

Nov. 27, 1962

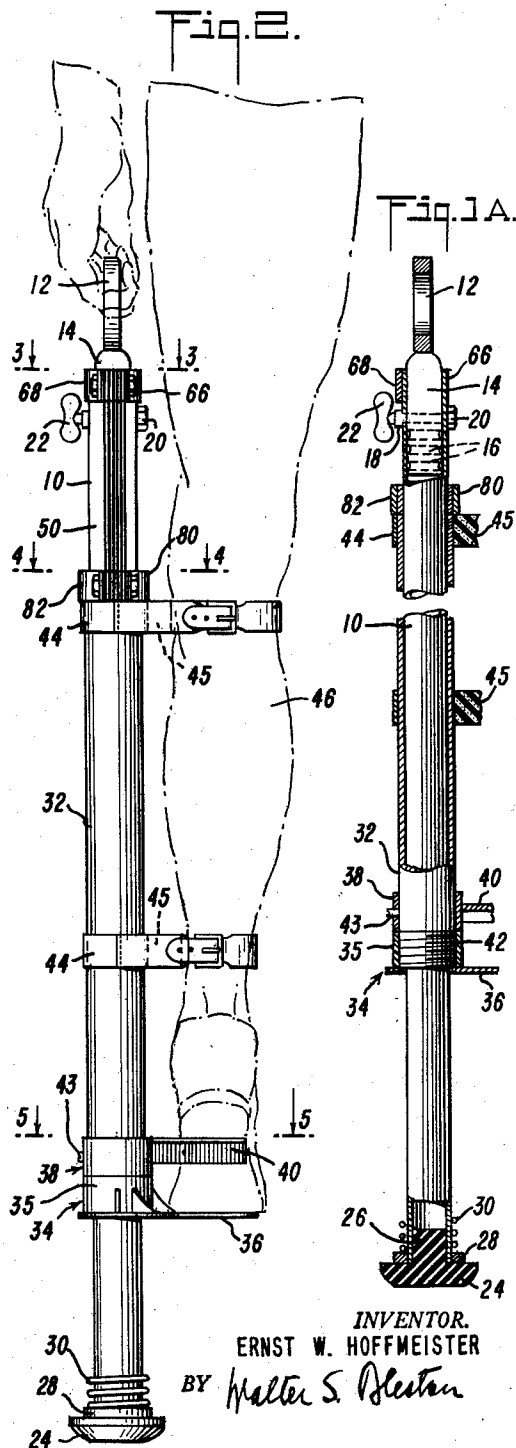
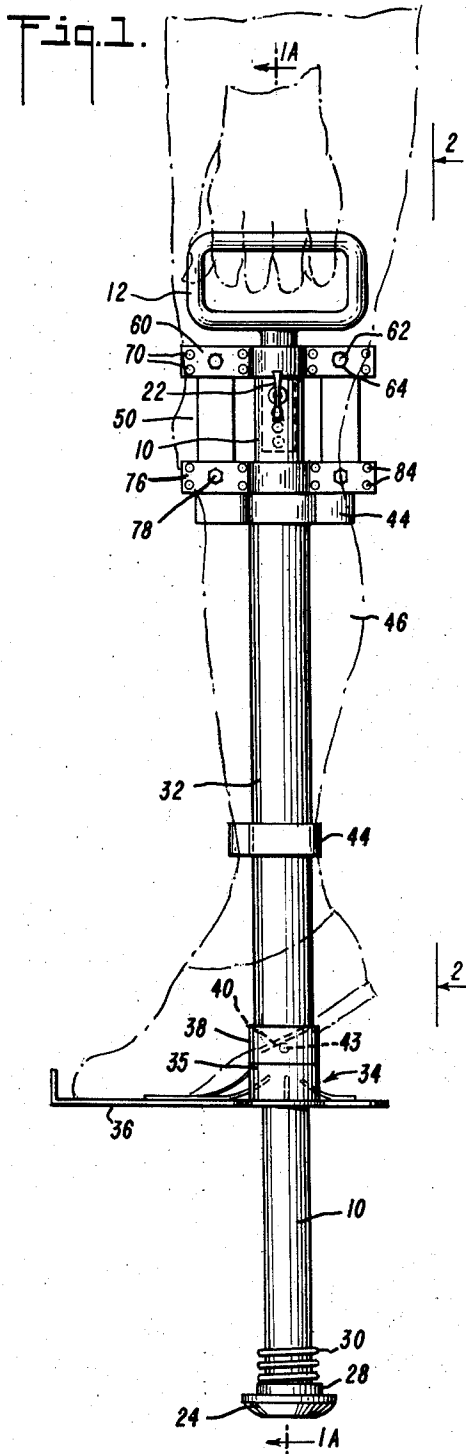
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3,065,962

JUMPING EQUIPMENT

Filed July 28, 1959

5 Sheets-Sheet 1



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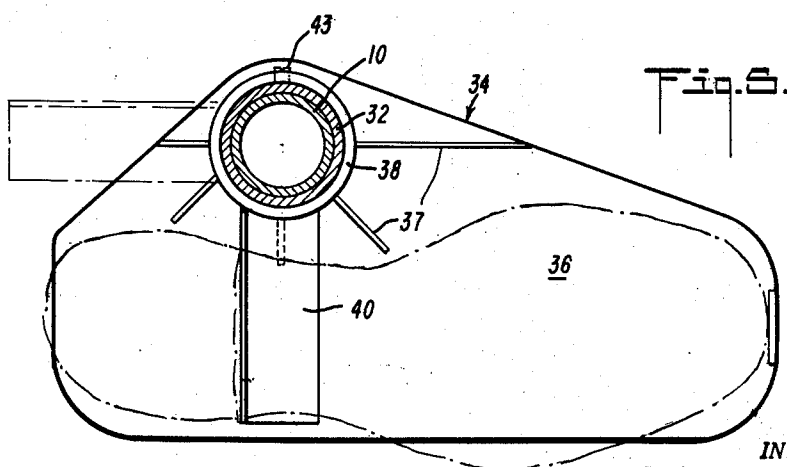
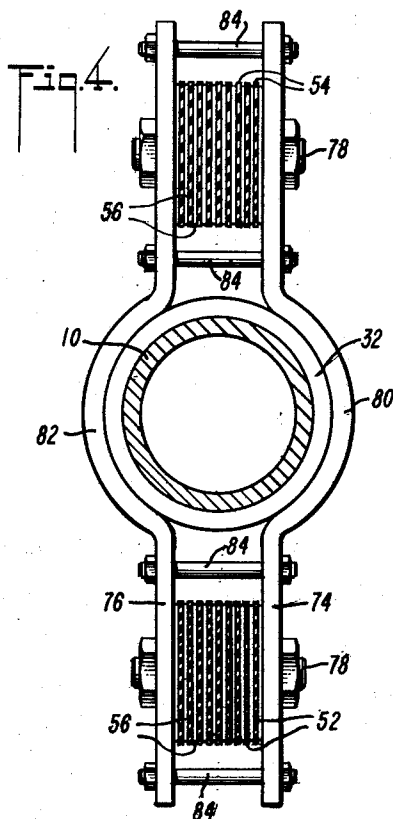
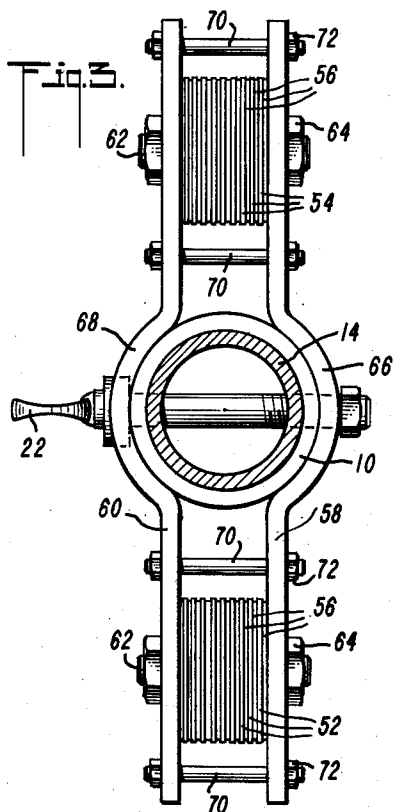
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JUMPING EQUIPMENT

