United States Patent

Calvert et al.

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[54] WIRE FORMING MACHINE

[72] Inventors: **Rodney K. Calvert**, Dunwoody; **Dale Keith Scott**, Jonesboro, both of Ga.

[73] Assignee: **The Mead Corporation**

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[52] **U.S. Cl.**.....**72/190**, 72/DIG. 16, 72/385, 140/105

[51] **Int. Cl.**.....**B21b 21/00**, B21d 13/02

[58] **Field of Search**..140/105; 72/DIG. 16, 196, 385, 72/187, 190

[56] **References Cited**

UNITED STATES PATENTS

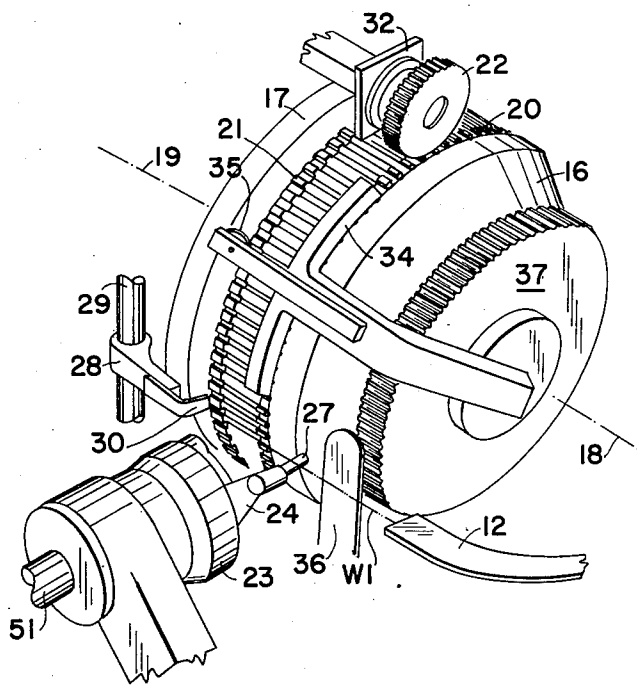
2,963,048	12/1960	Smith	140/105
2,334,671	11/1943	Gibbons	72/DIG. 16
1,922,270	8/1933	Southwell et al.	140/112
3,556,166	1/1971	Whitney	140/105
3,476,157	11/1969	De Wulf	72/196

Primary Examiner—Richard J. Herbst
Assistant Examiner—Michael J. Keenan
Attorney—Walter M. Rodgers

[57] **ABSTRACT**

A wire forming machine and method imparts an undulatory configuration to a strand of wire and includes a pair of wheels disposed alongside each other and rotatable about angularly disposed axes. Pins are disposed radially about the peripheries of both wheels. The angularly disposed wheel axes result in a variation in the spacing between the pins of one wheel and the adjacent pins on the other wheel so that wire looped about the pins is alternately tightened and loosened. Fixed wire removal and holding means are arranged so as to engage the wire at points of minimum and maximum lateral spacing respectively, an oscillatable releasing finger engages the wire following the looping thereof about one pin to release the wire from rotatable looping means, and a reciprocable plunger is arranged to engage another part of the wire to aid in securing the wire about a pin on one of the wheels.

