Oct. 4, 1949. F. R. ZIMMERMAN 2,483,865

SINUSOIDAL SPRING FORMING MACHINE

Filed Nov. 15, 1945 7 Sheets-Sheet 1

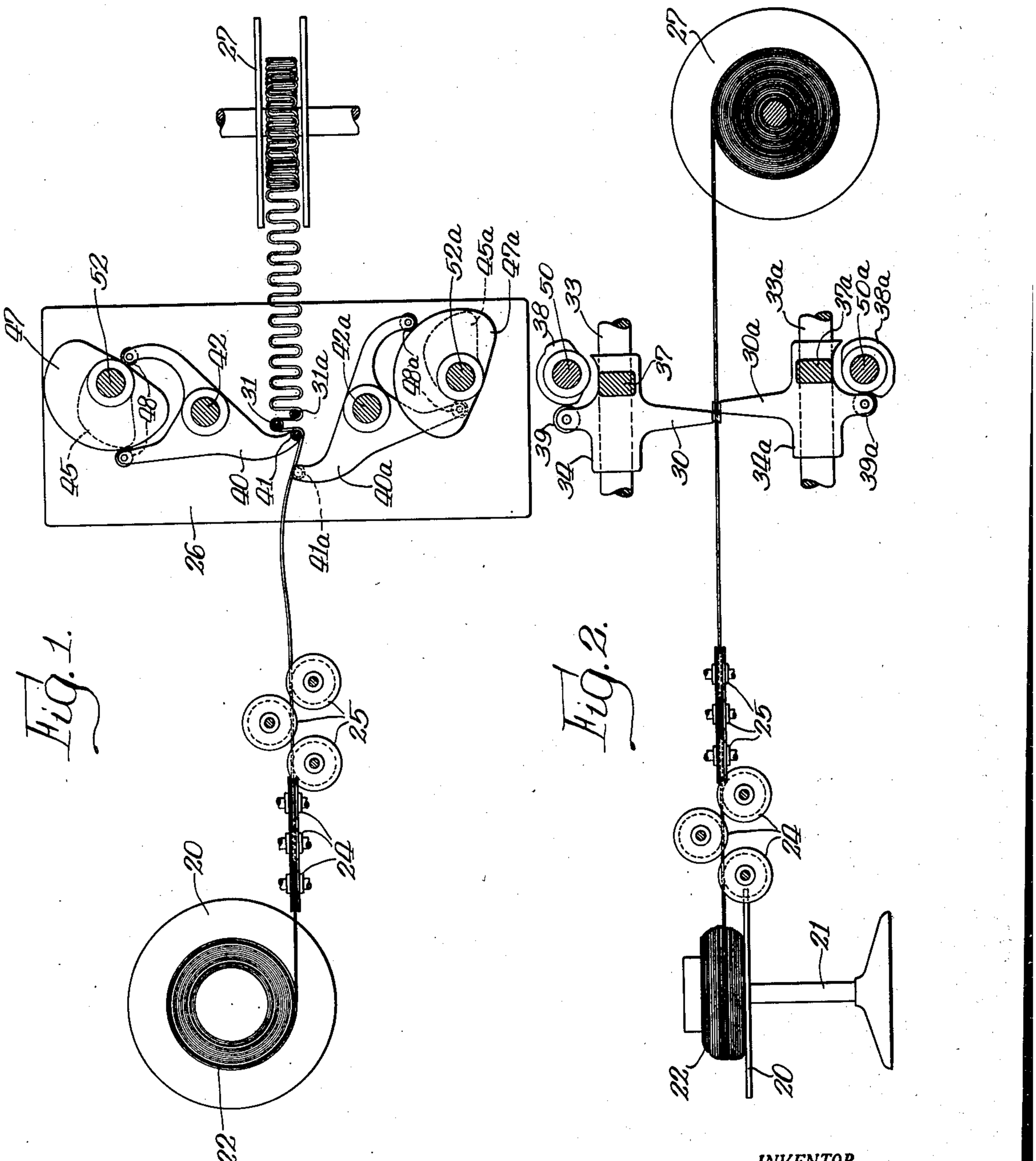

Fig. 1.

Fig. 2.

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SINUSOIDAL SPRING FORMING MACHINE

Filed Nov. 15, 1945 7 Sheets-Sheet 2

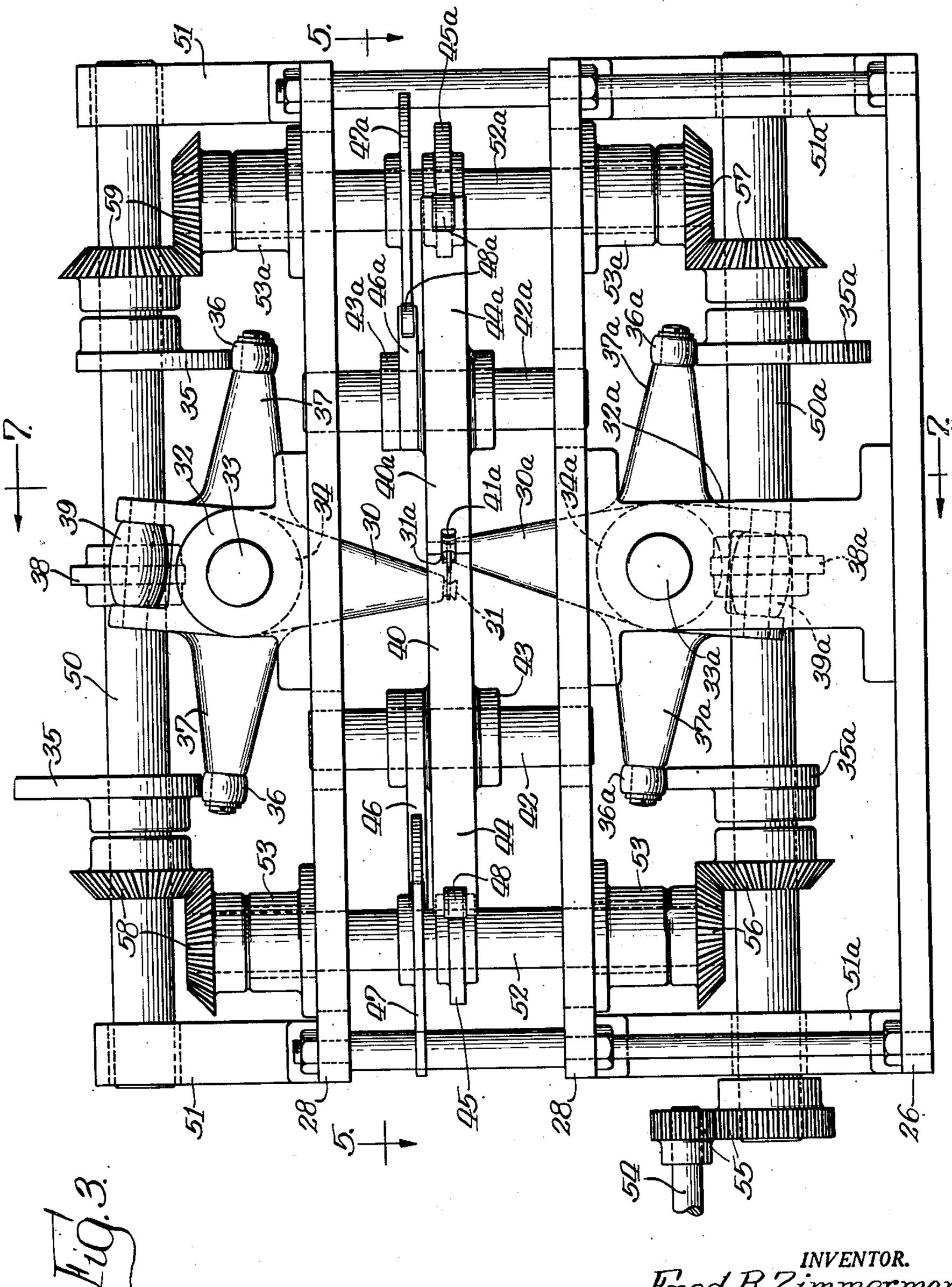

Fig. 3.