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5 Sheets-Sheet 2



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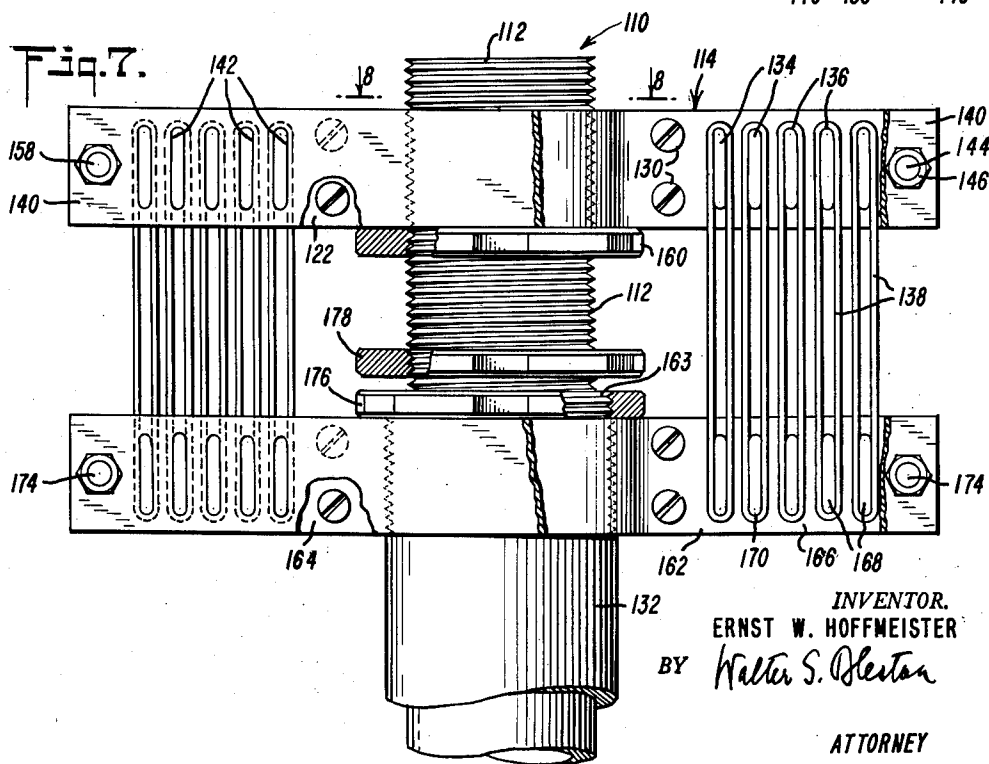
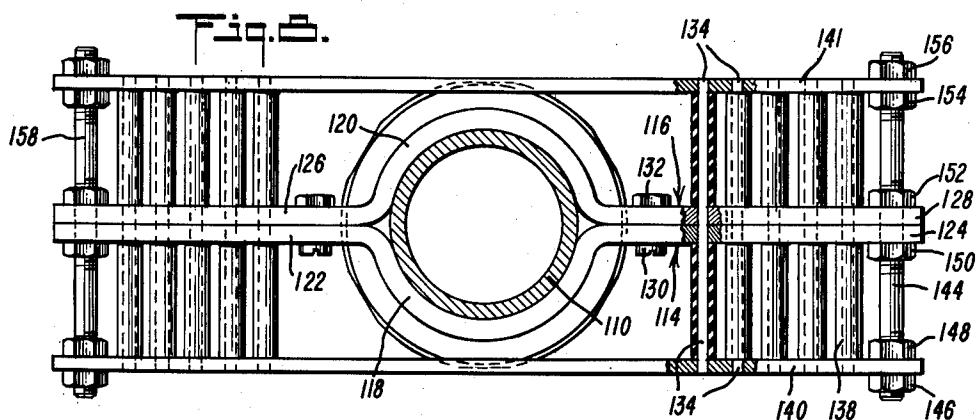
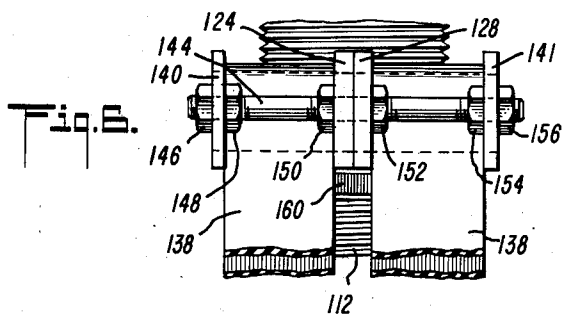
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JUMPING EQUIPMENT

