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McClain

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[54] **MACHINE FOR ROLL FORMING VARIABLE WIDTH PROFILES**

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[52] **U.S. Cl.** **72/181**

[51] **Int. Cl.** **B21d 5/08**

[58] **Field of Search** 72/181, 182, 247, 176, 72/178

[56] **References Cited**

UNITED STATES PATENTS

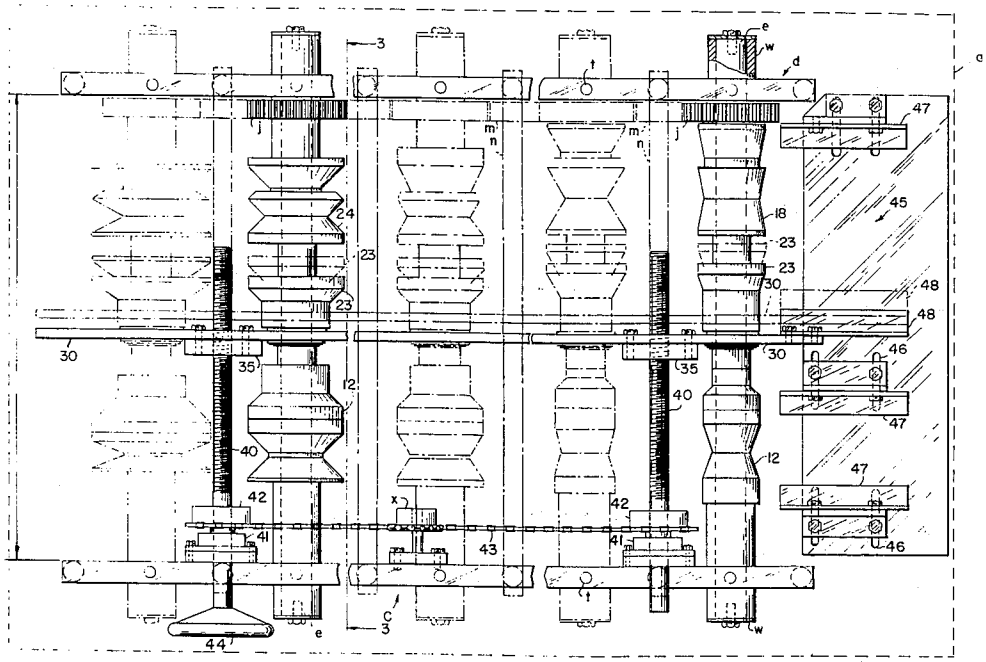
1,317,581	9/1919	Kipniss et al.	72/178
2,176,115	10/1939	Yoder	72/181
2,294,324	8/1942	Wilkens et al.	72/181 X

Primary Examiner—Milton S. Mehr

[57] **ABSTRACT**

A roll forming machine in which metal strip profiles may be formed to varying widths, without removal or replacement of spacers. The spindle shafts between side frames are filled in part by spacer bushings which bear against the constant position rolls and hold them in position. Shiftable rolls slide axially on the outer surfaces of these bushings. All the shiftable rolls are shifted simultaneously by an intermediate frame assembly which is cranked to the desired width, and which positions them precisely and reacts their thrust.