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SINUSOIDAL SPRING FORMING MACHINE

Filed Nov. 15, 1945 7 Sheets-Sheet 3

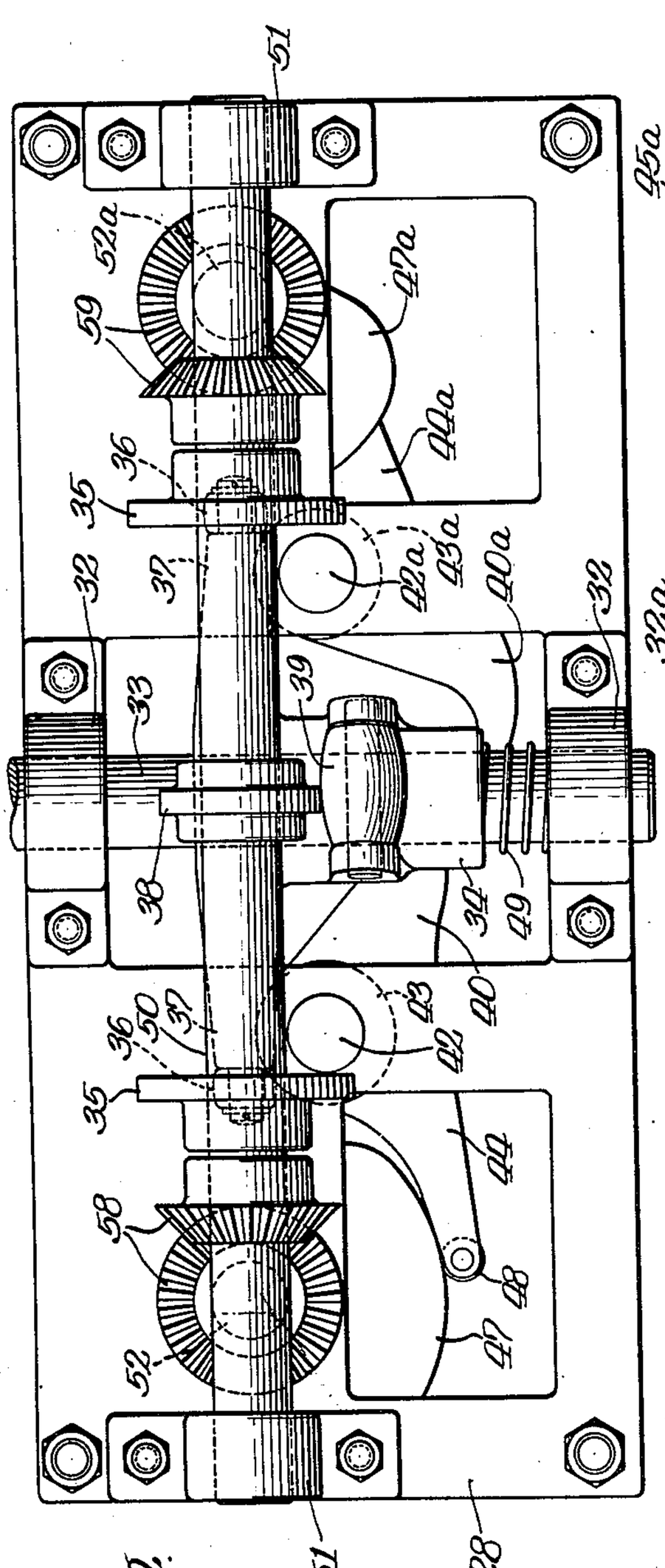

Fig. 4.

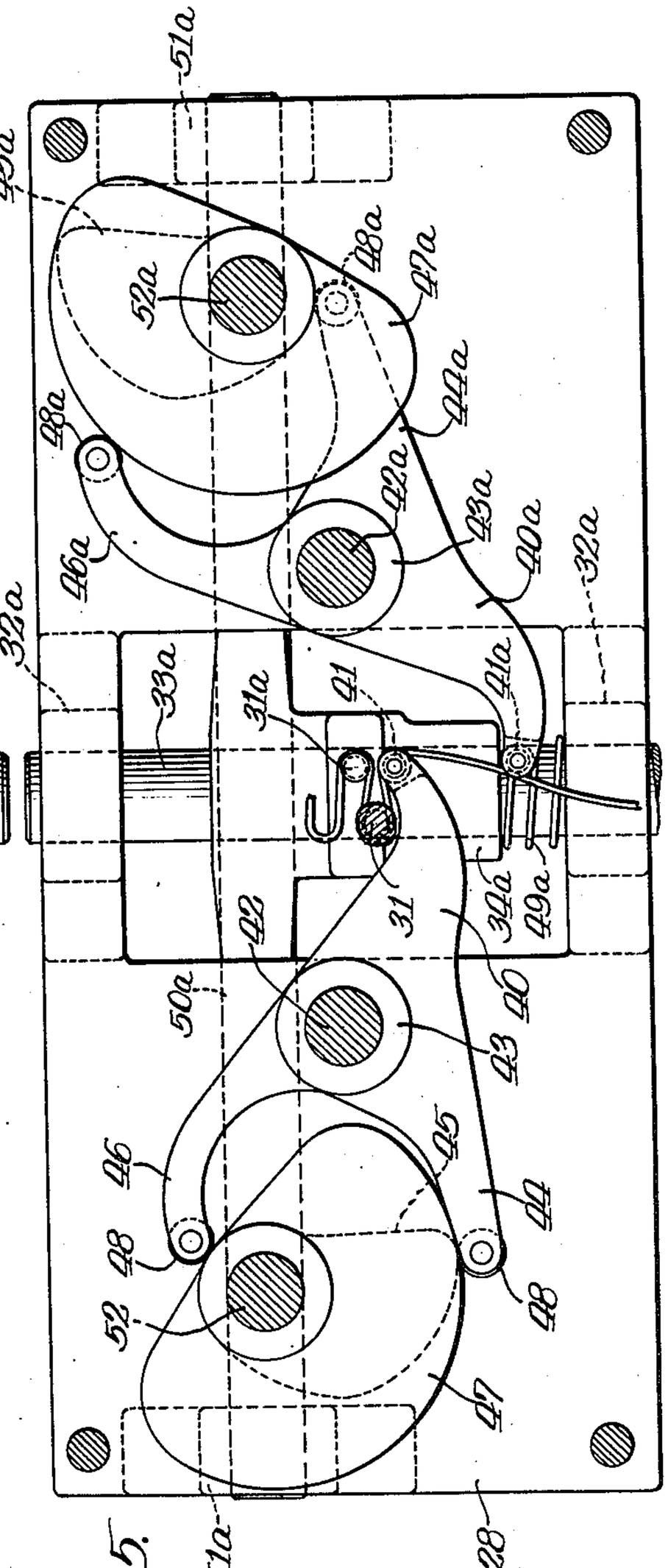

Fig. 5.

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SINUSOIDAL SPRING FORMING MACHINE

Filed Nov. 15, 1945 7 Sheets-Sheet 4

Fig. 7.