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Nov. 27, 1962

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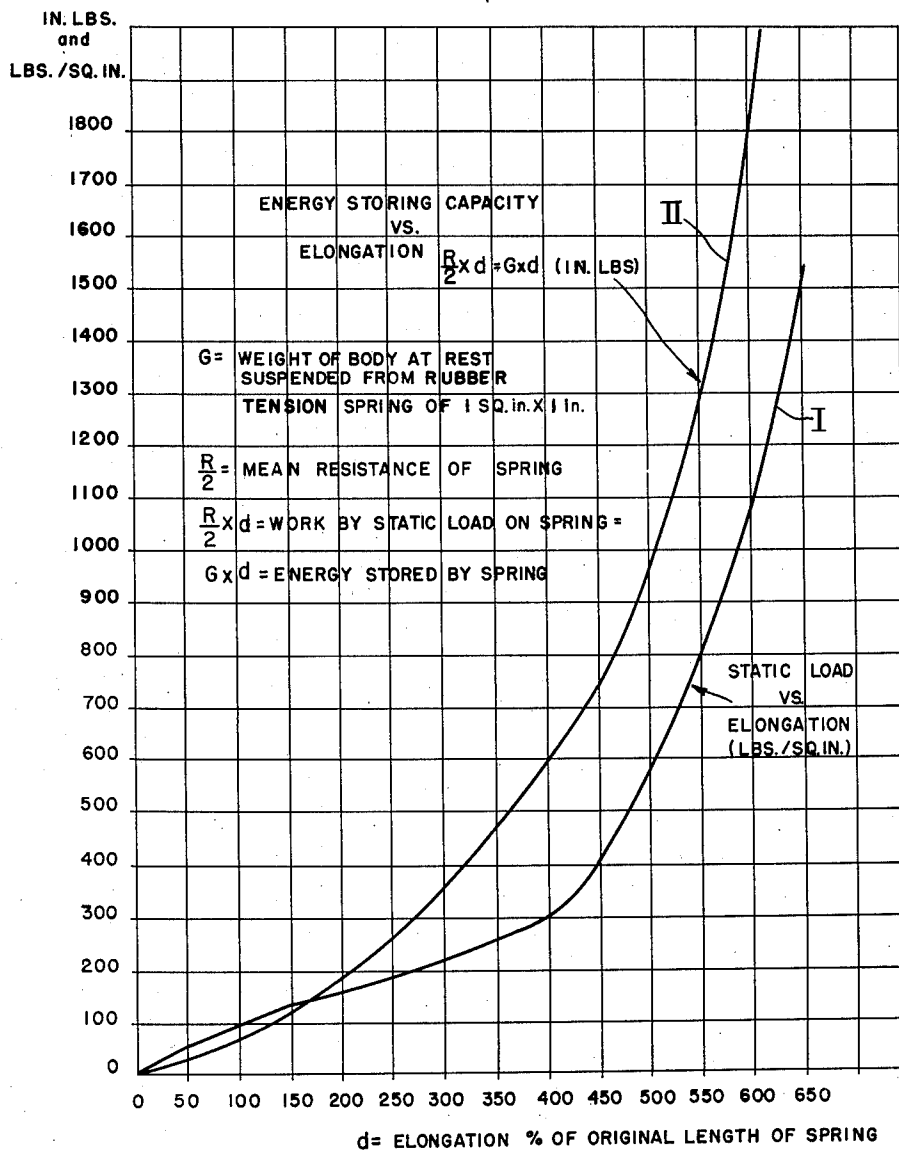
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Fig. 9.



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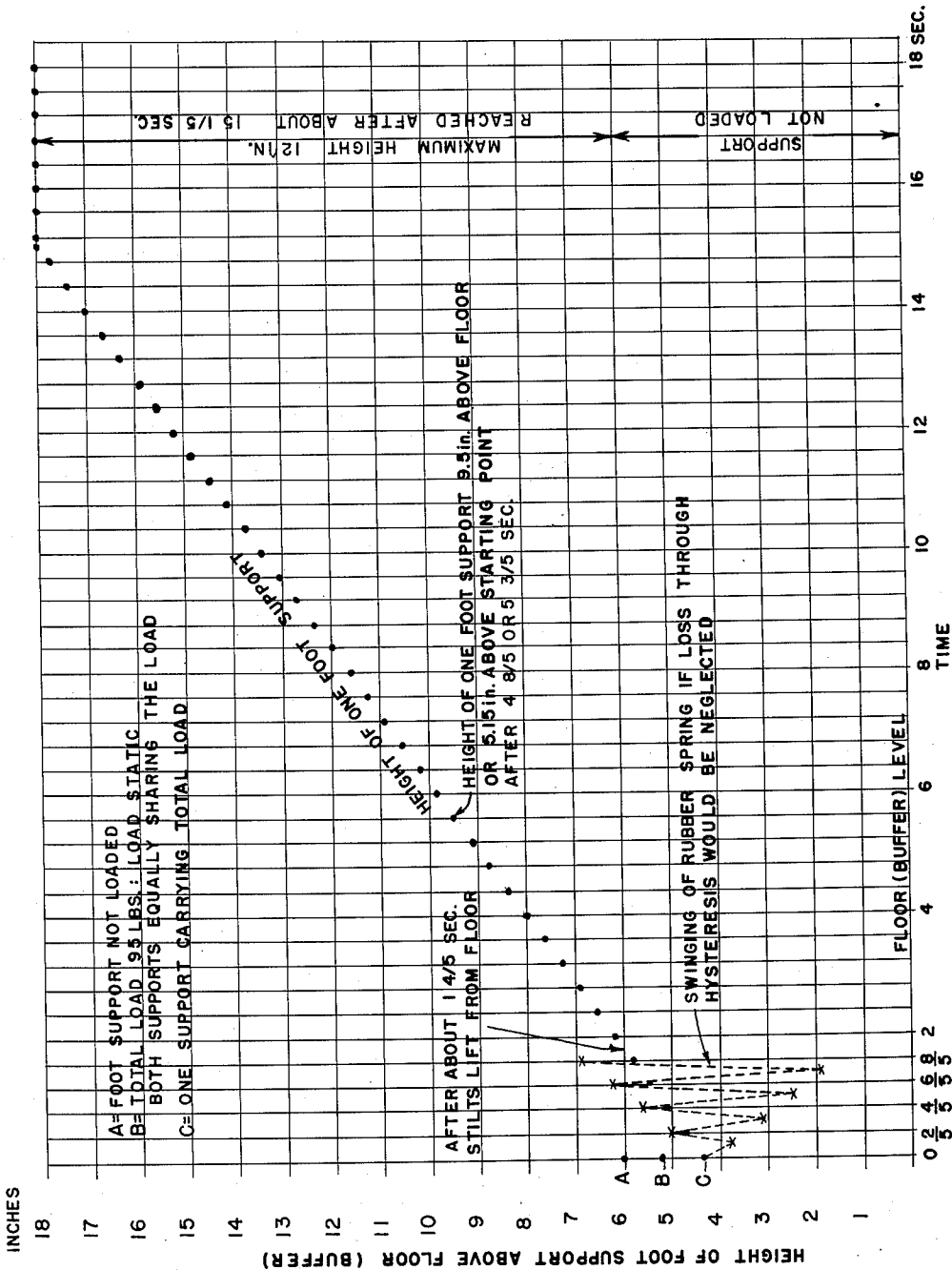


Fig. 10.

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3,065,962

JUMPING EQUIPMENT

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10 Claims. (Cl. 272—70.1)

The invention relates to jumping equipment in the field of sports. Quite in general, jumping equipment here under consideration, such as jumping sticks or jumping shoes have in common that the user bears on the equipment which is to be taken along by him when jumping. Conventionally, equipment of the mentioned type is provided with metal compression springs as boosters to increase the height of a jump. However, such conventional devices are deficient in many respects as their weight is relatively very high and the height of the feasible jumps is very limited.