10 Claims, 4 Drawing Figures



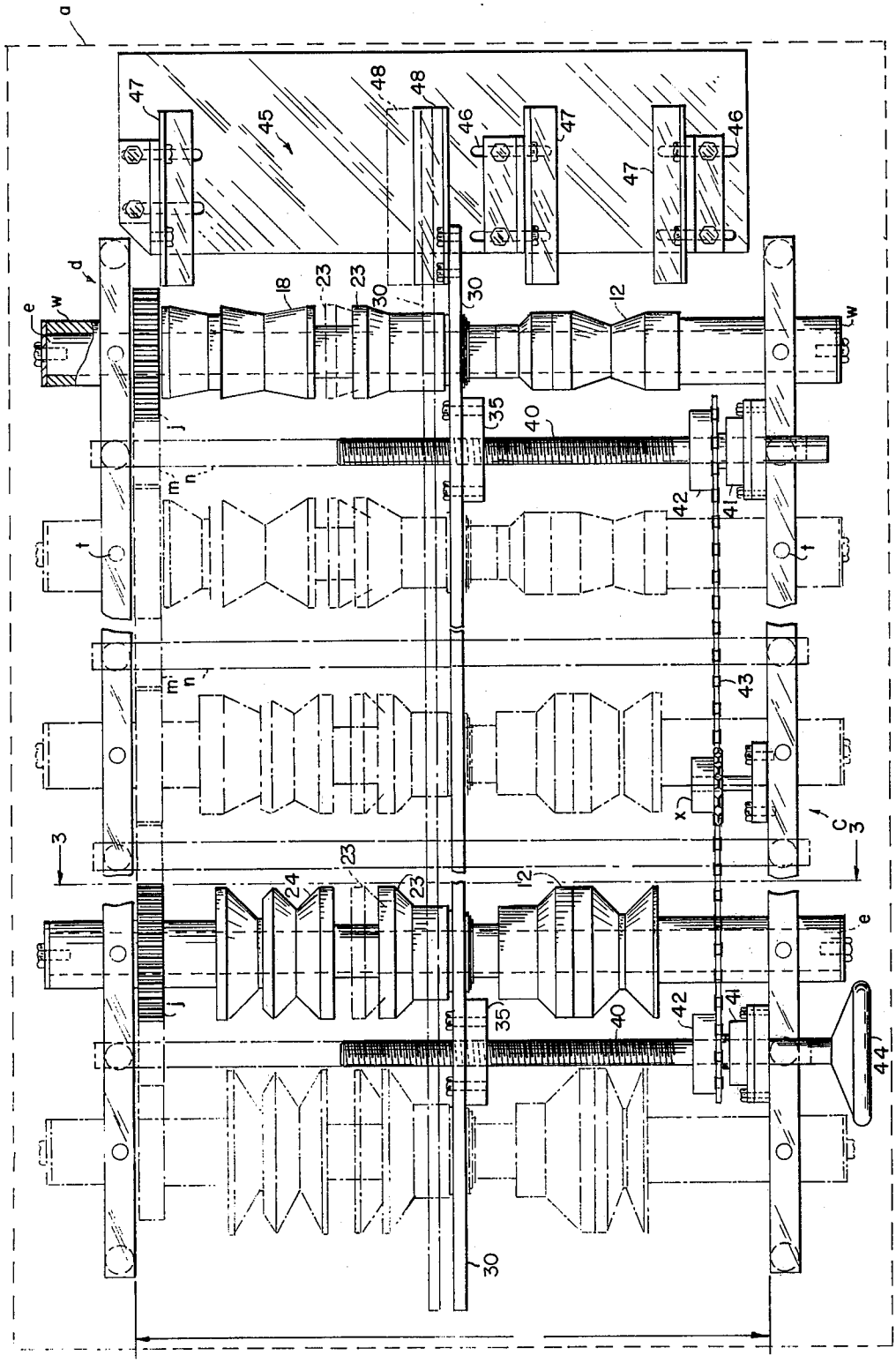


FIG. 1

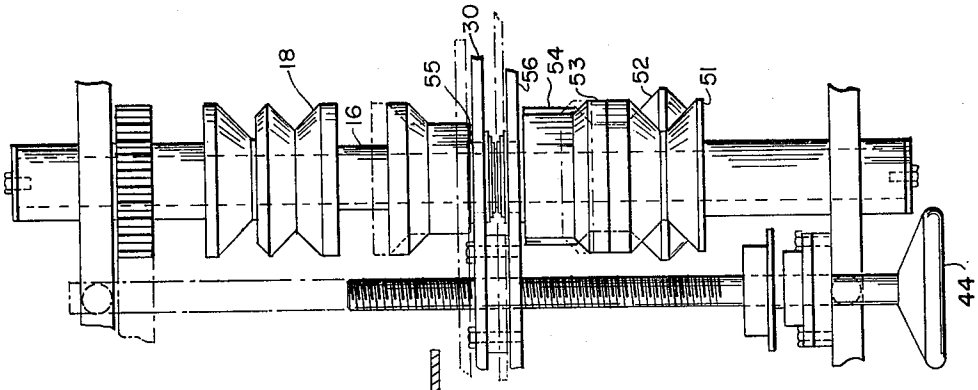

18
16
55
30
56
54
