March 26, 1940. D. S. HAYS 2,194,471

FLEXIBLE OPERATING MEANS

Filed Nov. 20, 1935

Fig. 1.

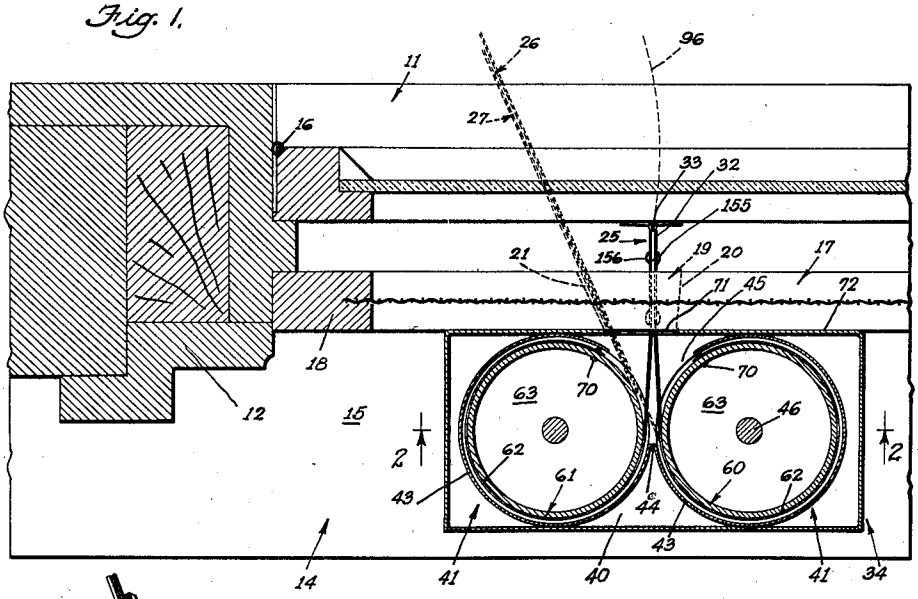


Fig. 3.

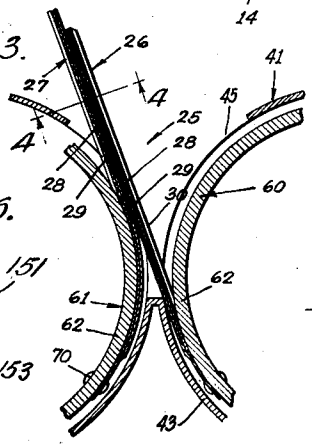


Fig. 2.

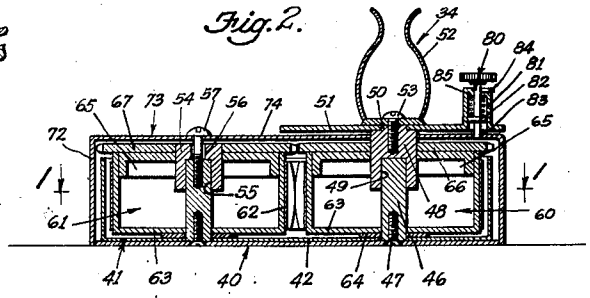


Fig. 6.

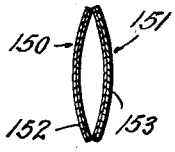


Fig. 5.

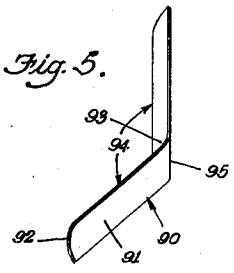
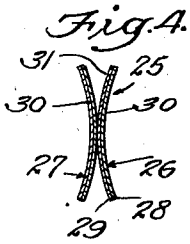


Fig. 4.



Inventor
Donald S. Hays.
by Hazard and Miller
Attorneys.

Patented Mar. 26, 1940

2,194,471

UNITED STATES PATENT OFFICE

2,194,471

FLEXIBLE OPERATING MEANS

Donald S. Hays, Redondo, Calif.

