July 29, 1969 J. G. LINDEMAN 3,457,751

SHEAVE FORMING MACHINE

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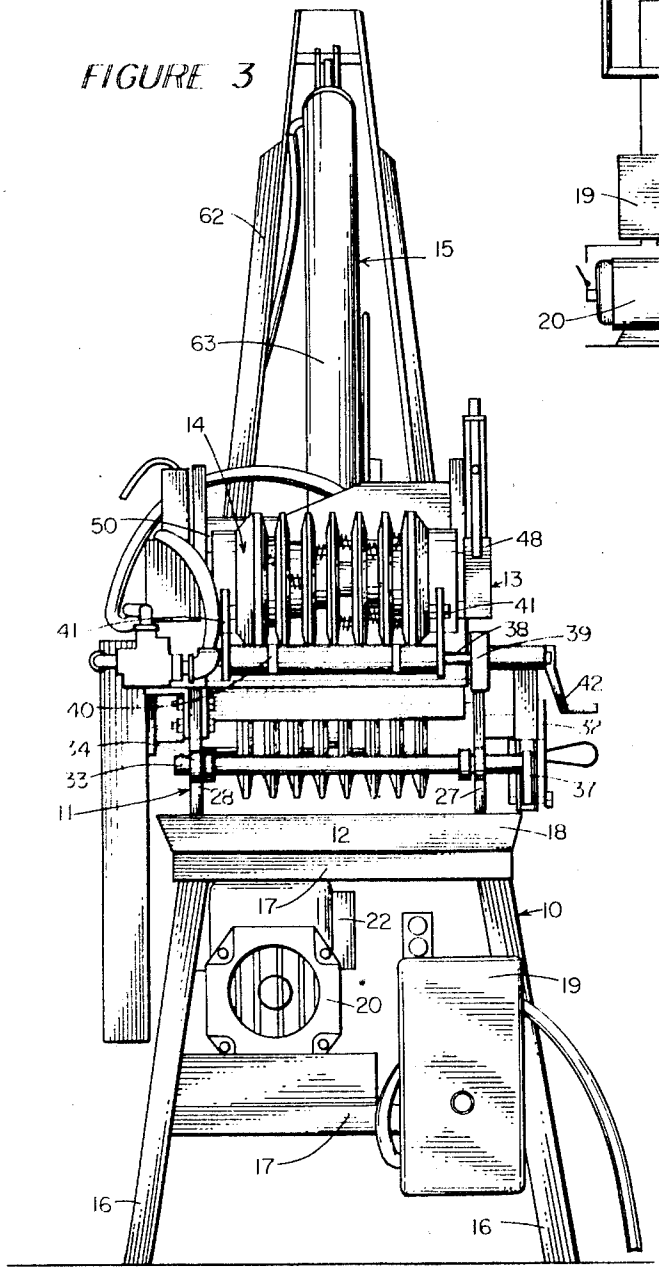
FIGURE 3