It is an object of my invention to provide a jumping equipment of relatively light weight and small and wieldy structure which offers a relatively high ratio of height of jumps to the resulting spring deflection, and with which any occurring physical shock effects are reduced to a very low rate.

By calculation and experiments I have found that one of the main causes of the deficiencies of the conventional devices are the metal compression springs used therewith, and that such deficiencies can be largely eliminated by applying rubber as a tension spring. However, the term "rubber" wherever occurring in this specification and the appended claims, as the material of a spring, is to be understood to comprise soft vulcanized rubber mixtures of natural or synthetic rubber and/or mixtures of synthetic rubber-like substances having properties more or less similar to those in conventional rubber bands, hoses, tires, tubes for tires and other articles. In view thereof, it is another object of the invention to apply a new resilient principle and to provide new resilient means useful not only in jumping equipment of the type specifically mentioned hereinbefore, but also in many other kinds of devices in which springs are used as boosters to increase the height of jumps. An essential feature of my invention thus consists of the use, in a jumping equipment or gear, of a soft rubber tension spring, and the invention also aims to provide a new type of jumping equipment in the form of a resilient, stilt-like jumping stick, preferably used in pairs, i.e. one stick for each of the user's feet, wherein the aforementioned principle and means are incorporated. With such an equipment the user will be able to bounce up and down, preferably shifting his weight from the one to the other foot until finally the desired height is reached in jumping at the same place or even moving forward with jumping steps.

Furthermore, since rubber under tension is subject to a hysteresis whereby only a fraction of the kinetic energy imparted to the rubber by an impact can be regained in the recoil, the invention also comprises a new type of a rubber tension spring so constructed that its hysteresis is reduced to a relatively low value.

Further objects and details of the invention will be apparent from the description given hereinafter and the accompanying drawing illustrating an embodiment thereof by way of example. In the drawing:

FIG. 1 is a side elevation of a stilt according to my invention, the stilt not being loaded, but with the user's leg shown in position thereon;

FIG. 1a is a section along line 1A—1A of FIG. 1;

FIG. 2 is a rear view of the same stilt as in FIG. 1 but loaded by the user's weight;

FIGS. 3, 4 and 5 are sections along lines 3—3, 4—4 and 5—5, respectively, of FIG. 2;

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FIG. 6 is a front elevation of a modified spring assembly according to the invention;

FIG. 7 is a side elevation of the spring assembly of FIG. 6;

FIG. 8 is a section along line 8—8 in FIG. 7;

FIG. 9 is a diagram showing the elongation of a rubber spring of a conventional quality under tension, and

FIG. 10 is a diagram illustrating the gradual reaching of the desired maximum jumping height.

Referring now to the drawing illustrating in FIGS. 1 and 2 one of a pair of stilts according to the invention, the device comprises, a rod-like member, substantially upright when in use and formed as a tube 10 in the upper end of which a hand grip 12 is inserted with its shank 14. Means may be provided to change the length the grip 12 projects from the upper end of the tube 10. For this purpose, in the illustrated embodiment, the shank is provided with a number of holes 16, any one of which may selectively be brought into registry with a bore 18 of the tube 10 so that a bolt 20 may be passed therethrough and the grip 12 may be fixed to the tube 10 at a desired length. A wing nut 22 may be screwed on the bolt 20 in order to hold the parts together. Into the lower end of tube 10 a rubber shoe 24, constituting a buffer, is inserted with its stem 26 and a ring 28 of a larger outer diameter than that of the tube bears on the shoe 24. A short compression spring 30 may or may not be applied on top of the ring 28 so as to serve as an additional buffer for a tube 32 which encompasses the tube 10 and is lengthwise shiftable in relation to the latter. Tube 32 is considerably shorter than tube 10 so that in the position shown in FIG. 1 the tube 10 projects a long distance downwards and a short distance upwards of the tube 32. The position of the parts in FIG. 1 is that of the stilt when not in use, or when during use the tube 32 has reached its highest point. The device is shown with the user's leg held or attached thereto without, however, the user's weight bearing thereon. In FIG. 2 the parts are shown as they are when the user's weight is carried by the tube 32, but with the stilt otherwise at rest, i.e. before or after a completed jump. It will be clear that upon an impact acting on the tube 32, this tube may slide down as far as the spring 30. In order to receive the user's weight, the tube 32 carries a bracket 34 extending sideways so as to form a rest or foot plate 36 for one of the user's legs. Above the bracket 34 another bracket 38 is carried by the tube 32 and this second bracket has an inclined extension 40 which constitutes a rest for the rear part of the user's foot, preferably in front of the heel, as clearly visible in FIG. 1, while the toes of the foot bear on the plate 36. The rests 36 and 40 are so located with respect to each other that the user's foot thereon is inclined in a position best fitted for jumping. The brackets 34 and 38 may be secured to the tube 32 by any suitable means. In the illustrated embodiment and as shown in FIG. 1A the lower portion of the tube 32 is provided with a screw thread 42 and the bracket has a shell-like interiorly threaded portion 35 with which the bracket 34 is screwed on the thread 42. The portion 35 is connected with the plate 36 by means of ribs 37. The bracket 38 bears on the bracket 34 and can be turned either into the illustrated position or into a position, indicated in dash and dot lines, at 90° in relation to that shown in solid lines, if it is preferred to have the whole foot rest on the plate 36. The adjusted position can be fixed by a set screw 43. Straps 44 may be provided to tie the tube 32 to the shank 46 of the user, pads 45 being preferably interpositioned, as clearly shown in FIGS. 1, 1A and 2. However, it will be understood that these straps are not necessary if hand grip 12 is secured to the top of the tube 10 and, conversely, if the straps are used, grip 12 may

be removed. But in some instances it may be desirable to have both the grip and the straps at the same time.

The tubes 10 and 32 are connected to each other by resilient means. As stated hereinbefore, I have found that in jumping equipment of practically all kinds and especially of the kind herein described, conventional metal springs are not satisfactory considering their weight and their relatively low effectiveness. This is true with respect to all types of metal springs, such as compression or tension coil springs, leaf springs and torsion springs, as it will be shown hereinafter. The only resilient material I have found to be satisfying in every respect for the purpose of this invention and also for other uses is a vulcanized soft rubber mixture having as its essential component natural or synthetic rubber or another material with rubber-like properties, and this again is used as a tension spring rather than as a compression spring. The correctness of the foregoing statement will be apparent from the following values found by calculation and experiments:

It may be assumed that for a pair of jumping stilts according to my invention, the weight of the user, i.e. an up and down swinging, bouncing or jumping person is 95 lbs., the maximum jumping or dropping height 1 foot above the level of the non-loaded foot support, and the height of the non-loaded foot support 6 inches above the ground, or more exactly, above the buffer at the foot of the device, which height is the distance the support is permitted to be shifted downwards due to the impact of the bouncing or jumping person. If conventional steel coil springs are considered, then for checking or for elastically return springing or recoiling of 95 lbs. from 1 foot dropping height plus the corresponding deflection of 6 inches, a battery of e.g. 12 parallel coil springs would be necessary for each leg, each spring with 100 convolutions of round steel wire, gage No. 11 (.121" dia.) and 3/4 inch outer coil diameter having a weight of 9 lbs. That means, the user would have to carry along 18 lbs. Steel springs of other dimensions for the same effect would be similarly weighty and cumbersome.