Application November 20, 1935, Serial No. 50,700

11 Claims. (Cl. 254—1)

I designate my invention as applying to a flexible operating means by which term I include metal strips or bands which may be caused to bend or follow a curve and be used either in tension or in compression for operating various devices.

My invention in a broad aspect makes use of thin metal strips or bands which are formed to have a transverse concave curve, that is, the strips are concave on one side and convex on the opposite. These types of strips are quite commonly used in measuring tapes. I find however, that strips of this character may be utilized to advantage as a flexible operating means for various devices. These strips are quite stiff under compression in regard to any bending in which the inside angle of the bend is on the convex side. Such stiffness is developed from the fact that before the strip will bend it is necessary to flatten the strip at the point or area of bending. Thus in a transverse line the strip becomes flat instead of concave convex at the place of bending. However, such strips are relatively weak under compression where the inside angle of the bend is on the concave side of the strip. Manifestly the strips may be used under tension, that is with a pull on the strip and considerable stresses may be transmitted as the material has high tensile strength.

Another feature of my invention consists of strengthening the strip or flexible member by utilizing two strips back to back, that is, with the convex sides of two strips adjacent one another. In this case if an elongated strip is necessarily mounted in the guide, it is not necessary to have the double strip back to back extending completely through the guide, but the unsupported end portion may have the double strips, one of which extends the full length of the guide and the other only a short distance in the guide. Thus the exposed end portion is formed by two concave convex strips with their convex sides contiguous and the outer ends of both strips secured preferably in a pivotal manner to the article or mechanism to be moved. This type of structure having the concave convex strips opposed develops greater strength against bending, for although one strip flexes readily towards its concave side, the other strip in flexing against its convex side offers considerable resistance.

Another feature of my invention resides in nesting the strips where it is desired to increase their resistance to bending, in view of the fact that it is necessary to make these concave convex strips of comparatively thin metal, in fact, so thin, that they will readily flatten, when making a bend or curve, increased strength may be obtained by nesting two or more strips together. By the term "nesting" I mean that the concave sides for instance, of two or more strips, all face in one direction. Likewise, the convex sides all face in the opposite direction; the two or more strips thus being fitted close together.

Another object and feature of my invention is instead of having the strips mounted for movement in straight or curved guides, to employ a construction by which the strips may be coiled or wound in a drum, circular shell or the equivalent, as the strips readily flex into a curve with the concave side inwardly, the strips may readily be wound into a drum or similar circular device. Thus by having a suitable mechanism for rotating the drum in one direction, the strip may be wound inwardly to exert a tension and when the drum is rotated in a reverse direction the strip is unwound and projected outwardly and may be used as a compression transmitting element.

In this connection, another adaptation of my invention is in using two strips back to back, that is, with the convex sides contiguous and winding each strip on a separate drum or container. Then by having these drums or containers geared together, both of the strips may be operated simultaneously in being wound in or unwound and thus by having the free ends of the strips connected to the article to be moved, a very considerable force may be developed on tensioning the strips to pull the article or device and on the unwinding or thrust on the strips sufficient stiffness is developed for moving articles or devices either with a straight line motion of the exposed free ends of the strips or through a slight angle from the ends of the guides; or if desired, directly from the periphery of the drum.

A particular adaptation of my invention in using the strips mounted for winding on a drum is in a device for opening and closing outside casement sash. In this construction in order to give the desired stiffness, two or more strips may be nested together; such nested strips being connected to a drum for winding in and out and another set of similar strips may be connected for winding in and out of a second drum. The two sets of strips at the exposed part beyond the end of a casing or a guide if such be used, have the convex sides back to back. In this construction the free outer ends of the two pairs of strips are pivotally connected to the sash. Thus as the sash turns on the hinge the two sets of strips deflect at an angle adjacent the end of the guide

or the contiguous portions of the drums. These drums as above mentioned are preferably geared or otherwise connected together to operate simultaneously.

My invention is characterized in that the strips which are wound on the drums are confined close to the drums by a casing curved to conform to the drum. This leaves a narrow channel. When the strips are wound in under tension manifestly they cling closely to the drum, but when they are thrust outwardly by rotating the drum in the opposite direction the strips press against the casing which forms an abutment to transmit the thrust through the free portions of the strip and the device to be moved.