53
52
51
44

FIG.5

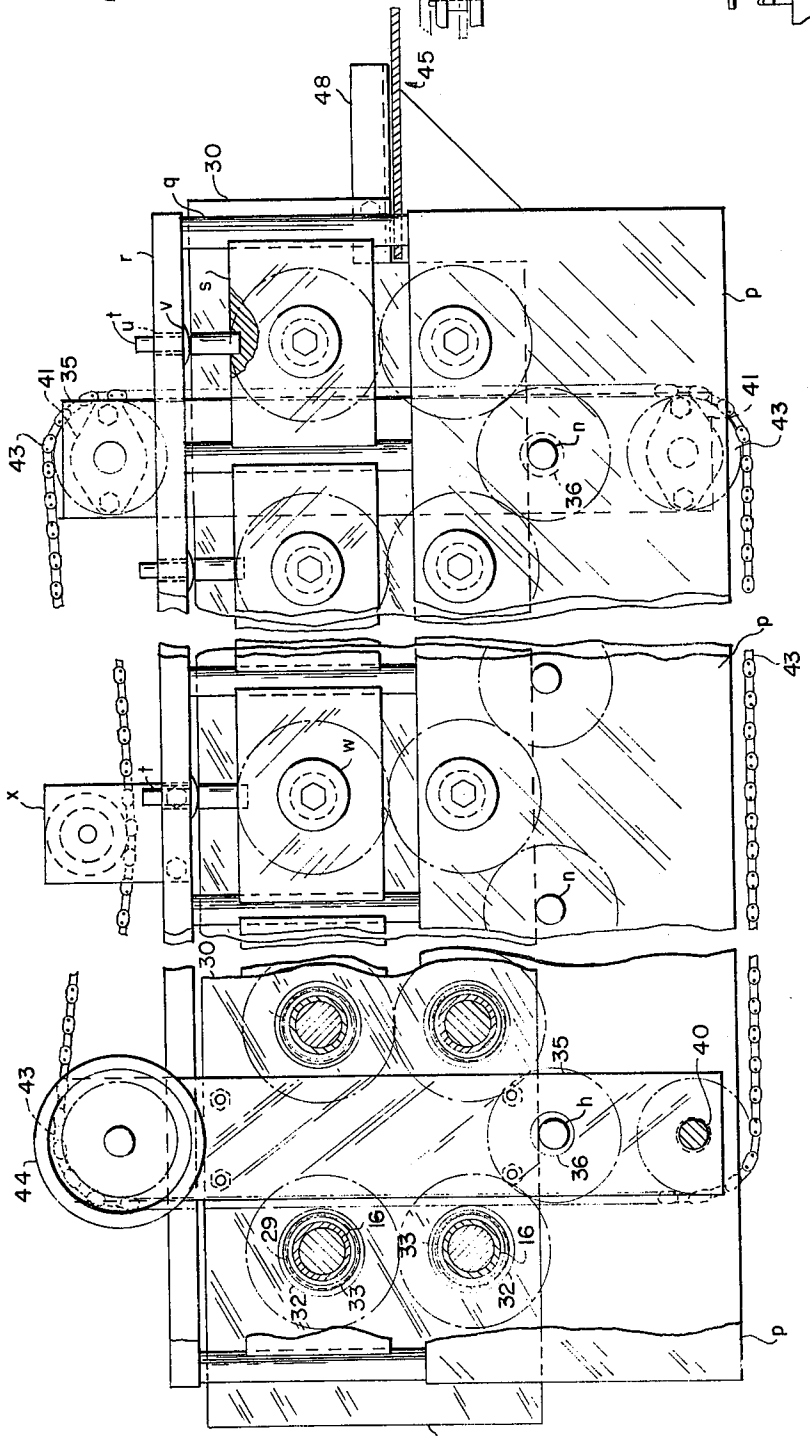
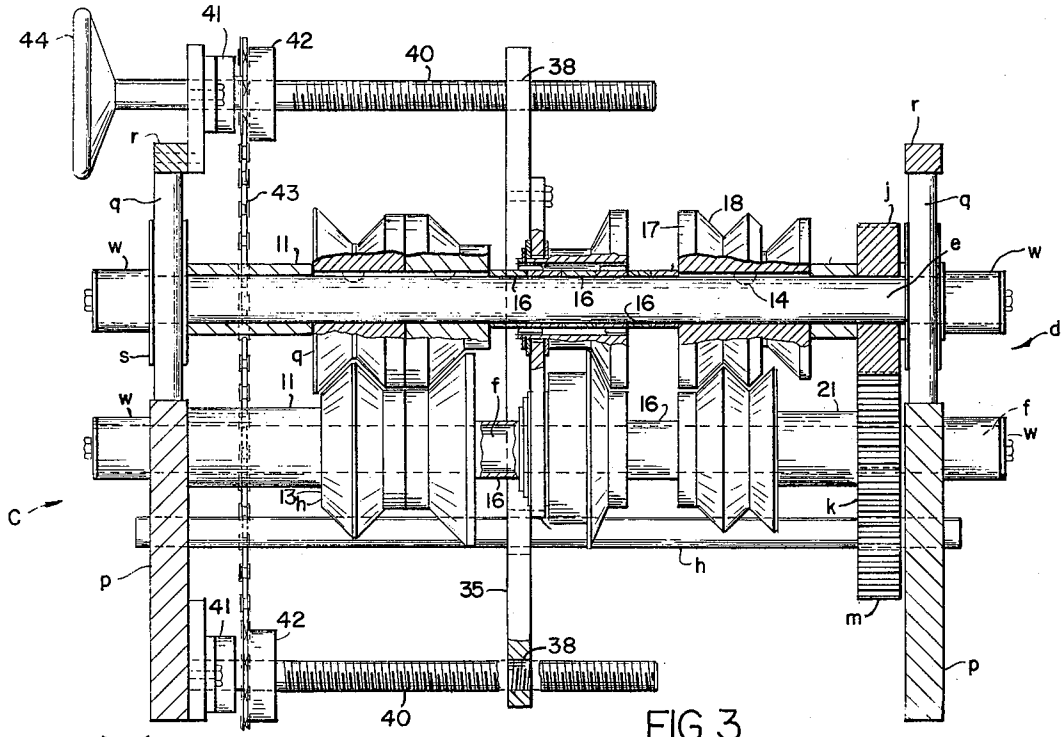
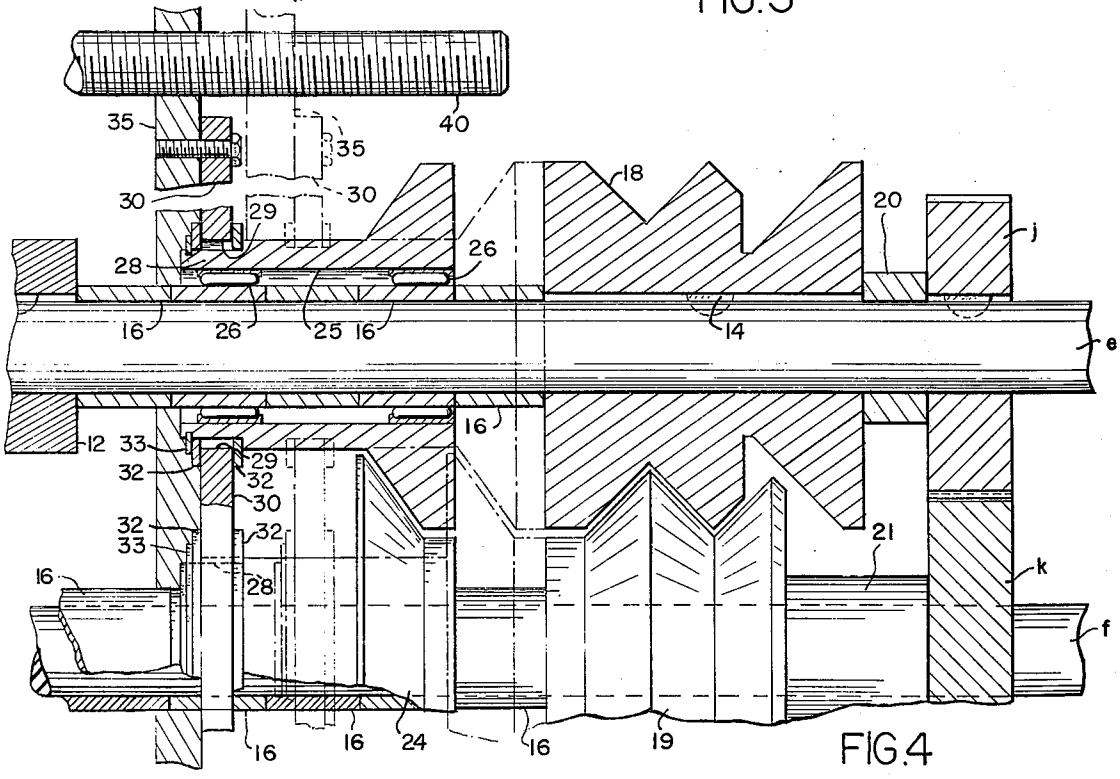