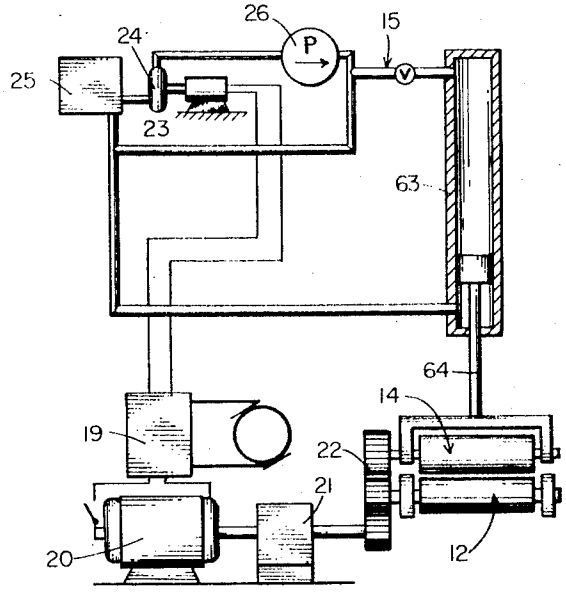




FIGURE 6

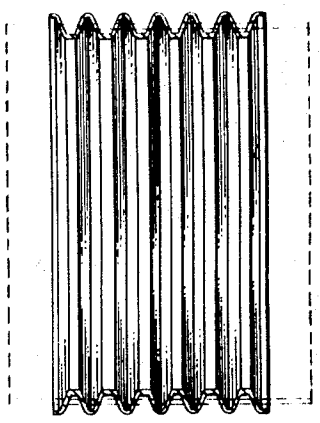


FIGURE 1

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SHEAVE FORMING MACHINE

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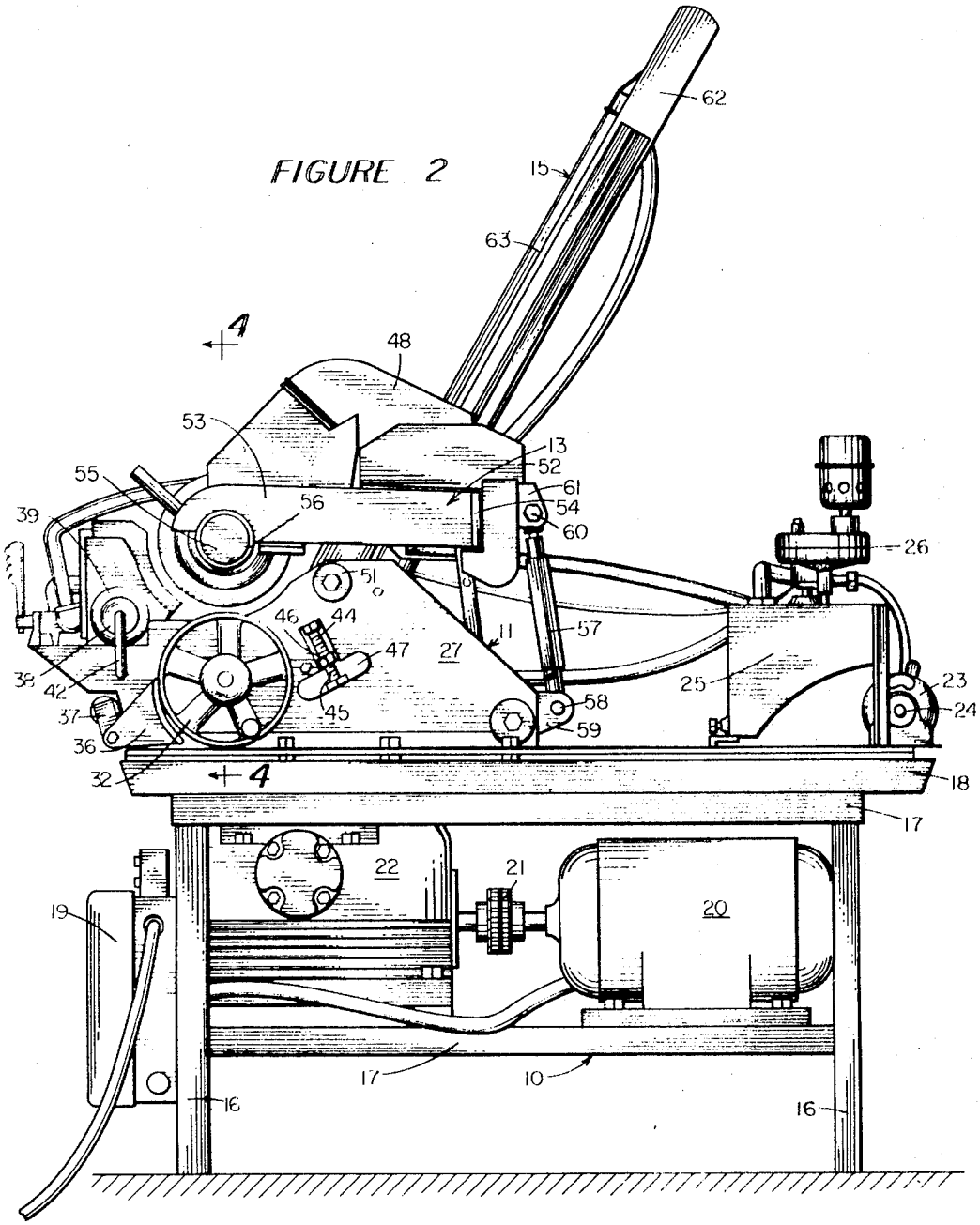
FIGURE 2