Another feature of my invention where it is desired to have a more or less dust-proof assembly is to place the concave sides of two strips contiguous, thus edges of the strips contact. With my invention the strips may be wound on the drum either with their concave or convex sides adjacent the periphery of the drum.

My invention is illustrated in connection with the accompanying drawing, in which:

Fig. 1 is an enlarged horizontal section on the line 1—1 of Fig. 2, through the winding drums for the flexible elements, the sash and screen being illustrated on the section of Fig. 2.

Fig. 2 is a vertical section on the line 2—2 of Fig. 1 in the direction of the arrows.

Fig. 3 is an enlarged view of a portion of Fig. 2.

Fig. 4 is a vertical section on the line 4—4 of Fig. 3.

Fig. 5 is a perspective view of a single concave convex strip having an angular bend to illustrate the principle of transmission of thrust by the flexible members.

Fig. 6 is a transverse section similar to Fig. 4, showing an alternative manner of locating the flexible strips.

As above mentioned, one application of my invention of the flexible operating means is in actuating for opening and closing and retaining in any desired position of opening, a casement sash particularly of the outside opening type. Therefore in Figs. 1 through 4 I show this adaptation of my invention. In this case the window frame is indicated by the numeral 11 in which the window stiles are indicated at 12, and the window sill, having a window stool 15. The sash is indicated as hinged at 16 and inside the sash there is a window screen 17 having a frame 18. The lower rail of the screen has an opening 19 (note Fig. 1); the sides of this opening being bevelled outwardly as indicated at 20 and 21.

The flexible operating member is designated generally by the assembly numeral 25 and in this case it is made of two pairs of nested strips 26 and 27. Each of these is formed of two distinct strips marked 28 and 29 nested together. Thus they have the concave side indicated at 30 facing in one direction and the convex side indicated at 31 in the opposite direction. The convex sides are back to back. The two sets of strips at their outer ends 32 are connected together and pivoted on a hinge 33 to the inside of the bottom rail of the casement sash. The two pair of strips extend through the opening 19 in the bottom rail of the screen and have their inner ends connected in a winding and unwinding housing designated by the assembly numeral 34.

This winding housing is shown in detail in Figs. 1, 2 and 3 and employs a base plate 40 which may be secured to the stool of the window sill. On this base plate is mounted an inner member casing 41 having a bottom plate 42 and partly circular sides 43 connected at 44 at the back and having openings 45. The openings face towards each other to form passages for the movement of the flexible operating strips. A vertical stud 46 is secured by a screw 47 in the axial center of each of the partly circular walls 43. On one of the studs there is mounted a rotatable cap 48 this having a socket 49 fitting over the stud. This cap has a neck 50 to which is secured a disk 51 and on the disk is mounted a finger grip handle 52 this being secured by a screw 53. The other stud has a cap 54 also having a socket 55. Such cap has a perforation 56 through which extends the screw 57.

There are two winding drums 60 and 61. Each drum has side walls 62 and a base 63; each base having a perforation through which passes the stud 46. The bottom of the drum is spaced from the bottom plate 42 by a washer 64. A flanged cap 65 is secured to the upper portion of the side walls of each drum, the cap fitting on the inside and being soldered or otherwise secured thereto; each cap having a perforation to accommodate the caps 48 or 54 mounted on top of the studs 46. A pair of meshing gears 66 and 67 are secured either to the caps 48 and 54 on the studs or to the cap 65 of the drums so that on rotation of the handle 52 both drums are rotated simultaneously.

The outer strip 29 of each nested pair of strips is secured by a rivet or solder 70 or the equivalent to the side wall of its drum. The inner strip 28 of the nested pair terminates somewhat short of the rivet but the inside strip 28 is contiguous to the outside surface of its drum, that is, the concave side of the strip faces the drum. These strips thus pass outwardly from each drum, through the openings 45 in the side walls 43 of the circular drum housing; also through an opening 71 in the wall 72 of the top cover member 73, this cover member having a top plate 74 with an opening to accommodate the cap 48 on the stud 46 and another opening for passage of the screw 57; such screw therefore attaching the cover to the housing structure.

