May 28, 1968 E. I. ROBINSKY 3,385,397

EXTENSIBLE-RETRACTILE STRUCTURE

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FIG. 1.

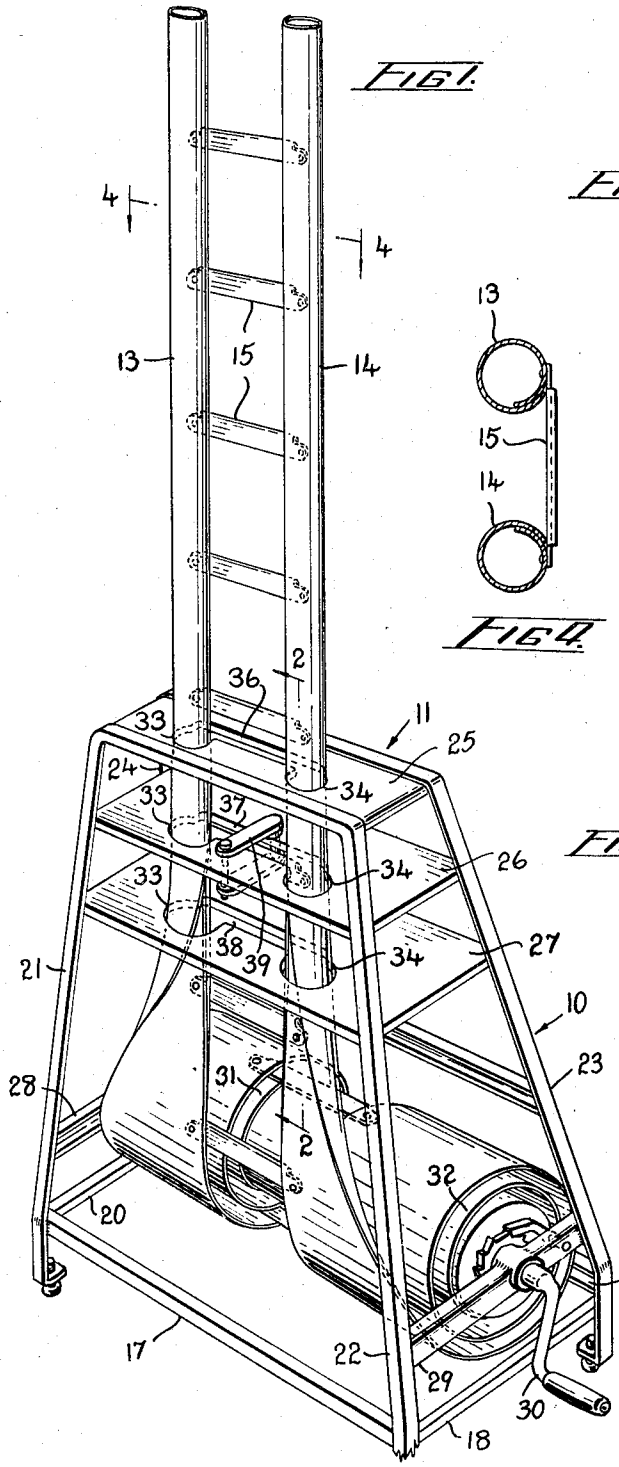


FIG. 4.

FIG. 2.

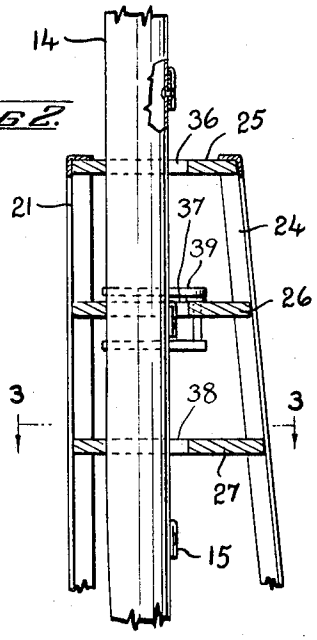
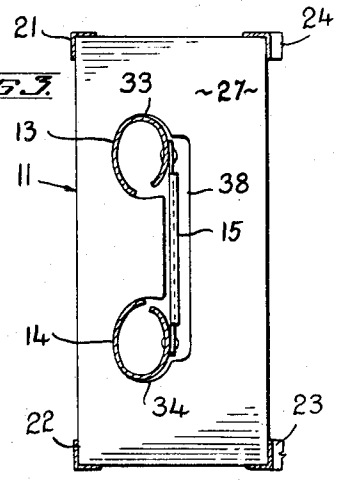


FIG. 3.