10 Claims, 9 Drawing Figures



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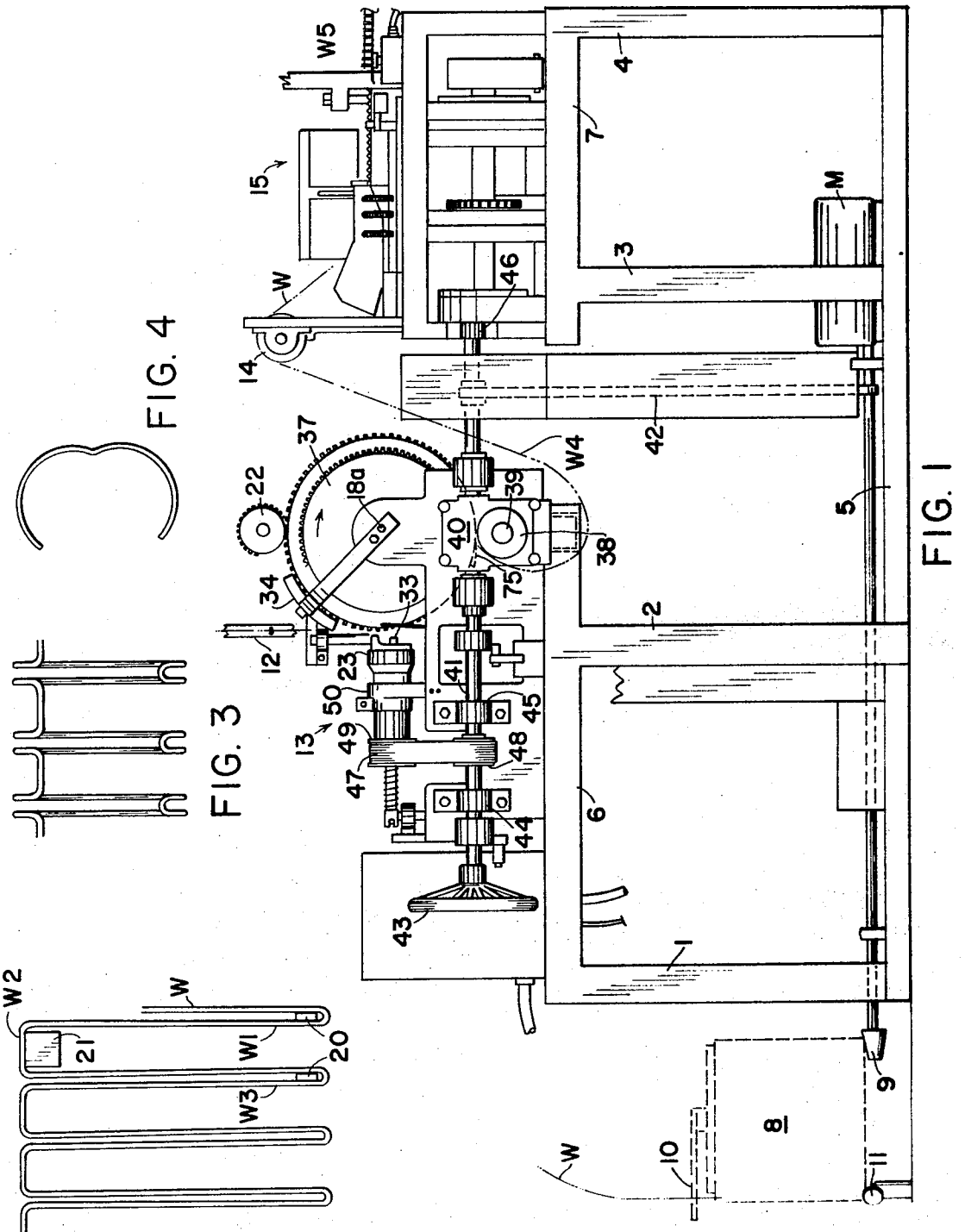

