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Englund et al.

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[45] **Nov. 11, 1975**

[54] **VENETIAN BLIND WITH WORM GEAR TILTING ASSEMBLY**

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[73] Assignee: **Alcan Aluminum Corporation,** Cleveland, Ohio

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[52] **U.S. Cl.** **160/176**

[51] **Int. Cl.**[2] **E06B 9/00**

[58] **Field of Search** 160/166–178; 74/439

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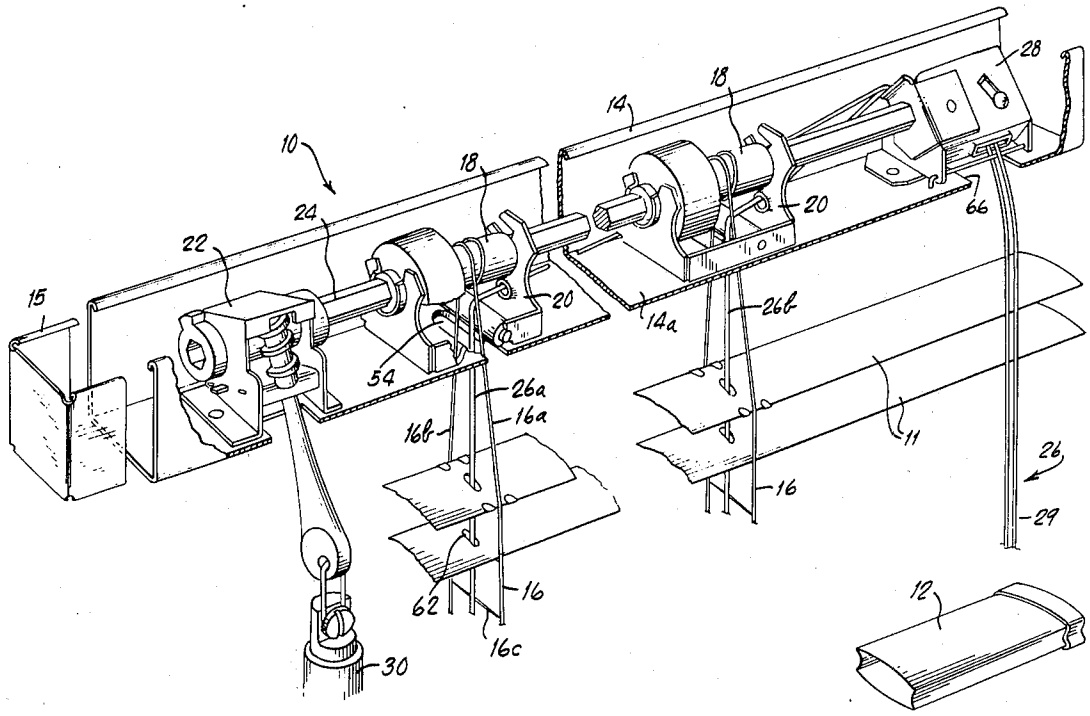
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Primary Examiner—Paul R. Gilliam
Assistant Examiner—V. Sakran
Attorney, Agent, or Firm—Cooper, Dunham, Clark, Griffin & Moran

[57] **ABSTRACT**

A venetian blind having a head rail of small transverse dimensions, containing a tilt rod rotatably supported therein for tilting the slats of the blind through tapes operatively connected to the tilt rod, and a worm gear mechanism for turning the tilt rod. The gear of this mechanism is in elongated cylindrical form, having a tooth-bearing portion and a shank portion with an axial socket for receiving and engaging one end of the tilt rod. The socket terminates short of the toothed portion, so that a desired tooth depth and tilt rod thickness can both be accommodated without unduly reducing the thickness of the socket-defining wall in a gear of small overall diameter. The gear is restrained by a housing against axial displacement, and the inner end of the socket acts as a stop at one end of the tilt rod, while a fixed stop plate mounted on a lift cord lock mechanism adjacent the other end of the tilt rod in the head rail cooperates with the socket end to prevent axial displacement of the tilt rod.

8 Claims, 20 Drawing Figures



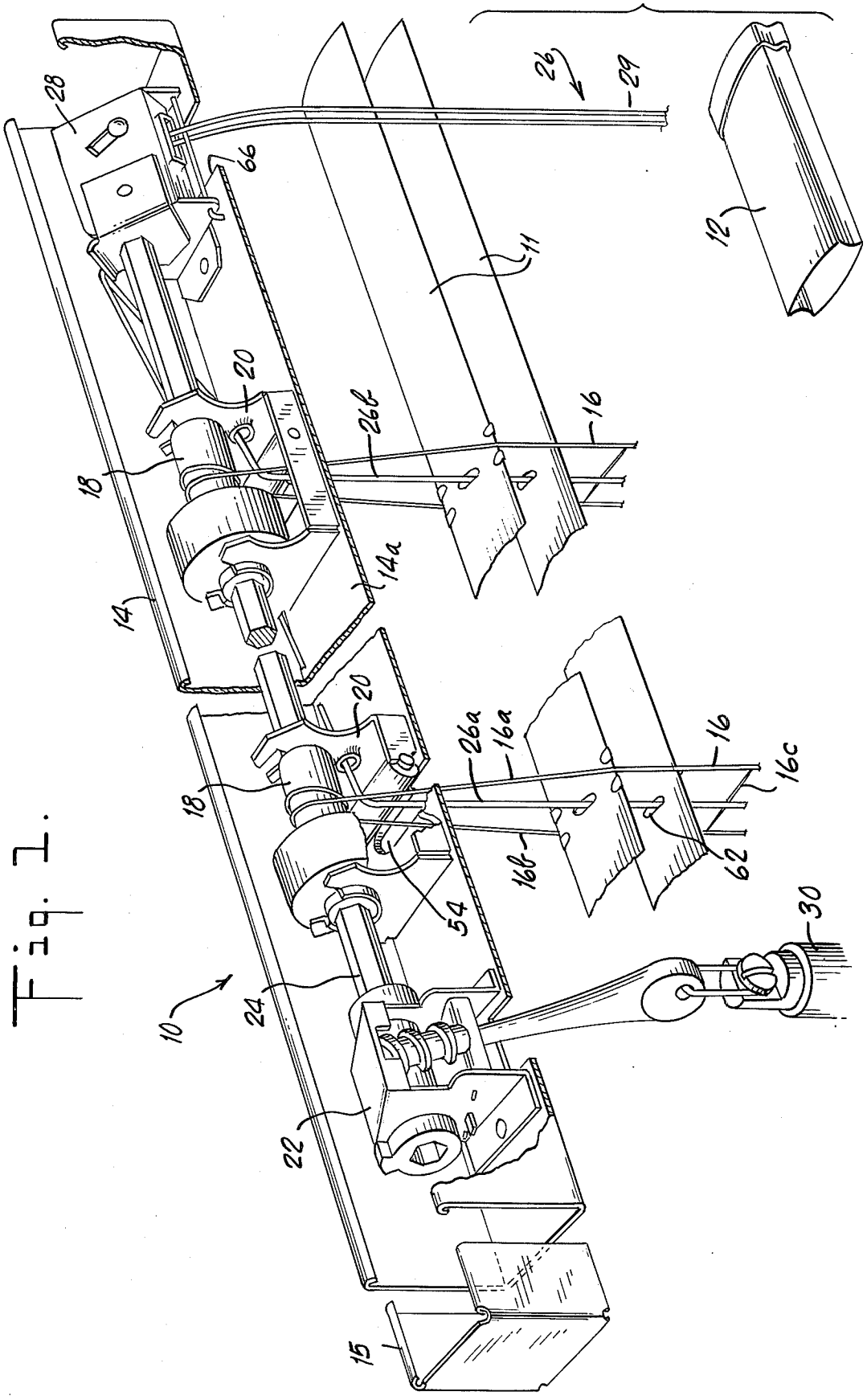

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Fig. 1.