Any suitable means may be employed to regulate the degree of opening of the casement sash and to latch this in the closed position. However, I find a convenient device is to employ the latch bolt 80 (note Fig. 2). This is constructed by forming a socket 81 in the disk 51. The bolt 82 is downwardly spring pressed and may enter a series of perforations 83 in the top plate 74 of the cover 73. The bolt may be latchced in its uppermost position by means of a pin 84 connected to the bolt riding on the upper edges 85 of the socket structure 84, which structure has a slot to accommodate the pin 84 when the bolt engages one of the locking perforations or sockets 83.

In Fig. 5 I show a simple form of a flexible strip, this being designated by the numeral 90 in which the strip has a concave side 91 and a convex side 92. The strip is made of thin metal bent to this concave convex curvature in cross section and suitably tempered to retain such transverse curvature or when flattened and released to return to this curvature. The strip is quite stiff when it has an angular or curved bend indicated at 93; the angle of bend 94 being on the convex side of the strip. The strip has a flattened section 95 at the corner of the angle. Therefore the strip when used under compression

resists bending towards the convex side. However, the strip is very weak in regard to bending when under thrust or compression when the angle of bend is towards the concave side. Manifestly the limit of strength of the strip under tension is high, on account of the high tensile strength of the highly tempered metal. Therefore in using my invention as a sash opener and closer, it is desirable to use concave convex strips opposed in order to give additional strength and thus resist bending in either direction. Each strip thus has a considerable resistance to the bending in an angle on its convex side and manifestly as the convex sides of the two strips are contiguous they would have a considerable resistance to bending in either direction and thus act somewhat as a stiff right rod or bar pivoted at its outer end to the sash but having a flexible connection to the two drums.

Where it is desired to add additional strength, two or more strips may be nested together as shown in Fig. 4. It is necessary to increase the strength in this manner as the flexible strips must be made quite thin so that they can be bent when desired and the convex concave curve flattened or straightened at the corners. Hence in the setup of my invention as illustrated for operating a window sash, when the sash is closed, for instance in the position of Fig. 1 and the latch bolt assembly 30 is released, then the handle 52 turned in the proper direction, both of the drums on account of being geared together are rotated in opposite directions and exert an outward thrust, each on their assembled strips. On account of the greatest outward thrust being necessary to start the sash from a closed position, it is desirable to have the strips leave contact with their drums so that the angle formed by a line through the centers of the drums and to the point of attachment of the strips to the sash is as near a right angle as possible. This causes both of the strips to act in direct compression and substantially at right angles to the sash. This position however, can be varied slightly.

As the sash is opened the hinge or pivot 32 follows the direction of the arc 96 (note Fig. 1); this arc being drawn from the hinge 16. Therefore in the setup shown in Fig. 1 the double strips from the drum swing first slightly to the right and then to the left until the sash is opened the maximum distance. The strips then occupy a relative position such as shown in Fig. 3. However, they are still tangential to their drums on which they are mounted and when the strips are displaced to one side, it brings their convex sides closer together adjacent the drum and thus gives greater stiffness against bending. It is desirable to have the length of the strips beyond their confined point, such as both the drum or the openings 45 as short as possible so that a considerable force may be used in thrust or compression without causing a bending of the strip, for when the strip is once bent at a sharp angle it has but little resistance to increase of the angle of bend. As above mentioned the sash may be held opened in different positions.

In Fig. 6 I illustrate an alternative manner of locating the flexible strips. In this case the two sets designated by the numerals 150 and 151, each concave-convex in cross section, are located with the concave sides contiguous. These sets may be made up of outer and inner strips indicated as 152 and 153, depending on the stiffness desired in the combined strips. This type with the concave sides facing one another has a certain advantage in excluding dirt or dust from being wedged between the strips. The contiguous placing of the strips as shown in Fig. 12 may be used for a number of purposes for which the back to back construction of Fig. 7 may be utilized.