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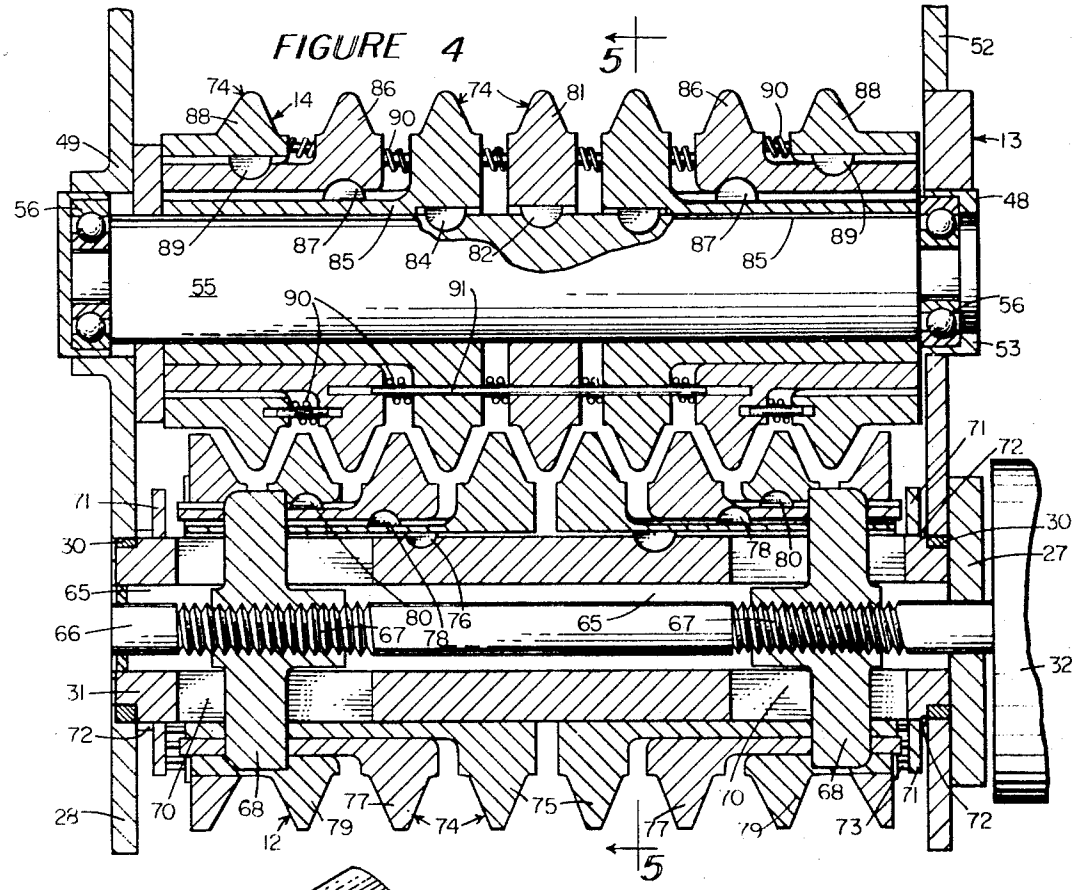
July 29, 1969 J. G. LINDEMAN 3,457,751