Fig. 2.

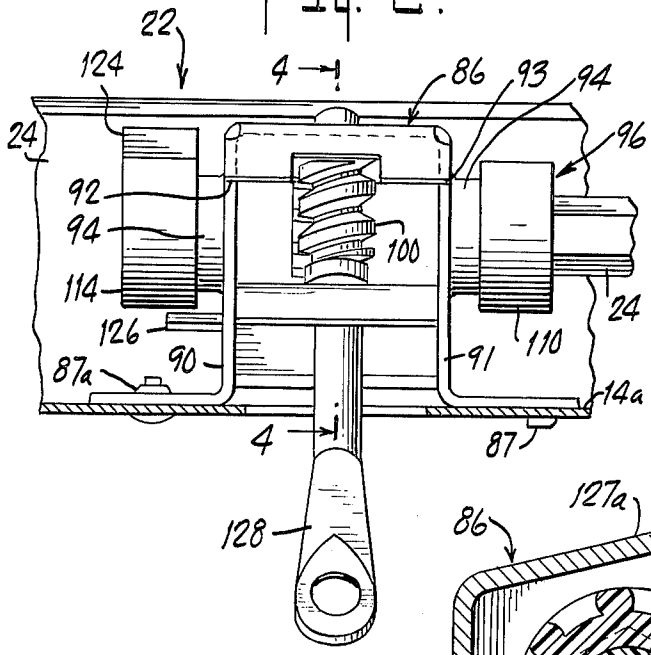


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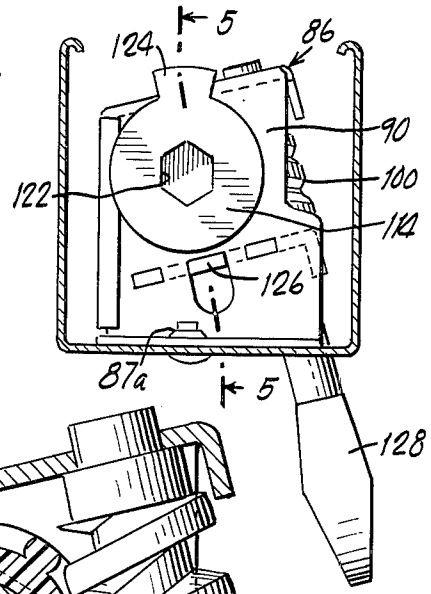


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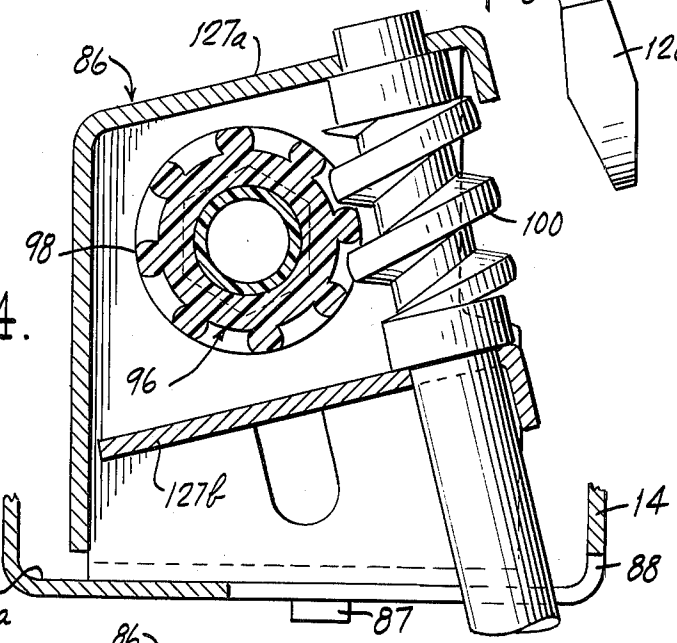


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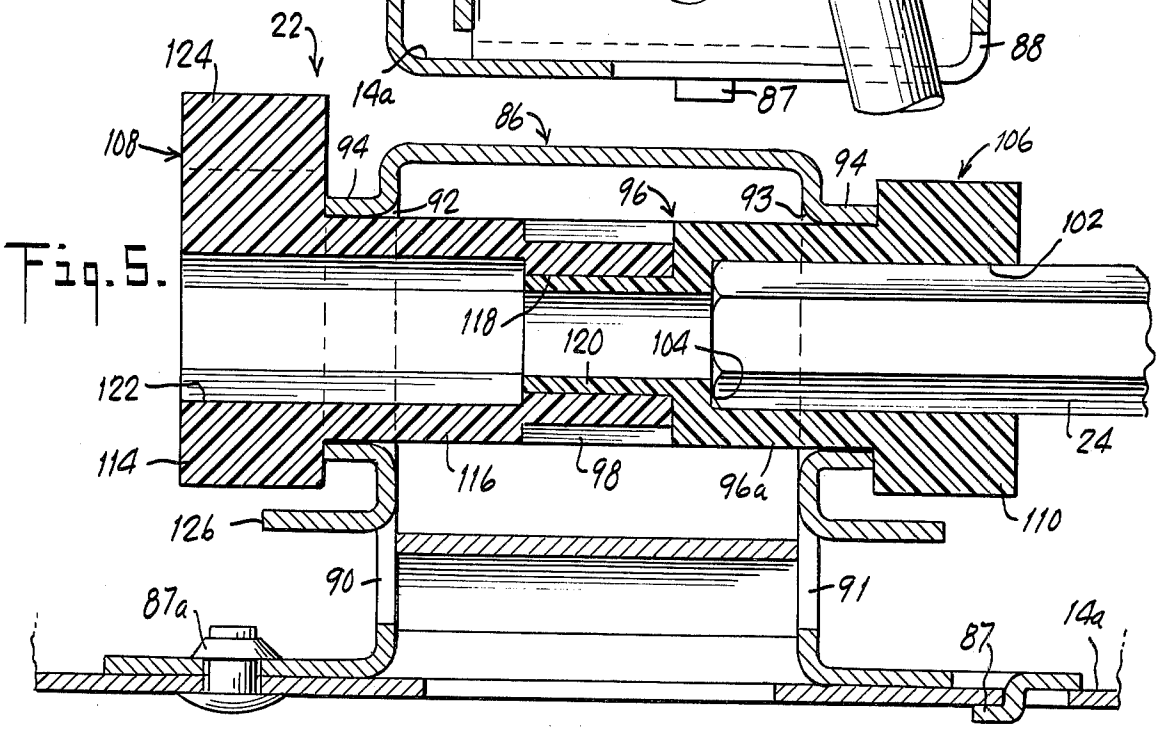