In order to form a stiffened portion of the strips adjacent the device to be moved in the construction of Figs. 1 through 3 I provide a stiffening member 155 adjacent the pivot 32, this stiffening member being secured to the two strips by rivets 156 or the like, the stiffening member however terminates with its inner end spaced from the contact portion of the flexible strips and the drum. This construction gives an increased stiffness to the flexible members adjacent their pivot to the article to be moved and also when the sash is closed they develop a substantially rigid member between the drums and the sash for the initial opening of the sash.

An advantage of my construction for opening and closing outside casement sash, that is, in which the sash opens outwardly, is that the operating means may extend through openings in the frame of the screen and as the housing device for the drums may be placed close to the opening in the frame of the screen flies are prevented from entering such openings.

It will be apparent that the strips may be wound on the drums with either their convex or concave sides towards the drum and proper confined by the outside casing or shell. This therefore develops a slot in which the flexible strips operate, and when they are thrust outwardly the strips spread slightly away from the periphery of the drum and develop a thrust against the casing.

A relatively important characteristic of my invention using the flexible strip wound on the two drums as illustrated in Figs. 1, 2 and 3 resides in there being a three-point thrust action and the strips in effect forming two sides of a triangle between the base, such being their points of tangential contact with the convex periphery of the drums and the apex being the connection to the movable structure or the point of contact of the two strips. For instance, referring to Fig. 1, the two strips where they have the tangential contact with the drums have their sides forming in effect two sides of a triangle, the base being the distance between the contact point on the two drums and the apex being the attaching connection to the sash. Therefore in a thrust action during the simultaneous rotation of the drums, the outward thrust against the sash is along the two sides of the triangle, thus a greater thrust may be given without the bending or flexing of the strips than would be the case either with a single strip or with the strips in close contact throughout their full length. It is usual that a greater force is required to start the opening of the sash by a thrust action than to move the sash after it is once released from its frictional or other contact with the frame. This triangle continues with the base portions spaced apart during the swinging of the sash and even in the extreme position of Fig. 3 there is a small substantial triangle form of the thrust portions of the two strips. It is manifest that on the pull or tension on the strips it is more or less immaterial as to the formation of the triangle or three points of pull as there is no danger of the strips buckling under a tension pull.

Various changes may be made in the details of construction without departing from the spirit or scope of the invention as defined by the appended claims.

I claim:

1. A flexible operating means comprising in combination a guide structure having a curved portion, a resilient strip which when unconfined is concave and convex in cross section, a portion of the strip being located in the guide, a pull and thrust means connected to the portion of the strip in the guide, the curved portion of the guide having a convex surface adapted to flatten the strip, the outer end of the strip having a pivotal connection to a moving structure whereby the strip in its inward and outward movement from the end of the guide moves in an arc, there being a clear space from the end of the guide to the pivot of the strip whereby the arcuate movement of the strip in its concave convex form is unopposed from the end of the guide to the said point of pivot.

2. A flexible operating means comprising in combination a cylindrical rotatable drum with a convex periphery, a casing concentric therewith having a concave inner surface and spaced a slight distance therefrom to form between the convex periphery of the drum and the concave surface of the casing, an arcuate guide, an elongated resilient strip which when free and unconfined is concave convex in cross section, means attaching one end of the strip to the drum, a moving structure having a pivotal connection to the outer or free end of the strip constructed and adapted to develop an arcuate movement of the strip during its outward and inward movement as to the guide on rotation of the drum, there being a clearance space from the tangential contact of the strip with the convex periphery of the drum and the outer pivot of the strip to permit free angular movement of the strip when assuming its concave convex cross section from the point of tangency to the outer pivot.