FIG. 1

FIG. 2

FIG. 3

FIG. 4

INVENTORS
RODNEY K. CALVERT
DALE K. SCOTT
BY Walter M. Rodgers
ATTORNEY

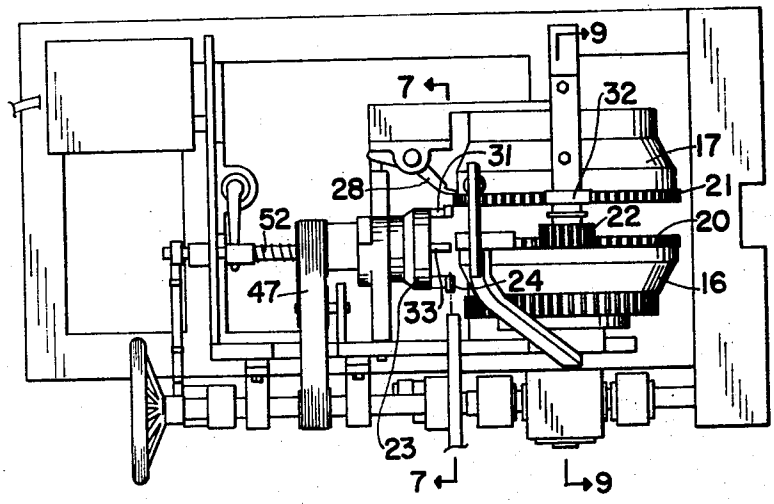

FIG. 5

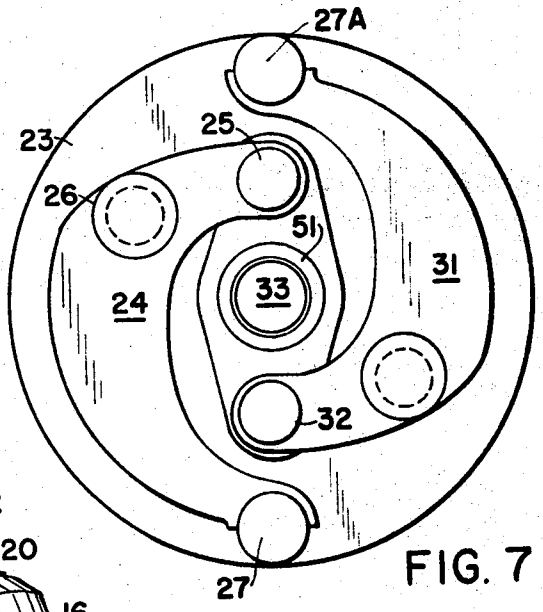

FIG. 7

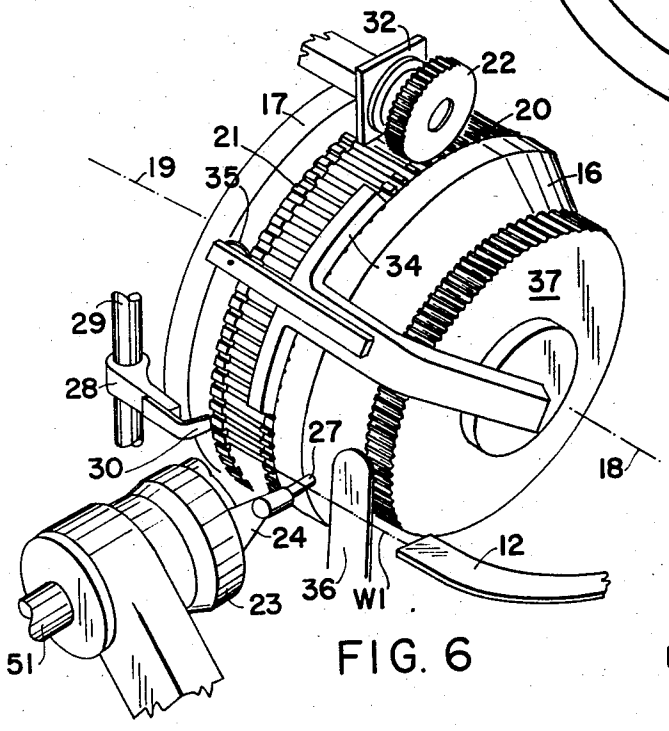

FIG. 6

INVENTORS
RODNEY K. CALVERT
DALE K. SCOTT
BY Walter M. Rodgers
ATTORNEY

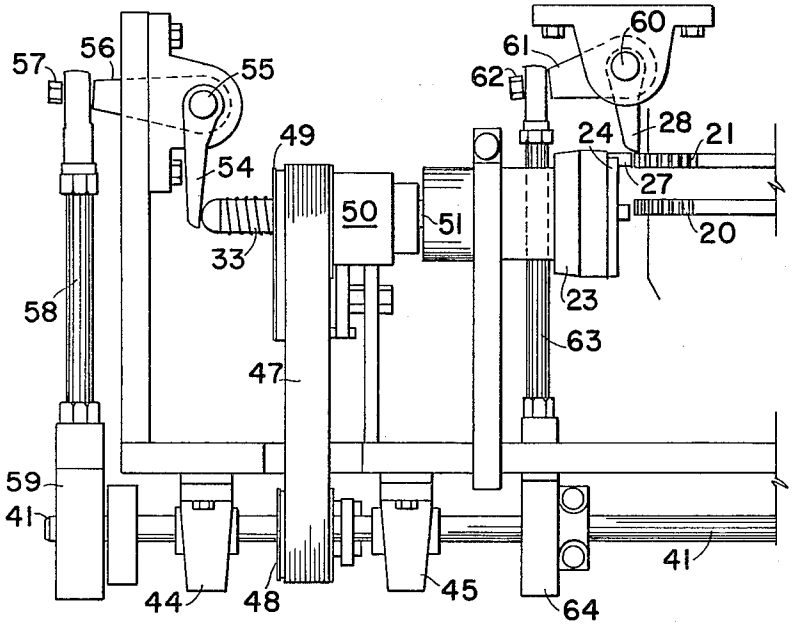

FIG. 8

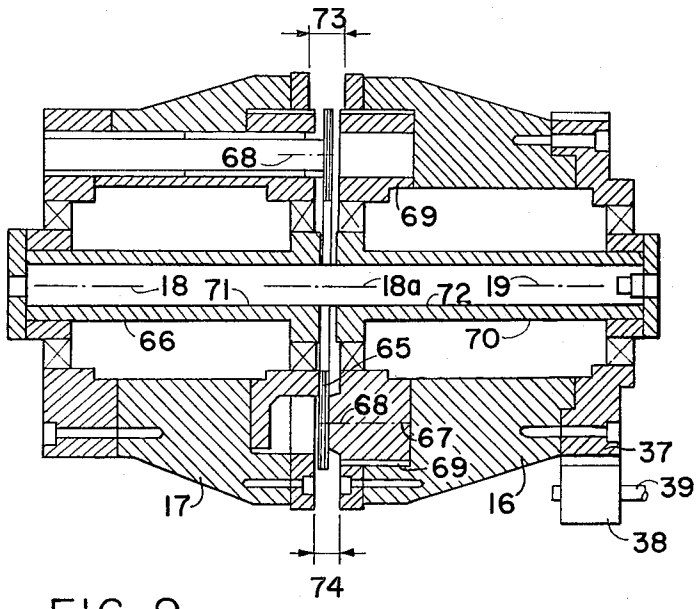

FIG. 9

INVENTORS
RODNEY K. CALVERT
DALE K. SCOTT
BY Walter M. Rodgers
ATTORNEY

WIRE FORMING MACHINE

Known machines for imparting an undulatory configuration to a strand of wire conventionally utilize the pair of serrated complementary dies for engaging the wire and bending it into the desired configuration. Such devices are necessarily reciprocable in nature and hence are characterized by high inertia and inherent low operating speed. Such known die devices are not only expensive to build but require a substantial maintenance effort if a satisfactory product is to be formed.

According to this invention reciprocable parts are eliminated and rotatable elements are used instead. More specifically, a pair of wheels disposed alongside each other are rotatably mounted on axes which are angularly disposed so that a plurality of pins disposed about the peripheries of both wheels are caused to occupy spaced relationships which continuously vary throughout each revolution of the wheels. This space variation allows rapid formation of loops of wire about the pins followed by a tightening of the loops due to increased spacing between a particular pin on one wheel and the adjacent pin on the other wheel. Thus a permanent set is imparted to the wire according to a feature of the invention. Various mechanisms for securing the wire in place on the wheels and for removing the wire are provided in accordance with specific features of the invention.