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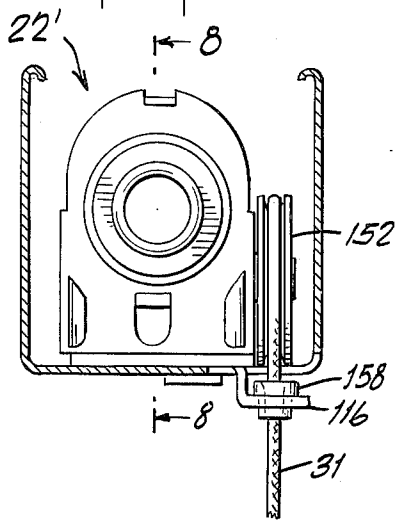


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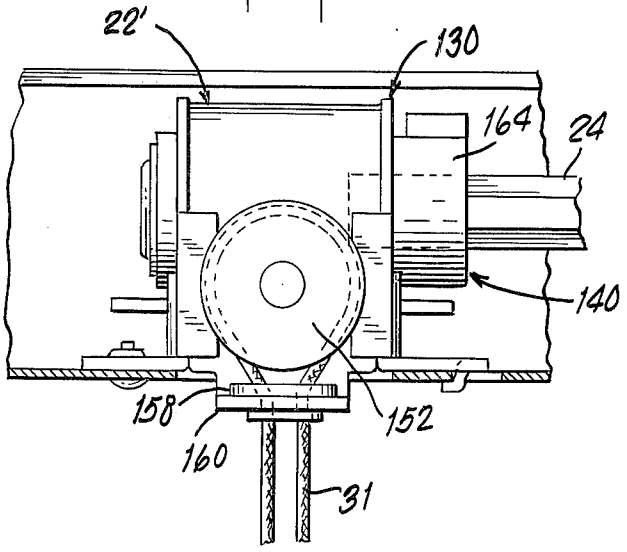


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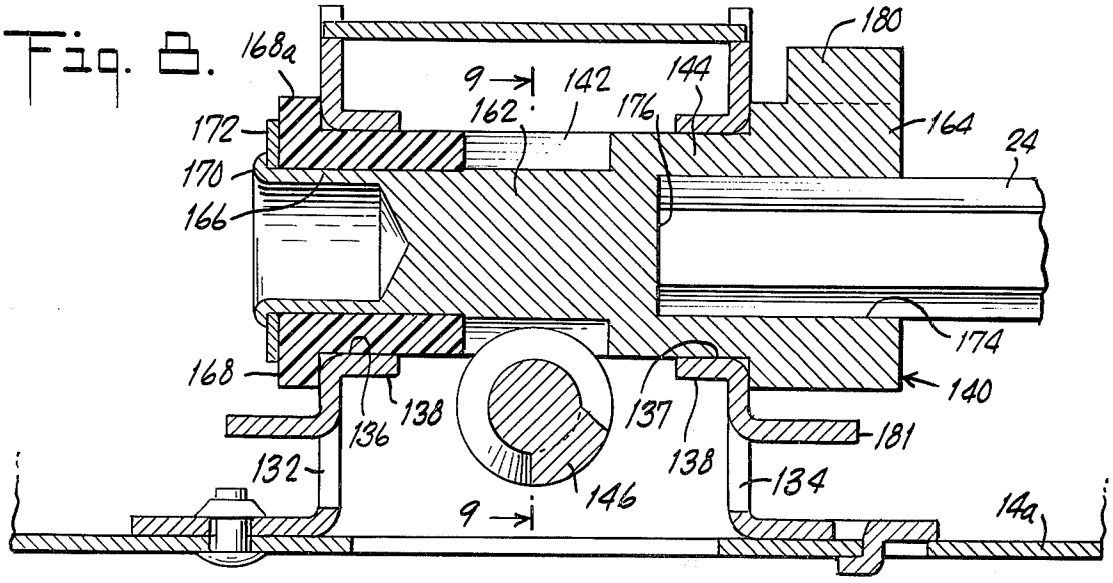


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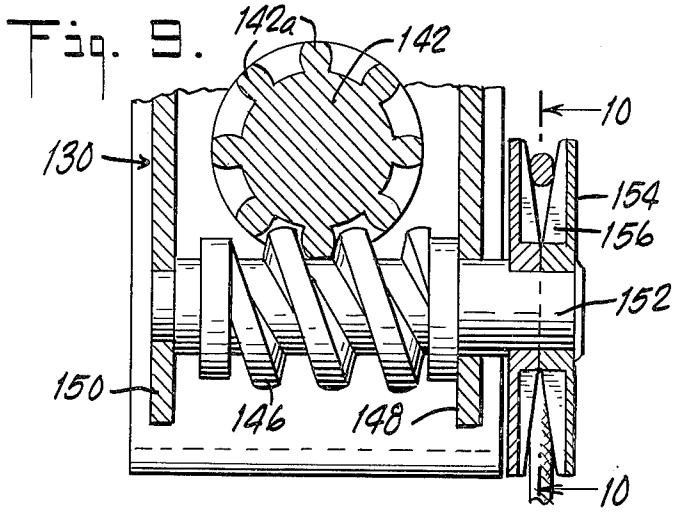


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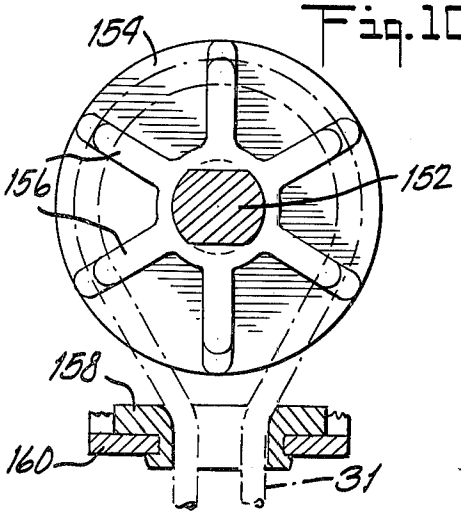