3. A flexible operating means comprising in combination a pair of cylindrical drums each with a convex periphery, each mounted for rotation on parallel axes, a casing concave on its inside surface partly surrounding each drum but leaving a space between the contiguous portions of the periphery of the drums, each drum and the adjacent casing forming an arcuate guide, an elongated flexible resilient strip attached to each drum, each strip when free and unconfined being concave convex in cross section, a movable structure, a pivotal connection between the outer ends of both of the strips to said movable structure, there being a clearance space from the portion of the casing adjacent the contiguous peripheries of the drums to the outer pivot of the strips whereby in the out and in movement of the strips on rotation of the drum the strips may swing in an arcuate movement and each strip assume its convex concave shape from its point of tangency to its drum to its outer pivot, the drums and the casing structure being adapted to flatten the portion of the strip adjacent the drum.

4. A flexible operating means comprising in combination a pair of similar cylindrical drums convex on the periphery mounted with their axes parallel, means to simultaneously rotate said drums with the contiguous portions moving in the same direction, a casing partly surrounding each drum, each casing having a concave inside surface, the two contiguous casings terminating at a back portion, such back portions being offset rearwardly from a plane through the axes of the drums, there being an opening in each casing from such back to the front portions of the drums, two resilient elongated strips, each having its inner end attached to a drum, the strips having the characteristic when free and unconfined of being concave convex in cross section, the convex periphery of each drum and the concave inside of the casing forming a confining guide structure, the said strips extending outwardly directly through the said openings in the casings, a structure mounted for movement by the action of the strips having a pivotal connection to said structure, there being a clearance space from the point of tangential contact of each strip with the convex periphery of its drum whereby on the inward and outward movement of the strips caused by the rotation of the drums the two strips may swing in an arcuate movement from the point of tangency of each strip to its drum and the pivot and occupy in such clearance space a concave convex cross section, the portion of each strip in contact with its drum being flattened.

5. A flexible operating means comprising in combination a cylindrical rotatable drum with a convex periphery, a casing having a concave inside surface concentric with the periphery of the drum and forming therewith an arcuate guide, an elongated resilient strip having one end attached to the drum, said strip when free and unconfined being concave convex in cross section and adapted to flatten in contact with the convex periphery of the drum and in the guide, means to rotate the drum, the free end of the strip having means for connection to a structure to be moved, there being a clear unobstructed space between the point of tangential contact of the strip with the drum, and its connection to the said structure whereby the strip may assume and retain its concave convex shape from its point of tangency on the drum to its connection to the said structure, the casing having an end portion in proximity to the tangential contact of the strip and the drum sufficiently close to the strip to prevent buckling of the said strip.

6. A flexible operating means comprising in combination a cylindrical rotatable drum, a casing concentric therewith and spaced a slight distance therefrom to form between the periphery of the drum and the casing, an arcuate guide, an elongated resilient strip which when free and unconfined is concave convex in cross section, means attaching one end of the strip to the drum, a moving structure having a pivotal connection to the outer or free end of the strip constructed and adapted to develop an arcuate movement of the strip during its outward and inward movement as to the guide on rotation of the drum, there being a clearance space from the tangential contact of the strip with the periphery of the drum and the outer pivot of the strip to permit free angular movement of the strip when assuming its concave convex cross section from the point of tangency to the outer pivot, a second elongated strip similar to the first strip and nested therewith, both strips having their outer end connected to the same pivot, the inner end of the second strip being unattached to the drum but confined between the drum and the first strip whereby the friction between the drum, the second strip and the second strip and the first strip develop a thrust and pull action on the second strip during the rotation of the drum but permit a slippage of the second strip relative to the drum and to the first strip.

