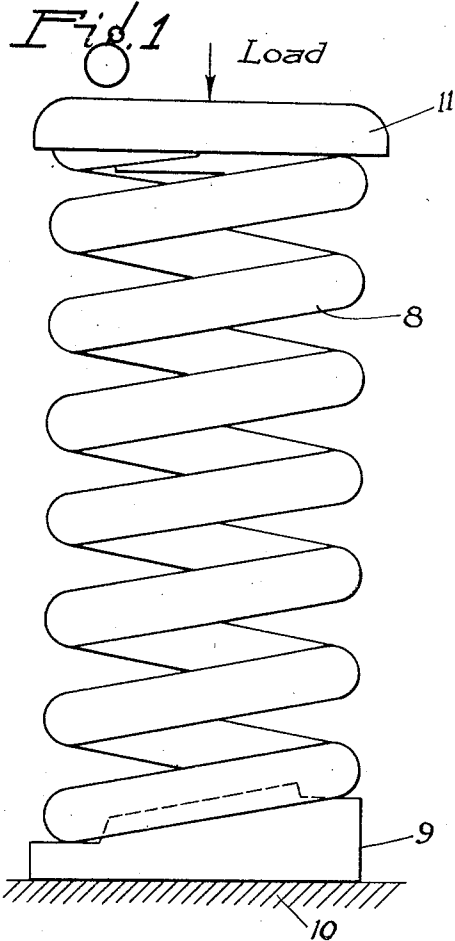
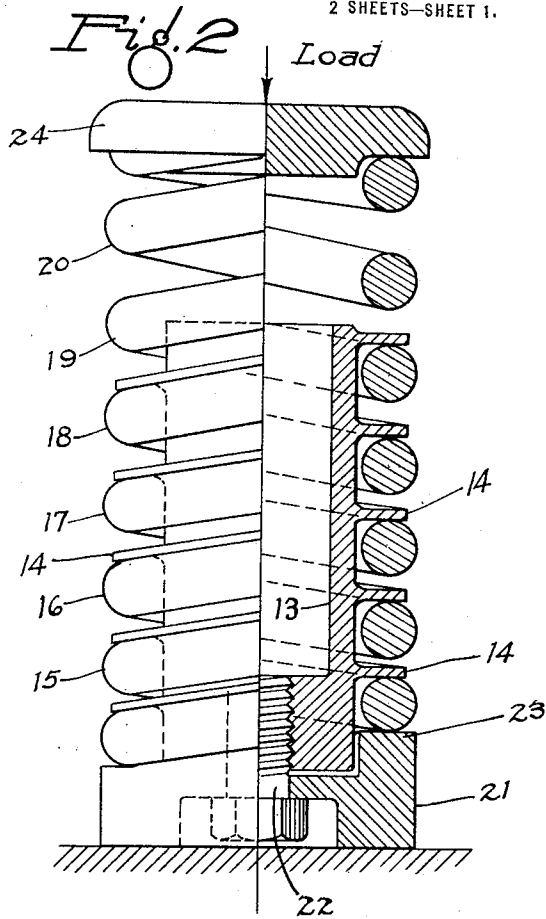
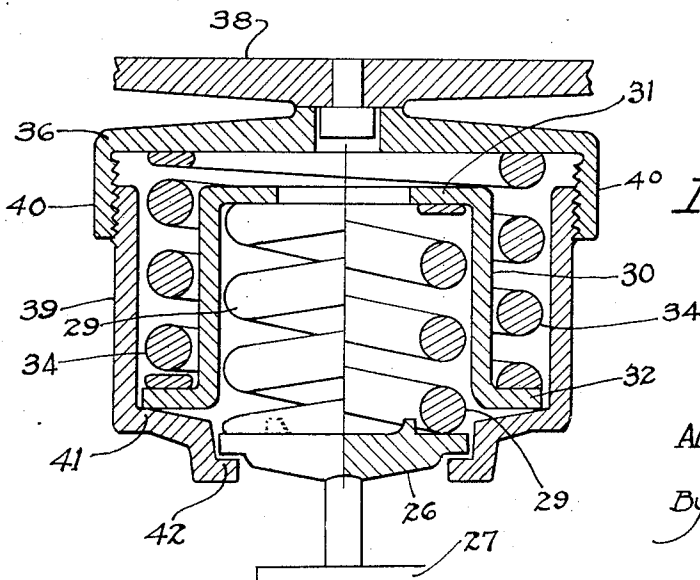