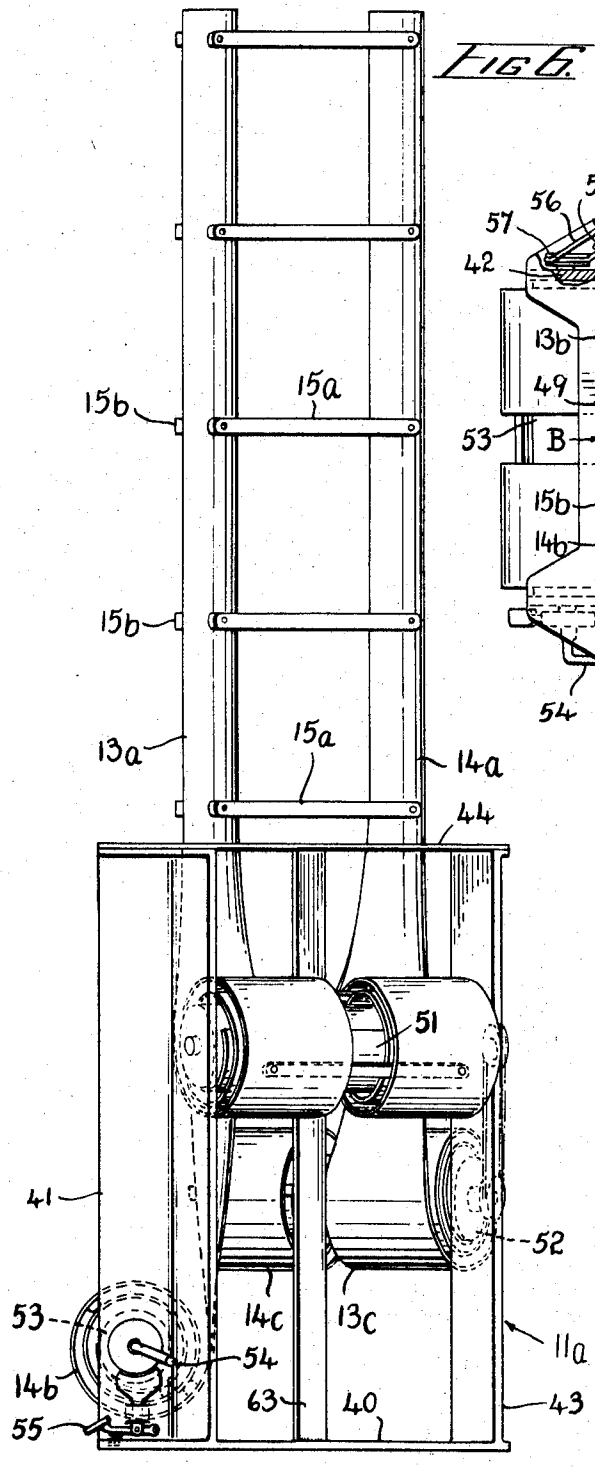
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EXTENSIBLE-RETRACTILE STRUCTURE

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FIG 6.



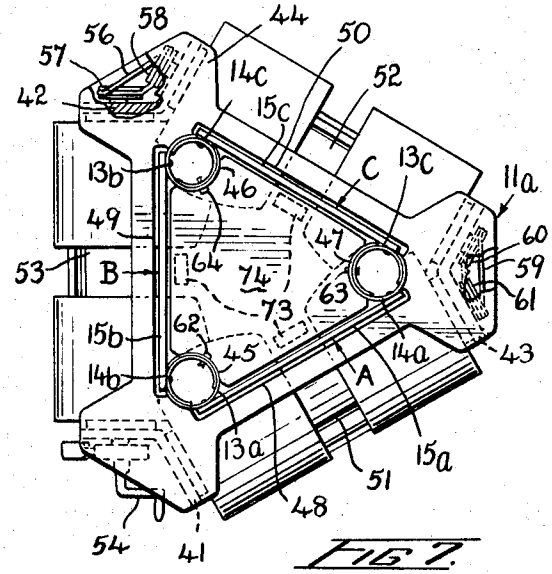


FIG 7.