For a better understanding of the invention, reference may be had to the following detailed description taken in conjunction with the accompanying drawings in which

FIG. 1 is an overall front view of a machine constructed according to the invention;

FIG. 2 is a view of a strand of wire formed into a particular configuration by the invention;

FIG. 3 is a view of a formed portion of wire such as is shown in FIG. 2 after a subsequent bending operation has been imparted thereto;

FIG. 4 is an end view of the wire shown in FIG. 3;

FIG. 5 is a plan view of the left-hand end of the machine depicted in FIG. 1 and which is constructed according to the invention;

FIG. 6 is an enlarged perspective view of certain principal components of the invention as shown in FIGS. 1 and 5;

FIG. 7 is an enlarged view taken along the line 7—7 indicated in FIG. 5 but showing only the central rotatable looping device formed according to the invention;

FIG. 8 is an enlarged plan view of the left-hand portion of FIG. 5 and which shows certain levers for operating the holding and releasing means of this invention;

and in which FIG. 9 is a cross-sectional view taken along the line designated 9—9 in FIG. 5.

With reference to the drawings, the numerals 1, 2, 3 and 4 designate vertically disposed upright support elements interconnected at their lower ends by a horizontal base member designated by the numeral 5. Horizontal cross beams 6 and 7 are mounted atop the pedestals 1, 2, 3 and 4. Of course corresponding support members such as 1–7 are disposed on the opposite side of the machine and together constitute a frame structure for supporting the mechanism.

Generally speaking, a reel of wire 8 rotated by means of a rotatable cone 9 to feed the wire W into the machine for subsequent forming operations. Radial arm 10 facilitates the feeding of wire W and a rotatable roller 11 aids in supporting the reel 8. Preferably a plurality of rollers 11 are utilized although only one such device appears in FIG. 1.

The strand of wire W is fed along a fixed feeding tract 12 into the wire looping mechanism generally designated by the numeral 13 which imparts a configuration in the wire W such as is shown in FIG. 2. Following the completion of the operation as performed by mechanism 13, the wire as shown in FIG. 2 is fed across the pulley 14 and into a stamping machine comprising two sets of dies, the machine being generally designated by the numeral 15. The two sets of dies constituting the machine 15 convert the wire from the condition depicted in FIG. 2 to that depicted in FIGS. 3 and 4. The machine generally designated by the numeral 15 is largely conventional in nature, and the invention is primarily concerned with the wire forming mechanism generally designated by the numeral 13 and apparatus directly associated therewith.

Generally speaking, a wire looping mechanism constituting a rotatable device having laterally projecting arms thereon engages the wire as fed in by the track 12 and loops the wire about a pair of pins disposed respectively on the peripheries of a pair of rotatable wheels. More specifically and as best shown in FIGS. 1, 5 and 6, a pair of wheels 16 and 17 are rotatably mounted about shafts 18 and 19. As may be best understood from FIG. 6, the axes of shafts 18 and 19 are angularly disposed with respect to each other, it being apparent particularly from FIG. 6 that the axes indicated by the center lines 18 and 19 in FIG. 6 are disposed in a vertical plane with their point of intersection constituting a vertex.

A plurality of radial pins 20 are disposed about the periphery of wheel 16 and a similar plurality of pins 21 are disposed about the periphery of the wheel 17. The pins such as 20 are individually staggered relative to the pins such as 21 to facilitate looping the wire into the configuration shown in FIG. 2.

From the above description and particularly from FIG. 6, it is apparent that the pins 20 are spaced a maximum lateral distance from the pins 21 when particular pins occupy their uppermost positions such for example as that immediately below the wire holding means designated by the numeral 22. When the pins occupy the diametrically opposite or lowermost position they are disposed at a minimum lateral spacing from each other while points in between constitute points of intermediate spacing.