1,404,464.

Patented Jan. 24, 1922.

2 SHEETS—SHEET 1.



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2 SHEETS—SHEET 2.

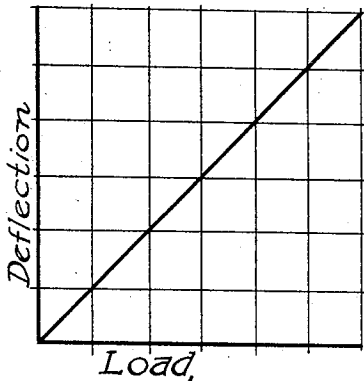


Fig. 4

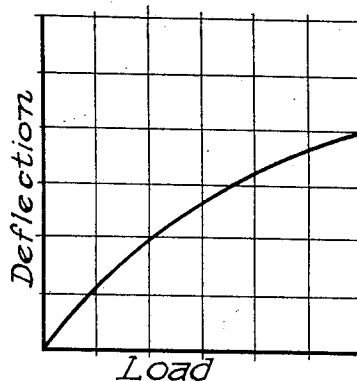


Fig. 5

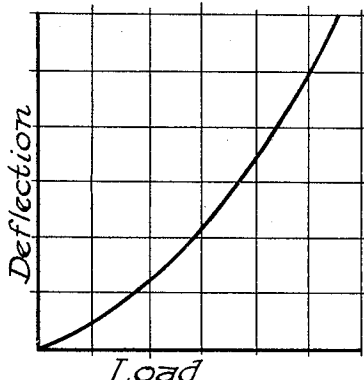


Fig. 6

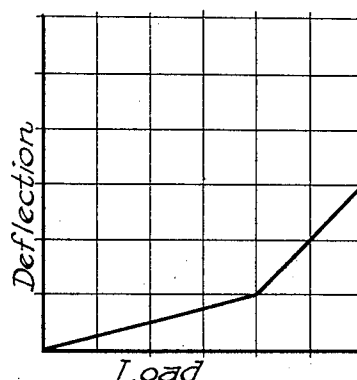


Fig. 7

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# UNITED STATES PATENT OFFICE.

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## SPRING.

1,404,464.

Specification of Letters Patent.

Patented Jan. 24, 1922.

Application filed December 13, 1920. Serial No. 430,382.

*To all whom it may concern:*

Be it known that I, ADOLPH F. MEYER, a citizen of the United States, resident of St. Paul, county of Ramsey, State of Minnesota, have invented certain new and useful Improvements in Springs, of which the following is a specification.

This invention relates to improvements in springs and particularly to springs having an increasing rate of deflection or distortion under load. This novel spring construction is such that the larger the weight or load on the spring becomes, the greater becomes the rate of deflection of the spring; that is, equal load increments produce increasingly greater deflection increments. In the case of the common type of helical springs of uniform diameter coils, equal load increments give uniform deflection increments. In the case of the usual form of elliptical vehicle springs and the common type of cone-shaped coiled springs, equal load increments give decreasing deflection increments.

The object, therefore, of this invention is to provide an improved spring.

A more specific object of this invention is to provide an improved spring having an increasing rate of deflection under load.

Other objects of the invention will more fully appear from the following description and the accompanying drawings and will be pointed out in the annexed claims.