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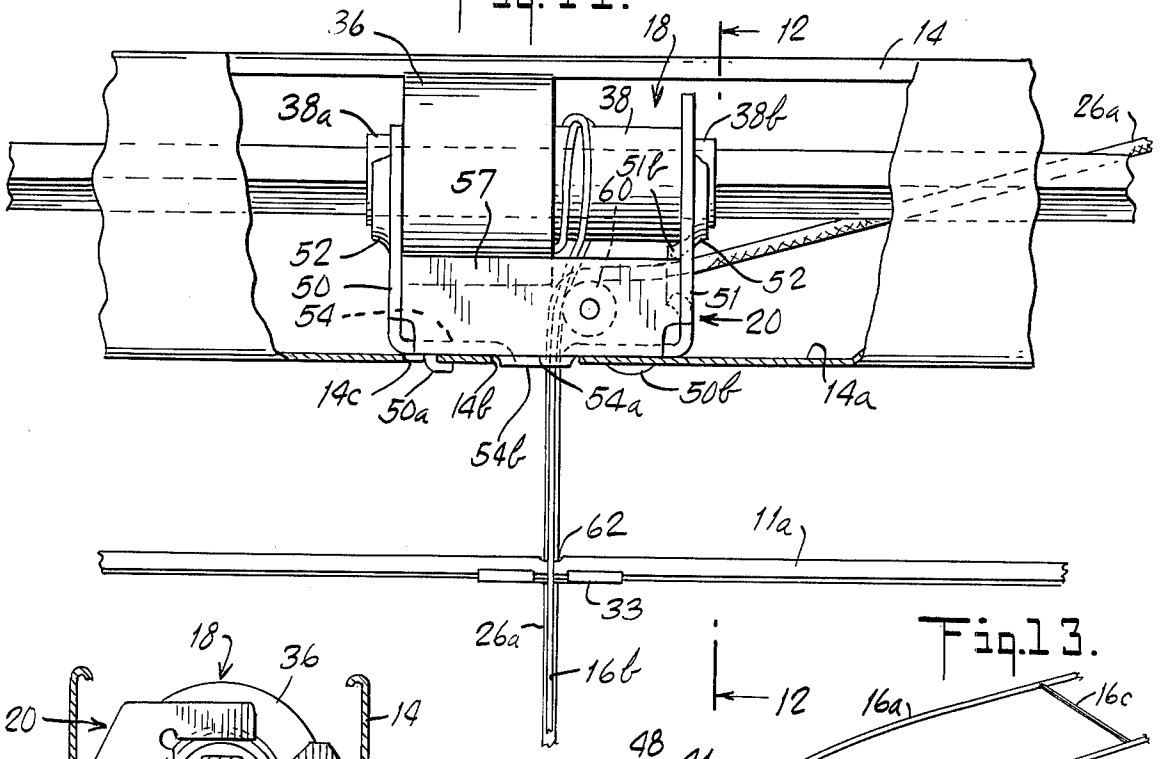
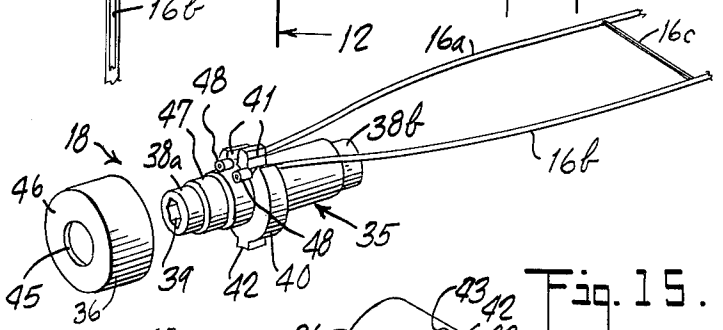


Fig. 13.



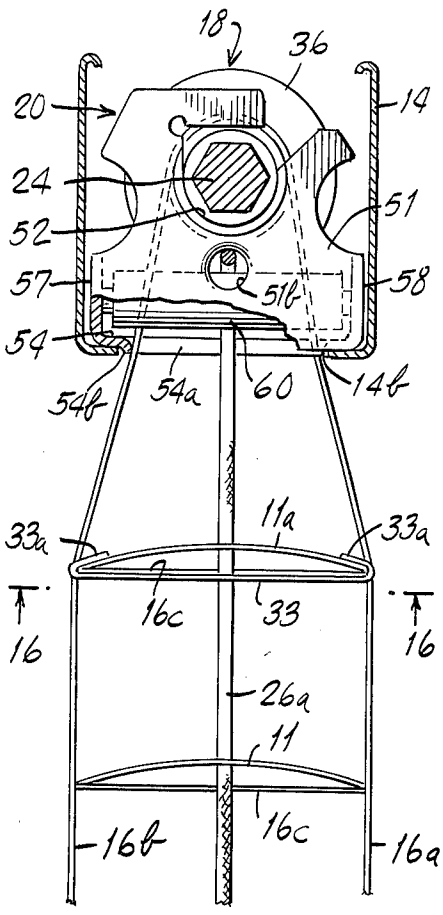


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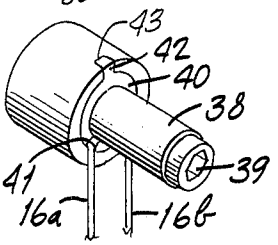


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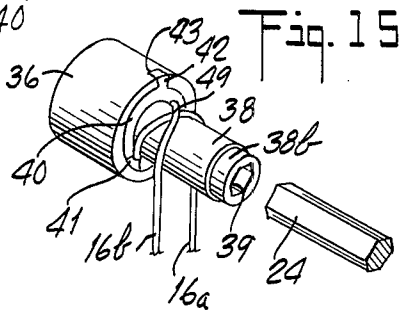


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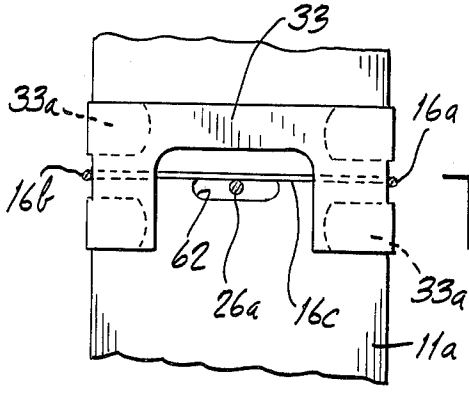


Fig. 16.

Fig. 17.

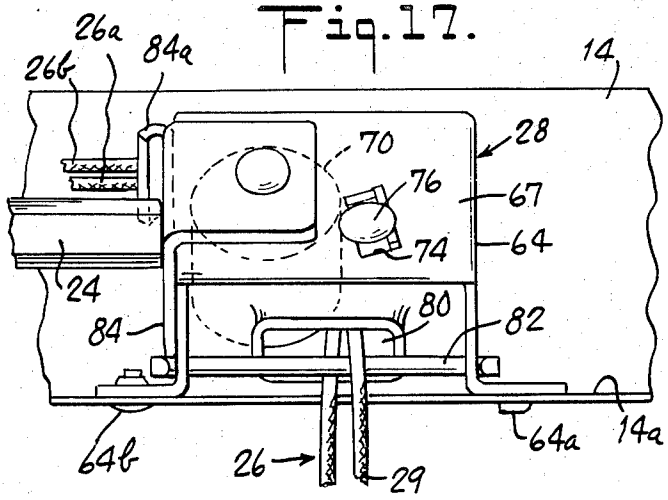
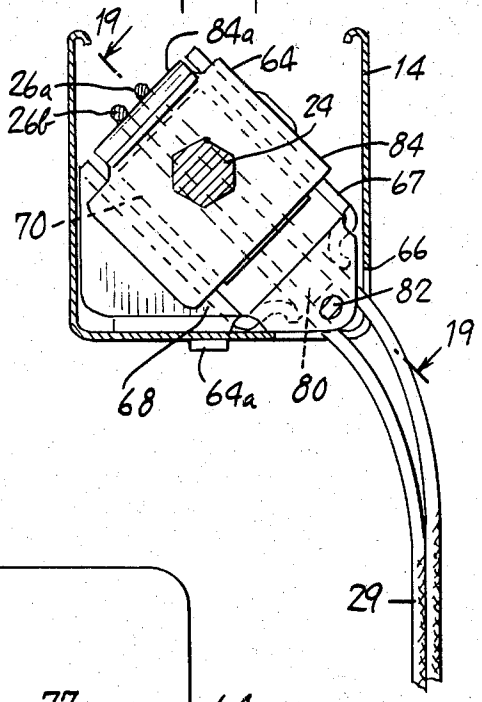


Fig. 18.