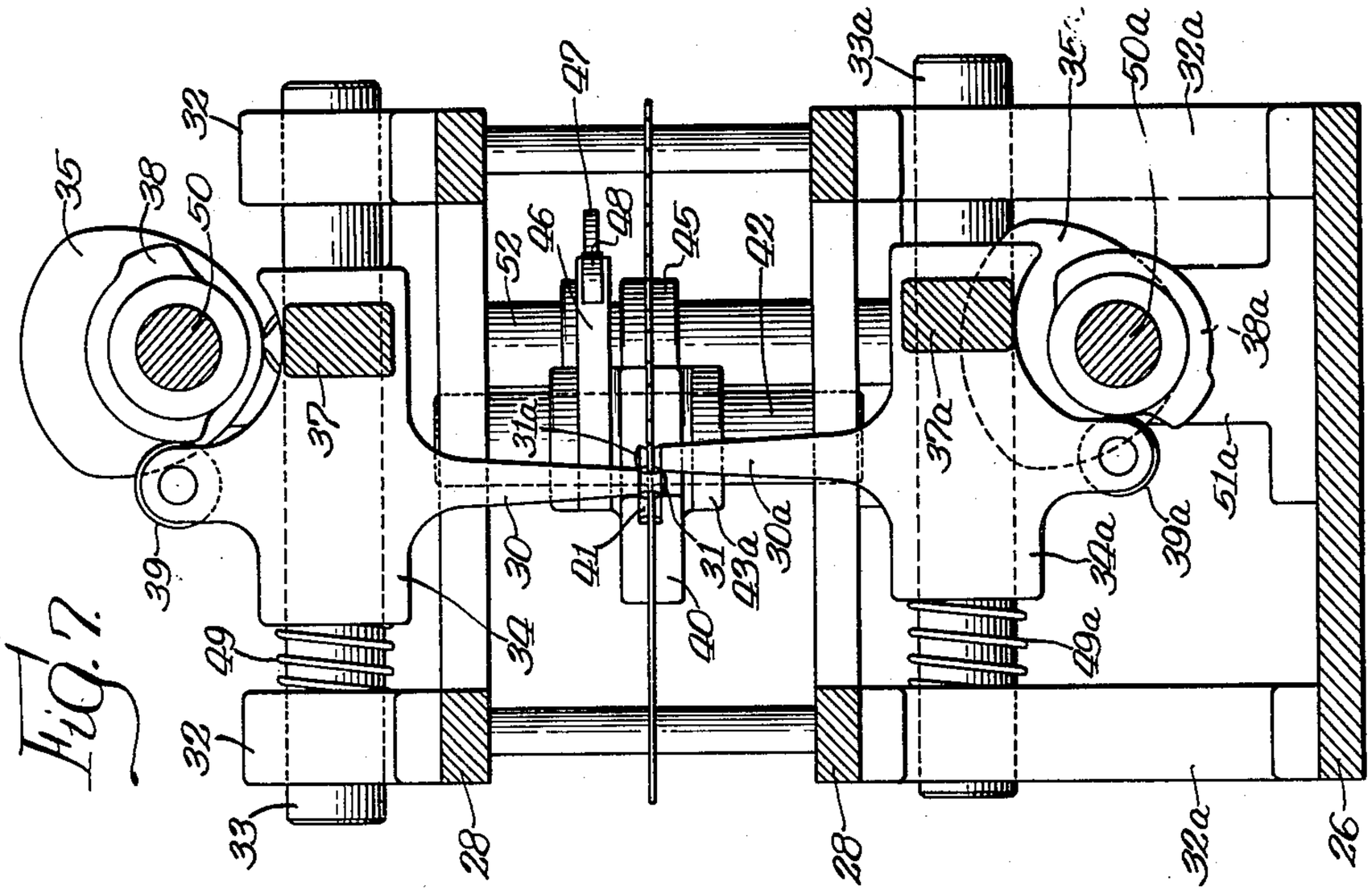
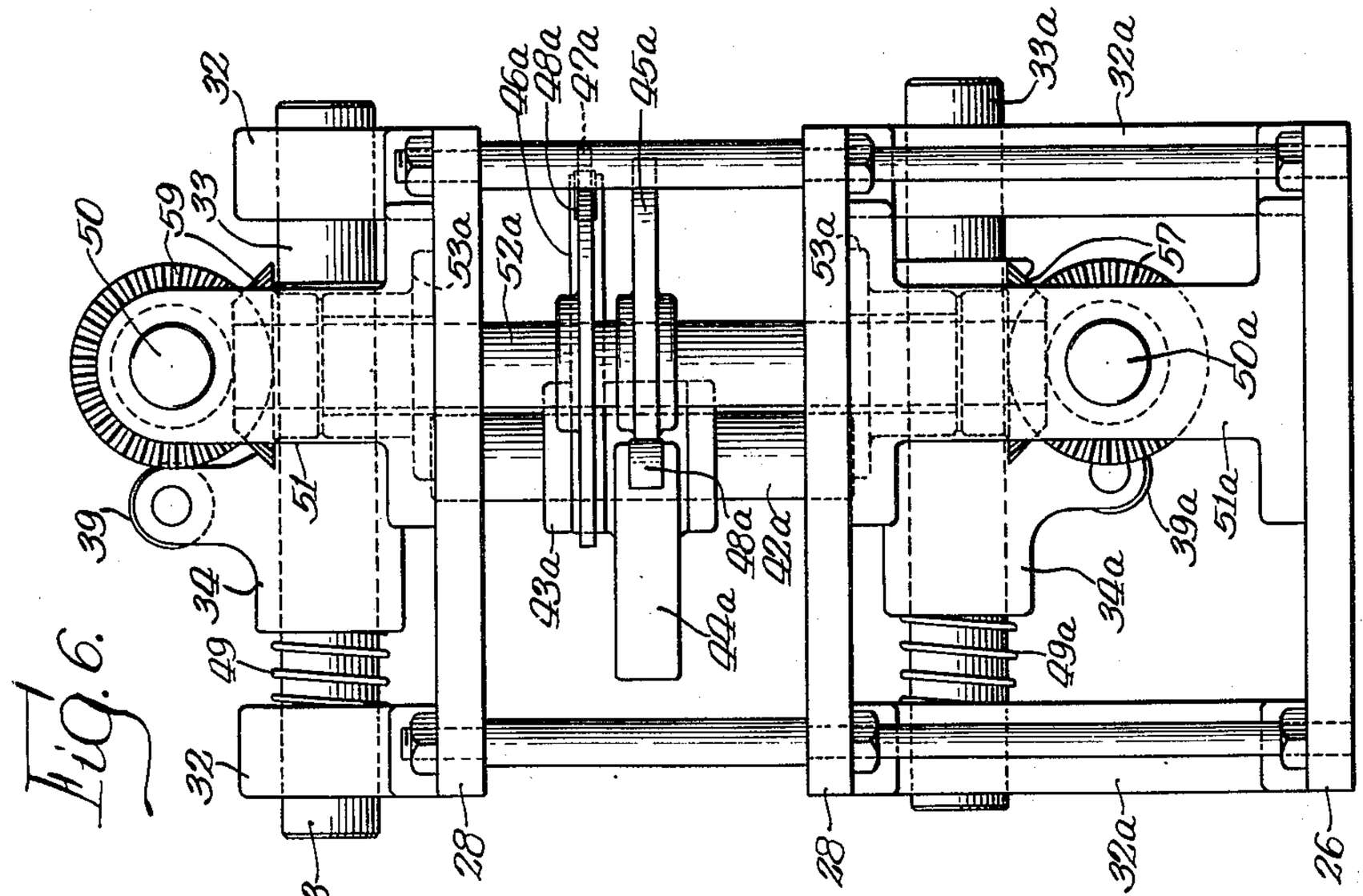


Fig. 6.



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SINUSOIDAL SPRING FORMING MACHINE

Filed Nov. 15, 1945 7 Sheets-Sheet 5

Fig. 8.