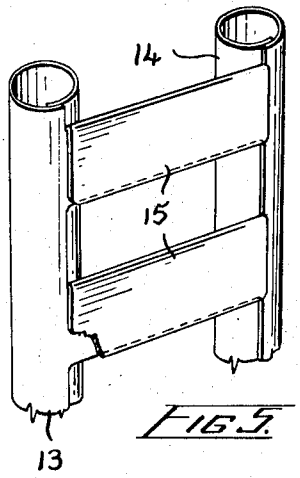


FIG 5.

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EXTENSIBLE-RETRACTILE STRUCTURE

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ABSTRACT OF THE DISCLOSURE

A ladder, tower or the like which has each of its upright members formed from a flat sheet of resilient material which is preformed to coil into a tube when unwound from a flat roll and when rewound, to automatically uncoil. Each rail of each pair of rails, such as a ladder is wound into a separate roll. Each pair of rails are secured together by uniformly spaced crossbars. When formed into tubes an overlapping edge portion of each tube wedges between the cross bar and the other edge of the same tube to prevent relative movement both longitudinally and circumferentially between overlapping portions of the tubular rail to prevent lateral distortion or deflection of the walls under load. The same members are used to make an upright structure of three or more upright members. In this case, the rails are unwound from their roll so that adjacent tubes will lock together, one inside the other, to form a unitary structure.

Extensible-retractile structures have already been proposed and one such structure is set forth in U.S. Patent 3,199,627 dated Aug. 10, 1965 to Aladin Saders Inc. That structure comprised a ladder which was formed of a plurality of inter-connected sections which could be rolled up into a relatively small package. Such a structure is complex and expensive to manufacture. The numerous joints limit its usefulness and will have a number of objections apparent to those familiar with this field.

A novel feature of the present invention and one of its advantages is that it can be wound up on a reel for storage and when it is unwound it will automatically form into a rugged and stable structure as hereinafter described.

Another advantage of the invention is that it provides an extensible-retractile structure, such as an extension ladder, of any practical length without any transverse joints which will adversely affect its rigidity transversely or longitudinally. The foregoing features distinguish the present invention from the conventional type of extension ladder presently in use and which extension ladder is made up of several sections, which telescopically fit together, each section being anywhere from 20 to 80 feet in length to obtain the required length; and also the roll-up type of ladder disclosed in U.S. Patent 3,199,627.

Another feature of the present invention is that a plurality of the extensible-retractile structures can be readily combined to form a tower as hereinafter described.

Other and further advantages of this invention will be explained in the following description of a preferred embodiment in which it is used for the manufacture of an extension ladder or the alternative structure in which three such ladders are combined into a unitary structure to form, for example, an extensible-retractile tower or mast.

In the drawings:

FIGURE 1 is a perspective view illustrating the present invention constructed as an extensible-retractile ladder;

FIGURE 2 is a fragmentary sectional view on the line 2—2 of FIGURE 1;

FIGURE 3 is a cross-sectional view taken on the line 3—3 of FIGURE 1;

FIGURE 4 is a cross-sectional view taken on the line 4—4 of FIGURE 1;

FIGURE 5 is a plan view illustrating the ladder in which the rails and rungs are made from one piece of sheet steel;

FIGURE 6 is an alternative structure in which three ladders similar to the one described in conjunction with FIGURES 1–5 are combined to form a three sided structure, e.g., a mast.

FIGURE 7 is a plan view looking down on the structure shown in FIGURE 6.

The roll-up ladder illustrated in the drawings comprises a base **10**, ladder support members **11**, a rotatable storage reel **12**, a pair of longitudinally extensible-retractile tubular rails **13**, **14** which are connected together by rungs **15** in spatial relationship and a releasable locking member, to be described for locking the rails when extended, as illustrated in FIGURE 1, against downward movement when a load such as the weight of a man, is applied to the rungs **15**. These components will now be particularly described as to their construction and relationship to one another.

The base **10** is fabricated from any suitable material such as angle iron, angle aluminum, etc. and comprises the horizontal framing members **17**, **18**, **19**, **20**; upright frame members **21**, **22**, **23**, **24** forming a skeletal framework, the top ends of the upright members **21**, **22**, **23**, **24**, being tied together by a plurality of plates **25**, **26**, **27** through which the side rails **13**, **14** are slidably projected as herein described, the plates providing a support for the lower end of the ladder rails and also to direct the rails in an upright direction as they are extended by unwinding from the storage reel **12** which is supported by said frame.