If contrary thereto, according to the invention, a soft rubber tension spring is used for the same purpose and result as hereinbefore stated, the rubber material being e.g. one ordinarily on the market, then the spring may have a cross-section of 1.113 sq. in. with a working length of 1.5 in. Adding thereto the length of 2 times 1 in. for the attachment of the spring by clamping, the total length of the rubber is 3.5 in. Thus, the rubber spring for one leg has a volume of 3.89 cubic in. with a weight of .48 ounce per cubic inch or a total of 1.81 ounces. That means, the total spring weight to be carried by the user is only about 3 3/4 ounces. If higher efficiency is required, the superiority of the rubber tension spring over a steel spring becomes still more convincing. Thus, for a weight of the user of 160 lbs. and a jumping height of 2 feet with 6 in. clearance of the foot support from the ground, calculation gives the weight of steel springs as about 63.56 lbs., there being required for each leg a battery of 16 springs of a wire #9 (.148" dia.) wound to form a coil of 7/8" dia. and 150 convolutions. Contrary thereto, the soft rubber tension springs of equal efficiency would require each a cross-section of 1.69 sq. in., and a total length composed of the working length of 1.5 in., plus two clamping ends of 1 in. each which may be necessary, i.e. a volume of $1.69 \times 3.5 = 5.9$ cb. in. Hence, the weight of both springs would run up only to $2 \times .48 \times 5.9 = 5.68$ ounces. This surprisingly high superiority of the rubber tension spring over the steel spring as to weight and bulk renders it possible to reach heights of jumps with my jumping stilts which are practically not attainable with any conventional jumping stick or similar jumping equipment.

Of course, I do not claim that a rubber spring according to my invention is a proper substitute for steel springs in all sorts of machinery. This is not so be-

cause rubber is subject to deterioration by the action of many substances, media and external influences. Where, however, such effects do not occur or are of no or minor importance, the rubber tension spring particularly in its hereinafter described specific form is extremely valuable. This high value results from various remarkable properties of the rubber, of which I have fully made use in my jumping equipment. First of all, conventional rubber approximately of the quality of rubber bands as ordinarily on the market has a capacity of storing a static load about 153 times higher than spring steel, according to "Engineering with Rubber" by Walter S. Burton, McGraw Hill Book Co. Inc., New York, 1949, p. 18. In the diagram of FIG. 9, the curves relate to a similar rubber quality. Curve I gives the elongation d in percentage of the unloaded length of a spring having a cross-section of one square inch, under static loads. The elongation of the contemplated rubber rises non-uniformly up to 650% at a breaking load of 1550 lbs. per sq. in. Contrary thereto, a steel spring of rod form of one sq. in. cross-section shows under increasing loads up to the elastic limit of about 50,000 lbs. per sq. in., a uniformly increasing elongation the maximum value of which is .00167 in. or .167%. In curve II of the diagram the above mentioned energy storing capacity A of the rubber is plotted against the elongation d . This energy storing capacity being equal to the work performed by the spring under static load is equal to

$$A = \frac{R}{2} \cdot d = G \cdot d$$

wherein

$$\frac{R}{2}$$

is the mean spring resistance and G is the weight of the body at rest but suspended from the rubber tension spring of one square inch cross-section and one inch length. It will be found that for an elongation of 600% the energy storing capacity of the spring is about 1,800 lbs./in. For a comparison, the maximum energy storing capacity of a steel spring in the form of a rod or block of the same dimensions can be found from the equation

$$A_s = \frac{S^2}{2E}$$

wherein S is the load at the elastic limit of 50,000 lbs./sq. in. and E is the modulus of elasticity of 30,000,000 lbs., so that the maximum energy storing capacity of the contemplated steel spring is merely 41.66 lbs./in.

The diagram of FIG. 9 and the foregoing explanation of the curves I and II are brought merely to show in a simple manner the vast superiority of the rubber tension spring over a steel spring in apparatus of the kind here under consideration. In actuality, the behavior of rubber under dynamic loads is different from that shown by the curves under static loads. In fact, the capacity of storing shock or impact energy increases in rubber with the speed of the applied load, e.g. with the height of a fall or jump. This is again contrary to the behavior of steel where the impact storing energy is constant, i.e. independent of the speed with which the load is applied. The changeability of the energy storing capacity of the rubber under impact loads with the speed of the impacting body is an essential factor in the proper dimensioning of a rubber spring for the purpose of the present invention. If, e.g. it is desired, as in the present case, not to exceed an elongation of 400% in order to allow for a high factor of safety or for other reasons, the dimensioning need only to consider the dynamic load and may neglect the static load of the impacting body, as the static load would seem to require much larger cross-sections without sufficiently taking the elasticity of the rubber into account. Thus, comparing a rubber

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spring and a steel tension spring substantially of rod form and of equal dimensions, i.e. equal cross-section and equal loaded length, the capacity of the rubber spring may be hundreds of times higher than that of the steel spring when the latter is loaded up to the elastic limit. The necessary cross-section and length of a suitable rubber spring can be found by trial or calculation provided the properties and behavior of the rubber used are known. In the present case the dimensions of the examples given hereinbefore have been determined by me in experiments. The stated values have been ascertained under impact load for a maximum elongation of 400% which corresponds to the height of the foot support above the buffer at the lower end of the device. The maximum length of the spring is then determined for the illustrated embodiment in view of the 400% elongation as one fourth of the distance between the lower end of the tube 32 and the buffer spring 30. In figuring the mentioned distance it may be considered that there will occur a remaining elongation of the spring which, however, is so small, about .3 to .5% of the total maximum elongation that it may be neglected.

The length of the spring has quite an influence on its behavior. This should be duly considered. First of all, an increase of the length of the spring tends to decrease losses due to the hysteresis of the rubber to which special reference will be had later on, and consequently to increase the restoring energy of the spring. By selecting a longer spring which of course means enlarging the length of the active portion of the spring which is subject to the elongation under load, the duration or period of the spring oscillations can be increased. Whereas the total cross-section of a rubber spring should be so dimensioned that under the maximum impacting force the elongation of the spring does not exceed a selected measure, say 400% for safety reasons in view of occurring fatigue, the length of the non-loaded spring may be varied, but only so far that the maximum elongation remains below the desired maximum jumping height. However, the height of the non-loaded foot support must correspond to the maximum elongation, e.g. 400% of the desired original length even if that length is increased. The length of the spring is also a decisive factor with respect to the capacity of storing energy if impact effects are concerned. Quite in general, an increase of the spring length may become advisable in order to render the spring softer, to increase the period of oscillation which is proportional to the square root of the elongation and, furthermore, to decrease the impact impulse on the spring and to decrease also the distance a falling body has to travel before the tensioning of the spring sets in. In consequence of such increased length, the hysteresis becomes also smaller and the recovery of energy becomes greater. Hence, the muscular impulses of the user will be better stored and the efficiency of the muscular force required for the up-swinging will be higher.