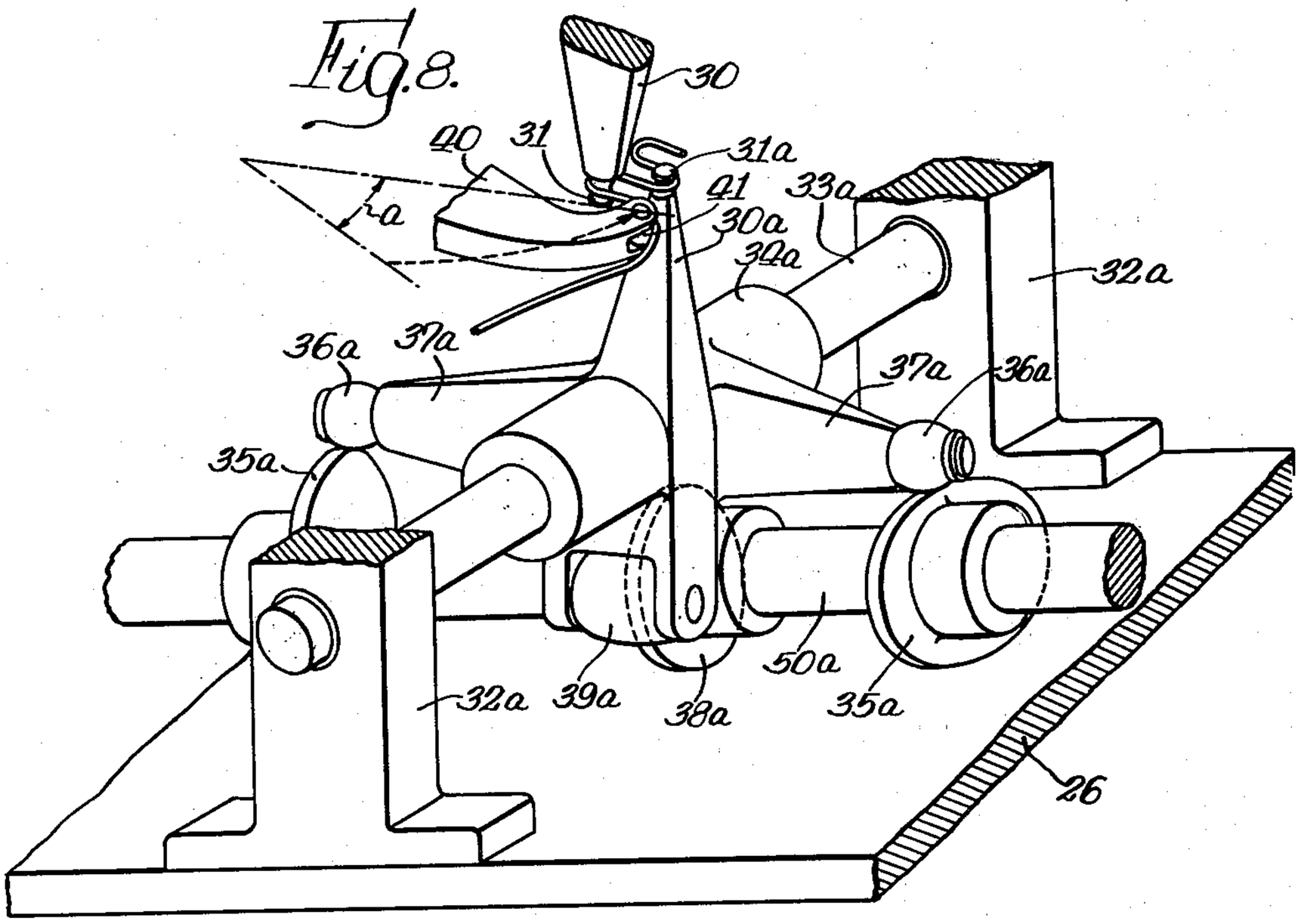
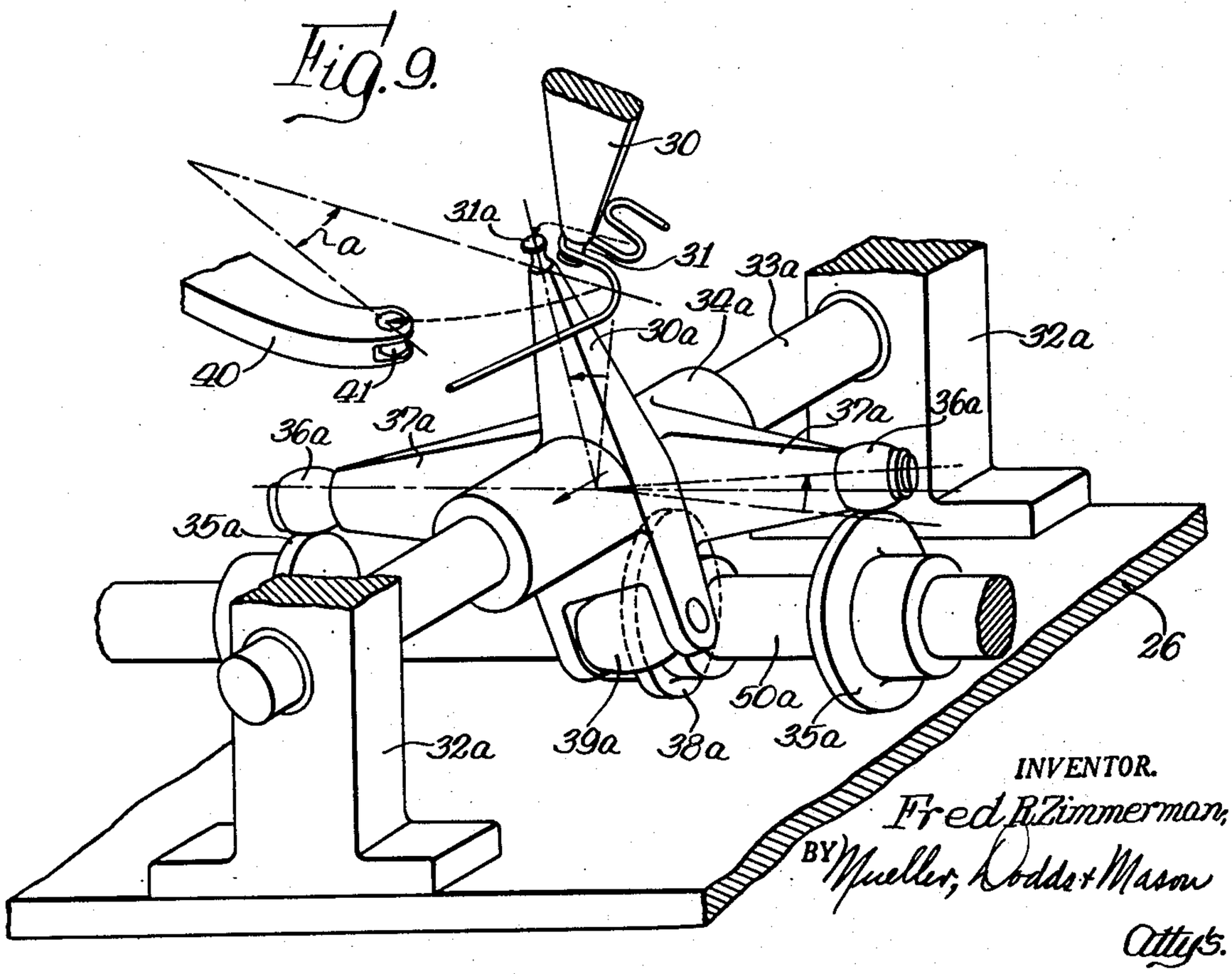


Fig. 9.



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SINUSOIDAL SPRING FORMING MACHINE

Filed Nov. 15, 1945 7 Sheets-Sheet 6

Fig. 10.

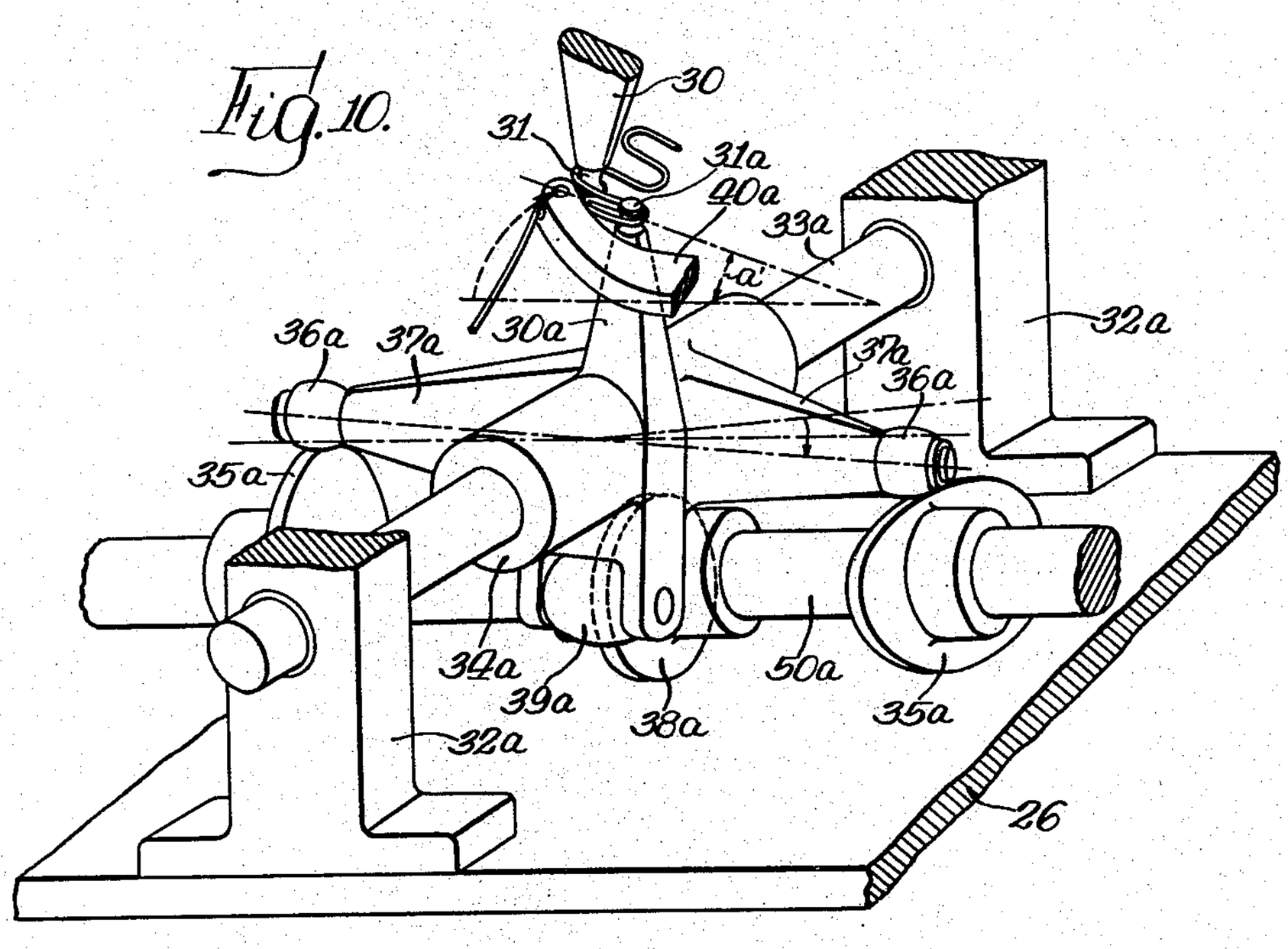
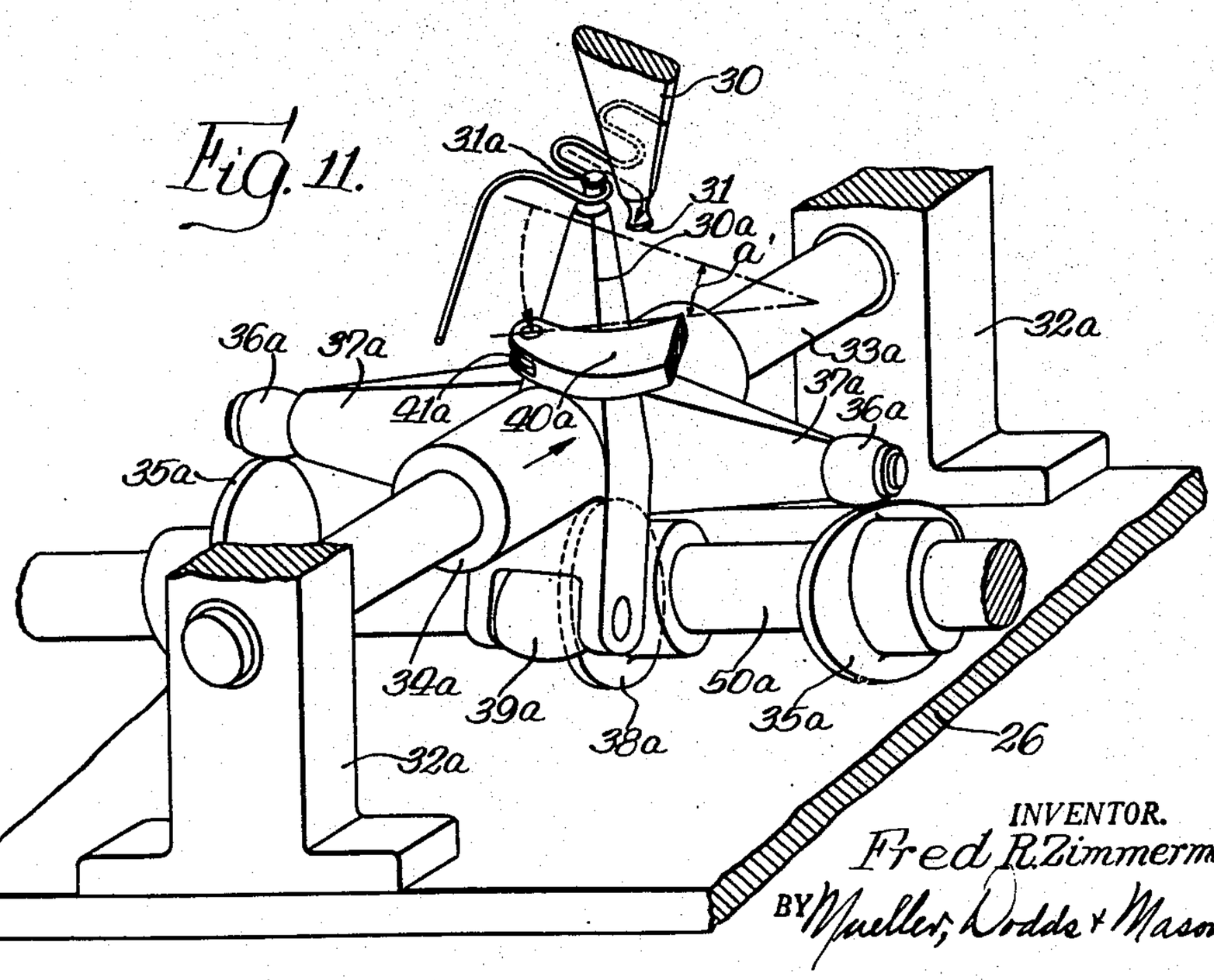