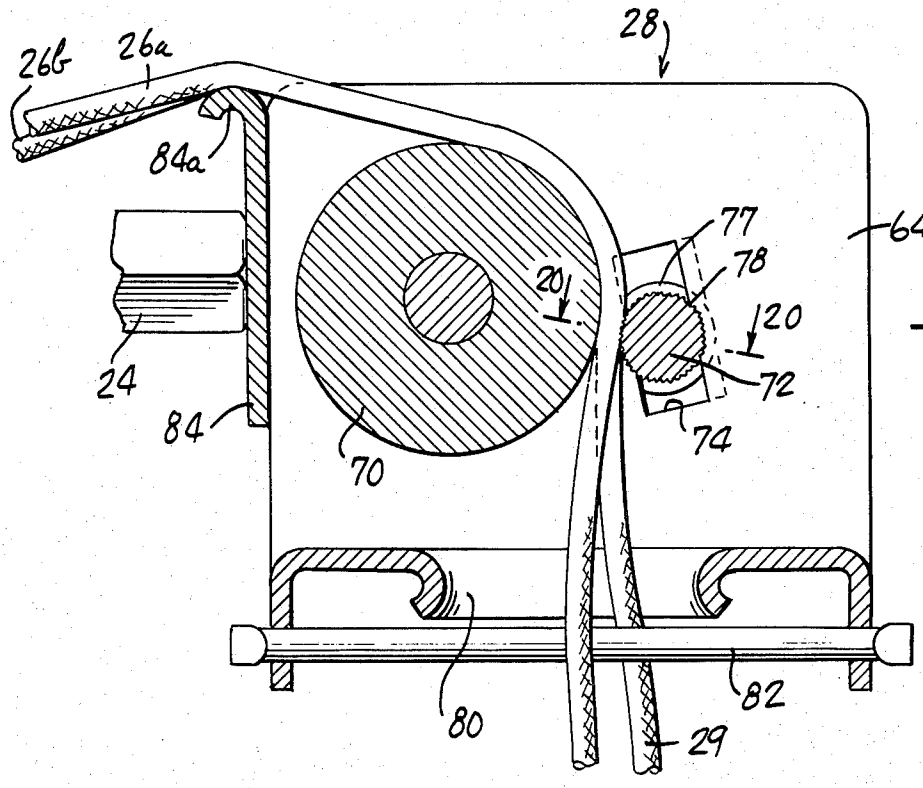


Fig. 19.

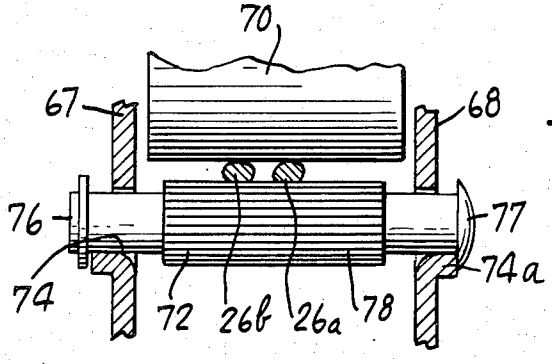


Fig. 20.

VENETIAN BLIND WITH WORM GEAR TILTING ASSEMBLY

BACKGROUND OF THE INVENTION

This invention relates to venetian blinds, and in a specific sense to venetian blinds incorporating, within a head rail, a new and improved assembly for tilting the slats of the blind, capable of embodiment in a durable, reliably operable and easily assembled structure of unusually small dimensions.

In a conventional venetian blind, a bottom rail and an array of slats are suspended beneath a head rail which is fixedly mounted to a wall or the like adjacent the top of a window. The slats and bottom rail may be suspended by plural tapes from a tilt rod mounted within the head rail for rotation to move the tapes in a manner that effects tilting of the rail. For example, the tilt rod may be driven by a worm-gear assembly within the head rail, the worm of such assembly being turned manually by a depending cord or other means; such assemblies are advantageous in preventing backlash, because the worm can drive the gear of the assembly to tilt the slats as desired, but the gear cannot drive the worm, which thus effectively locks the slats in a desired tilted position. Lifting of the blind is accomplished by means of a lift cord having ends anchored to the bottom rail, and extending upwardly therefrom through the slats and the head rail and through a suitable cord-locking mechanism mounted within the head rail, the free control loop of the lift cord depending from the locking mechanism so as to be manually accessible.

Venetian blinds having very narrow (e.g. one inch wide) slats and narrow, stringlike tapes have won wide acceptance in recent years for aesthetic reasons, as providing a less obtrusive, more attractive appearance (and requiring less space) than older forms of venetian blinds with wide slats and tapes. However, comparable reduction in width of the head rail has not been satisfactorily achieved, owing to difficulties in reducing the size of the operating mechanism therein contained. It is desirable to provide a head rail as narrow, for instance, as the one-inch slats, not only because of aesthetic considerations but also to enable mounting of the head rail in a narrowly constricted space such as a narrow, downwardly opening wall pocket adjacent the top of a window; but heretofore head rails have had to be made substantially wider than this desired dimension.

By way of illustration of the difficulties involved in attempting to achieve a venetian blind operating mechanism of reduced size, the tilting assembly of a conventional blind commonly includes a tilt rod e.g. of square cross-section extending through and beyond a central aperture of corresponding (e.g. square) shape formed in the gear of the worm-gear tilting mechanism, so that the tilt rod turns with the gear. The overall diameter of the gear, and the size of the necessary support structures therefor, limit the attainable reduction in head rail dimensions; yet mere miniaturization (i.e. proportionate reduction of all dimensions) would result in undesired weakening of the parts and/or prevention of satisfactory operation. In particular, for a given worm-gear ratio, effective meshing action requires a certain minimum tooth depth despite small gear diameter. Reduction in tilt rod thickness is limited by considerations of strength and rigidity. Given these constraints, decrease in overall gear diameter would necessarily involve a decrease in radial thickness of the centrally apertured gear body, especially at the localities of the valleys between the teeth, tending undesirably to weaken the gear. Another problem presented by a conventional tilting assembly is that the tilt rod may slide axially with respect to the gear, and may indeed become dislodged from its operative engagement therewith, e.g. during transport or handling of the blinds prior to installation.