SHEAVE FORMING MACHINE

Filed Jan. 9, 1967 3 Sheets-Sheet 3

FIGURE 4



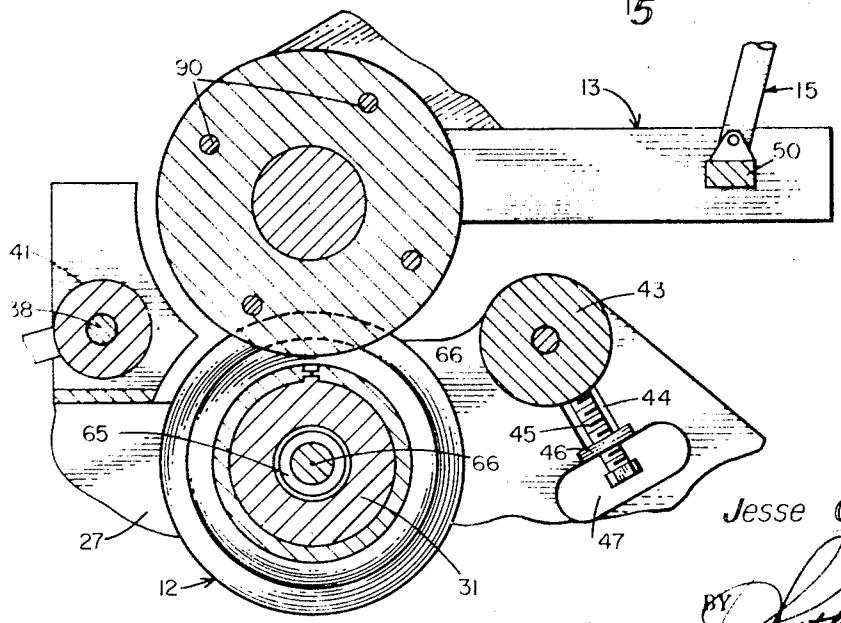




FIGURE 5

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United States Patent Office

3,457,751

Patented July 29, 1969



3,457,751

# SHEAVE FORMING MACHINE

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U.S. Cl. 72—105 2 Claims

## ABSTRACT OF THE DISCLOSURE

A metal forming machine to press a cylindrical blank between opposed compound roller dies to form the blank surface as for a multiple sheave. Each roller die has plural elements with at least one set being axially movable by positive mechanical linkage during the forming process to form a sheave blank having substantially uniform wall thickness.

My invention relates generally to a machine for forming from a cylindrical blank the external peripheral element of a sheave and more particularly to such a machine that forms such a member, with relatively uniform wall thickness throughout, by rolling the blank between opposed mating dies having relatively moveable elements adapted to shrink the blank to the desired form.

Light weight sheaves, formed with a cylindrical peripheral member adapted to receive plural belts by means of alternating indentations and protuberances and provided with a web supported hub of similar light construction, are especially desirable in high speed reversible mechanisms because of their low inertia. Heretofore if a peripheral sheave element of such nature be formed by rolling a cylindrical blank between unitary positive and negative dies having the final desired shape, the finished member will have thicker and thinner portions depending upon whether that portion of the metal was stretched or shrunken from the original to form the final shape. In some products this type of structure is not detrimental, but in sheave structures it is undesirable, as the thinner portions are those that generally receive most wear.

In response to this problem some solutions have heretofore been offered. Principal among these is the die rolling of such members in multiple stages so that the final product has more uniform wall thickness. Multiple rolling, however, is difficult, time consuming and expensive, as it requires a plurality of relatively costly dies, and creates other difficulties encountered with discontinuous manufacturing processes. Oftentimes, also, especially if the angularity between adjacent depressions and protuberances be great, the process has not been effective as the metal moves sufficiently to cause failures or undesirable changes of physical characteristics.