48
45
30
q
r
s
v
u
t
p
41
35
43
n
36
x
w
h
40
29
16
33
32

FIG.2


44
41
42
40
38
r
q
43
11
18
17
j
e
w
16
14
d
s
f
21
h
13
k
c
p
35
m
FIG.3


40
35
30
29
28
26
18
20
j
16
25
14
e
12
33
32
21
k
24
19
f
FIG.4

MACHINE FOR ROLL FORMING VARIABLE WIDTH PROFILES

BACKGROUND OF THE INVENTION

Roll forming machines, used to bend metal strips progressively to a desired profile, may have as many as 12 or 14 forming stations, with upper and lower spindles and roll assemblies at each.

Heretofore there has been no commercially available roll former machine whose forming width could be readily varied to achieve any desired width of forming. In standard machines, it has been known that profile elements which extend parallel to the mid-plane of the machine might be widened by spacing apart the roll elements used. Variations in forming width were effected by stacking thick washer-like spacers between the roll elements. However, this required disassembly of the roll spindles from the machine frames, a difficult, time-consuming task which could not be performed by the ordinary workman who fed strip steel to the machine.

Special products might be formed to specific differentials in width by forcing C-spacers on and off the machine spindles. The principle examples of use of such spacers are the cleat strips used to attach adjacent sections of heating ducts.

One variety of cleat may be prescribed with an element of the profile in three different widths, at intervals of one-half inch. The rolls on both upper and lower spindles are divided perpendicular to the shaft, so that one may remain in a constant position and the other be positioned either adjacent to it, or spaced from it by a one-half inch, or spaced from it by a full inch. To provide such spacing, two one-half inch spacers may be used. Spacers in common use are springy C-shaped pieces, which are difficult to handle. A more advanced type of spacer is shown in U.S. Pat. No. 3,444,776 to Frizzell; it discloses a C-shaped spacer having an elastic latch to grasp the spindle shafts.

For forming the narrower width two of such spacers would be mounted on the shafts outwardly of the shiftable rolls; for the next wider width, one of them would be removed, the rolls shifted a one-half inch, and the spacer inserted in the one-half inch space between the two rolls; and for the greatest width the second spacer would be similarly moved, with the roll shifted still farther. Thus for a 12-station machine having 24 spindles, to change from the narrowest to the widest of three spacings requires removing 48 of the spacers individually, shifting the 24 shiftable roll elements individually, and reinserting the 48 spacers individually. In addition to the time required, the work of changing is made difficult by close tolerances and narrow working spaces. Even if the side frames are loosened, it is still very difficult to change such a machine; when working on the lower roll spindles, special extraction and driving tools may be necessary; and spacers may be lost in the recesses of the machine.