Fig. 11.



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SINUSOIDAL SPRING FORMING MACHINE

Filed Nov. 15, 1945 7 Sheets-Sheet 7

Fig. 12.

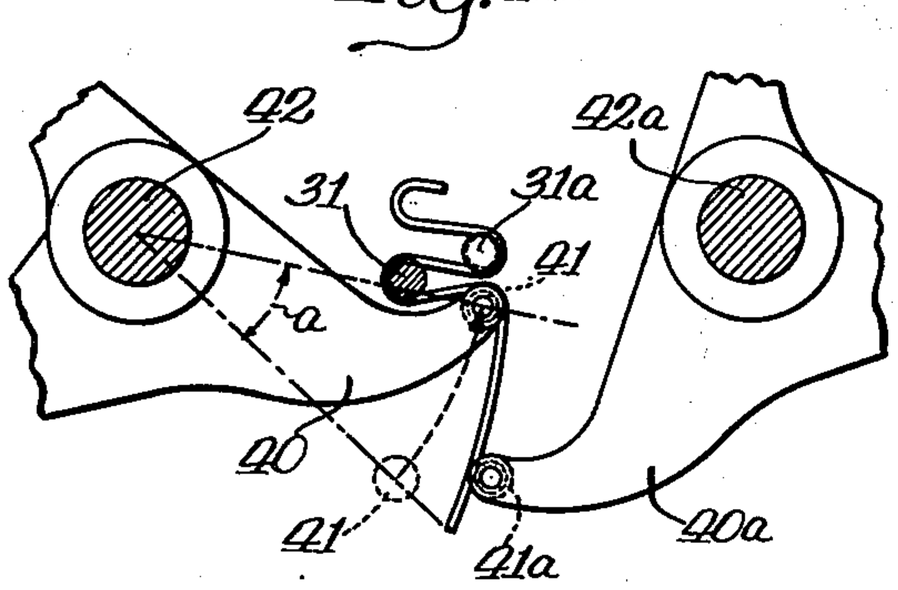


Fig. 13.

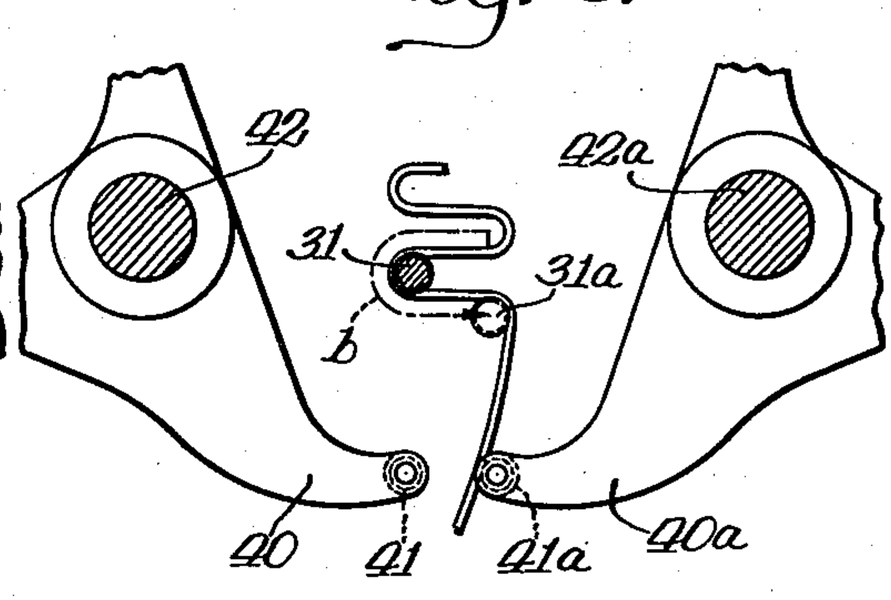
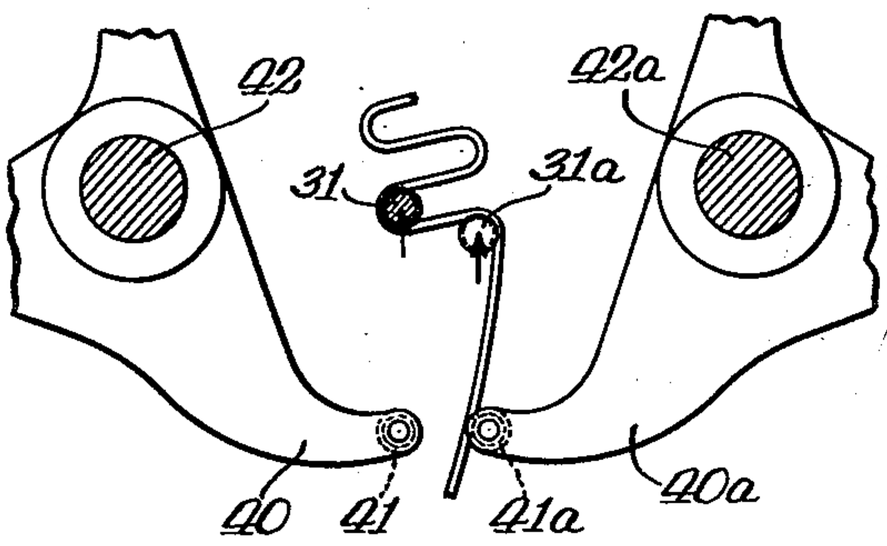


Fig. 14.

Fig. 15.