In response to this problem the instant invention was conceived to form a peripheral sheave member or similarly shaped product by die rolling in one continuous process to a final state wherein the product has appropriate configuration with relatively uniform thickness throughout. This result is accomplished by providing paired opposed roller dies with several relatively laterally moveable elements adapted to move inwardly during a continuous rolling process to shrink a cylindrical blank to a final desired configuration with uniform wall thickness.



In so doing it is:

A principal object of my invention to create a machine that will form a cylindrical member having alternating annular indentations and protuberances from a cylindrical blank to a finished product, having relatively uniform wall thickness, in one continuous operation by rolling between positive and negative rolling dies having a plurality of elements laterally movable relative to each other during the rolling process to shrink the original blank to a structure of uniform wall thickness.

A further object of my invention is to provide such a machine that forms the said product in a continuous operation with one set of dies.

A still further object of my invention is to provide a continuous rolling process of novel character for the formation of such a cylindrical member of uniform wall thickness, adapted particularly for use as the peripheral member of a multiple sheave.

A still further object of my invention is to provide such a machine that is of new and novel design, of simple and economical manufacture, of rugged and durable nature, and one that is otherwise well adapted to the uses for which it is intended.

These and other objects of my invention will become apparent from a consideration of the following specification and accompanying drawings which form a part of this application. In carrying out the objects of my invention, however, it is to be understood that its essential features are susceptible of change in design and structural arrangement, with only one preferred and practical embodiment being specified and illustrated, as required.

In the accompanying drawings, wherein like numbers of reference refer to similar parts throughout:

FIGURE 1 is an elongate cross-sectional view of a typical multiple sheave peripheral member with the original blank illustrated in dotted outline.

FIGURE 2 is an orthographic side view of my invention showing its various parts, their arrangement and configuration.

FIGURE 3 is an orthographic front view of my invention showing its parts, their configuration and relationship from this aspect.

FIGURE 4 is an orthographic, vertical cross-sectional view through the die forming heads of my invention, taken on the line 4—4 of FIGURE 2, in the direction indicated by the arrows thereon.

FIGURE 5 is a vertical, orthographical view of the same rolling heads illustrated in FIGURE 4, taken at right angles to the view point of FIGURE 4, on the line 5—5 thereon, in the direction indicated by the arrows.

FIGURE 6 is a diagrammatic representation of the various powering systems of my invention, illustrated in normal symbology.

Referring now to the drawings in greater detail and particularly to those of FIGURES 2 and 3, where my invention is shown in its gross aspects, it will be seen that it embodies bed frame **10** carrying the various operating mechanisms and supporting, in its upper forward part, lower roll frame **11** rotatably journaling lower die roll **12** and pivotally supporting upper roll frame **13** ro-

tatably journaling upper die roll **14**, with hydraulic means **15** communicating between the roll frames to adjustably position the rolls relative to each other.

Red frame **10** is formed with vertical legs **16** structurally communicating with intermediate cross members **17** and top members **18** to form a rigid structural support. This member carries the electrical switching apparatus **19**, controlling power supply to the various motive systems of my invention, preferably in a forward position on vertical legs **16** so that the apparatus is readily accessable during operation. Intermediate cross supports **17** carry principal prime mover, electric motor **20**, communicating by couple **21** to gearing mechanism **22**, again carried by the intermediate cross members **17**.

The rearward portion of bed frame **10** supports, on top member **18**, the hydraulic system including motor **23** driving pump **24** which is supplied with hydraulic fluid from reservoir **25**, through regulating apparatus **26** to distribute it under some pressure into the hydraulic system **15**.

Lower roll frame **11** includes similar right side plate **27** and left side plate **28** joined by cross members **29** and supported in the forward portion of top **18** of bed frame **10**. Journaled for rotation by bearings **30** in the forward portion of this member is hollow lower die shaft **31** maintained in lateral alignment by the thrust nature of bearings **30**.