SUMMARY OF THE INVENTION

The purposes of the present invention are to provide a roll forming machine with the capacity for infinite changes in width of forming, made readily not by a mechanic but by the workman who feeds such machines, without substantial loss of machine time, and without removing any spacer or other part from the machine. Another purpose is to change the spacing of all the rolls on all the spindles simultaneously in a single operation. A still further purpose, applied to a machine having two sets of adjustable rolls, is to utilize the same spacing-shift mechanism for both sets of rolls. Still further purposes will be apparent from the disclosure which follows.

Briefly summarizing the present invention, without limiting its scope, I utilize a roll former machine which is conventional to the extent of having at least two parallel side frame assemblies at a fixed spacing, and a succession of pairs of upper and lower rolls spindles mounted perpendicularly thereacross, with a power train to rotate the spindles, and complementary upper and lower roll forming sets. Each roll set includes an axially-constant roll and an axially-shiftable roll. In the preferred type of machine utilized, all elements mounted on the spindles between the side frames are slid thereon axially as the spindles are assembled, and their combined width is sufficient to fill the spacing; that is, they hold each other in fixed positions.

Unlike prior machines, the shiftable rolls do not fit directly onto the spindles; instead their inner diameters are sized to fit slidably on spacer members mounted on the spindles. One of such spacer members has its edge bearing against the constant position roll to hold it in position. Such spacer members serve as lateral shift paths for the shiftable rolls. The lateral shift path width will at least equal the total of the width of the shiftable roll itself plus the lateral distance over which the roll is to be shifted.

To effect such shifting, I used a shifting frame assembly parallel and intermediate to the fixed frame assembly, positioned adjacent to the sides of the shiftable rolls opposite the constant position rolls. Rotation-permitting means, operable between the shiftable frame and these rolls, retain them in thrust-transferring relation to the shiftable frame, wherever it may be positioned. Simple mechanism is used to shift the shiftable frame laterally, thus shifting all the shiftable rolls simultaneously on their spacer members. By this means the width of forming is changed on all of the spindles simultaneously, without removing or replacing any members from the spindles.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a plan view, somewhat fragmentary, of a progressive roll forming machine embodying the present invention, in which roll elements are shifted simultaneously by movement of an intermediate frame.

FIG. **2** is a fragmentary side view, partly broken away, corresponding to the front of FIG. **1.**

FIG. **3** is a sectional view taken along line **3—3** of FIG. **1.**

FIG. **4** is an enlarged fragmentary view showing the upper right portion of FIG. **3.**

FIG. **5** is a plan view of a portion of an alternate embodiment, utilizing shiftable rolls on both sides of the movable frame, the portion shown corresponding to that to the left of line **3—3** of FIG. **1.**

DESCRIPTION OF THE PREFERRED EMBODIMENT

The progressive roll forming machine illustrated in the drawings is designed to form metal strips progressively. It is equipped at each forming station with two sets of rolls, each for a different profile; and third and fourth sets of rolls may be added outward of the side

frames. The problem met by the present machine is to form to a profile having a flat portion of a larger or smaller dimension. Typical are the strip profiles utilized for joining adjacent sections of sheet metal ducts. A typical profile, called the "standing S" cleat, has a segment which may be formed to a narrow width, to an intermediate width one-half inch greater, or a maximum width one inch greater. Another type of cleat, referred to as a "Government lock", is typically formed to two widths, one three-eighths inch greater than the other.

Sets of rolls suited for forming either or both these profiles may be incorporated in the present machine; thus in the modified embodiment shown in FIG. **5** the rolls at the right side are to be used for the standing S cleat, whereas those at the left are for the Government lock profile. The present machine is also capable of accommodating other types of rolls and is uniquely useful where the width to be formed is to be infinitely adjustable.

Referring to the plan view, FIG. **1**, the present machine is mounted on a table frame generally designated *a* shown in phantom lines. The machine shown is of the type which has left and right vertical, parallel side frame assemblies generally designated *c*, *d* mounted at a substantially fixed spacing *b*. A succession of pairs of upper roll spindles *e* and lower roll spindles *f* are mounted perpendicular to, and rotatable in, the side frame assemblies *c*, *d;* they may be equipped with conventional upper and lower roll forming sets mounted between the frame assemblies *c*, *d*, such as the sets *g*, *h* shown in FIG. **3**; and auxiliary roll sets may be added outward of the frame assemblies. Power train means is provided to rotate the spindles *e*, *f*, including upper spindle gears *j* meshing with lower spindle gears *k* and keyed to the upper and lower spindles *e*, *f* at each of the forming stations, the lower gears *k* meshing with intermediate spur gears *m* mounted on idler shafts *n* positioned below and between the successive lower spindles *f*. The power train is driven by conventional motor and chain drive means not shown.

The illustrated machine is of the type in which the spacing *b* between the side frames *c*, *d* is filled by the gears *j*, *k*, the forming rolls *g*, *h* and other spacing members to be described. This permits assembly of the gears, rolls and spacing members by axially sliding on the spindles *e*, *f* as they are inserted through the fixed position side frames *c*, *d*.

