Dec. 14, 1948. J. L. WOLF ET AL 2,456,353

WIRE BENDING MACHINE

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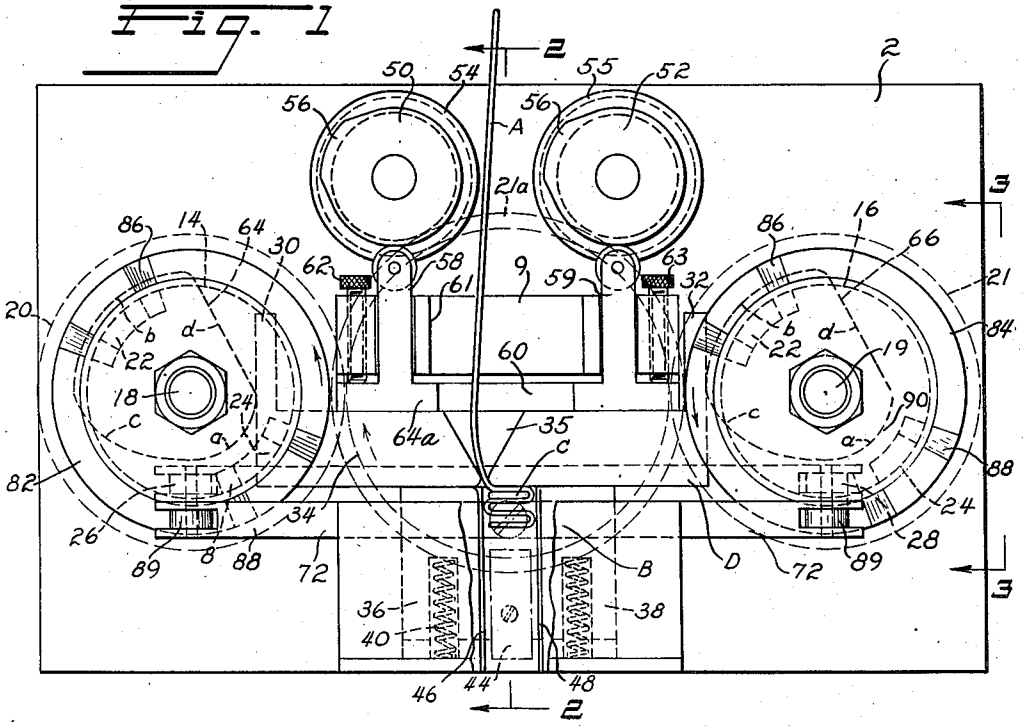
Fig. 1