The wire W is fed in via track 12 and is looped about the pins 20 by virtue of the rotatable element 23 on which arm 24 is pivotally mounted at pivot point 25. A cam follower 26 rides in an appropriate fixed cam surface and imparts predetermined desired swinging movement of arm 24 about center 25. Thus as is best shown in FIG. 6 clockwise rotation of arm 24 causes the lateral projection 27 thereon to engage the wire at W1 and to loop the wire W1 downwardly and about the particular one of the pins 20 which is disposed below the wire W1. Continued rotation of arm 24 causes the course W1 of wire W to ride above the adjacent pin 21 on wheel 17. Thereafter releasing means in the form of arm 28 oscillates about its shaft 29 to cause the inturned end 30 thereof to engage the end of course W1

thereby to force the loop W2 of the wire W into snug engagement with the periphery of wheel 17. Continued rotation of rotatable element 23 causes the arm 31 pivotally mounted at 32 to engage a subsequent course of the wire such as is designated in FIG. 2 at W3 to form a loop about pin 20 adjacent thereto. Thus arms 24 and 31 alternately form loops about the pins 20 and 21.

As the particular undulation of the wire W which is adjacent the releasing element 30 moves upwardly and in a clockwise direction due to the clockwise rotation of wheels 16 and 17 as viewed in FIG. 6, the particular strand is tightened about the pins 20 and 21 because the pins continue to move apart until an uppermost position is reached immediately below the holding pinion 22. The tension of the strands of wire at the uppermost position conceivably could force the wire to pop away from the pin. This possibility is precluded according to a feature of the invention by means of the hold down pinion 22 which is rotatably mounted on shaft 31A in such manner that the teeth thereof engage pins 20 as well as the strands of wire and thus securely hold the wire in snug engagement with the pins 20. The portion of the wire adjacent pin 21 is held down by means of a holding down block 32 fixed in position adjacent the holding pinion 22 as is obvious from FIG. 6. Thus according to a principal feature of the invention, the wire initially is looped about the pins such as 20 and 21 and then, due to the movement away from each other as described, a set bend is formed in the wire as is represented by FIG. 2 without appreciably changing the disposition of the undulations along the length of the strand.

As explained, the releasing means 28–30 forces the wire W2 against wheel 17 and of course effectively releases the projection 27 to allow subsequent rotation thereof. The other side of the strand in the region adjacent the pins 20 is held in secure engagement with the wheel 16 by means of a reciprocable plunger 33 which is driven in proper synchronism with the rotation of the wheels 16 and 17 so as to perform a wire holding operation at the proper time sufficient to hold the wire in place and to move it clear of entanglement with operation of the projections 27 and 27A. After the wheels 16 and 17 rotate through a certain angle of movement the strands of wire are held down by the arcuate fixed arm 34 and roller 35 aids in squaring up the parts of the wire such as W2 by rolling in close contact with the flat sides of the pins 21.

In order to prevent entanglement of the wire W1 with certain portions of the mechanism, a fixed finger 36 is mounted alongside course W1.

Rotary motion is imparted to the wheels 16 and 17 by driving means in the form of gear 37 which is rigidly affixed to wheel 16 and which is rotated by means of driving pinion 38. Pinion 38 is disposed on shaft 39 as best shown in FIGS. 1 and 9 which in turn is driven by the gear box 40 and drive shaft 41. Rotary motion is imparted to drive shaft 41 by a driving belt or chain 42 which in turn is coupled to driving motor M. Hand wheel 43 is directly connected with shaft 41 and may be utilized to operate the machine manually if desired. Shaft 41 is rotatably supported on the frame structure by means of bearings such as are indicated at 44, 45 and 46.

For the purpose of imparting rotary motion to rotatable looping element 23, a driving belt 47 cooperates with a pulley 48 mounted on shaft 41 and imparts rotary motion to a pulley 49 secured to a sleeve type hollow shaft 51 mounted within bearing 50. Rotatable element 23 of course is securely affixed to shaft 51. By this means rotary motion is imparted to the rotatable looping device 23.