There is the property already mentioned of vulcanized soft rubber which must be taken well into consideration as it does not permit to utilize the total capacity of storing energy which renders the rubber so vastly superior to steel when used as a tension spring. This is the aforementioned hysteresis which is caused by the heating up owing to the molecular friction originating from the tensioning and the resulting elongation of the rubber. The hysteresis, i.e. the elongation of the rubber remaining after the tensioning load is removed, disappears after a certain time. An effect of the hysteresis becomes apparent by the fact that the time during the rising will be longer than during the fall of the loading body. The hysteresis which dampens the shock of the falling body, reduces the recoil energy when the load bounces up and down. It is not of the same quantity in different kinds of rubber. For instance, it is higher in the conventional rubber bands than in the better

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qualities as e.g. used in the tubes or even still higher than in the rubber of tires. It has been stated that the length of the spring has an effect on the hysteresis. In fact, for the same impulse energy shorter springs become warmer than longer springs. Otherwise expressed, the recoverable energy accumulation and thus the spring force increases with the length of the spring, though not in proportion thereto.

In any event, in order to reduce the drawback, i.e. the loss in potential energy resulting from the hysteresis, I construct rubber tension springs according to my invention in such a manner that an automatic cooling occurs during the alternating tensioning and relaxing of the rubber spring whereby the hysteresis will be reduced. Although the hysteresis cannot be entirely eliminated, it or its effect can be kept in such limits if my invention is applied that even the relatively poor quality of conventional rubber bands is useful in my jumping equipment with very satisfactory results. For this purpose, I first calculate or otherwise find by experiment the proper area of cross-section which in the foregoing example was e.g. 1.113 sq. in. Considering that the heat due to molecular friction in the rubber increases within limits with the thickness of the rubber spring, I subdivide the cross-section in thin strips, that means, I construct the spring of a plurality of thin lamellae. A spring of the mentioned cross-section may be composed e.g. of 24 lamellae, each having a thickness of .0625 in. and a width of .75 in. giving a total cross-sectional area of 1.125 sq. in. I do not recommend the use of lamellae or bands of a smaller thickness than .0625 in. because below a certain thickness the elastic property of rubber diminishes. Furthermore, I have found that the ratio of width to thickness may be selected between 16 and 1. If this ratio is higher than 16, the bands tear easily under load.

The division of the total cross-section of a rubber tension spring into a plurality of lamellae is a first measure to reduce the hysteresis as thereby the molecular friction will be reduced and, consequently, less heat will be created. A further very effective means is the arrangement of the lamellae with air spaces therebetween. These spaces may be of a width similar to the thickness of the individual lamellae or even larger. The air between two adjacent lamellae will then have a cooling effect. This effect will be increased during the alternating tensioning and relaxing of the spring as in consequence of the repeated elongation and contraction, the thickness of the lamellae will alternately decrease and increase and the air spaces will accordingly increase and decrease in width. Thus, a certain breathing takes place whereby the cooling air of the air spaces will be at least partly renewed upon the operation of the spring. Whereas the hysteresis loss may rise to 30 or even 40% in an ordinary rubber spring of a solid cross-section, it can be greatly reduced by selecting a higher grade soft rubber mixture material and, furthermore, by designing the spring according to my invention. Thus, I have found that by laminating a rubber spring and spacing the lamellae from one another it is possible to reduce the hysteresis, otherwise occurring in any rubber mixture material of solid cross-section, by as much as 50% or even more.

In the illustrated embodiment of FIGS. 1 to 5, the spring is denoted in general by 50. It consists of two sets of rubber lamellae 52 and 54 in front and in the rear, respectively, of the upper end portion of the tube 10. Spacers 56 having rough surfaces are interpositioned between the end portions of each two adjacent lamellae. A pair of bridle-like members 58 and 60 clamp the upper ends of the lamellae and their spacers together with the aid of screw bolts 62 and nuts 64. The bolts are passed through the clamping members, the lamellae and their spacers so as to hold the sets of lamellae tightly together and to prevent a shifting of the lamellae when the spring is tensioned. The clamping members have arcuate median portions 66 and 68, respectively, with which they encom-

pass the top end of the tube 10. They are clamped tight about the tube by means of bolts 70 provided with nuts 72 and passing through both members 58 and 60 on the outer ends of these members and intermediate the tube and the sets 52 and 54. Similarly, the lower ends of the lamellae with spacers 56 are clamped together by members 74 and 76, and nut-provided bolts 73. The members 74 and 76 have also arcuate median portions 80 and 82 of somewhat larger radii, however, than the portions 66 and 68, so as to encompass the upper end of the tube 32 about which they are tightened by bolts 84, similar to the bolts 70. Thus, the active length of the spring is that intermediate the clamp 58, 60 and the clamp 74, 76.

The stilts hereinbefore described may be used in the following manner. Before the user starts to jump, he will stand on the foot supporting plates 36, his weight equally distributed among both stilts, each spring being tensioned by half the user's weight. His hands will have grasped the grips 12 so that the stilts are upright along the outsides of his shanks 46. The straps 44 may or may not be attached to the legs. To start a jump the user will now shift his whole weight on one of his legs, say the left leg. Thereby the spring of the right stilt will be relaxed and tend to assist in lifting the user's right leg. Simultaneously, the spring of the left stilt will be additionally tensioned by about half the weight of the user who may stretch the spring still more by pulling the left grip 12 against the reaction exercised by the leg on the foot support, so that the latter moves correspondingly downward in relation to the tube 10. Thereupon, the user's whole weight is shifted by a jumping movement from the left to the right stilt. This movement is supported by the force of the tensioned left spring so that the right side foot support receives a certain shock-like downward thrust which tensions the right side spring correspondingly. Simultaneously, the user will pull the grip of the right hand stilt thereby increasing the spring tension still further. Again the user's weight will be shifted from the right to the left hand stilt simultaneously increasing the spring tension by the pull at the grip. In the same manner alternately loading the one and the other stilt while adding spring tension with the aid of the grip, the jumping movement will become higher and higher commensurate with the tension of the spring of the loaded stilt, which tension becomes greater and greater owing to the increasing height and, therefore, the increasing shock imparted to the foot support by the fall of the body's weight thereupon. With a very few ups and downs, the stilts will lift from the ground and the jump will increase until finally the foot supports of the stilts alternately come to engage the compression spring 30 whereupon no increase of the tension of the rubber spring is possible.