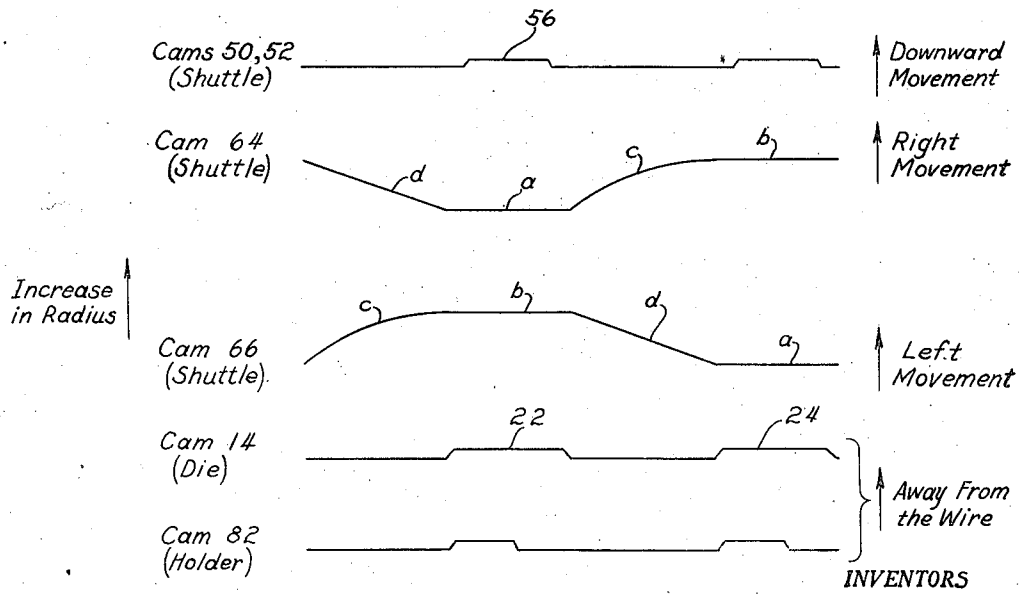


Fig. 13

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Fig. 2

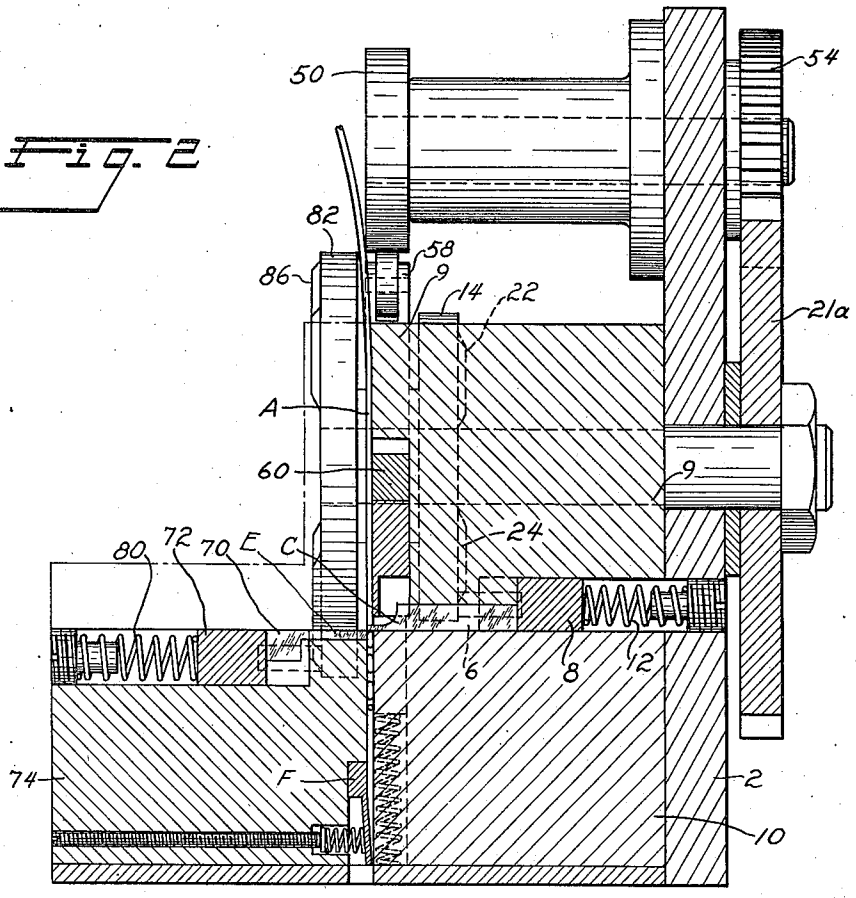
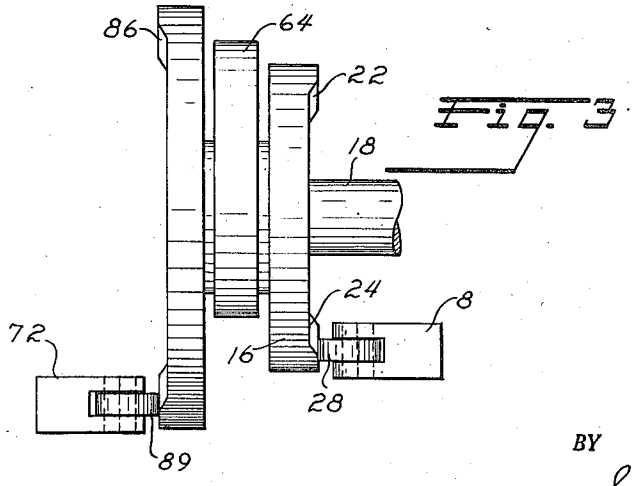