SUMMARY OF THE INVENTION

An object of the invention is to provide a venetian blind structure having its operating mechanism contained within a head rail of significantly reduced transverse dimensions, as compared with conventional head rails.

Another object is to provide a venetian blind tilting assembly, mounted in a head rail, which is advantageously small in size (so as to permit attainment of small head rail dimensions) yet durable and effective in operation and easy to assemble.

A further object is to provide such assembly including a tilt rod which is positively restrained against accidental dislodgement by displacement in an axial direction.

To these and other ends, the present invention broadly contemplates provision of improvements in a venetian blind assembly of the general type having slats tiltably supported by tapes; a head rail; a tilt rod within the head rail and operatively connected to the tapes; means mounted in the head rail for supporting the tilt rod for rotation to move the tapes to tilt the slats; and a worm-gear tilting mechanism, mounted in the head rail, including a gear connected to the tilt rod, a worm meshing with the gear, a housing for supporting the worm and gear, and manually movable means connected to the worm for turning the worm to drive the gear and tilt rod. Specifically, significant features of the invention reside in the structure and arrangement of elements of the tilting mechanism in this combination.

Thus, in accordance with the invention, the gear is of elongated, generally cylindrical configuration, disposed in coaxial relation to the tilt rod at one end thereof, and includes a first shank portion journalled in the housing and a second portion, disposed in side-by-side relation to the shank portion along a common axis and bearing on its outer periphery a plurality of gear teeth with which the worm meshes. The first or shank portion has a socket formed coaxially therein and opening at one end thereof for receiving the end of the tilt rod and engaging the same so that the tilt rod rotates with the gear. This socket terminates inwardly in a seat within the shank portion; i.e. it is entirely contained within the shank portion and does not extend at all into the toothed portion of the gear. In other words, the shank portion constitutes an axial extension of the gear, within which extension the socket for the tilt rod is wholly confined. As a result, desired reduction in overall diameter of the gear (and consequent small size of the tilting mechanism and of the head rail that contains it) may be achieved in a sturcture that provides requisite tooth depth and accommodates a tilt rod of adequate thickness, yet without undue reduction in the radial dimension of the gear portion surrounding the tilt rod, such as would tend to weaken the gear.

Also in accordance with the invention, the gear may include a further shank portion coaxial with the toothed portion and disposed on the side thereof opposite to the first shank portion. Each shank portion may

have an enlarged extremity; the housing may include opposed fixed end walls with openings through which the two shank portions extend, inwardly of their enlarged extremities, so that these extremities in cooperation with the housing walls (which are fixed in relation to the head rail) prevent axial displacement of the gear in either direction. Advantageously, for ease of assembly, the toothed portion and both shank portions may all have the same overall diameter, and the gear may comprise two interfitting bodies (one including one shank portion, and the other including the toothed portion and the other shank portion) which are respectively inserted through the openings in the two housing end walls, i.e. into interfitting relation with each other.

The seat of the socket, in the gear just described, serves as a stop at one end of the tilt rod, preventing axial displacement of the tilt rod toward the gear. As an additional specific feature of the invention, a lift cord lock mechanism (for controlling operation of a lift cord connected to a bottom rail of the blind, to lift the blind) may be fixedly mounted in the head rail, just beyond the other end of the tilt rod and may include a stop plate, positioned in facing relation to the tilt rod end, for preventing axial displacement away from the gear. The latter plate thus cooperates with the described socketed gear to prevent dislodgement of the tilt rod by axial motion thereof in either direction, as well as protecting the lift cord lock mechanism from damage or interference by the tilt rod which might otherwise slide into that mechanism because of the absence of clearance space in a head rail of small width.

The tapes, each of which has two parallel vertical stringlike elements, may each be secured (at the upper ends of such elements) to a roll supported in a bearing or cradle mounted within the head rail, for rotation about the tilt rod axis. The tilt rod, which is preferably hexagonal in cross-section, extends through bores in these rolls (which engage the rod for rotation therewith); i.e. the tilt rod is effectively journalled in and supported by the tape roll cradles, and the weight of the slats, transmitted by the tapes, is supported by the cradles rather than by the tilt rod, thereby avoiding excessive load on the tilt rod such as might interfere with ease of tilting operation especially with a tilting mechanism of small size.

Additional specific features of the invention reside in the structure of the tape rolls. Each is formed in two parts: a molded plastic body, having a shank with an axial bore for the tilt rod and a central flange with two peripheral notches to receive the ends of the two tape elements; and a molded plastic cap, press-fittable over the flange from one side thereof to enclose and retain the tape ends, and having an opening in its end through which the shank protrudes. The tape element ends bear ferrules for retention in the notches. A key projection, formed on the flange in opposed relation to the tape-end-receiving notches and received in a notch of the cap skirt, provides a visual indication of the angular orientation of the roll and tape ends. These features provide special advantages with respect to ease of assembly.

Thus, with the present invention, there is achieved a venetian blind operating mechanism that can readily be dimensioned to fit inside a head rail e.g. of 1 inch square cross-section, without sacrifice of durability and effectiveness of operation.

Further features and advantages of the invention will be apparent from the detailed description hereinbelow set forth, together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a fragmentary perspective view, partly broken away, of a venetian blind embodying the present invention in a particular form;

FIG. **2** is an enlarged side elevational view of the tilting mechanism of the device of FIG. **1**;

FIG. **3** is an end elevational view of the FIG. **2** mechanism;

FIG. **4** is an enlarged sectional view taken along line **4—4** of FIG. **2**;

FIG. **5** is a similarly enlarged sectional view taken along line **5—5** of FIG. **3**;

FIG. **6** is a view, similar to FIG. **3**, of a modified form of the tilting mechanism of the invention;

FIG. **7** is a view, similar to FIG. **2**, of the FIG. **6** mechanism;

FIG. **8** is an enlarged sectional view taken along line **8—8** of FIG. **6**;

FIG. **9** is a sectional view taken along line **9—9** of FIG. **8**;

FIG. **10** is a sectional view taken along line **10—10** of FIG. **9**;

FIG. **11** is a side elevational view of a tape roll and cradle, and associated elements, in the blind of FIG. **1**;

FIG. **12** is a view taken along line **12—12** of FIG. **11**;

FIG. **13, 14** and **15** are perspective views illustrating successive steps in attaching a tape to a tape roll of the blind of FIG. **1**;

FIG. **16** is a fragmentary view taken along the line **16—16** of FIG. **12**;

FIG. **17** is a side elevational view of the cord lock mechanism in the blind of FIG. **1**;

FIG. **18** is an end elevational view of the cord lock mechanism;

FIG. **19** is an enlarged sectional view taken along line **19—19** of FIG. **18**; and

FIG. **20** is a detail view taken along line **20–20** of FIG. **19**.

DETAILED DESCRIPTION

The invention will be described as embodied in a venetian blind wherein the head rail, as well as the array of slats, is not more than about **1** inch wide, since the provision of a durable and effective operating mechanism within a head rail of such relatively small dimension constitutes an especially important advantage thereof.