As explained the plunger 33 is arranged to reciprocate and impart wire holding movement to the wire adjacent pin 20. This plunger 33 is disposed within the shaft sleeve 51 and is biased toward the left by compression spring 52. Reciprocal motion is imparted to plunger 33 as is best shown in FIG. 8 by means of an arm 54 pivoted at 55 and operated in an oscillatory fashion by means of link 56 connected by bolt 57 to operating rod 58. Operating rod 58 is connected at 59 by an eccentric which is disposed about and operated by the shaft 41. Arm 31 is omitted from FIG. 8 for the sake of clarity.

For the purpose of operating the releasing arm 28 and as is best shown in FIG. 8, a pivot 60 is provided for arm 28 which is oscillated by operating arm 61 which is connected by bolt 62 to operating rod 73 which at its near end is connected by an eccentric 64 with main drive shaft 41. Thus rotation of shaft 41 imparts oscillatory movement to releasing arm 28 to release the wire W2 and to force it to slide down around the pin 21 and to release the transverse part 27 of looping arm 24.

The motion of arms such as 24 and 31 about their centers of oscillation 25 and 32 respectively is controlled by cam surfaces forming integral parts of structure fixedly mounted within the rotatable element 23. These surfaces are of conventional configuration and the detailed showing thereof is not deemed necessary. Suffice it to say that the arm 24 following looping of the wire about pin 21 must swing upwardly in order to commence a subsequent wire looping operation whereby the portion W1 of the wire W is looped around pin 20 on wheel 16.

For the purpose of causing the wire formed as indicated in FIG. 2 to be released from the peripheries of the wheels 16 and 17, a wire removal structure best shown in FIG. 1 is indicated in dotted lines at 75 and causes the wire to depart from contact with the wheels 16 and 17 and to loop upwardly as indicated at W4. The completed structure as indicated in FIGS. 3 and 4 is depicted generally at W5 following bending from the condition shown in FIG. 2 to that shown in FIGS. 3 and 4 by the mechanism 15 which is pointed out above is more or less conventional.

In order to insure that the wheels 16 and 17 operate at the same speed, and as best shown in FIG. 9, these wheels are interconnected by structure generally designated in FIG. 9 by the numeral 65. Preferably structure 65 constitutes a plurality of face contacting metal plates affixed at their center to shaft 18 on which sleeve 66 is mounted and which in turn supports wheel 16. Mounting bolts 67 are affixed at 68 to structure 65 and are slidable within the apertures 69 formed in wheel 16. Thus the wheels 16 and 17 rotate in unison, wheel 17 being driven by wheel 16 which in turn is driven by pinion 38.

In order to impart an angular disposition to the shafts 18 and 19, a pair of sleeves such as 66 and 70 are pro-

vided with skewed bores **71** and **72** which are not aligned with the cylindrical supporting rod **18A** and by virtue of these nonaligned bores **66** and **70** resting on the circular rod **18A**, the wheels **16** and **17** are farther apart at their topmost portions such as are indicated by the distance **73** which distance is a maximum spacing for the wheels and the adjacent pinions. Likewise spacing **74** at the bottom of the wheels is a minimum.

From the above description it is apparent that the removal of the formed wire occurs near the minimum spacing designated by the numeral **74** by virtue of the removal device **75** whereas the looping operation occurs where the spacing is intermediate maximum and minimum as is represented by the part of the wire immediately adjacent to the wire holding means in the form of oscillatable releasing means **28–30**. Of course the wire is tightened as the wheel rotates clockwise as viewed in FIG. **6** from a position adjacent arms **24** and **28** to a maximum tension immediately below the holding means **22** without appreciably shifting the loops along the length of the strand.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A wire forming machine comprising a pair of rotatable wheels disposed alongside each other, a plurality of pins secured to each of said wheels about the periphery thereof, a rotatable element having an arm pivotally mounted thereon for engaging and looping the strand about a pin on one of said wheels to impart an undulatory configuration to said strand, said rotatable element being disposed adjacent the peripheries of said wheels at a position at which the pins of one wheel are spaced from the adjacent pins of the other wheel by a distance intermediate the maximum and minimum spacing between said pins, and mounting means for rotatably supporting said wheels in such manner that their axes of rotation are angularly disposed to each other.