Fig. 3



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WIRE BENDING MACHINE

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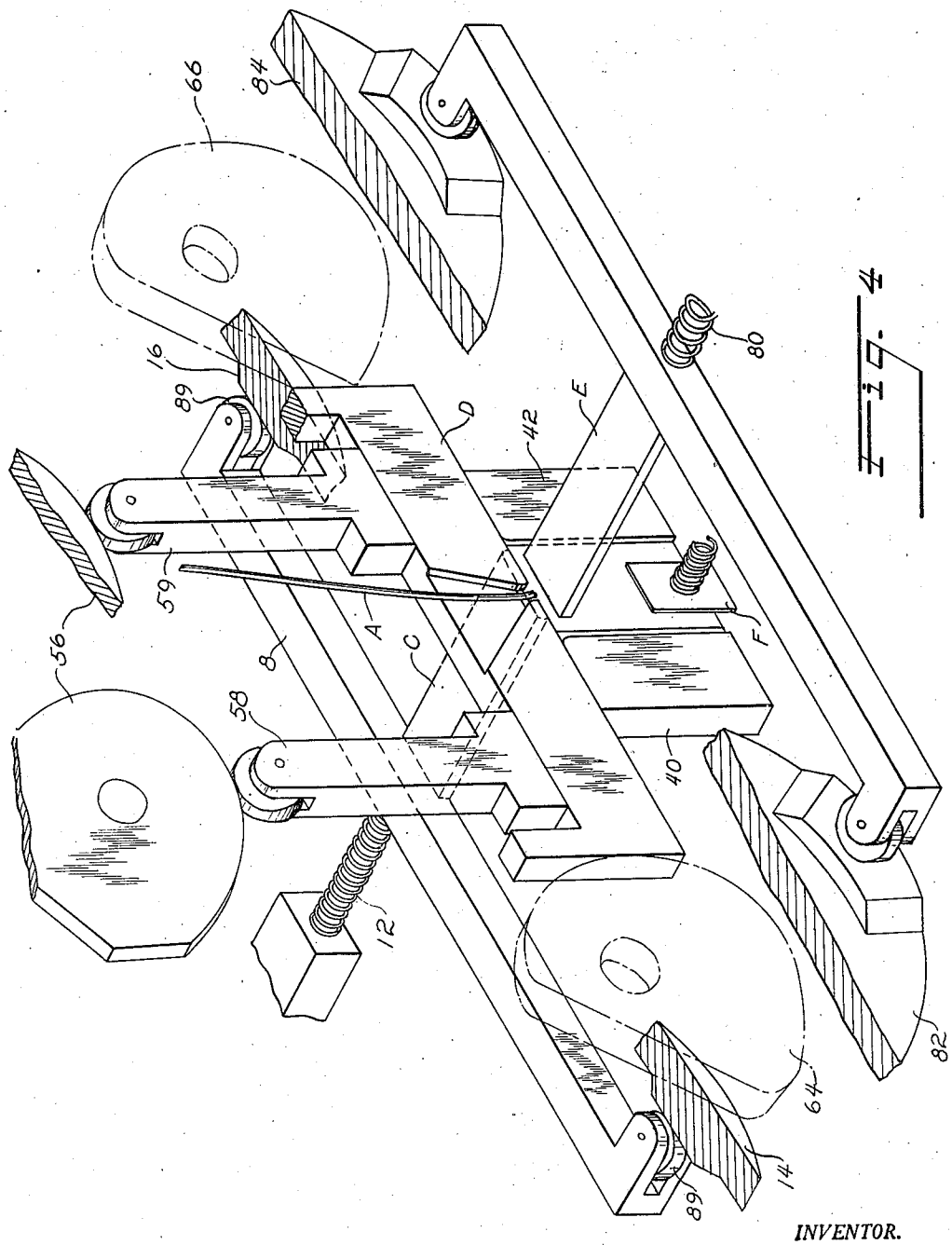