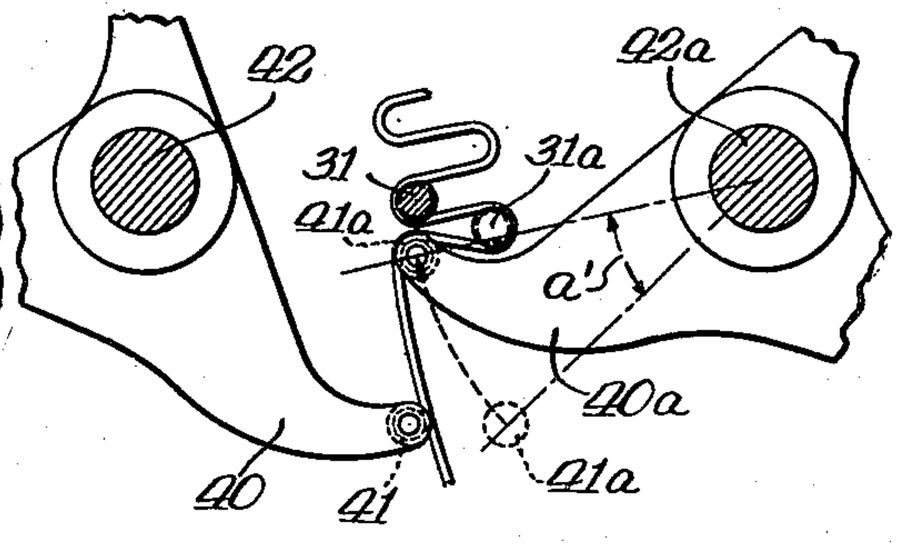
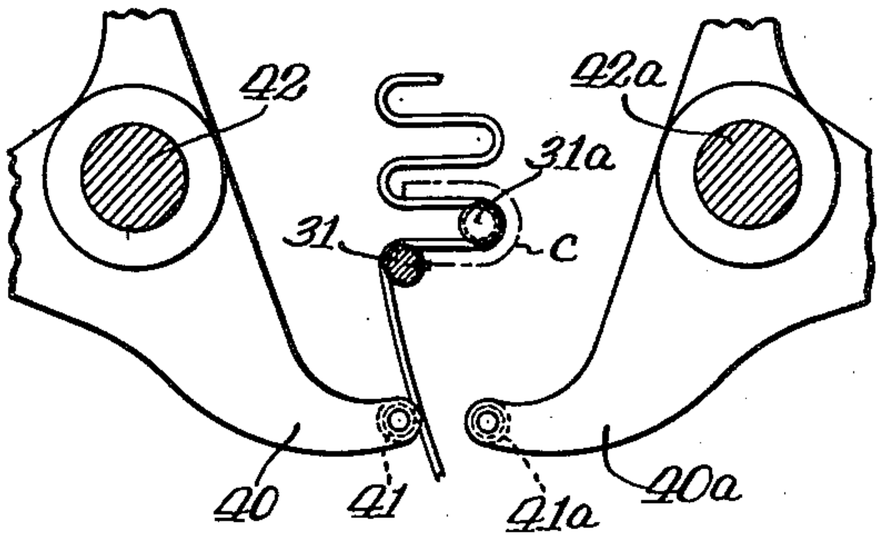
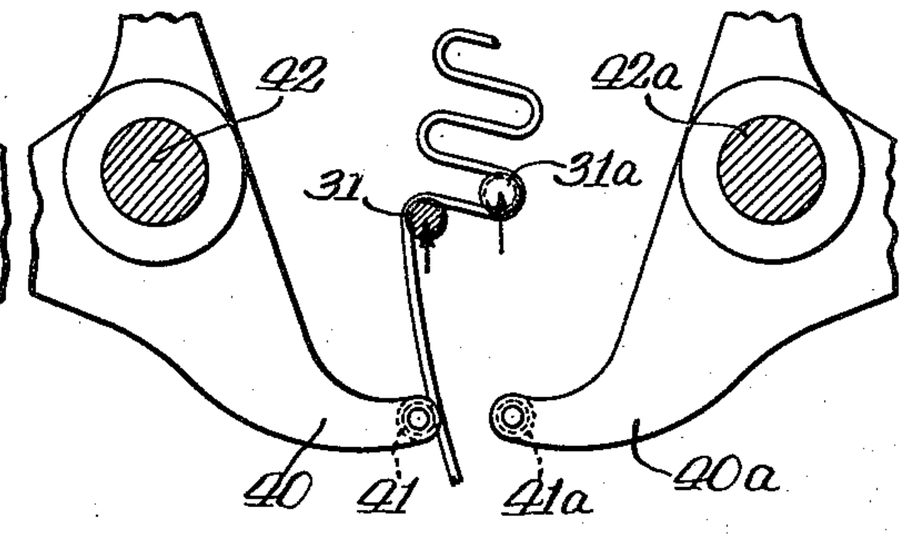


Fig. 16.

Fig. 17.





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Patented Oct. 4, 1949 2,483,865

UNITED STATES PATENT OFFICE

2,483,865

SINUSOIDAL SPRING FORMING MACHINE

Fred R. Zimmerman, Davenport, Iowa, assignor to Nichols Wire and Steel Company, Davenport, Iowa, a corporation of Iowa

Application November 15, 1945, Serial No. 628,799

14 Claims. (Cl. 140—71)

1

This invention relates to spring-forming machines for forming from spring-wire stock an elongated flat spring consisting of a series of successive oppositely directed lateral folds. Such springs are generally set with a longitudinal curvature or arch and are referred to as non-sagging springs.

Heretofore there have been proposed various types of machines for forming springs of the type described. Certain of these machines have comprised a plurality of forming posts, one or more wire-folding element and means for operating the folding element or elements to fold the wire successively in opposite directions about the several forming posts in succession, the posts being withdrawn from the loop at some time subsequent to its formation.

These spring-forming machines of the prior art have been subject to several limitations, particularly with respect to the size or gauge of the wire which they were capable of forming into springs. In the first place, if it is attempted to form a properly tempered, heavy gauge wire into springs of the type described, there is a tendency for the wire to slip from the formers or the folding elements, or both. On the other hand, if these elements are grooved in order to engage the spring-wire stock firmly, the forming posts cannot be withdrawn from the plane of the folds after they are formed. Furthermore, the mechanisms heretofore devised for this purpose have been very complex, involving a large number of intricate moving parts unsuitable for withstanding the large forces involved in forming springs from heavy gauge stock.

It is an object of the invention, therefore, to provide a new and improved machine for forming from spring-wire stock an elongated flat spring consisting of a series of successive oppositely lateral folds which is simple and rugged in construction and capable of forming springs from stock of any desired gauge.

It is another object of the invention to provide a new and improved spring-forming machine of the type described in which the formers and the folding arms are all movable substantially in a common plane, thus avoiding the necessity of withdrawing the formers from the spring folds in a direction normal to the plane of the spring after the folds have been formed.

In accordance with the invention, a machine for forming from spring-wire stock an elongated flat spring consisting of a series of successive oppositely directed lateral folds comprises a pair

2

of formers and a pair of folding arms individually cooperating with the formers. The machine further includes a first means for moving the formers alternately into forming position and a second means operating in timed relation to the first means for actuating the folding arms alternately to fold a stock wire about their respective formers. In a preferred form of the invention, the stock-engaging portions of the formers and the folding arms move in generally horizontal paths, that is substantially in a common plane, thus avoiding the necessity of withdrawing the formers from the spring folds in a direction normal to the plane of the spring.

For a better understanding of the invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawings while its scope will be pointed out in the appended claims.

Referring now to the drawings, Figs. 1 and 2 are schematic top and side views, respectively, of a complete apparatus embodying the invention for forming springs of the type described; Fig. 3 is a side elevation and Fig. 4 is a top plan view of the spring forming machine, per se; Fig. 5 is a horizontal sectional view along the lines 5—5 of Fig. 3; Fig. 6 is an end view and Fig. 7 a transverse vertical sectional view along the lines 7—7 of the spring forming machine of Fig. 3; Figs. 8–11, inc., are perspective simplified views of the lower portion of the spring forming machine in several successive phases of operation; while Figs. 12–17, inc., are fragmentary top views of the stock-engaging portions of the formers and the folding arms in several successive phases of operation of the machine.

Referring now to Figs. 1 and 2 of the drawings, there is represented a complete apparatus for forming a spring of the type described. This apparatus comprises a reel 20 rotatably supported from a standard 21 for supporting a roll 22 of spring-wire stock and feeding it to the machine of the invention. The stock from the roll 22 is passed through a series of vertical straightening wheels 24 and a series of horizontal straightening wheels 25 before being fed to the machine 26 of the invention. The spring-wire stock is formed in the machine 26 into an elongated flat spring consisting of a series of successive oppositely directed lateral folds, as described hereinafter, and the formed spring is wound on a take-up reel 27 for subsequent cutting into desired lengths.

The details of the spring forming machine 26,

per se, will be best understood by reference to Figs. 3–7, inc., of the drawings. This machine comprises a pair of similar opposed generally vertically extending formers **30** and **30***a* having grooved stock-engaging portions **31** and **31***a*, respectively, at their adjacent opposed ends. The machine also includes means for individually supporting the formers **30** and **30***a* for combined pivotal and translatory movement. This means comprises a rigid frame **28** which may be made up of castings, rolled shapes, or the like, of sufficient strength to withstand the considerable forces involved in the spring-forming operation. Secured to the frame **28** are the pairs of bearings **32**, **32** and **32***a*, **32***a* in which are mounted the pivot shafts **33** and **33***a*, respectively, which are disposed for both pivotal and axial movement. The formers **30** and **30***a* are provided with extended hubs **34** and **34***a*, respectively, which are supported from and secured to the pivot shafts **33** and **33***a*, respectively.