In the drawings, there has been disclosed a structure designed to carry out the objects of the invention, but it is to be understood that the invention is not confined to the exact features shown, as various changes may be made within the scope of the claims which follow.

In the drawings:

Figure 1 is a view in side elevation, of a common type of spring;

Figure 2 is a view in side elevation and partially in section of an improved spring;

Figure 3 is a view in section of a modification of an improved spring;

Figure 4 is a graph illustrating the uniform deflection increments for equal load increments of a common type of helical spring of uniform diameter;

Figure 5 is a graph illustrating the decreasing deflection increments for equal load increments of the common elliptical vehicle springs and cone-shaped coiled springs;

Figure 6 is a graph illustrating the in-

creasing deflection increments for equal load increments of the novel spring, and

Figure 7 is a graph illustrating the increasing deflection for equal load increments, of the two-stage spring shown in Figure 3.

Broadly considered, the invention provides an elastic means which is initially distorted or deflected by means independent of the load. For the purpose of aiding in disclosing this novel invention, there is shown in Figure 1 a common form of helical spring, having six active coils 8, the lowermost of which is suitably supported upon a base 9 mounted upon a support 10. The spring disclosed in Figure 1 is shown as provided with a cap or head 11 shaped on its under face to be seated upon the upper coil and adapted to receive a weight or load which may downwardly exert its force. Assume, for example, that such load is 200 pounds, and that in the case of this particular spring, the vertical deflection or distortion of each coil under this total load is  $\frac{1}{10}$  of an inch or a total deflection for six coils of  $\frac{6}{10}$  of an inch. With this type of spring a load of 600 pounds will then produce a deflection in each coil amounting to  $\frac{3}{10}$  of an inch or a total deflection of one and  $\frac{3}{10}$  inches. Each coil of the spring is deflected an equal amount. The deflection increments of this spring are directly proportional to the increments of load, as clearly indicated by the graph in Figure 4, wherein it is seen that equal load increments produce equal deflection increments.

In the graph shown in Figure 5, there is represented the deflection under equal load increments of a spring of the elliptical or cone-shaped type. In these well known types, equal load increments result in decreasing deflection increments.

A selected embodiment of this invention is shown in Figure 2, wherein an elastic means, such as a coiled spring, similar to the spring shown in Figure 1, is placed under an initial and partial distortion by means which are independent of the load to be resisted by the spring. The means for partially distorting the spring is here shown as a worm 13. The threads 14 of the worm are provided with an upwardly increasing pitch. This worm is adapted to be inserted within one end of the coiled spring and rotated with relation to the spring so

as to travel to any desired position, as for example, to the position shown in Figure 2. After the worm has been inserted into operative position, the coil and worm are placed upon a suitable support 21, so that the lowermost coil will rest upon the substantially spiral shoulder 23 thereof. This support is centrally apertured to permit the passage therethrough of a screw 22 received in threaded engagement within a longitudinal bore formed in the worm 13. This screw 22 is adjustable to draw the worm up against the support, placing the portion of the coil within the worm under an initial deflection or distortion. Furthermore, due to the variation in pitch which upwardly increases, the lower effective coil 15 may, for example, be placed under an initial compression of 400 pounds; the next upper coil 16 may be placed under an initial compression of 300 pounds; the next coil 17 under 200 pounds, and the next coil 18 under 100 pounds, while the last two coils 19 and 20 in this illustration are free. This compression is achieved by the resistance of the spring coils to their distortion or deflection by the variable pitch of the worm. The upper coil is adapted to have a cap or head 24 suitably seated thereon, the coil being partially received within a suitable curved groove in the under side of the head. The load application may be made by way of the head.

By the employment of this worm, it will readily be understood that some of the coils are variably compressed and constrained in such position. The constrained portion, for example, the coils 15, 16, 17 and 18, will come into action to resist a load on the head 24, when such load has reached a predetermined amount, ranging from zero up to any desired initial load, depending upon the construction of the spring and of the worm. A fundamental concept of the invention may thus be that of a spring which in effect becomes longer as the load increases instead of becoming shorter or remaining of uniform length as do present springs.