FIG. 4

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WIRE BENDING MACHINE

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Fig. 5

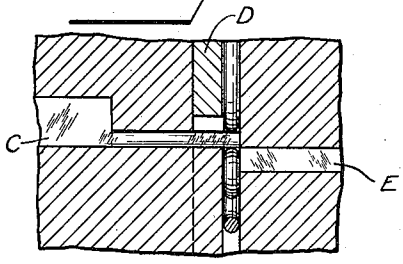


Fig. 6

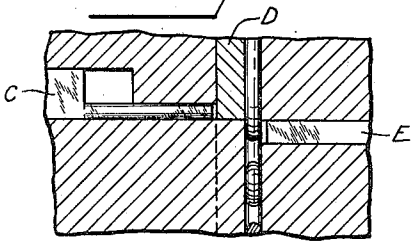


Fig. 7

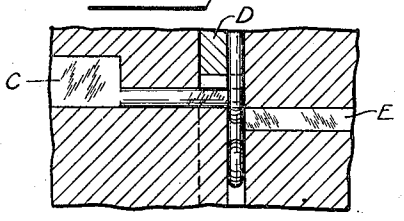


Fig. 8

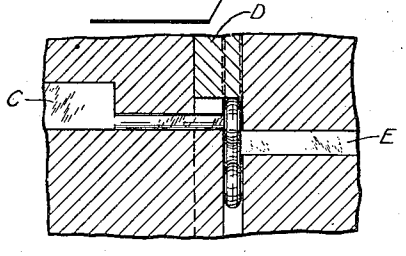


Fig. 9

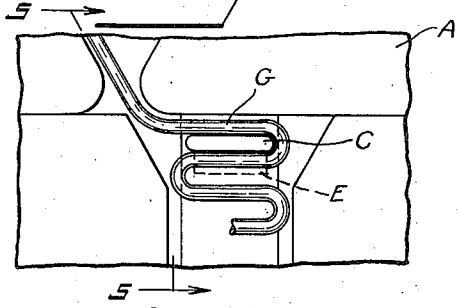


Fig. 10

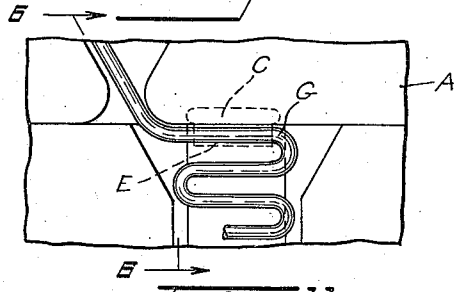


Fig. 11

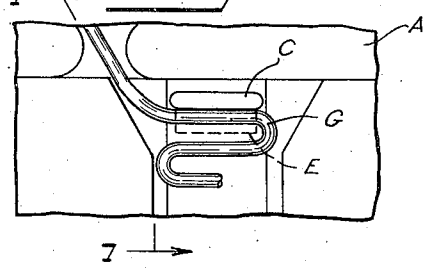
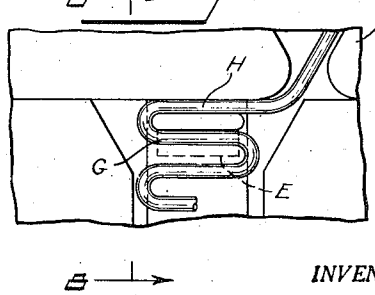


Fig. 12



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UNITED STATES PATENT OFFICE

2,456,353

WIRE-BENDING MACHINE

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Application August 22, 1947, Serial No. 770,012

3 Claims. (Cl. 140—71)

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This invention relates broadly to metal forming machines and, more particularly, to machines for bending wire or strip material into sinuous form in which it comprises a series of spaced transverse parts, or flights, the two ends of each of which are connected respectively to the adjacent ends of the preceding and succeeding flights by loop portions which are alternately oppositely faced along the length of the formed device. Wire or strip material formed in this manner provides a ribbon-like element which finds a wide field of use, for example as an electric resistance heating element and the like.

These wire or strip elements are sold at very low prices and consequently must be produced very cheaply. It has therefore been one of the principal objects of this invention to provide a simple and inexpensive machine for producing such elements at a speed much greater than is possible with known machines, thereby decreasing their cost of manufacture.

A great number of different machines for forming elements of the described type are now known. In many of these machines the wire or strip is formed into flights by bending it at regularly spaced intervals about pins carried by rotating wheels or by the oscillating end of a bell-crank lever. In these machines the work strip is unsupported except by the pins about which it is bent. It has been found that this limits the reduction of the spacing between flights (i. e. limits the number of flights per inch) although it is desirable in many cases to have many more flights per inch than is permitted by known machines. This is due to the fact that the reduction of the spacing between flights is limited by the diameter of the pins about which the wire is bent and that, as these pins provide the only support for the wire, they cannot be reduced in diameter below a safe value which is too great to provide the desired small spacing. Our invention provides a machine which is not subject to this disadvantage and which will produce wire ribbons of the described type having much smaller spacing between flights and consequently many more flights per inch than known machines. The provision of a machine capable of doing this has been one of the principal objects of our invention and is achieved in the machine disclosed in this application by providing a die member having a width substantially equal to the length of the flights and a thickness substantially equal to the spacing between them, about the opposite side edges of which the oppositely facing end loops of the wire

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ribbon are alternately formed, and which provides a support for the entire length of each flight of the ribbon throughout the formation thereof and the formation of the loops.

It is very desirable, in machines for producing formed wire elements of the described type to be able to adjust the machine to vary the spacing between flights and it has been an important object of this invention to provide a simple means for effecting this. The achievement of this in machines according to the present invention is another advantageous result flowing from the provision of the forming die described above, as it will be apparent that by using a forming die of the desired thickness, and replacing this with a die of another thickness when it is desired to change the spacing, the spacing between flights may be easily and quickly changed.

It has been a further object of this invention to provide a wire bending machine of the described type having a die member on which the wire is formed and having, in addition, a single means for positively drawing the wire from a source of supply, training it across and onto the die in alternately different directions and moving the formed ribbon longitudinally of itself so that additional loops may be formed, by reason of which single operating member a very simple, inexpensive and rapid machine might be produced having all of the advantages provided by the die member, as described hereinbefore. This object is achieved in the present invention by the provision of a so-called "shuttle" which controls and moves the wire at all times, causing it to be drawn from a reel or other source of supply and trained in alternately opposite directions across the forming die, and which also moves the formed ribbon longitudinally of itself after the formation of each flight, in order to permit another flight to be formed.

A still further object of the invention has been to provide means for positively and firmly holding the formed wire element during the formation of each flight in order to cause the wire to be bent about the die in the desired manner without slipping from the die. This is achieved in our invention by the provision of a so-called "holder" which operates in synchronism with the shuttle and die to separately engage each flight immediately after it has been formed and moved away from forming position, thus insuring that the formed ribbon will be held immovable and in proper relation to the die during formation of the next succeeding flight.