Referring to FIG. **1**, the invention in its illustrated embodiment comprises a venetian blind structure **10** including the customary array of horizontal slats **11** and bottom rail **12** suspended below a head rail **14** which contains the operating mechanism of the blind structure and which is adapted to be mounted as by means of suitable brackets (now shown), e.g. adjacent the top of a window. As shown, the head rail **14** is an upwardly opening metal channel member of square cross section (e.g. 1 inch square), having a metal end lock **15** press-fitted into each end. The slats and bottom rail are suspended at spaced locations along their length by a pair of tapes **16** which are respectively secured at their upper ends to a pair of tape rolls **18** respectively supported within the head rail by cradles **20** for rotation about a common axis parallel to the long dimension of

the head rail. Also mounted within the head rail, adjacent one end thereof, is a tilting mechanism **22** from which a tilt rod **24** extends (within, and longitudinally of, the head rail) through the tape rolls, along their common axis, to effect rotation of the tape rolls for tilting the slats upon operation of the tilting mechanism. A lift cord **26**, having opposite ends **26***a* and **26***b* secured to the bottom rail **12** at spaced locations, and extending upwardly through the slats and through the head rail, is passed through a lift cord lock mechanism **28** mounted within the head rail adjacent the end thereof remote from the tilting mechanism. The central portion **29** of the lift cord depends from cord lock **28** for manual operation to raise or lower the blind, while the tilting mechanism **22** has a depending wand **30** or cord **31** (FIG. **6**) for manual operation to tilt the slats, all as hereinafter further described.

Each of the tapes **16** is a so-called string or cable tape, comprising two parallel vertical stringlike (e.g. braided) flexible tape elements **16***a* and **16***b* interconnected, at regularly vertically spaced locations, by a plurality of flexible horizontal ladders **16***c* (FIG. **12**) for individually supporting the slats **11**. At its lower end, each tape is secured in a suitable and e.g. generally conventional manner (not shown) to the bottom rail **12**; the slats are inserted between the elements **16***a* and **16***b* of each tape in such arrangement that each slat rests on and is supported by corresponding ladders **16***c* of the two tapes, at spaced locations intermediate the slat ends, in a horizontal position. Above the uppermost slat **11***a*, the two elements **16***a* and **16***b* of each tape extend for a predetermined equal distance without interconnecting ladders, and are secured to a tape roll as hereinafter explained. When the tape rolls are rotated, one of the elements **16***a* or **16***b* of each tape is raised while the other such element is lowered; this causes simultaneous tilting of all the ladders **16***c*, and consequent tilting of the slats supported thereon, in a common direction about axes parallel to the long dimension of the slats. To ensure proper tilting of the uppermost slat **11***a*, the ends of the tape ladders **16***c* supporting that slat may be anchored to the slat by means of metal clips or tape spacers **33** (FIGS. **12** and **16**) which extend beneath slat **11***a* and the associated ladders **16***c* and have tabs **33***a* gripping the slat edges on either side of the ladder.

Each tape roll **18** comprises an integral molded rigid plastic body **35** and a molded rigid plastic cap **36** (FIGS. **11–15**). For use with a tilt rod **24** of hexagonal cross-section, the body **35** has an axially elongated cylindrical shank **38** having an axial bore **39** of hexagonal cross-section dimensioned to receive rod **24** sufficiently snugly so that the body **35** rotates with the rod **24**. A generally annular flange **40**, formed integrally with the shank **38**, projects outwardly therefrom at a central locality on the shank; this flange **40** has two peripheral notches **41** and also bears a peripheral key projection **42** positioned in opposed relation to the notches. Cap **36** is dimensioned to fit snugly over flange **40**, with key projection **42** received in a key notch **43** formed in the edge of the cap skirt, and with one end **38***a* of shank **38** protruding through a circular opening **45** in the end **46** of the cap. To arrest the cap against displacement toward flange **40**, shank **38** may have a shoulder **47** formed intermediate end **38***a* and flange **40** for engaging the inner surface of the cap end.

The attachment of a tape **16** to a tape roll **18** is illustrated stepwise in FIGS. **13–15**. Initially, small metal ferrules **48** are clamped onto the free upper ends of the two vertical tape elements **16***a* and **16***b*, and these ends are inserted in the notches **41** of the flange **40**, with the ferrules **48** disposed on the side thereof toward shank end **38***a* (FIG. **13**) so as to retain the tape ends in the notches and to be enclosed by the cap **36**, which may then be placed on the body. With the shank **38** disposed horizontally and the notches positioned below it (FIG. **14**), the elements **16***a* and **16***b* are lifted above the shank, twisted over as indicated at **49** (FIG. **15**), and allowed to drop below the shank. The described structure of the parts, and the use of the ferrules **48**, permits rapid and secure attachment of the tapes to the tape rolls (i.e. in such manner that rotation of the rolls tilts the tape ladders and slats) by the foregoing succession of steps.

The two tape rolls **18**, having the two tapes **16** respectively attached thereto, are mounted on rod **24** (by insertion of the rod through their axial bores **39**) in spaced relation to each other intermediate the ends of the rod and with their respective key projections **42** oriented in the same direction, i.e. in the same angular relation to a given flat side face of the rod **24**. Typically, the two key projections **42** of the two tape rolls are both oriented upwardly. The key projections provide a convenient visual means for thus assembling the tape rolls on the rod in identical angular orientation, with specific reference to the position of the notches **41**, so that rotation of rod **24** about its axis will effect an identical tilting movement of both tapes.

Each of the tape roll cradles **20** is a unitary rigid metal member having opposed upstanding end walls **50** and **51** formed with outwardly flaring semicircular notches **52** for receiving and supporting the opposed ends **38***a* and **38***b* of the shank of a tape roll in such manner as to permit rotation of the tape roll about its axis. Each tape roll cradle further includes a base portion **54** which rests on the floor or web **14***a* of the head rail **14** and has a transverse slot **54***a* positioned for register with a corresponding slot **14***b* formed in the head rail web. As shown in FIGS. **1**, **11** and **12**, slot **54***a* is formed with a depending lip **54***b* that fits within the periphery of the head rail slot **14***b* when the cradle is mounted on the head rail. Each cradle is fixedly secured to the head rail by a bent tab **50***a* (FIG. **11**) which projects downwardly from the cradle adjacent end wall **50** for insertion through a small slot **14***c* in the head rail web, and by blind rivet **50***b* inserted through the web and the base **54** between slot **14***b* and end wall **51** of the cradle. The positions of the two cradles **20** and the associated slots **14***b* in the head rail web are spaced along the central portion of the head rail intermediate the respective locations of the tilting mechanism and cord lock.