2. A wire forming machine according to claim **1** wherein wire removal means is disposed adjacent the peripheries of said wheels at a position at which the pins of one wheel are spaced from the adjacent pins of the other wheel by a distance less than the maximum spacing between said pins.

3 A wire forming machine according to claim **1** wherein wire holding means is disposed adjacent the peripheries of said wheels at a position at which the pins of one wheel are spaced from the adjacent pins of the other wheel by a distance which is approximately the maximum spacing between said pins.

4. A wire forming machine according to claim **1** wherein cam means forming a part of said rotatable element is engageable with a part of said arm to provide predetermined swinging movement of said arm about its pivotal mounting on said rotatable element.

5. A wire forming machine according to claim **1** wherein means associated with the strand of wire affords a frictional drag resistance against feeding of the strand of wire so as to facilitate looping of said strand about a pin on the other of said wheels.

6. A wire forming machine comprising a pair of rotatable wheels disposed alongside each other, a plurality of pins secured to each of said wheels about the periphery thereof, a rotatable element having an arm pivotally mounted thereon for engaging and looping the strand about a pin on one of said wheels to impart an undulatory configuration to said strand, mounting means for rotatably supporting said wheels in such manner that their axes of rotation are angularly disposed to each other, means associated with the strand of wire to afford a frictional drag resistance against feeding of the strand of wire so as to facilitate looping of said strand about a pin on the other of said wheels, and moveable releasing means disposed adjacent said other wheel and operable in coordination with movement of said arm for engaging the wire adjacent a pin on said other wheel to swing the wire out of engagement with said arm.

7. A wire forming machine according to claim **6** wherein said releasing means comprises an oscillatable finger which engages the wire and moves it toward said other wheel a distance sufficient to disengage said arm.

8. A wire forming machine comprising a pair of rotatable wheels disposed alongside each other, a plurality of pins secured to each of said wheels about the periphery thereof, a rotatable element having an arm pivotally mounted thereon for engaging and looping the strand about a pin on one of said wheels to impart an undulatory configuration to said strand, mounting means for rotatably supporting said wheels in such manner that their axes of rotation are angularly disposed to each other, and a reciprocal plunger engageable with the wire adjacent said one wheel following looping thereof about a pin thereon for moving the wire toward said one wheel and for securing the wire against dislodgment from its looped relation relative to said pin.

9. A wire forming machine according to claim **8** wherein said reciprocal plunger is arranged with its axis in coincidence with the center of rotation of said rotatable element.

10. A wire forming machine comprising a pair of rotatable wheels disposed alongside each other, driving means for imparting constant rotation to said rotatable wheels, a plurality of pins secured to each of said wheels about the periphery thereof and extending radially outward therefrom, the pins on one wheel being spaced axially from the adjacent pins on the other wheel, continuously rotatable means for looping the strand of wire about the pins on said wheels to establish a series of loops along the length of said strand thereby to impart an undulatory configuration initially fixed in position on said strand while said wheels rotate continuously, and mounting means for rotatably supporting said wheels in such manner that their axes of rotation are angularly spaced to each other, said means for looping a strand of wire about the pins being disposed adjacent the peripheries of said wheels at a position at which the adjacent pins of one wheel are spaced axially from the adjacent pins of the other wheel by a distance intermediate the maximum and minimum axial spacing between said pins whereby rotation of said wheels imparts a tension force to the strand of wire to cause the wire to become stretched and set without appreciably changing the initial disposition of the strand of wire relative to said pins and without shifting the undulations along the length of said strand.

* * * * *