In connection with the holding of the formed ribbon by the holder and the movement of each flight by the shuttle from forming position into the discharge passage of the machine to permit the formation of the next succeeding flight, it has been an object of the invention to provide means for securely holding each flight against the shuttle immediately after formation thereof and until it is engaged by the holder, in order to assure that the flight will be in a predetermined position and location which is determined by the location and shape of the face of the shuttle with which it is in contact. The provision of such means insures that each flight will be securely held by the holding bar in a predetermined position and relation to other parts of the machine. This would not be the case if the means now referred to were not provided as, in the absence of such means, the inherent resilience of the wire or strip material would cause it to spring away from the shuttle, or would cause different flights to engage the shuttle differently, whereby they would not be held uniformly by the holder. In our invention this object is achieved by the provision of means which exert pressure against the formed ribbon in the discharge passage of the machine, thus braking or retarding its movement and causing it to crowd against the shuttle, thus holding the last-formed flight firmly against the shuttle.

Other objects and features of novelty of the invention will be made apparent by the following description and the annexed drawings which disclose one embodiment of my invention and in which drawings,

Fig. 1 is a plan view, with parts broken away, of a wire bending machine according to the invention;

Fig. 2 is a sectional view taken on line 2—2 of Fig. 1;

Fig. 3 is an end view, taken on line 3—3 of Fig. 1, of the cams at one end of the machine for operating the die bar, the holder bar and the shuttle;

Fig. 4 is a perspective, schematic view showing the shuttle, die, holder, operating and other elements of the machine of Fig. 1;

Figs. 5, 6, 7 and 8 are enlarged sectional views of parts shown in Fig. 2, illustrating different steps in the operation of the disclosed machine;

Figs. 9, 10, 11 and 12 are front views of the parts and elements shown in Figs. 5, 6, 7 and 8, respectively, and

Fig. 13 is a diagrammatic representation of the relation of the various cam surfaces of the machine.

In this application there is disclosed a machine for forming straight wire, strip or similar preferably metallic material, which is indicated at A in the drawings, into a ribbon of the type and structure described hereinbefore and which is illustrated at B in the drawings. This machine comprises a frame, which may be a flat plate 2, and the following operable elements which are more fully described hereinafter, which are mounted directly or indirectly on the frame.

1. A die C which, in the preferred form, is a flat plate having thickness and length substantially equal respectively to the desired spacing between flights of the finished ribbon and the desired width of the ribbon (i. e. the length of the flights, and on and about which the wire is bent into sinuous form.

2. A shuttle D through which the unformed wire passes to the die, and which has the functions of laying the wire on the die in alternately opposite directions, moving the formed flight into the outlet passage of the machine, and moving the formed ribbon through the outlet passage.

3. A holder E, the function of which is to hold the last-formed flight rigidly in place at the outlet side of the die while the shuttle is forming each flight and while the shuttle is moving to forming position from the position it occupied in moving the last-formed flight to the discharge side of the die.

4. A tension plate F, which retards or brakes the movement of the formed ribbon through the discharge passage of the machine in order to cause the last-formed flight to tightly engage the shuttle while the ribbon is being moved into and through the discharge passage.

5. The necessary operating members, such as means for imparting lateral reciprocatory movement to the shuttle, i. e. across the die, vertical reciprocatory movement to the shuttle, i. e. at right angles to the forming face of the die, in timed relation to its lateral movements, reciprocatory movement of the die toward and away from the wire, and reciprocatory movement of the holder toward and away from the formed wire ribbon, the movements of each of these parts being synchronized with the movements of the others.

The die C of the disclosed machine comprises a strip of metal having flat, parallel upper and lower faces against and on which the straight parallel flights of the wire ribbon are formed, and semi-circular ends about which the wire is bent to form the oppositely-facing end loops which connect the flights. The width of the die is approximately equal to the length of the separate flights, while the thickness of the die is approximately equal to the spacing between flights. The die is preferably formed as the end of a part 6 extending at right angles from the side of a bar 8. The die part 6 and bar 8 are mounted in a recess in an upper block 9 and are slidably supported on a lower block 10 for sliding reciprocatory movement laterally of the length of the bar whereby the die may be advanced into and withdrawn from the path of the wire A being fed into the machine. The bar 8 and die C are constantly urged by springs 12 to an extended, or outer, operative position in which the die is in the path of the wire A entering the machine, and other means are provided for moving it to a retracted, inoperative position out of the path of the wire. Such means comprise cam wheels 14, 16, which are mounted on spaced parallel shafts 18, 19 journaled in plate 2 and rotated through gearing 20, 21 respectively from a main gear 21a which is driven by a suitable machine. Each of the cam wheels 14, 16 has formed thereon diametrically spaced axial cam surfaces 22, 24 which engage rollers 26, 28 at the ends of bar 8 on the side thereof opposite the springs 12. This die provides a means having flat parallel faces on which the wire is formed into the transverse flights of the ribbon and having end edges about which the wire is alternately bent to form the oppositely-facing loops which connect the spaced flights.

