **54** which run on the backing members **50**. The rollers **64**, **66** and the backing rollers are staggered. Slip is mainly confined to the interfaces of the rollers **64**, **66** and **54**, which spares the backing members.

Another expedient is seen in FIG. 16. If the billet **16** is fairly narrow, the rollers **68**, **70** may be mounted on the links **56** of chains **58**. The chains connect together series of rollers **68** that roll on the backing members **50**. The rollers **70** being free-rolling, the problem of slip is entirely eliminated, but it must be borne in mind that the rollers are only supported by their pintles **46** and not backed across their full length as in previous embodiments, so that, if the rollers are other than short they will tend to bend.

What is claimed is:

1. A mill to roll a metal billet to obtain a large reduction of cross-sectional area in one pass, comprising a plurality of series of circular section rollers, each said series defining a wall, said walls defining and surrounding continuously on all sides the entire periphery of an elongated throat diminishing in cross-sectional area from one end to the other, at least one of said series consisting of an endless line of small work rollers disposed to follow one after another in a closed orbit.

2. The mill of claim **1** in which the rollers of some of the series are arranged for free rotation about fixed axes.

3. The mill of claim **1** including backing members for each series of rollers.

4. The mill of claim 3 in which the backing members are rollers.

5. The mill of claim 1 in which there are four series of rollers and the series of rollers defining two opposed walls of the throat are spaced apart the same distance throughout the length of the throat, and the other two series are spaced progressively nearer, for the throat to converge.

6. The mill of claim 1 in which there are two series of rollers, contoured to provide between them a circumferentially continuous throat.

7. The mill of claim 1 in which the series of rollers are intercalated.

8. The mill of claim 7 in which there are four series of rollers, two series being intercalated with the other two series.

9. A mill as claimed in claim 1, and means holding said rollers spaced apart.

10. A mill as claimed in claim 9, said means holding said rollers spaced apart comprising a continuous member, and means to circulate the continuous member thereby to advance the small work rollers in their said orbit.

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U.S. Cl. X.R.

72—225