Referring to the side view, FIG. **2**, since the sheet metal strips to be formed may be of various thicknesses, the side frame assemblies *c*, *d* are designed to permit the upper spindles *e* to yield upwardly. As is known, each of the side frame assemblies may have a lower vertical plate *p* into whose upper edge are fixedly mounted, midway between the roll stations, round vertical rods *q* whose upper ends are connected by longitudinal top bars *r*. Vertically slidable chocks *s*, which mount the upper spindles *e*, have concave side edges fitted to permit vertical sliding on the rods *q*. Pins *t*, loosely fitted in vertical bores *u* in the top bars *r*, are biased downwardly against the chocks *s* by concave spring washers *v*.

Commencing with the left side of FIG. **3**, if no outboard rolls are to be mounted, each of the spindles *e*, *f* may have an outer end rentention cap *w* outward of the frame assembly *c*. Describing the typical forming station illustrated in FIG. **3**, inwardly of the frame *c*, each shaft *e*, *f* has a cylindrical spacer **11**; then upper and lower mating roll sets **12, 13** (conveniently formed of vertically divided elements, as is conventional) are secured by keys **14** so they will be driven by the spindles. Adjacent to these conventional roll sets **12, 13,** in the present invention a lateral shift path is provided, made up by one or a series of adjacent cylindrical spacer bushings **16**; these extend the entire width from the conventional fixed position roll sets **12, 13** to bear against the vertical, inward-facing surfaces **17** of constant position upper and lower rolls as best seen in FIGS. **3** and **4.**

The constant position roll portions **18, 19** are keyed to the spindles *e*, *f*. They are not of themselves sufficient to form the desired profile; they must be supplemented by axially shiftable roll portions, to be described hereafter. At the right side of these roll portions **18, 19** may be cylindrical spacers **20, 21** of the width required to abut against the gears *j*, *k*. Thus the entire space *b* between the side frames *c*, *d* is filled by the elements described; and the axial position of the constant position roll portions **18, 19** is maintained by the bearing against their faces **17** of the bushings **16** closest thereto.

To form the standing S cleat strips of varying widths, the axially constant rolls **18, 19** are supplemented by cooperating axially shiftable upper and lower roll portions **23, 24.** I have found that the axially shiftable roll portions **23, 24** need not be keyed to the spindles *e*, *f*, especially if they present to the sheet metal strips a lesser surface area than the constant position roll portions **18, 19.** Hence, in the embodiment illustrated, the shiftable rolls **23, 24** are simply mounted on the lateral shift paths provided by the spacer bushings **16.** As best seen in FIG. **4**, each of the shiftable rolls **23, 24** has an enlarged inner diameter **25,** preferably accommodating caged needle bearings **26** which fit on the outer surfaces of the bushings **16.** The length of the shift paths (that is, the combined widths of the bushings **16**) must at least equal the total of that width along the bushings **16** occupied in supporting the roll portions **23, 24** plus the lateral distance of which these roll portions are to be shiftable.

With some increase in complexity, the shiftable roll portions **23, 24** need not be free to idle, as in the embodiment shown, but may be power driven. Thus, instead of using the bushing **16,** a corresponding slide path length might be provided by a splined collar of the same length, keyed to the spindles *e*, *f*. Instead of using needle bearings **26,** the rolls **23, 24** would have inward projecting splines fitting onto such spline collar. Spline provisions are conventional, and require no illustration.

To permit free rotation and yet achieve lateral shifting by mechanism which is rigidly thrust-resistant, the shiftable upper and lower roll portions **23, 24** are equipped with annular neck parts **28,** best seen in FIG. **4,** which project axially at their sides opposite the axially constant roll portions **18, 19.** These neck parts pass with large clearance through oversize bores **29** in a laterally shiftable frame plate **30,** which extends the entire length of the machine, parallel to and intermediate between the frame assembly *c*, *d*. It serves to retain all the shiftable rolls **23, 24** aligned either abutting the constant roll portions **18, 19** or at any chosen spacing therebetween. The frame plate **30** also reacts the axial thrust on the shiftable rolls **23, 24,** when sheet metal strips pass through the machine.

The shiftable frame plate **30** is best seen in FIG. **1**; the solid lines show it so positioned as to hold said shiftable roll portions **23, 24** at a rather large spacing from the axially constant roll portions **18, 19**, while the phantom lines of FIG. **1** show the frame plate **30** fixed laterally to position the shiftable rolls at an intermediate spacing. In FIG. **4**, the phantom lines show the frame plate **30** shifted to bring and hold the shiftable roll portion **23, 24** into abutment against the axially constant rolls **18, 19.**

Referring to the enlarged view, FIG. **4**, the purpose of the large oversize frame plate bores **29** is to permit the upper spindle *e* to adjust its position vertically as sheet metal strips of varying thickness pass through the machine. This is achieved by flanking the frame plate **30** with a pair of slidable thrust washers **32** on the neck part **28** of each of the shiftable rolls **23, 24,** and securing the assembly by a snap ring **33.** So assembled, the neck parts **28** are rotatable within the frame plate **30,** transfer axial thrust thereto and are shiftable axially thereby. They may be shifted along the shift path made up by the bushings **16,** which ends at the inward-facing surfaces **17** of the constant roll portions **18, 19.**