Forwardly and below die shaft **31** is brake shoe shaft **33** journaled in bearings **34** on side plates **27**, **28** and maintained in lateral alignment by thrust rings **35**. This shaft irrotatably carries in its right end portion bell crank **37** pivotably journaling brake shoe **36**, adapted to communicate with the peripheral surface of friction wheel **32**.

Forwardly and above lower die shaft **31** is blank aligning shaft **38** rotatably journaled by bearings **39** in side plates **27**, **28**. This shaft has spaced medial threaded portions **40**, each threaded in opposite direction to the other and threadedly carrying aligning ears **41**. The shaft is laterally aligned by the thrust nature of bearings **39** and provided with irrotatably communicating crank **42** in its right end portion for manual manipulation. This structure allows aligning ears **41** to be moved laterally along shaft **38** relative to each other, but yet at all times to remain symmetrically equidistant from the central point of the shaft.

Rearwardly and above lower die shaft **31** is back-up roll shaft **43**, journaled in moveable bearings **44**, adapted for motion at an angle forwardly and upwardly, as illustrated particularly in FIGURE 2, by adjustment of studs **45** threadedly carried in paired opposed yokes **46** structurally communicating with side plates **27**, **28**. An appropriate orifice **47** is provided in the side plates to allow adjustment of stud **45**. This shaft maintains a blank in proper rolling position relative to the two die shafts during the rolling operation.

All of the various shafts **31**, **33**, **38** and **43** are aligned with their axes parallel to each other and provided with appropriate lateral motion limiting structures as specified.

Upper roll frame **13** is formed with similar right side member **48** and left side member **49** structurally joined by cross-members **50**. Right side member **48** pivotally communicates with lower side plate **27** by bolt-nut combination **51** and left side member **49** communicates with lower left side plate **28** by similar bolt-nut combination, each of said structures being axially aligned with the die rolls to provide pivotable movement between upper and lower roll frames **11**, **13** with the die axes remaining parallel. Right side member **48** is a compound structure with rearward and upper portion **52** communicating with bolt **51** and forward lower portion **53** constituting a separate unit pivotably supported on rearward portion **52** by hinge **54** providing for laterally outward, substantially horizontal movement of lower element **53**, to allow for insertion of a cylindrical sheave blank over and about upper die roll **14**.

Upper die shaft **55** is journaled for rotation in bearings **56**, the left bearing carried by the left side member **49** and the rigid bearing supported, at least against upward movement, by forward pivotable portion **53** of right side member **48**.

Adjustable slideable turnbuckles **57** extend from pins **58** in ears **59** of the lower rearward portion of side plate **27**, **28** to pins **60** in ears **61** of the rearward portion of upper side members **48**, **49**, to limit the motion of upper die shaft **55** toward lower die shaft **31** to prevent damage to the machine.

Hydraulic frame **62** extends upwardly and rearwardly from top members **18** of bed frame **10** in a medial position between the roll frames. This frame **62** rigidly supports double acting cylinder **63** relative to bed frame **10**. Piston shaft **64** communicates with cross member **50** of upper roll frame **13** in a pivotable fashion so that upon lineal movement of the piston shaft, the upper roll frame will be pivotably moved relative lower roll frame **11** and thusly upper die shaft **55** moved relative lower die shaft **31**. The double acting capabilities of hydraulic cylinder **63** allow the dies to be opened or closed as desired.

Upper and lower die rolls are best illustrated in the sectional views of FIGURES 4 and 5 where it will be seen that each roll carries a plurality of positive and negative die elements laterally moveable relative to each other. Herein lies the essence of my invention.

In FIGURE 4 the dies are expanded or in an initial position. It is seen that lower die shaft **31** is a hollow member having axially aligned, central cylindrical channel **65**. This channel carries die moving shaft **66** irrotatably journaling friction wheel **32** on its right side and having laterally spaced, medial threaded portions **67** carrying die moving dogs **68**, each having outwardly extending arms **69** projecting through appropriate elongate slots **70** in die shaft **31** to communicate with the forming dies. With this structure the die shaft **31** may rotate as desired independently of die moving shaft **66**, which in turn may be rotated to varyingly position the die moving dogs **68** laterally relative to each other.