FIG. 10 is presented in order to illustrate in a simplified form the effect of alternately loading the two stilts for the utilization of the restoring energy of the rubber spring in order to reach the desired height of a jump or jumps. In plotting the diagram of FIG. 10 it is assumed that the non-loaded foot supports are six inches above the buffer, that a maximum jumping height of twelve inches is desired and that the spring completes a full cycle of oscillation up and down in two fifths of a second. Point A indicates the position of the unloaded foot support above the buffer at the start. Point B shows the height of the two foot supports equally loaded by the total weight as e.g. 95 lbs. in the stated example, and point C gives the height of one support when carrying the whole load. Now by using the device as explained, by shifting the body weight from the one to the other foot, the originally loaded foot will reach a height as indicated by the next higher point after a period of two fifths of a second. The following dots indicate the heights of one foot support after the other reached at the end of each up swing. Thus, e.g. after 4% or 5% seconds a height will be attained of 9.5 inches above the

buffer or 5.15 inches above the starting point. After about 1% seconds the stilts will lift from the ground, and after about 15 seconds the full height of a jump of 12 inches will have reached. The points in FIG. 10 are found under consideration of a normal hysteresis loss. However, the difference between the time required by the up and down swinging, which is actually caused by the hysteresis, has not been taken into account. If the hysteresis could be disregarded the springs would swing the supports approximately in the manner indicated by the little crosses connected by dotted lines.

The values of the diagram have been figured under the assumption of a synchronism of the natural period of the spring and the exciter oscillation with approximation of resonance, whereby the shortest periods are obtained. Depending on the application of the arm or leg force by the user with a phase shift with respect to the natural period the duration of the oscillations may be slowed down more or less with respect to the basic natural oscillation of the spring body. The hand grip offers another possibility of slowing the oscillations down as the user may hold the grip tensioned at the crest of the oscillation as long as desired.

It has been assume heretofore that the height of the foot support above the buffer should be six inches for a jumping height of twelve inches. It is, of course, possible too to select for the same jumping height a suitable other support height of e.g. ten inches whereby the active length of the non-loaded spring would become 2.5 in. rather than 1.5 in. In order to fit such longer spring to the illustrated embodiment it would only be necessary to shift the lower spring attachment of the upper end of the tube 32 to a lower portion of the tube. Even with such an increase of the height of the foot supports the two units are readily usable as stilts. They can be easily mounted and balance can be kept. It may also be taken into account that when mounting the stilts the elongation by the static load is to be deducted from the height of the non-loaded foot supports. It will be understood, however, that the user will lift the stilts from the floor only after the foot support has reached the height of 10 in.

Another manner of using the jumping stilts, according to my invention, consists in that the user loading both stilts equally may start to jump up and down with both feet simultaneously. The down-coming body will tension the rubber springs which will release the energy stored thereby upon the upward movement of the subsequent jump, thus helping to reach an increasing height. The height of the jump can be still further increased by the user pulling the grips 12 with some force against the reaction exercised by the legs on the foot supports. This pulling force may be applied most favorably towards the end of the downward stroke so that the rubber spring becomes tensioned beyond the amount due to the shock of the falling body. In this way the springs become more and more tensioned from jump to jump, the heights of which increase until the maximum is reached when the rubber springs are stretched so much by the shock of the falling body that the foot supports come to bear on the compression springs 30. It will be understood that by the first few jumps there will be only an upward shift of the tubes 32 in relation to the tubes 10, but when the height of the jumps increases owing to the increase of the tension of the rubber springs, the jumps will lift the stilts held at their grips by the user more and more from the ground until the mentioned maximum is reached.

A third manner of using the stilts according to my invention is as follows: After reaching a certain height through movements in the manner of the first described operation, the upwardly directed movements are combined with forward movements whereby kangaroo-like jumps can be performed. This, however, is possible only after the stilts have been lifted from the floor.

It has been stated that certain hysteresis losses of a

rubber spring are unavoidable, that means, that the amount of work imparted to the spring by the falling body cannot fully be recovered on the rebound. This loss, however, is readily over-compensated by the pull on the grips of the stilts so that an ever increasing height of jump up to the stated maximum can be attained.

A modified rubber spring and attachment to the tubes of the stilts are shown in FIGS. 6 to 8. In this embodiment the inner tube 110 and the outer tube 132, of which only upper portions are shown, are similar to the tubes 10 and 32, respectively, that means, the tube 110 is substantially longer than the tube 132 and may be provided with a grip 12 and a bolster 24 and compression spring 30, the same as shown in FIGS. 1 to 3, whereas the tube 132 may be provided with foot support brackets 34 and 38 and with straps 44. The upper portion of the tube 110 is provided with an exterior screw thread 112. A preferably two-partite spring holder comprises parts 114 and 116 which have interiorly threaded semi-circular portions 118 and 120, respectively, forming a nut screwed on the thread 112. Bar-like portions 122, 124, 126 and 128 extend from the portions 118 and 120 towards both sides opposite each other. These portions have a substantial height as clearly visible in FIG. 7. The portions 122 and 124 lie flat against the portions 126 and 128, respectively, and are held together by a plurality of screw bolts 130 with nuts 132. A plurality of relatively thin cross-bars 134 of a height somewhat smaller than the height of the holder parts 114 and 116 extend equal distances from the portions 122, 124, 126 and 128. The upper edges of the cross-bars are well rounded, as indicated at 136. An endless rubber band 138 is hung over each of the cross-bars which are so spaced from each other that each two adjacent rubber bands 138 are also spaced from each other approximately an amount equal to the thickness of the band but preferably not less than the thickness of the cross-bars. The cross-bars 134 may either be individually welded to the clamp portions from which they extend, or the pairs of bars oppositely extending from the portions 122 and 126 may each be of one piece which is passed through corresponding slots in the portions 122 and 125 and secured therein e.g. by spot welding against shifting. Similarly, the pairs of cross-bars oppositely extending from the holder portions 124 and 128 may be made each of one piece and inserted and secured in slots of these portions. Retaining metal strips 140 and 141 are provided with similar slots 142 to those in the portions 122, 124, 126 and 128 so that the ends of the cross-bars 134 can be located therein. The strips extend parallel to the last mentioned portions as far as their ends where holes are provided so that a threaded bolt 144 can be passed through retainer strip 140, both the portions 124 and 128 and through the strip 141. The bolt 144 has a head 146 and five nuts 148, 150, 152, 154 and 156. The head 146 and nut 148 hold the strip 140 in position. The nuts 150 and 152 bear against the portions 124 and 128, respectively, and the nuts 154 and 156 ensure the proper position of the strip 141. The nuts are so set that the strips 140 and 141 are spaced from the portions 124 and 128, respectively, according to the width of the rubber bands 138. At the other ends of the holder portions 114, 116, i.e. at the free ends of the portions 122 and 126 another bolt 158 with five nuts similar to the bolt 144 is secured to the mentioned portions and the strips 140 and 141. A nut 160 is screwed on the thread 112 of the tube 110 underneath the holder 114, 116 to serve as a jam nut for the latter. The structure just described renders it possible readily to replace a rubber band which might have become defective or even to replace all the rubber bands by others of different dimensions, within limits.