The machine of the invention also includes a pair of generally horizontally extending folding arms **40** and **40***a* individually cooperating with the formers **30** and **30***a*, respectively, and having grooved stock-engaging portions **41** and **41***a*, respectively, which may be in the form of grooved rollers or pulleys to reduce frictional drag during the spring forming operation. There are also provided means for individually pivotally supporting the folding arms **40** and **40***a* which may be in the form of pivot shafts **42** and **42***a*, respectively, supported in the frame **28**, the arms **40** and **40***a*, respectively, being provided with hubs **43** and **43***a*, respectively, mounted upon and secured to the pivot shafts **42** and **42***a*, respectively.

The machine of the invention also includes means for intermittently moving the stock-engaging portions **31** and **31***a* of the formers alternately into forming positions substantially in a given plane, specifically in generally horizontal paths. To this end there are provided two pairs of cams **35**, **35** and **35***a*, **35***a* for individually moving the formers **30** and **30***a* in one direction, as for example pivotally moving them about the axes of their pivot shafts **33** and **33***a*, respectively. The pair of cams **35**, **35**, which are similar, are mounted on a cam shaft **50** with a 180° displacement. These cams cooperate with and act upon cam followers in the form of rollers **36**, **36** disposed at opposite ends of a transverse arm **37** of the former **30**. Similarly, the pair of cams **35***a*, **35***a* engage rollers **36***a*, **36***a* disposed at the opposite ends of a transverse arm **37***a* of former **30***a*. It will be apparent that, rather than employing the pairs of cams **35**, **35** and **35***a*, **35***a*, a single pair of cams **35** and **35***a* may be utilized for actuating the formers **30** and **30***a*, respectively, in one direction, the return movement being effected by suitable biasing springs.

There is also provided a second pair of cams **38** and **38***a*, mounted on cam shafts **50** and **50***a*, respectively, for individually moving the formers **30** and **30***a*, respectively, normal to the first direction, that is to impart a translatory motion to the formers, as by axially sliding the formers and their associated pivot shafts **33** and **33***a* axially in their respective bearings. The cams **38** and **38***a* engage cam followers in the form of rollers **39**, **39***a* mounted in extensions of the hubs **34** and **34***a* of the formers **30** and **30***a*, respectively, to effect axial movement of the formers **30** and **30***a* and their associated pivot shafts **33** and **33***a*, respectively. The cams **38** and **38***a* are, however, single-acting and the return movement of the formers **30** and **30***a* is effected by means of biasing compression springs **49** and **49***a*, respectively, surrounding their pivot shafts **33** and **33***a* and engaging corresponding ends of their hubs **34** and **34***a*, respectively. The cam shafts **50** and **50***a* are supported in bearings **51**, **51** and **51***a*, **51***a*, respectively, secured to the frame **28**. The cams **35**, **35**, **38** and **35***a*, **35***a*, **38***a* are designed with such a configuration that the formers **30** and **30***a* are alternately moved into and out of forming positions in open, substantially U-shaped paths and are then simultaneously advanced to close the U's and advance the formed spring, as explained in detail hereinafter.

The spring-forming machine of the invention also includes means operating in timed relation to the means for actuating the formers **30**, **30***a* for actuating the folding arms **40**, **40***a* in generally horizontal arcuate paths; that is, substantially in the same plane as the paths of movement of the stock-engaging portions **31**, **31***a* of the formers **30**, **30***a*, respectively, alternately to fold the stock wire about the respective formers. This means may be in the form of actuating cams **45**, **45***a* individually engaging and actuating extended arms **44**, **44***a* of the folding arms **40** and **40***a*, respectively. In order to effect more positive withdrawal of the folding arms **40** and **40***a* after a fold-forming operation, these arms are also provided with extending arms **46** and **46***a*, respectively, engaging withdrawal cams **47** and **47***a*, respectively. Obviously the cams **45** and **45***a* are complementary to the cams **47** and **47***a*, respectively, so that they continuously engage their respective followers during the working and return strokes. The follower arms **44**, **44***a* and **46**, **46***a* may carry anti-friction rollers **48** and **48***a* engaging their respective cams in order to reduce frictional drag and wear. The cams **45** and **47** are mounted on a cam shaft **52** supported from bearings **53**, **53** secured to the frame **28** while the cams **45***a* and **47***a* are secured to a cam shaft **52***a* supported in bearing **53***a*, **53***a* secured to the frame **28**.

There is also provided a common driving means for all of the above described cams. This common driving means may be in the form of a power input shaft **54** which is connected to drive the cam shaft **50***a* through the spur gearing **55**. The cam shaft **50***a*, in turn, is connected to drive the cam shafts **52** and **52***a* through one-to-one-ration bevel gearing **56** and **57**, respectively, while the cam shafts **52** and **52***a* are both connected to drive the cam shaft **50** through the one-to-one-ration bevel gearing **58** and **59**, respectively. In this way the cam shafts **50**, **50***a*, **52** and **52***a* are all interlocked to insure synchronous operation at all times, while the very considerable forces required in the spring-forming operation are uniformly distributed through the several driving cam shafts. As stated above, the operation of the formers **30** and **30***a* is intermittent and, in order to minimize binding and cramping of the cams and cam followers driving the formers **30** and **30***a*, the several cams are so designed that the folding arms **40** and **40***a* are active to fold a stock wire about the formers **30** and **30***a* only when the latter are at rest.

Referring now to Figs. 8–17, inc., of the drawings, there are represented schematically simplified views of the various steps in the movement of the formers **30** and **30***a* and the folding arms **40** and **40***a* during the several phases of the spring forming operation. Considering first the phase represented by Figs. 8 and 12, it is seen that the

stock-engaging portion **31***a* of the former **30***a* anchors and restrains the preceding loop or fold of the spring while the folding arm **40** moves through the angle *a* to fold or bend the wire stock about the portion **31** of the former **30** to form the next oppositely directed fold. During this folding operation, the folding arm **40***a* remains at rest. The next phase in the operation is represented by Figs. 9 and 13. During this interval, the stock-engaging portion **31***a* of former **30***a* moves along the dotted line U-shaped path *b* of Fig. 13 into the position just occupied by the stock-engaging portion **41** of former **40**. Simultaneously the folding arm **40** is withdrawn through the angle *a* to the position shown in Figs. 9 and 13. The succeeding phase in the spring-forming operation is represented in Fig. 14 in which the stock-engaging portions **31** and **31***a* of the formers **30** and **30***a*, respectively, are permitted to advance in the direction of the arrows under the influence of their biasing springs **49** and **49***a*, respectively, thereby advancing the formers by the distance of one fold. During this step the portions **31** and **31***a* are moved in a direction to close the U-shaped path *b* of Fig. 13.

The succeeding step in the operation is represented by Figs. 10 and 15 which illustrate the pivotal movement of the folding arm **40***a* through an angle *a'* equal to the angle *a* traversed by the folding arm **40**, as described above. During this step in the operation, the portion **31** engages the previous fold of the spring and restrains the spring and holds it in position while the arm **40***a* folds the spring stock about the former portion **31***a*.

In Figs. 11 and 16 is represented the relative positions of the parts after the next succeeding step in operation in which the folding arm **40***a* is withdrawn through the angle *a'* to its initial position, while the former portion **31** is moved along the U-shaped path *c* and into position to serve as a fulcrum for the next folding operation by the arm **40**. Finally in Fig. 17 the former portions **31** and **31***a* are permitted to advance in the direction of the arrows under the influence of the biasing springs **49** and **49***a*, respectively, and thereby advance the formed portion of the spring by the distance of one fold.

The various steps described in detail above represent one complete cycle during which two adjacent oppositely directed spring folds are formed and this cycle is repeated indefinitely to form a spring of the desired length. It is seen that the formers **30** and **30***a* are alternately moved into and out of forming position in open substantially U-shaped paths and are then simultaneously advanced to close the U's and to advance the formed spring. It is also to be noted that the motion of the folding arms **40** and **40***a* occurs only during intervals when the formers **30** and **30***a* are at rest. This is a distinct advantage in avoiding the binding and cramping, due to the considerable forces involved in the spring-forming operation, which would be encountered if it were attempted to actuate the folding arms while the formers **30** or **30***a* were in motion At the same time, it is seen that the spring-forming machine described is extremely simple, involving essentially only four spring-forming parts, the formers **30** and **30***a* and the folding arms **40** and **40***a* and their associated driving cams. At the same time, the construction is such that all of the parts may be made extremely rugged and capable of withstanding the forces involved in forming a spring of even the heaviest gauge stock.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit or scope of the invention.