The storage reel **12** is rotatably supported on the cross-frame members **28**, **29** of the base as shown. The reel is provided with some means for rotating it in the proper direction to wind and unwind the ladder as hereinafter described. In the present illustration this means comprises a crank **30** which is manually operated to turn the reel. However, it is apparent that the crank **30** could be replaced by some power means such as an electric motor suitably geared to the storage reel to rotate it in any direction desired.

The ladder per se comprises the pair of spaced apart rails **13**, **14** connected together by a plurality of rungs **15**, the rungs being connected to the rails by rivets, welding or other suitable connecting means. Each of the rails **13**, **14** are made of a thin strip of resilient sheet material, such as sheet steel, each rail being pre-formed to coil into overlapping cylindrical tube about the longitudinal axis when unwound from the reel as illustrated. The bottom end of each of the rails **13**, **14** is fastened in a flattened condition to the reel as shown. For convenience in description the bottom ends of the respective rails are identified as the lead-in ends **31**, **32** of the rails **13**, **14** respectively. If desired the reel can be dispensed with and the rails rolled up by simply manipulating the ends **31**, **32** into a flat position and then rolling up the ladder which during the rolling will automatically force the tubular rails to a flat position. When the rails are flat they are flexible and can be rolled but when tubular as hereinbefore stated the rails are rigid.

Each of the plates **25**, **26**, **27** as will be seen in the drawings, are provided with aligned guideways **33**, **34** through which the rails **13**, **14** when tubular will pass, the guideways associated with each plate being interconnected by slots **36**, **37**, **38** respectively through which the rungs **15** can pass as the ladder is extended and retracted.

It is desirable to prevent the downward movement of the rails under load, and a convenient way of doing this is by a removable U-strap **39** which straddles the slot **37** with one of the rungs **15** engaged between the upper

and lower arms of the U-strap. The U-strap **39** is mounted so that it can be easily disengaged from the rung to permit the raising and the lowering of the ladder.

If preferred, the ladder may be fabricated from a single sheet of material of the required length and width. As illustrated in FIGURE 5, when the rails and rungs are fabricated from a single sheet of material, the first operation is to form the rungs by cutting the central portion of the sheet to leave the longitudinal edge portions which will eventually be formed into the tubular rails **13, 14** connected together by transverse strips spaced apart the required distance to form the rungs **15**. The cut central portion is folded over the transverse strips to form the rigid rungs **15**.

The operation of the extensible-retractile ladder is very simple and requires little explanation. The lead-in ends **31, 32** are attached in a flattened condition to the reel **12**. No guiding means is necessary for flattening or reforming the rails **13, 14** during the retraction or extension. The rungs do not interfere with the flattening of the rails nor do they interfere with the reforming of the rails into tubes. To extend the ladder to its extended position, the U-strap **39** is released from engagement with the rung **15** and the storage reel rotated in the required direction. As soon as the flattened portions are a short distance above the reel they will start to reform into the tubular form and by the time they reach the plate **26** they will have completely reformed into the tubular rails **13, 14.** In the transition phase the plate **27** gives support to the rails. When reformed, the plates **25, 26** give support to the completely extended ladder. In reforming, one longitudinal edge of each rail is allowed to jam between the other edge of the rail and the rung, thus preventing further coiling and at the same time supplying a degree of rigidity for the assembly.

In the structure illustrated in FIGURES 6 and 7, a plurality of extensible-retractile units each unit being constructed as illustrated in FIGURES 1 to 5 inclusive are employed, with one rail of one unit coiled around the contiguous rail of the adjacent unit to form a unitary structure which is rigid and may be extended from a retracted position and vice versa as often as required. For the purpose of illustrating this modification the same will be described employing three units releasably interconnected together to form a three sided tower. The structure illustrated comprises a first unit A, a second unit B and a third unit C, each unit being constructed in accordance with the preceding description relative to FIGURES 1 to 5.

The first unit A comprises a pair of longitudintally extensible rails **13*a*, 14*a*** connected together by a plurality of spaced rungs **15*a***; the second unit B comprises a plurality of longitudinally extensible rails **13*b*, 14*b*** connected together by a plurality of spaced apart rungs **15*b***; and the third unit C comprises a plurality of longitudinally extensible rails **13*c*, 14*c*** connected together by a plurality of of spaced apart rungs **15*c***.