A plurality of such die moving dogs might be used, one for each die element, if desired, to position and move each die element independently. This structure has in practice been found somewhat complex and not necessary to the proper functioning of my invention, however.

Lower die shaft **31** carries die positioning disks **71**, laterally positioned on the shaft by thrust rings **72** immediately adjacent the die positioning disks and side plates **27**, **28**. These die positioning disks adjustably threadedly carry die aligning pins **73** adapted to properly laterally align the various elements of the die rolls relative to each other at their outwardmost extension and limit this lateral extension.

The lower positive forming die comprises a plurality of laterally alternating positive and negative elements to form the finished sheave periphery. In the member illustrated in FIGURE 4, a six groove sheave would be formed. Each of the die elements has a forming portion **74** of an appropriate configuration to form, in cooperation with its opposed mate, the final member desired. The laterally innermost elements **75** are cylindrical structures bearing on die shaft **31** and prevented from rotation relative thereto by key **76**. The next laterally outward members **76** bear on the laterally extending cylindrical neck of member **75** and are prevented from rotating relative thereto by key **78** therebetween. The third laterally outward members **79** bear on the cylindrical neck of the members **77** and are prevented from rotating relatively thereto by keys **80**, and the fourth laterally outward members bear upon the lateral extensions of members **79** and are prevented from rotating relatively thereto by the outward arm **69** of die moving dogs **68**. With this structure, it is seen that each of the lower die elements will rotate in response to rotation of lower die shaft **31**, but each

will be laterally moveable, within limits, relative to the other; since arms **69** of die moving dogs **68** extend through the shafts of each of the individual die members, each will be moved in response to motion of the die moving dogs **68**, so that the entire structure will be laterally expanded or contracted, as desired.

The upper negative forming die member is formed in the same fashion as the lower die with appropriately mating peripheral configuration. Central die **81** is immoveable laterally on upper die shaft **55** and is irrotatably carried thereon by means of key **82**. The next laterally outward members **83** have laterally extending cylindrical necks **85** and are maintained irrotatably upon shaft **55** by keys **84**. The next laterally outward dies **86** slideably bear on the necks **85** of dies **83** and are maintained irrotatable relative thereto by key **87**; the outermost dies **88** bear on the laterally extending necks of dies **86** and are maintained irrotatable relative thereby to keys **89**. This structure is the same as that for the lower die member except that no provision is made for the die moving assembly; none need be as the negative die will follow the positive die naturally in the forming operation.

The several die members are biased to an outwardly extended position, away from each other, by plurality of extension springs **90** carried by spring rods **91** extending between adjacent die members so that the entire structure is biased open but yet yieldable to a closed position—the configuration of a finishing die in a multiple stage rolling process.

The various powering mechanisms, and their relationship, are illustrated in normal symbology in FIGURE 6. From the foregoing description, it can be seen that power source **92** supplies energy through control panel **19** to motor **20** which converts this energy to rotary torque that is transmitted through coupler **21** and gearing mechanism **22** to power the die rolls **12, 14**. Electric energy is also supplied from panel **19** to motor **23** activating pump **24** which transmits fluid under pressure from reservoir **25** through hydraulic control **26** to double acting cylinder **63** to hydraulically activate it as specified. The various circuitry, control mechanisms and control devices are known in the art. Obviously the various motive means are matters of choice and other means which would accomplish the same purpose may be substituted if desired.

Having thusly described the mechanism of my invention, its operation may now be understood.

To use my machine, a cylindrical blank member having wall thickness essentially the same as that desired in the finished product is chosen, with an axial length somewhat greater—approximately 30%—than the finished product desired. The blank is established in my machine, having dies formed to previously determined specifications to form the particular product desired, by opening lower-forward portion **53** of right side member **48** of roll frame **13** and inserting the blank around upper die roll **14**. The part **53** of side member **48** is then replaced to support upper roll bearing **56** against upward thrust.