As the graph in Figure 4 illustrates the action of the common type of spring shown in Figure 1; so, the graph in Figure 6 illustrates the action of the novel spring means shown in Figure 2. In the actual operation of this novel spring, the coils will naturally come into action an infinitely small portion at a time so that the rate of deflection is represented by a smooth curve as shown in Figure 6.

For purposes of further explanation, it may be assumed that one whole coil comes into action at one time. Assuming that the spring of Figure 2 is the same as the unconstrained spring in Figure 1, then under a load of 200 pounds the two upper free

coils 19 and 20 will each have a deflection of one-tenth of an inch, the next lower coil 18 will have a deflection of five-hundredths of an inch, while the coil 17, and lower coils 16 and 15, being under an initial compression of 200 pounds or more, will have zero load deflection. Thus, for 200 pounds load the total deflection will be twenty-five hundredths of an inch. When the load is 600 pounds, all coils will be deflected as the greatest initial compression is assumed to be only 400 pounds. Under the 600 pound load, the upper free coils 19 and 20 will have a deflection of three-tenths of an inch; the coil 18 will be deflected twenty-five hundredths of an inch; the coil 17 will be deflected two-tenths of an inch; the coil 16, fifteen-hundredths of an inch; and the coil 15, one-tenth of an inch.

The total deflection of this novel spring under a load of 200 pounds, therefore, will be twenty-five hundredths of an inch, but its total deflection under a load three times as great will not be merely three times this 200 pound deflection or seventy-five hundredths of an inch, but will be one and three-tenths inches. Thus an increased rate of deflection is attained under load.

Consider the principle involved from another angle. Assume a six coil spring of different sized wire from that shown in Figures 1 and 2 to have four of its coils variably compressed. Assume that the two free coils have a normal rate of deflection of  $1/100$  of an inch for every 90 pounds until the total load exceeds the initial compression of the third coil. Then the third coil comes into action and provides a spring of three coils in length. These three coils, then being free of the initial compression and responding only to the load, will have a rate of deflection of  $1/100$  of an inch for every 60 pounds. When the total load exceeds the initial compression of the fourth coil, that coil will come into play and provide a spring four coils in length which will have a rate of deflection of  $1/100$  of an inch for every 45 pounds. Similarly, when the fifth coil comes into play a rate of deflection of  $1/100$  of an inch for every 36 pounds is had. When the sixth coil comes into play, upon load increase, the six coils provide a spring which will deflect at the rate of  $1/100$  of an inch for every 30 pounds, or three times that of the initial rate of deflection. The load under which each succeeding coil comes into action depends upon the initial loading or compression under which each coil is constrained. The rate of deflection under load depends upon the character of the material used, the size and shape of the material from which the spring is made, the diameter of the coil, and the number of active coils in the spring. It will readily be seen that innumerable practical modifications may be

made of the typical spring here shown without departing from the fundamental novel features of this invention which consists essentially in providing a spring having the characteristics of giving increasing deflection increments for equal load increments. This principle, may, of course, be applied to tension, compression or other forms of springs as will readily be understood by those skilled in this art.

A modification of this novel spring is shown in Figure 3 while the graph in Figure 7 illustrates the two different rates of deflection of this spring under load. Broadly considered, this modification consists of the utilization of two separate springs, an inner and an outer. The inner spring is substantially free and the outer spring is constrained after being given a desired amount of initial compression. The construction, which may be called a two-stage spring, will give a deflection curve consisting substantially of two straight lines as shown in Figure 7. The initial rate of deflection is determined by the characteristics of the inner or free spring. The break in the deflection curve occurs at the point where the total load on the double spring equals the initial compression of the outer spring. The final rate of deflection is determined by the characteristics of the two springs both carrying the total load. In other words, the final deflection increments consist of the deflection increment of the inner spring for the given load increment, plus the deflection increment of the outer spring for the same load increment.