A support base **11*a*** is provided for supporting the three units which base carries three drums or reels **51, 52, 53,** one for each of the units. The function of the support base **11*a*** and the drums **51, 52, 53** is similar to the base and drum previously described in connection with FIGURES 1 to 5 inclusive. The base **11*a*** for the three units is of triangular form in plan and comprises a bed plate **40,** angle supports **41, 42, 43;** a triangular shaped outer frame **44** supported by said supports **41, 42, 43** and an inner central plate **74** carried on three uprights **73** fixed at the bottom end to base **40,** the perimeter of the plate **62** being spaced inwardly from the inside edges of the outer frame to form three equally spaced arcuate guideways **45, 46, 47** disposed at 60° to each other, said guideways being connected together by longitudinal slots **48, 49, 50.** The said guideways and slots perform the same function as the slots **36, 37, 38** and permit the unit to be raised and lowered by the mechanism hereinafter described.

The mechanical mechanism for raising and lowering the unit comprises the three sets of drums **51, 52, 53** one for each unit with the lower ends of the rails which form each unit fastened to their respective drum in a manner similar to that previously described relative to FIGURES 1 to 4 inclusive. The drum **51** is rotatably supported by the uprights **41, 43;** drum **52** is supported by the uprights **42, 43;** and the drum **53** is supported by the uprights **41, 42.** The drum **53** is illustrated as being provided with a manually operated crank **54** whereby the drum **53** can be rotated in the desired direction for selectively extending or retracting the units, and a brake **55** for locking the drum **53** against rotation. A belt and pulley drive **56, 57, 58** provides a driving connection between the drum **53** and the drum **52;** and a belt and pulley drive **59, 60, 61** provides a drive connection between drum **51** and the drum **52.** The elements referred to in the preceding sentence provides a means for rotating the three drums in unison which in turn extends or retracts the three units in unison. It will be apparent that power means may be utilized to replace the crank **54.**

The units are extended by rotating the drums which unwind the flattened rails, and shortly after leaving the drums, the flattened portions reform into rails and contiguous rails entwine with each other, for example, the rail **13*b*** in reforming into a tubular rail entwines with the reforming rail **14*c*** and so on. On retracting the rails onto their respective drums, the entwined rails disengage as they flatten out.

It will be seen in FIGURE 7 that at each corner of the structure an outside rail is coiled around an inside rail and the two longitudinal edges of the outside rail jam between the rung and the inside rail to which this rung is attached. This jamming provides a degree of rigidity for the assembly. To further ensure that there will be no longitudinal relative movement between the inner and outer rails which are coiled inside one another the top ends of the interengaged rails may be fastened together by rivets **62, 63, 64.** These rivets also ensure that all the rails will be moved in unison when the drums are rotated to extend or retract the units.

In the present embodiment the upper ends of the rails are permanently entwined to have the ladder readily available for use. However, some applications may require that the rails be completely separated when wound up in which case, at the start of the unwinding to extend the rails, the initial entwinement of the respective rails can be effected by manual manipulation or by some suitable guide means.

What I claim as new and desire to protect by Letters Patent of the United States is:

1. An extensible-retractile structure comprising in combination:

(a) a pair of longitudinally extensible-retractile rails of tubular shape when extended and of flat form when rolled up into a roll, each rail comprising a thin strip of resilient material of substantial length preformed to coil about its longitudinal axis to form the tubular shape when extended from the roll; and

(b) transverse rungs, in spatial relationship, connected to said rails to form a unitary structure without interfering with the rolling up of the rails into the roll.

(c) and stop means preventing relative movement both longitudinally and circumferentially between overlapping portions of each tubular rail to thereby prevent lateral distortion or deflection of the walls of the tube under load.

2. An extensible-retractile structure according to claim **1** in which said stop means comprise wedging members formed by the opposing faces of the rungs and the tubular rails to which the rungs are attached into which the longitudinal edges of the encircling tubular rails jam.