Blank aligning crank **42** is turned to move aligning ears **41** inwardly into contact with the lateralmost edges of the blank and in this condition the prime mover is activated to cause the lower power-driven die roll **12** to rotate. As roll **12** rotates, hydraulic cylinder **63** is activated to bring upper die roll **14** toward lower die roll **12** and the forming process begins. As soon as both dies contact the metal and begin to form it, the brake shoe **36** is activated to frictionally engage wheel **32** to cause rotary activation of die moving shaft **66**, thus causing die moving dogs **68** to move inwardly and move the various die elements toward each other. This process is continued until the dies have moved inwardly immediately adjacent each other. The speed of moving of the dies toward each other must be regulated relative to the speed of rotation of the dies and the particular metals and structures involved, according to principles well known in the art and empirical tests.

After the dies are immediately adjacent each other, or very nearly so, the two die shafts are backed away from each other, the dies tightened laterally, as tightly as they may be, and the structure given a final roll to assure that it is in its desired final form.

With this rolling operation it is to be noted that the metal blank will be shrunken into the final form, and by reason of this, the final thickness of the finished member will be nearly uniform throughout and substantially equal to that of the blank with which the operation began.

It is further to be noted that, by reason of the configuration of the dies, the negative or upper die will necessarily follow the lower or positive die in lateral motion; in fact, after the first forming is accomplished, the metal itself during continuance of the forming operation will draw the dies together and thusly not require any extensive use of the die moving apparatus.

The foregoing description of my invention is necessarily of a detailed nature so that a specific embodiment of it may be set forth as required, but it is to be understood that various modifications of detail, rearrangement and multiplication of parts may be resorted to without departing from its spirit, essence or scope.

Having thusly described my invention, what I desire to protect by Letters Patent, and,

What I claim is:

**1.** A metal forming machine of the nature aforesaid comprising, in combination:

a positive die roll comprising a plurality of elements, each laterally moveable and irrotatably carried upon a common die shaft;

a cooperating negative die roll comprising a plurality of elements laterally moveable and irrotatably carried upon a common die shaft;

means of journaling each of said die shafts in axially parallel, adjustably spaced relationship; and

means of moving the die elements of at least one die set laterally inward relative to each other while rotatably moving the die shafts relative to each other to form a sheet member of relatively uniform wall thickness therebetween, such means comprising a die moving shaft, carried within one of the die shafts and having spaced medial portions threadedly carrying radially outwardly projecting dogs extending through slots in the carrying die shaft to communicate with the laterally outward die elements of one die roll and means of rotating the die moving shaft independently of the carrying die shaft to laterally move said dogs.

**2.** A machine for forming the peripheral cylindrical member of a multiple sheave from cylindrical sheet stock, comprising, in combination:

a base frame;

a lower die roll frame carried thereby, rotatably journaling a lower die roll comprising a die shaft laterally slidably and irrotatably carrying a plurality of die elements for each separate feature of a sheave form;

an upper die roll frame, pivotably carried by the lower die roll frame and rotatably journaling, parallel to the lower die roll shaft, an upper die roll, comprising a plurality of coperating individual die elements for each separate feature of a sheave form, each individual die element being irrotatably carried by the upper roll shaft and laterally movable relative thereto;

means of adjustably pivotably moving the upper die roll relative the lower die roll to form a sheave blank therebetween;

means of moving one set of die elements from a laterally expanded to a laterally contracted position com-

prising a die moving shaft rotatably carried within one die shaft and having spaced medial portions threadedly carrying radially outwardly projecting dogs extending through slots in the carrying die shaft to communicate with the laterally outward elements of the die roll to move such elements toward each other upon rotation of the die moving shaft and means of turning the die moving shaft independently of the carrying die shaft to laterally move said dogs; and

means of powering at least one of the die rolls for rotation.



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U.S. Cl. X.R.

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