The shuttle D of the machine comprises a part through which the incoming wire A is fed and which traverses the die to lay the wire thereon and moves at right angles to the die to move the formed wire into and along the discharge passage of the machine. In the disclosed embodiment the shuttle is a U-shaped member having upstanding arms 30, 32 connected by a horizontal part 34 which has a V-shaped recess 35 in

the front face thereof through which the incoming wire A is fed. The outlet port at the lower end of recess 35 preferably has outwardly flared walls to prevent cold working of the wire by excess bending. The front face of the shuttle is disposed vertically above the die C and the restricted outlet port at the lower end of the recess 35 is positioned adjacent the die so that as the shuttle is reciprocated laterally, i. e. across the upper surface of the die, the outlet port will be caused to traverse the die, the stroke of the port terminating just outside the edge of the die at each side thereof. The lower surface of the horizontal part 34 of the shuttle rests freely and slidably on the upper surfaces of two spaced blocks 36, 38 which are resiliently supported at their lower ends on springs 40, 42 whereby the shuttle may be vertically reciprocated, by compressing the springs, from an upper position in which the lower surface of the horizontal part 34 of the shuttle is above the level of the upper surface of the die C by a distance equal to the thickness of wire A, to a lower position in which such lower surface is approximately at the level of the lower surface of the die. The blocks 36, 38 are positioned on opposite sides of the die and the space between their adjacent side faces is directly below the die and forms the discharge passage of the machine through which the formed ribbon is discharged. The blocks are held in spaced relation by a fixed member 44 which forms one wall of the discharge passage. The adjacent corner edges of the blocks 36, 38, which lie just below the opposite end edges of the die are cut away to form corner recesses 46, 48 which are flared outwardly at their upper ends and within which the opposite edges of the formed wire ribbon are received and along which the edge parts of the wire ribbon move as the ribbon moves along the discharge passage.

Means are provided for effecting vertical reciprocation of the shuttle and such means comprise spaced rotatable cam wheels 50, 52 which are mounted above the shuttle and are driven from main gear 21*a* through gears 54, 55. Each cam wheel has formed thereon a single radial cam surface 56, the two cam surfaces being identical in size and structure in order that they will operate simultaneously and with the same effect. The periphery of each wheel is in sliding engagement with means, such as a wheel, formed respectively on the ends of a pair of vertical rods 58, 59 which pass through spaced openings in block 9. At their lower ends the rods 58, 59 are attached to a lateral connecting bar 64*a* which freely and slidably rests on the upper surface of the lateral connecting part 34 of the shuttle, and has a recess 60 in the front face thereof which is positioned below a similar recess 61 in the front face of block 9 and through which recesses the incoming wire A passes to the recess 35 of the shuttle. Rotation of the cam wheels 50, 52 will cause the rods 58, 59, bar 64*a*, the shuttle, and blocks 36, 38 to reciprocate vertically against the force of springs 40, 42, the parts being so proportioned that the lower surface of the lateral part 34 of the shuttle will move between the described limits during such reciprocation. These limits may be varied if desired by means of adjusting screws 62, 63 which are threaded through the block 9 and bear at their lower ends on bar 64*a*. Obviously, a single cam might be used to effect vertical reciprocation of the shuttle instead of the two cams of the disclosed machine.

Means are provided by the invention for reciprocating the shuttle laterally of the machine, i. e. across the die, and such means comprise radial cams 64, 66 which are mounted on rotary shafts 18, 19 and which respectively engage the outer faces of the upstanding side arms 30, 32 of the shuttle. The cams are so constructed and positioned relatively to each other that when they are rotated a lateral reciprocating movement is imparted to the shuttle, which slides on the upper surface of blocks 36, 38 and on the lower surface of bar 64*a*, the stroke of such movement being such that the restricted outlet port at the lower end of the wire feed passage 35 in the shuttle traverses the die in the manner described hereinbefore. In the disclosed machine the cams 64, 66 are of similar size, structure and positioning on their respective shafts. Each cam has a constant-radius part *a* of small radius, a constant-radius part *b* of greater radius, and a curved cam surface *c* and a flat inactive surface *d* connecting these constant-radius parts.

The holder E of the disclosed machine comprises a strip of metal having a width approximately equal to that of the wire ribbon and a thickness which may be approximately equal to that of the wire A. The holder is positioned below the die, with its upper surface approximately in the plane of the lower surface of the die and extending in the opposite direction therefrom so that the ribbon may pass between their ends when they are retracted. The holder is preferably formed as the end of a part 70 which extends at right angles from the side of a bar 72 which is parallel to bar 8 and of substantially the same length. The holder, part 70 and bar 72 are mounted in a block 74, which is rigidly attached to block 10, for sliding reciprocatory movement laterally of the length of the bar whereby the holder may be advanced into holding engagement with the transverse wire flight which is resting against the lower face of the shuttle, i. e., the flight which has just been formed and moved by the shuttle into the discharge passage of the machine. Means are provided for effecting such reciprocatory movement and comprise springs 80 which engage the bar 72 and constantly urge it toward the formed wire ribbon, and cam wheels 82, 84 which are mounted on shafts 18, 19 and each of which has formed thereon diametrically-spaced axial cam surfaces 86, 88 which engage rollers 89 on the ends of bar 72 to intermittently urge the bar and holder E away from the formed wire ribbon against the force of the springs. While it is preferred that the die and the holder be on opposite sides of the wire and the formed ribbon they may both be positioned on the same side thereof if desired.