For lateral shifting of the frame plate **30,** mechanism is provided as best seen in FIGS. **2** and **3.** Referring first to FIG. **2,** the lower edge of the frame plate **30** may rest supportingly on the idler shafts *n*. It is positioned by at least two heavy vertical guide plates **35,** bolted to one side of the frame plate **30.** The guide plates **35** may be located between forming stations inboard of both ends of the machine, as shown in FIG. **2.** They extend upwardly above the longitudinal top bar *r* of the side frame assembly *c*, and downwardly below the idler shafts *n*, having clearance bores **36** through which these shafts may pass. The upward and downward projecting portion of the guide plates **35** have internally threaded parts **38** engaged by lateral, upper and lower threaded shafts **40** which project horizontally from conventional upper and lower thrust bushings generally designated **41,** secured laterally inward of the top bar *r* and of a lower vertical plate *p* of the side frame assembly *c*. On the shafts **40** adjacent to the thrust bushings **41** are sprockets **42.** A chain **43** surrounds the four sprockets **42** and is held taunt by a conventional chain tightening device *x*. A hand wheel **44** is mounted outstanding from the left end of the shaft **40** shown above in FIG. **3.** Turning the hand wheel **44** rotates the threaded shafts **40** simultaneously to shift the frame plate **30,** as indicated by the phantom lines of FIG. **1.** Thus the shiftable upper and lower roll portions **23, 24** are simultaneously set to establish and change the width of forming. Other conventional parallelism-maintaining means to shift the frame plate **30** might be substituted.

Mounted on the frame *a* in advance of the first station of the machine, at a level intermediate between the upper and lower spindles *e, f*, is a feed table **45** having laterally slotted holes **46** in which guide angle assemblies **47** are mounted. The positions of these may be fixed for the conventional fixed-width roll sets **12, 13** shown to the left of the shiftable plate **30** in FIG. **1.** However, to feed the variable-width roll sets **18, 19, 23,** 24 the feed guide spacing must be adjusted as their forming width is varied. For this purpose, to the forward end of the shiftable frame plate **30** I attach a shiftable guide angle **48,** whose spacing from the fixed guide angle **47** at the right side of FIG. **1** changes with the movement of the plate **30,** as shown by the phantom lines of FIG. **1.**

Purchasers of machines embodying the present invention which are equipped with variable width forming rolls **18, 19, 23, 24** for forming the standing S cleat, may also be interested in forming variable width Government locks. With the change illustrated in FIG. **5,** the machine heretofore described may be adapted to mount both sets of rolls for forming variable widths. Instead of the fixed-width upper and lower rolls sets **12,** 13 seen in FIG. **3,** FIG. **5** shows a second set of variable-width rolls generally designated **50,** including upper and lower axially constant roll portions **51, 52,** and axially shiftable upper and lower roll portions **53, 54.** The shiftable roll portions **53, 54** ride on bearings **26** and have neck parts **28** projecting from their sides opposite the constant position roll portions **51, 52,** in the same manner as the shiftable roll portions **23, 24** shown in detail in FIG. **4.** These neck parts **28,** equipped with thrust washers **32** and snap rings **33,** extend through clearance bores **55** in a second frame plate **56,** mounted to the left of the frame plate **30** heretofore described and bolted to the other side of the vertical guide plates **35.** When the hand wheel **44** is turned to move the assembled plate frames **30, 56** laterally, the shiftable rolls **53, 54** of the second split roll set **50** at the left side thereof will be shifted simultaneously with the roll portions **23, 24** of the forming rolls first described. For this shifting a shift path is made up of cylindrical spacer bushings **16** which extends the entire distance from the axially constant rolls **51, 52** of the second set **50** to the axially constant rolls **18, 19** of such first roll set. The bushings **16** thus serve to space the outer rolls **51, 52, 18, 19** in axially constant position.

Using either of the constructions here shown, the saving of time in adjusting the width of forming is incomparable. The best prior method required inserting C-shaped spacers between and flanking the movable rolls, all of which had to be removed from all of the spindles before the rolls could be shifted, and then replaced on the spindles to provide resistance to axial thrust. Some further time is saved by the automatic lateral shift of the feed guide provision. These results are attained without appreciable "down time" for the machine, and without any work by a skilled mechanic.

One entirely new result of eliminating C-shaped spacers is that the width adjustment provision is infinitely variable. This opens the way for rolling channel-like profiles to any desired width increment. No prior machine for progressive roll forming is known which possesses any of these advantages.

Modifications, as in the mechanism for lateral shifting of the plates **30, 56** and for securing the shiftable rolls thereto while permitting their rotation, will from the disclosure hereof be obvious to persons having ordinary skill in the art.