7. A flexible operating means comprising in combination a pair of similar cylindrical drums mounted with their axes parallel, means to simultaneously rotate said drums with the contiguous portions moving in the same direction, a casing partly surrounding each drum, each casing having a circular side, the two contiguous casings terminating at a back portion, such back portion being offset from a plane through the axis of the drums, there being an opening in each casing from such back to the front portions of the drums, two resilient elongated strips, each having its inner end attached to a drum, the strips having the characteristic when free and unconfined of being concave convex in cross section, the periphery of each drum and the circular side forming a confining guide structure, the said strips extending outwardly through the said openings in the casings, a structure mounted for movement by the action of the strip having a pivotal connection to said structure, there being a clearance space from the point of tangential contact of each strip with the periphery of its drum whereby on the inward and outward movement of the strips caused by the rotation of the drums the two strips may swing in an arcuate movement from the point of tangency of each strip to its drum and the pivot and occupy in such clearance space a concave convex cross section, the portion of each strip in contact with its drum being flattened, two additional strips each characterized when free and unconfined of being concave convex in cross section, each of the second strips being connected at its outer end to the same pivot as the first strips, each of the second strips being unattached to a drum and fitting between the first strips and the contiguous drum whereby the second strips have a slight slipping motion in regard to its contiguous drum and are moved by friction between the drums and the second strips and friction between the second strips and the first strips.

8. A flexible operating means comprising in combination a cylindrical rotatable drum with a convex periphery, means forming an arcuate guide with a concave inner surface concentric with the drum, an elongated resilient strip which when free and unconfined is concave convex in cross section, means attaching one end of the strip to the drum, a moving structure having a pivotal connection to the outer or free end of the strip constructed and adapted to develop an arcuate movement of the strip during its inward and outward movement as to the guide on rotation of the drum, a second elongated strip similar to the first strip and nested therewith, both strips having their outer end connected to the same pivot, the inner end of the second strip being unattached to the drum but confined between the drum and the first strip whereby the friction between the drum, the second strip and the second strip and the first strip develop a thrust and pull action on the second strip during the rotation of the drum but permit a slippage of the second strip relative to the drum and to the first strip.

9. A flexible operating means comprising in combination a pair of similar cylindrical drums convex on their peripheries mounted with their axes parallel, means to simultaneously rotate the drums with the contiguous portions moving in the same direction, means forming a partial arcuate guide as to each drum concave on its inside surface and concentric with the respective drums, two resilient elongated strips, each having its inner end attached to a drum, the strips having the characteristic when free end unconfined of being concave convex in cross section, a structure mounted for movement by the action of the strips with the free ends of the strips having a pivotal connection to such structure, two additional strips each characterized when free and unconfined of being concave convex in cross section, each of the second strips being connected at its outer end to the same pivot as the first strips, each of the second strips being unattached to a drum and fitting between the first strips and the contiguous drum whereby the second strips have a slight slipping motion in regard to its contiguous drum and are moved by friction between the drums and the second strips and friction between the second strips and the first strips.

10. A flexible operating means comprising in combination a pair of similar cylindrical drums convex on their peripheries mounted with their axes parallel and the contiguous portions moving in the same direction, means forming a partial arcuate guide as to each drum concave on its inside surface and concentric with the respective drums, two resilient elongated strips each having its inner end attached to a drum, the strips having the characteristic when free and unconfined of being concave convex in cross section, a structure mounted for a movement by the action of the strips, means forming a pivotal connection of the free ends of the strips to the structure, the connection of the strips to their respective drums and to the said structure forming a three element thrust device, the two strips forming in effect two sides of a triangle, the base of which is the distance between the two strips where they contact their respective drums, the strips being adapted to oscillate during a thrust or a pull by the strips on the said structure from their respective points of tangency with their respective drums and there being a clear space from such points of tangency to the point of connection to the said structure.

11. A flexible operating means comprising in combination a pair of similar cylindrical drums mounted with their axes parallel, means to rotate said drums with the contiguous portions moving in the same direction and at the same peripheral speed, two resilient elongated strips each having its inner end attached to a drum, the strips having the characteristic when free and unconfined of being concave convex in cross section, a structure mounted for movement by the action of said strips, means forming a connection between the free ends of the strips and the said structure, there being a clear and unobstructed space between the point of tangency of each strip and its connection to the said movable structure with the strips when in at least one position forming two sides of a triangle, the base of the triangle being the distance between the contact point of the strips and their respective drums, the strips being adapted when forced outwardly by rotation of the drums to exert a thrust on the movable structure and the strips when contacting being adapted to mutually support each other against buckling, said strips on a reverse rotation of the drums exerting a tension pull on the movable structure.

DONALD S. HAYS.