The positions and shapes of the various cam surfaces and their relation to each other to produce the operations and sequence of operations described herein is disclosed in Fig. 13 of the drawings. The relative speeds of rotation to be used for proper operation of the machine may be produced by gearing having the proportions disclosed in the drawings. The cam wheels 14, 64, and 82 and the cam wheels 16, 66, 84 are mounted on shafts 18, 19 respectively and therefore rotate at the same speed, being driven by gears 20, 21 of the same size and number of teeth. The gears 54, 55 which drive the cam wheels 50, 52 are so related to gears 20, 21 that the cam wheels 50, 52 make two revolutions for every single revolution of the cams on shafts 18, 19.

In the operation of the disclosed machine to form a sinuous wire element B from a straight

wire A the machine parts are first positioned so that the shuttle is at the extreme right or left-hand end of its longitudinal stroke. In this position the cam **64** (or **66**) which has moved the shuttle to the described position will be at the end of the cam surface *c* and will have begun rotation on the constant radius *b*. When the cam and the shuttle are in this position, one of the axial cams **22, 24** which operate the die will be in such position that the die will be held in its retracted position against the force of springs **12**, in which position the die is withdrawn from the path of the wire. When the shuttle and the die and their operating cams are in these described positions one of the cams **86, 88** which operate the holder will be in such position that the holder will be retracted away from the formed wire ribbon against the force of springs **8**. When the shuttle, the die, the holder, and their operating cams are in the described positions, the cams **56** which impart vertical movement to the shuttle will be in such position that they are just moving out of contact with the arms **58** which transmit vertical movement from the cams to the shuttle. When the parts are in the described positions the wire A can be threaded through recess **61** in block **9**, and recess **60** in bar **64***a*, then through the V-shaped recess **35** in the shuttle, then between the die and the holder, which are now retracted, and into the outlet passage of the machine between the blocks **36, 38**. The machine is now ready to operate.

When the machine is operated the holder C first moves in against the wire, holding it firmly against the plate **44** which forms one side of the discharge passage. The shuttle is then moved upwardly by the springs **40, 42**, during which movement the cam wheels **50, 52** engage the arms **58** over the constant radius portions of their peripheries. This upward movement of the shuttle will not have any effect on the wire which has been threaded through the machine. When the shuttle has moved to its most upward position as shown in Figs. 5 and 9, the die-bar operating cams will be moved to permit the springs **12** to move the die into the path of the wire and at one side thereof, it being remembered that the shuttle is in an extreme right or left-hand position. With the parts in the described positions the shuttle now makes a traversing movement, carrying the outlet port of the wire-receiving recess **35** across the top face of the die at a distance above the upper face of the die approximately equal to the thickness of the wire A. This movement is illustrated in Figs. 5 and 9 in which the shuttle has moved from an extreme right-hand position to an extreme left-hand position, carrying the wire across the upper surface of the die and forming a flight G of the ribbon. The next operation of the machine is to move this last-formed flight G downwardly below the die so that the shuttle may pull the wire again across the upper surface of the die in the opposite direction from the flight G. Accordingly, in the next sequence of operations of the machine the die and the holder are withdrawn, as shown in Figs. 6 and 10, and the cams **56** which impart vertical movement to the shuttle cause the same to be moved downwardly without traversing movement, thereby forcing the formed wire ribbon downwardly through such a distance that the upper surface of the flight G is at approximately the level of the lower surface of the die. When the parts are in this position, the holder operating cams **86, 88** move to such a position that the holder is forced outwardly by its operating springs into engagement with the flight G, holding the same firmly against the fixed plate **44**. With the parts in this position, the die being still retracted, the cams **56** move away from the arms **58, 59**, permitting the springs **40, 42** to move the shuttle vertically upwardly to the position shown in Figs. 7 and 11, in which the lower face of the shuttle is spaced above the upper surface of the die by a distance approximately equal to the diameter of wire A. The die-operating cam surfaces **22, 24** now move away from the rollers on bar **8**, causing the die-operating springs **12** to move the die outwardly to its operative position in the path of the wire A, as shown in Figs. 7 and 11. The shuttle now traverses the die again, pulling the wire back over the upper face of the die, forming a second flight H as shown in Figs. 8 and 12. The described operations are now repeated to form additional flights. The sequence of operations may be set forth briefly as follows:

(1) The shuttle pulls the wire across the top of the die,
(2) The die and holder are withdrawn,
(3) The shuttle moves downwardly, moving the transverse flight of wire which has just been formed to a position below the die,
(4) The holder moves inwardly against the formed flight,
(5) The shuttle moves upwardly to return to operative position,
(6) The die moves inwardly above the formed transverse flight which has just been moved downwardly,
(7) The shuttle pulls the wire across the top face of the die, forming a second flight,
(8) The die and holder are again withdrawn, this being a repetition of step (2),
(9) The shuttle moves downwardly, moving the last-formed flight below the die, this being a repetition of step (3).
(10) Etc.