What is claimed is:

1. In a roll forming machine in which metal strips are progressively formed to a profile, the machine being of the type having at least two parallel side frames at a substantially fixed spacing, a succession of pairs of upper and lower powered roll spindles mounted by and perpendicular to and rotatable in said side frames, power train means to rotate said spindles, and upper and lower roll sets thereon between said frames, each set including an axially constant roll and an axially shiftable roll, the machine being further of the type in

which the members mounted on the spindles between said frames have a combined width sufficient to fill the spacing therebetween and are assembled on the spindles by axial sliding as the spindles are inserted,

the improvement by which roll spacings may be changed simultaneously on all spindles, said improvement being characterized in that

the members so mounted on the spindles to fill the spacing between said side frames include spacer means to permit axial sliding thereon of the shiftable rolls and to bear edgewise against the constant rolls,

said spacer means providing for each shiftable roll a lateral shift path whose length at least equals the sum of that occupied by the shiftable roll portions thereon plus the lateral distance over which the such roll is shiftable,

the improvement being further characterized in having

laterally shiftable frame means parallel and intermediate to said fixed frame assemblies and adjacent to the shiftable rolls,

rotation-permitting means, operable between the shiftable frame means and the shiftable rolls, to retain said shiftable rolls in thrust-transferring relation to said shiftable frame means, and

means to shift said shiftable frame means,

whereby to shift all said shiftable rolls simultaneously by axial sliding on their spacer means without removing and replacing any spacing members from the spindles.

2. In a roll forming machine in which metal strips are progressively formed to a profile, the machine being of the type having at least two parallel side frame assemblies at a substantially fixed spacing, a succession of pairs of upper and lower powered roll spindles mounted by and perpendicular to and rotatable in said frame assemblies, power train means to rotate said spindles, and complementary upper and lower forming roll sets thereon, each set including an axially constant roll and an axially shiftable roll,

the invention comprising

laterally shiftable frame means parallel and intermediate to said fixed frame assemblies and having apertures through which said roll spindles pass, said shiftable frame means being adjacent to the shiftable rolls and remote from the contstant rolls,

means to shift said laterally shiftable frame means, and

rotation-permitting and thrust transfer means connecting the shiftable frame means and the shiftable rolls,

whereby to establish and change a spacing, common to all of said spindles, between the shiftable rolls and the constant rolls on the spindles simultaneously.

3. The invention as defined in claim **2,** wherein

the means to shift the laterally shiftable frame means comprises

a plurality of internally threaded members secured to said laterally shiftable frame means,

threaded shafts engaging each of said internally threaded members and extending to thrust bushings at one of said side frames, and

means to rotate said threaded shafts simultaneously.

4. A roll forming machine as defined in claim **2,** wherein

the axially constant position roll portions are keyed to the spindles for rotation therewith, and

the axially shiftable roll portions are free to rotate relative thereto.

5. The invention as defined in claim **2,** further characterized in that

the rotation-permitting means operable between the shiftable frame means and the shiftable rolls includes

annular neck parts projecting axially from said shiftable roll sides,

bores through the shiftable frame means through which said neck parts project, and

retention and thrust-transfer means mounted on said neck parts on both sides of the shiftable frame means adjacent to the ends of said bores.

6. In a roll forming machine of the type described in claim **5,** being further of the type wherein the vertical spacing between each pair of the upper and lower spindles may yield increasingly to accommodate the thickness of such metal strips being formed,

the invention as defined in claim **5,** and further characterized in that

the bores through which said neck parts project are of such diameter as to allow such increased vertical spacing of the spindles.

7. In a roll forming machine of the type described in claim **2,** being further of the type in which the rolls and other spacing members mounted on the spindles have a combined width sufficient to fill the spacing between the side frames, and are assembled thereon by axial sliding as the spindles are inserted,

the invention as defined in claim **2,** and further characterized in that

such other members which fill such spindles include spacer means radially inward of the shiftable rolls, on whose outer surfaces said shiftable rolls may slide axially, over which such roll is shiftable.

8. In a roll forming machine of the type described in claim **2,** being further of the type having on said same spindles, second upper and lower forming roll sets,

the invention as defined in claim **2,** and in which

each of said second roll sets includes a shiftable roll adjacent to the shiftable frame means and an axially constant roll remote therefrom, together with

rotation-permitting and thrust transfer means connecting the shiftable frame means and the shiftable rolls of said second sets,

whereby to shift them axially along the spindles simultaneously with the shifting of the first set of shiftable rolls at the other side of the shiftable frame means.

9. In a roll forming machine as defined in claim **7,** being further of the type having on said same spindles second upper and lower forming roll sets,

the invention as defined in claim **7,** and in which

each of said second roll sets includes a shiftable roll adjacent to the shiftable frame means and an axially constant roll remote therefrom, together with

rotation-permitting and thrust transfer means connecting the shiftable frame means and the shiftable rolls of said second sets, further characterized in that

the said spacer means are bushings inwardly of the shiftable rolls extending along said spindles from edgewise abutment against the constant roll of said

first set to edgewise abutment against the constant roll of said second set.

10. The invention as defined in claim **2,** together with a feed guide secured to the laterally shiftable frame means in advance of the first of said progressive forming roll sets,

whereby, to adjust the strip feed position automatically as the roll spacing is changed.

* * * * *