3. An extensible-retractile structure comprising in combination:

(a) a base member;

(b) structure support members carried by the base;
(c) a rotatable storage reel supported by said base member;
(d) a pair of longitudinally extensible-retractile rails of tubular shape when extended and of flat form when retracted, each rail comprising a thin strip of resilient material of substantial length preformed to coil about its longitudinal axis to form the tubular shape; the lower end of each rail being secured in a flat condition to the reel thereby permitting the rails to be unwound thereon when retracted:
(e) transverse rungs, in spatial relationship, connected to said rails to form a unitary structure without interfering with the winding of the rails on the reel;
(f) said rails, after assuming tubular form, being slidably supported in an upright load carrying position by the said support members; and
(g) and stop means preventing relative movement both longitudinally and circumferentially between overlapping portions of each tubular rail to thereby prevent lateral distortion or deflection of the walls of the tube under load;
(h) means for rotating said storage reel whereby on turning the reel in one direction the flat thin rails are extended in tubular shape and on turning the reel in the opposite direction the rails, as they approach the reel, assume a flat condition on said reel.

4. An extensible-retractile structure according to claim 3 having load carrying releasable means locking said rails against downward movement under the force of an applied load when in an extended position.

5. An extensible-retractile structure according to claim 3 in which the ladder support members comprise a plurality of transverse frame members in parallel spaced relationship, said members having vertically aligned passages in which the tubular rails are slidably engaged and supported.

6. An extensible-retractile structure according to claim 3 in which said stop means comprises wedging members formed by the opposing faces of the rungs and the tubular rail to which the rungs are attached, into which members a longitudinal edge of the encircling portion of the tubular rail jams.

7. An extensible-retractile structure comprising in combination:
(a) at least three pairs of longitudinally extensible-retractile rails of tubular shape when extended and of flat form when rolled up into rolls, each pair being wound on and extended from a separate roll, each rail of each pair of rails comprising a thin strip of resilient material of substantial length preformed to coil about its longitudinal axis to form the tubular shape when extended from the rolls;
(b) transverse rungs in spatial relationship connected to each pair of said rails;
(c) one rail of each pair being coiled around the contiguous coiled rail of the adjacent rail of another pair when said rails are extended thereby forming a closed geometric figure and separated therefrom when wound into rolls;
(d) and stop means preventing relative movement both longitudinally and circumferentially between overlapping portions of each tubular rail to thereby prevent lateral distortion or deflection of the walls of the tube under load.

8. An extensible-retractile structure according to claim 7 in which said stop means comprises wedging members

formed by the opposing faces of the rungs and the tubular rail to which the rungs are attached, into which members a longitudinal edge of the encircling portion of the tubular rails jams.

9. An extensible-retractile structure comprising in combination:
(a) a base member;
(b) structure support members carried by the base;
(c) a plurality of operatively connected rotatable storage reels supported by said base member;
(d) a plurality of longitudinally extensible-retractile rails of tubular shape when extended and of flat form when retracted, said rails being arranged in pairs and corresponding in number to the number of reels, each rail of each pair of rails comprising a thin strip of resilient material of substantial length preformed to coil about its longitudinal axis to form the tubular shape, the lower ends of each pair of rails being secured in a flat condition to a reel thereby permitting the rails to be wound thereon when retracted;
(e) transverse rungs in spatial relationship connected to each pair of said rails;
(f) one rail of each pair being coiled around the contiguous tubular rail of the adjacent rail of another pair when said rails are extended thereby forming a closed geometric figure and separated therefrom when wound on said reel;
(g) said tubular rails being slidably guided and supported in an upright load carrying position by the said support members;
(h) each pair of rails and rungs associated therewith forming an extensible-retractile rigid column in its extended position;
(i) drive means operatively interconnecting said reels whereby, on turning the reel in one direction all of the rails and associated rungs are moved in unison to an extended position as a unit and on turning the reels in the opposite direction the rails are uncoiled as a unit and assume a flat condition on said reels.

10. An extensible-retractile structure according to claim 9 in which the ladder support members comprise a plurality of transverse frame members in parallel spaced relationship, said members having vertically aligned passages in which the tubular rails are slidably engaged and supported.

11. An extensible-retractile structure according to claim 9 having stops limiting the coiling of the rails about the longitudinal axis.

12. An extensible-retractile structure according to claim 11 in which said stops comprise wedging members formed by the opposing faces of the rungs and the tubular rails to which the rungs are attached, into which the longitudinal edges of the encircling tubular rails jam.

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