As stated hereinbefore, the invention provides means for retarding the movement of the formed wire ribbon through the discharge passage of the machine which lies between the blocks **36, 38** in order to cause the last-formed flight to tightly engage the lower face of the shuttle as the shuttle moves downwardly to move the wire ribbon through the outlet passage, whereby the holder is caused and permitted to engage the last-formed flight throughout its length and in alignment therewith. Such means comprise the tension plate F which is positioned between the blocks **36, 38** and forms the front (or back) of the outlet passage of the machine, the other being formed by fixed part **44**. This tension plate is urged toward and into the outlet passage by spring means **100** so that in its normal position it restricts the outlet passage to a depth slightly less than the thickness of the wire A. As the wire ribbon moves through the outlet passage it will exert a force against the tension plate F, slightly compressing the spring means **100** and the tension plate will therefore exert a frictional or retarding force on the movement of the wire ribbon. This will cause the wire ribbon to "back up" in the outlet passage so that it will be slightly compressed between the lower face of the shuttle and the outlet edge of the tension plate. As the shuttle moves downwardly the last-formed flight of the wire ribbon will therefore be held in tight engagement with the lower face of the shuttle. This causes the holder to engage the last-formed flight most effectively, as the flight

will be forced to lie more squarely in the path of the holder and in alignment therewith and will not be permitted to move away from the bottom face of the shuttle because of its inherent resilience.

If it is desired to change the spacing between flights of the formed ribbon, this may be easily and quickly done by changing the die to correspond to the new desired spacing. For this purpose a supply of dies may be kept on hand.

Throughout the specification and claims of this application the words "wire" and "strip" are used to describe the material formed by the machine which has been invented. It is to be understood that these words are used interchangeably to denote wire, flat strip, rod, spring-wire, piano-wire, or other material which may be formed on or by the use of, the machine, and it is to be understood that the machine and the claims covering it are not limited to the formation of any specific material.

While we have described and illustrated certain embodiments of our invention, it will be apparent to those skilled in the art that other embodiments, as well as modifications of those disclosed, may be made without departing in any way from the spirit or scope of the invention, for the limits of which reference must be had to the appended claims.

What is claimed is:

1. A machine for forming straight wire or strip material into sinuous shape to provide a wire ribbon having spaced transverse flights the ends of each of which are connected respectively to the adjacent ends of the preceding and succeeding flights, comprising a die having surfaces shaped to correspond to a flight and the flight-connecting parts respectively and on which these are formed, a shuttle above the die having a passage through which the straight wire is led from a source to the die and being reciprocable to traverse said passage and wire across the flight-forming surface of the die, means for holding the formed ribbon on the outlet side of the die during traversing movement of the shuttle whereby such movement causes wire to be drawn from the source thereof through the shuttle passage and about and over the flight forming surface of the die to form a flight of the wire ribbon, means for moving the shuttle against the formed ribbon to discharge the same from the machine, and means resiliently opposing movement of the shuttle against the formed ribbon and comprising spaced blocks disposed on opposite sides of the die on the discharge side thereof on the upper surfaces of which the shuttle is freely and slidably supported, and springs disposed below the blocks and resiliently supporting them.

2. A machine according to claim 1, in which the adjacent edges of the blocks are recessed to receive the side edges of the wire ribbon formed on the die and passing therefrom between said blocks.

3. A machine for forming straight wire into sinuous shape to provide a wire ribbon having spaced transverse flights the ends of each of which are connected respectively to the adjacent ends of the preceding and succeeding flights, comprising a shuttle having a passage therethrough through which straight wire is led from a source, separate means for imparting reciprocatory traversing and vertical movements to said shuttle, said means being so adjusted and related that the cycle of movement of the shuttle is upward, across, downward, upward, across, downward, a die positioned adjacent the discharge side of the shuttle passage and having surfaces about and on which the wire is formed into the flight-connecting part and the flight of the finished ribbon, means for advancing the die into operative forming relation to the shuttle passage and retracting it therefrom, said means being so related to the shuttle moving means that the die is in advanced operative position while the shuttle is traversing and is in retracted position while the shuttle is moving vertically, a holder on the discharge side of the die for rigidly holding the formed wire ribbon whereby traversing movement of the shuttle passage causes the wire to be formed about and on the surfaces of the die, means for moving the holder into and out of holding engagement with the ribbon, said means being so related to the shuttle-moving means that the holder is in engagement with the ribbon during traversing and upward movements of the shuttle and is out of engagement with the ribbon during downward movements of the shuttle.

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