The construction here shown consists of a base 26 carried by any suitable support 27. The base 26 is adapted to bear the lower coil of the inner or free spring 29. The lower face of the bottom coil is preferably flattened to rest upon the base.

The substantially cylindrical member 30 is provided with radially annular terminal flanges. The upper flange 31 inwardly extends, while the lower flange 32 outwardly extends. The inner flange 31 rests upon the upper coil of the inner spring 29 and the member 30 is thereby supported. The outer spring 34 has its lower coil provided with a substantially flattened face which rests upon the upper face of the flange 32. The head 36 is seated upon the upper coil of the outer spring. The head 36 is adapted to receive and bear a load by means of the platform 38 carried thereby. A substantially cylindrical housing 39 is provided with screw threads on its outer face which are adapted to engage suitable threads formed on the inner face of the depending flange 40 of the head 36. The lower end of the cylindrical housing 39 inwardly extends to form an annular shoulder 41 upon which may rest the flange 32 of the member 30. A terminal

flange 42 is also provided at the lower end of the housing 39 which is adapted to hold the several parts in assembled relation.

The outer spring may be constrained by rotating the member 39 to approach the head 36. The outer spring is thereby constrained between the under face of the head 36 and the lower flange 32 of the member 30 which is supported by the shoulder 41.

In explanation of the operation of this spring means, it may be assumed that the outer spring is initially distorted by being constrained through the rotation of the housing 39 so that this spring is under a tension of two hundred pounds. Hence, any load on the platform 38 up to two hundred pounds will cause deflection only of the inner or free spring. After deflection of the free spring has exceeded the predetermined amount caused by the load of two hundred pounds, the initially distorted outer spring comes into action and is further distorted by any load over two hundred pounds, whereby an increased rate of distortion is thereafter afforded under load.

While the two springs, employed in this selected embodiment of a modified form, are referred to as the inner and outer springs and are shown in substantially telescopic relation, it is to be understood that such arrangement is merely optional, as these springs may be arranged in axial alinement or otherwise. The form shown is preferred, as such arrangement results in a shorter and more compact unitary structure.

I claim as my invention:

1. Elastic means, adapted to resist a load tending to distort the same, in combination with inelastic means distorting a portion of said elastic means, said distortion being initial, whereby an increasing rate of distortion is afforded under load.

2. Elastic means, adapted to resist a load tending to distort the same, in combination with inelastic means variably distorting a portion of said elastic means, said distortion being initial, whereby an increasing rate of distortion is afforded under load.

3. Elastic means, adapted to resist a load tending to distort the same, having in combination a free portion and an initially distorted portion, said initially distorted portion being adapted to be further distorted under load after distortion of said free portion has exceeded a predetermined amount, whereby an increased rate of distortion is thereafter afforded under load.

4. Elastic means, adapted to resist a load tending to distort the same, having in combination a free portion and a variably initially distorted portion, said initially distorted portion being adapted to be further distorted under load after distortion of said free portion has exceeded a predetermined

amount, whereby a variably increased rate of distortion is thereafter afforded under load.

5 5. Elastic means, adapted to resist a load  
tending to distort the same, in combination  
with inelastic means initially distorting said  
elastic means, and means to maintain a vari-  
10 ance in said initial distortion whereby a  
variably increasing rate of distortion is af-  
forded under load.

6. Elastic means, adapted to resist a load  
tending to distort the same, in combination  
with means initially distorting portions of  
said elastic means, and means to maintain a  
variance in said initial distortion of said 15  
portions whereby a variably increasing rate  
of distortion is afforded under load.

In witness whereof, I have hereunto set  
my hand this 10th day of December, 1920.

ADOLPH F. MEYER.