What is claimed as new is:

1. A machine for forming from spring-wire stock an elongated flat spring consisting of a series of successive oppositely directed lateral folds comprising, a pair of formers having supporting means therefor positioning the formers to extend away from one another in opposite directions, said formers each having a forming portion adjacent one another and a driven portion separated from one another, a pair of folding arms individually cooperating with said formers, a first means for intermittently moving said formers at the driven portions alternately into forming position, and a second means operating in timed relation to said first means for actuating said folding arms only while said formers are at rest alternately to fold a stock wire about their respective formers.

2. A machine for forming from spring-wire stock an elongated flat spring consisting of a series of successive oppositely directed lateral folds comprising, a pair of formers having supporting means therefor positioning the formers to extend away from one another in opposite directions, said formers each having a forming portion adjacent one another and a driven portion separated from one another, a pair of folding arms individually cooperating with said formers, a pair of cams for individually moving said formers at the driven portions alternately into forming position, a second pair of cams for individually actuating said folding arms alternately to fold a stock wire about their respective formers, and a common driving means for all of said cams.

3. A machine for forming from spring-wire stock an elongated flat spring consisting of a series of successive oppositely directed lateral folds comprising, a pair of formers having supporting means therefor positioning the formers to extend away from one another in opposite directions, said formers each having a forming portion adjacent one another and a moving portion separated from one another, a pair of folding arms individually cooperating with said formers, a first pair of cams for individually moving said formers in one direction, a second pair of cams for individually moving said formers normal to said first direction, whereby said formers are alternately moved into and out of forming position, and a third pair of cams for individually actuating said folding arms alternately to fold a stock wire about their respective formers, and a common driving means for all of said cams.

4. A machine for forming from spring-wire stock an elongated flat spring consisting of a series of successive oppositely directed lateral folds comprising, a pair of formers having supporting means therefor positioning the formers to extend away from one another in opposite directions, said formers each having a forming portion adjacent one another and a moving portion separated from one another, means for individually supporting said formers for combined pivotal and translatory movement, a pair of folding arms individually cooperating with said formers, means for individually pivotally supporting said folding arms, a first pair of cams

for individually pivotally moving said formers, a second pair of cams for individually translating said formers, whereby said formers are alternately moved into and out of forming position, and a third pair of cams for individually actuating said folding arms alternately to fold a stock wire about their respective formers, and a common driving means for all of said cams.

5. A machine for forming from spring wire stock an elongated flat spring consisting of a series of successive oppositely directed lateral folds and capable of being self-supporting as it moves through the machine in the forming operation, said machine comprising a pair of formers extending away from one another in opposite directions, means individually supporting said formers for combined pivotal and translatory movement, a pair of pivoted folding arms individually cooperating with said formers, a first means for moving said formers alternately into forming position in open substantially U-shaped paths and for simultaneously advancing said formers to close the U's and advance the formed spring, and a second means operating in timed relation to said first means for moving said folding arms.

6. A machine for forming from spring wire stock an elongated flat spring consisting of a series of successive oppositely directed lateral folds comprising, frame means having generally two portions disposed laterally relative to one another with a cam and shaft assembly in each portion, a pair of oppositely disposed pivoted formers each positioned in a frame means portion and each having a forming portion at the inner end and a driven portion at the outer end, with the driven portion of each being driven by a corresponding one of said two cam and shaft assemblies, a pair of pivoted folding arms individually cooperating with said formers, and means for driving said folding arms each in an arcuate path in timed relation to said formers and in a path substantially intermediate the two portions of the frame means.

7. A machine for forming from spring wire stock an elongated flat spring consisting of a series of successive oppositely directed lateral folds and capable of being self-supporting as it moves through the machine in the forming operation, said machine comprising frame means having generally two portions disposed laterally relative to one another with driving means in each of said two portions, a pair of formers having a driven part in each of said frame portions and a former part adjacent to one another in a position intermediate said two frame means portions, means for supporting said formers so that they are driven by said driving means into forming position in open substantially U-shaped paths, pivoted folding arms movable individually in an arcuate path in timed relation to said formers, and means for moving said folding arms.

8. A machine for forming from spring wire stock an elongated flat spring consisting of a series of successive oppositely directed lateral folds comprising, frame means, two pairs of cam and shaft assemblies mounted on the frame means and each pair thereof including a pair of cam shafts and cam means with the cam shafts of one of said two pairs of assemblies mounted parallel to one another and in a position extending in a direction at right angles to the position of the cam shafts in the other pair of said assemblies, a pair of oppositely disposed pivoted formers each having a forming portion at one end and a driven portion at the other end driven by one of said pairs of assemblies, a pair of pivoted folding arms individually cooperating with said formers and driven by the other of said pairs of assemblies, and means for driving the cam shafts in each of said assemblies.

9. A machine for forming from spring wire stock an elongated flat spring consisting of a series of successive oppositely directed lateral folds comprising, frame means, a first pair of cam and shaft assemblies each including a shaft and cam means with such shafts mounted in a parallel position on the frame means, a second pair of cam and shaft assemblies each including a shaft and cam means with such shafts mounted in a parallel position on the frame means and at right angles to said shafts in said first pair of assemblies, a pair of oppositely disposed pivoted formers each having a forming tip portion at the inner end thereof and having a portion at the other end portion thereof in engagement with the cam means of one of the pair of assemblies, a pair of pivoted folding arms individually cooperating with said formers and each having a portion in engagement with cam means of said other pair of cam and shaft assemblies, and means for driving the cam shafts.

10. A machine for forming from spring wire stock an elongated flat spring consisting of a series of successive oppositely directed lateral folds comprising, frame means, a first pair of cam and shaft assemblies each including a shaft and cam means with such shafts mounted in a parallel position on the frame means, a second pair of cam and shaft assemblies each including a shaft and cam means with such shafts mounted in a parallel position on the frame means and at right angles to the position of said shafts in said first pair of assemblies, a pair of oppositely disposed individually operated formers each having a forming tip portion at the adjacent ends thereof and each having a portion at the seperated ends thereof in engagement with cam means of one of each of the respective pair of assemblies, means individually supporting said formers for combined pivotal and translatory movement, a pair of pivoted folding arms individually cooperating with said formers and each folding arm having a portion in engagement with cam means of said other pair of cam and shaft assemblies, and means for driving the cam shafts.

11. A machine for forming a spring product from spring wire stock which is sufficiently heavy to be self-supporting as it moves through the machine to be formed into successive oppositely directed lateral folds, such machine including in combination a pair of oppositely extending formers each having a forming head thereon, means supporting each former for forming movement and in a position such that the two forming heads are overlapping, a pair of oppositely extending folding arms, means supporting said folding arms in a position such that they each pivot in a single plane which extends through each of said forming heads, with said forming heads and said folding arms entirely supporting and forming spring wire stock as it moves through the machine, and driving means operatively connected to said formers and said folding arms to drive them in timed sequence.

12. A machine for forming successive oppositely directed folds in spring wire stock which is sufficiently heavy to maintain its folded con-

figuration without support, such machine comprising a pair of formers having forming heads respectively adapted to be disposed in proximity to the wire stock on opposite sides thereof, mounting devices respectively supporting said formers for reciprocatory movements of said forming heads transversely of the wire stock in the directions of the respective folds, a pair of movable folding arms respectively adapted to be disposed on opposite sides of the wire stock near said formers, and driving means operatively connected to said formers and to said folding arms for driving them in timed sequence to fold the wire stock about said forming heads.

13. A machine for forming successive oppositely directed folds in spring wire stock which is sufficiently heavy to maintain its folded configuration without support, such machine comprising a pair of formers having forming heads respectively adapted to be disposed in proximity to the wire stock on opposite sides thereof, mounting devices respectively supporting said formers for reciprocatory movements of said forming heads transversely of the wire stock in the directions of the respective folds and also supporting said formers for reciprocatory movements of said forming heads longitudinally of the wire stock, a pair of movable folding arms respectively adapted to be disposed on opposite sides of the wire stock near said formers, and driving means operatively connected to said formers and to said folding arms for driving them in timed sequence to fold the wire stock about said forming heads and to advance the formed wire, said driving means including portions for

respectively moving said forming heads transversely and longitudinally of the wire stock in conformity with closed paths that are substantially U-shaped in part to follow the configurations of the respective folds.

14. A machine for forming successive oppositely directed folds in spring wire stock which is sufficiently heavy to maintain its folded configuration without support, such machine comprising a pair of formers having forming heads respectively adapted to be disposed in proximity to the wire stock on opposite sides thereof, each of said forming heads being grooved to receive and grip the wire stock, mounting devices respectively supporting said formers for reciprocatory movements of said forming heads transversely of the wire stock in the directions of the respective folds, a pair of movable folding arms respectively adapted to be disposed on opposite sides of the wire stock near said formers, and driving means operatively connected to said formers and said folding arms for driving them in timed sequence to fold the wire stock about said forming heads.

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