Similar to the holder 114, 116 on the tube 110, a bipartite holder 162 provided with an interior threading is screwed on an exterior thread 163 provided on the top end of the tube 132. The holder 162 has lateral extensions 164 and 166 positioned parallel to the extensions

122, 126 and 124, 128, respectively. Cross-bars 168 are provided and affixed in a manner similar to the cross-bars 134 with the sole difference, however, that their lower edges 170 are rounded rather than the upper edges. Retaining strips 172 are provided and secured by bolts 174 with five nuts, the same as described with respect to the bolts 144 and 158, after the endless rubber bands have been hooked with their lower loops on the cross-bars 168. A jam nut 176 is screwed on the thread 163 on top of the holder 162. An additional nut 178 is screwed on the thread 112 of the tube 110. This nut serves as an adjustable abutment for the nut 176 and prevents the rubber bands from getting undesirably slack, whereas the screw connection of the holders with the tubes renders it possible to adjust a pre-tension of the rubber spring if so desired. It will be understood that the modification illustrated in FIGS. 6 to 8 functions in practically the same manner as the corresponding parts of the stilts according to FIGS. 1 to 5. However, a difference will be noted in that in the first described embodiment the rubber spring is active only between the clamped ends whereas in the modification according to FIGS. 6 to 8 practically the whole length of the endless bands participates in the spring action.

It will be apparent to those skilled in the art that many modifications and alterations of the structure illustrated and described may be made without departure from the essence and spirit of my invention which for that reason shall not be limited but by the scope of the appended claims.

I claim:

1. A resilient stilt comprising a rod-like member substantially upright when in use, a tubular member shorter than said rod-like member and enclosing a median portion thereof so as to be shiftable lengthwise in respect to the rod-like member which projects with both its ends from said tubular member, a first clamp attached to the top end of said tubular member, a second clamp attached to said rod above the top end of said tubular member, said clamps extending towards opposite sides of said tubular member and said rod-like member, respectively, and being parallel to each other, a soft rubber tension spring secured endwise to each pair of clamp ends on the same side of said tubular member and said rod, a foot support for a user secured to the lower end portion of said tubular member, a means connected with one of said members to hold said stilt substantially alongside the user's shank when his foot is placed on said support and a hand grip secured to the top end of said rod like member.

2. A device as in claim 1, said spring comprising a plurality of soft rubber elements of equal length in parallel arrangement and defining freely accessible air spaces therebetween, thin spacers between the adjacent end portions of said elements so as to keep said elements slightly apart from one another, and means to secure the adjacent ends of said elements and said interpositioned spacers together.

3. A device as in claim 1, said spring comprising a plurality of parallel soft rubber lamellae in a side by side arrangement and defining freely accessible air spaces therebetween, thin plate-like members having highly frictional surfaces and being between the end portions of each two adjacent lamellae, and means to secure the adjacent end portions of said lamellae and said interpositioned plate-like members together.

4. A resilient stilt comprising a rod-like member substantially upright when in use, a tubular member shorter than said rod-like member and enclosing a median portion thereof so as to be shiftable lengthwise in respect to the rod-like member which projects with both its ends from said tubular member, the upper ends of said rod-like member and said tubular member being provided with exterior screw threads, a first and a second nut body being screwed on the threads of said rod-like and said tubular members, respectively, each nut body including

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a pair of bar-like extensions projecting in opposite directions, equal numbers of cross-bars extending from said extensions at right angles thereto and in opposite directions therefrom so that each cross-bar of an extension of the one nut body is in registry and co-ordinate with a cross-bar of an extension of the other nut body, as many separate endless rubber bands as there are cross-bars connected to one nut body, the separate rubber bands defining freely accessible air spaces therebetween, the cross-bars of each pair of adjacent cross-bars being spaced from each other somewhat more than twice the thickness of one of said rubber bands, the loops of each of said bands being hooked on a pair of said co-ordinate cross-bars, a foot support for the user secured to the lower end portion of said tubular member, and a means connected with one of said members to hold said stilt substantially alongside the user's shank when his foot is placed on said support.

5. A tension spring comprising a plurality of soft rubber bands of equal length, width and thickness, and in parallel relation to one another so that the wide sides of said bands face one another and define freely accessible air spaces therebetween, first means to hold the one ends of the bands spaced from one another, second means to hold the other ends of said bands spaced from one another, and two elements connected to said first and second means, respectively, and adapted to be respectively attached to two extraneous members.

6. A tension spring comprising a plurality of soft rubber bands of equal length and in a side by side arrangement, said bands defining freely accessible air spaces therebetween, a plate-like spacer piece of high frictional property between the end portions of each pair of bands adjacent to each other, a first clamp binding the one ends of the bands with the interpositioned spacer pieces together, and a second clamp binding the other ends of the bands with the interpositioned spacer pieces together, each clamp including means for attachment to an external member.

7. A tension spring comprising two bar-like members parallel to and spaced from each other, equal pluralities of cross-bars extending from said bar-like members respectively, said cross-bars of the one member being parallel to and in registry and co-ordinate with the cross-bars respectively of the other member, as many separate endless soft rubber bands as there are pairs of co-ordinate cross-bars, the separate rubber bands defining freely accessible air spaces therebetween, the cross-bars of each

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pair of adjacent cross-bars being spaced from each other somewhat more than twice the thickness of one of said rubber bands, the loops of each of said bands being hooked on a pair of said co-ordinate cross-bars, and each bar-like member including means for attachment to an external member.

8. A tension spring as in claim 7, said pluralities of cross-bars extending from opposite sides of said bar-like members.

9. A tension spring as in claim 7, further comprising a retaining strip for each bar member, the ends of the cross-bars opposite the ends connected to said bar member being connected to said retaining strip, and means connected to the ends of said retaining strip to secure the latter to the free ends of said bar member in a spaced relationship thereto.

10. A jumping equipment comprising a rod-like member in a substantially upright position when in use, a load carrying tube enclosing a median portion of said rod-like member and being lengthwise movable in relation thereto, said rod-like member projecting with both its ends from said tube, at least one soft rubber tension spring, said spring comprising a plurality of soft lamellae parallel to each other and defining freely accessible air spaces therebetween, first means to hold the one ends of said lamellae spaced from one another, a first element for securing said first means to said rod-like member, second means to hold the other ends of said lamellae spaced from one another, a second element for securing said second means to the upper end of said tube, a foot support for the user secured to the lower end of said tube, and a hand grip secured to the top end of said rod-like member.

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