After the cradles **20** are mounted in the head rail (by sliding them endwise along the rail to the positions of the two slots **14***b* respectively, inserting and bending the tabs **50***a* and riveting), the two tape rolls **18**, mounted on rod **24** and having the tapes **16** attached to and depending therefrom, are seated in the cradles. The tapes respectively drop downwardly from the tape rolls through the slots **54***a*, i.e. through and below the head rail web. These tapes, as stated, carry the bottom rail and slats of the assembly; thus the weight of the slats and bottom rail is transmitted through the tape

rolls **18.** Since the opposite ends **38***a* and **38***b* of the tape roll shank are supported by the cradle end walls **50** and **51,** i.e. seating in the semicircular notches **52,** this weight is supported by the cradles and not by rod **24.** The tape rolls and their associated cradles effectively constitute bearings supporting rod **24** at intermediate locations for rotation. The described arrangement whereby the blind assembly is supported by the tape rolls and cradles and not by the tilt rod is important for avoidance of an excessive load on the tilt rod such as might interfere with desired operation of the tilting mechanism, especially in view of the dimensional limitations imposed on the operating parts of the tilting mechanism (hereinafter described) by the small size of the head rail.

Each cradle end wall **51** has a tab **51***a* above its semicircular notch **52.** This tab is initially parallel to the tilt rod, to facilitate mounting of the tape rolls in the cradles, but may thereafter be bent transversely of the tilt rod as shown in FIG. **12** to prevent upward dislocation of the tilt rod and tape roll.

Each cradle **20,** as shown in FIGS. **11** and **12,** also has low side walls **57** and **58** in which are journalled a small steel roller **60** on the side of slot **54***a* toward the cord lock mechanism **28.** The two ends **26***a* and **26***b* of lift cord **26** respectively extend from the cord lock mechanism through the head rail over the rollers **60** of the two cradles and then downwardly, through the cradle slots **54***a* and through transverse slots **62** formed in each of the slats in register with the tape positions, to the bottom rail, to which the cord ends are securely fastened. The rollers **60** prevent excessive friction between the lift cord and the cradles. Openings **51***b* are provided in the cradle end walls **51** for passage of the lift cord therethrough; these openings as shown in FIGS. **11** and **12** have inwardly flared lips to provide smoothly rounded surfaces again for minimization of friction between the cradle wall and cord.

The lift cord lock mechanism **28** (FIGS. **17–20**) includes a rigid metal housing **64** fixedly secured to the head rail web **14***a* in the same manner as the cradles **20,** i.e. by means of a bent tab **64***a* and blind rivet **64***b*, adjacent the right-hand end of the head rail as seen in FIG. **1.** Specifically, housing **64** is positioned for register with an opening **66** formed in the head rail at the angle of web **14***a* and the front wall of the head rail, to accommodate the lift cord. Housing **64** includes front and rear side walls **67** and **68** oriented in parallel planes diagonal to the vertical side walls of the head rail. A wooden roller **70** is journalled in the walls **67** and **68,** and a cylindrical pin **72** has its ends slidably received in slots **74** of these walls of housing **64** so as to be axially parallel with roller **70** and to be slidable upwardly toward and downwardly away from a position generally tangent to the roller **70.** Each of the slots **74** in the housing walls **67** and **68** is formed with an outwardly flaring lip **74***a* on one side (as best seen in FIG. **20**) to provide a bearing surface for enlargements **76** and **77** respectively formed at opposite ends of the pin; thus as the pin slides (in a direction perpendicular to its axis) in the slots **74,** it is retained against axial movement by enlargements **76** and **77,** yet without wear on the walls **67** and **68.** The pin **72** has a ridged outer surface **78** for frictional engagement with the two end portions of lift cord **26,** which pass between the pin and the roller **70.**

The looped central portion **29** of the cord **26** depends from the housing **64** through a slot **80** formed in a lower wall portion of the housing and thence through the opening **66** in the head rail; to maintain the two end portions of the lift cord properly separated, a separating pin **82** may be mounted in the housing immediately beneath and parallel to slot **80,** the opposite end portions of the cord **26** being respectively disposed on opposite sides of this pin. When the looped central portion of the cord **26** is pulled manually downward, as may best be understood from FIG. **19,** the pin **72** is caused to slide downwardly in slots **74,** i.e. away from the roller **70,** releasing the cord **26;** hence a continued downward pull on the cord lifts both ends of the cord (which are secured to the bottom rail **12**) thereby raising the blind. Upon release of cord **26,** the weight of the blind acting on the cord ends attached to the bottom rail tends to pull the cord upwardly over roller **70,** but such cord motion causes the pin to slide upwardly until the cord is tightly clamped between the pin and the roller **70.** The cord is thus arrested and locked against undesired descent of the blind.

As a particular feature of the invention in a specific aspect thereof, the cord lock housing **64** includes an end plate **84,** fixedly disposed on the end of the housing facing the tape rolls and cradles within the head rail, and having a curved upper lip **84***a* over which both end portions of the lift cord **26** pass to the cradles **20.** The curvature of the lip **84***a* prevents undesired friction between the lift cord and the plate **84.** As best seen in FIGS. **17–19,** plate **84** is positioned to be abutted by the free end of the tilt rod **24,** i.e. the end thereof remote from the tilting mechanism **22,** to prevent axial movement of the tilt rod **24** beyond the position of plate **84.** In other words, plate **84** acts as a stop to hold the tilt rod in place against accidental dislodgement in an axial direction.

Further important features of the invention reside in the structure and arrangement of the tilting mechanism, now to be described. As shown in FIGS. **2–5,** the mechanism **22** includes a rigid metal housing **86,** secured (in the same manner as cradles **20**) by a bent tab **87** and blind rivet **87***a* to the web of the head rail **14** in register with an opening **88** formed in the head rail at the angle of the head rail web and front wall adjacent the end of the head rail remote from the cord lock mechanism. Housing **86** has spaced vertical end walls **90** and **91** respectively having central circular openings **92** and **93,** each formed with a laterally flared lip **94,** and both disposed in coaxial relation to the tilt rod **24,** so as to constitute bearings for a gear **96** to which the tilt rod is connected.

The gear **96** is an axially horizontal, elongated, generally cylindrical body extending through the housing and rotatably supported by the lips **94** of housing end walls **90** and **91.** A plurality of gear teeth **98** (e.g. eight teeth, FIG. **4**) are formed on a central portion of the gear, within the housing **86,** for meshing engagement with a worm **100** also journalled in the housing **86** for rotation about an axis lying in the plane of rotation of gear **96.** The worm and gear are adapted to constitute an anti-backlash arrangement for rotating the tilt rod; i.e. rotation of the worm turns the gear, but the worm cannot be driven by the gear. The design of such an anti-backlash worm and gear system is well known to those skilled in the art.

As a particular feature of the invention, a socket **102** of hexagonal cross-section for receiving an end of the tilt rod **24** is formed in one end of the gear **96,** coaxially

therewith but displaced entirely to one side of the location of gear teeth **98**, so that no portion of the socket extends through that part of the gear which bears the teeth. Specifically, the socket extends through the smooth cylindrical shank portion **96***a* of gear **96** which is located to the right of teeth **98** as seen in FIG. **5**, to such depth as to intersect the plane of housing end wall **91** (so that the end of tilt rod **24**, when inserted in the socket, projects through wall **91**), but stops short of the toothed region of the gear periphery; and the outer diameter of the latter toothed region (i.e. the diameter of the locus of the crowns of the gear teeth) is the same as the outer diameter of the cylindrical shank **96***a* extending through wall opening **93**. In this way, the requisite gear tooth depth is accommodated (and the tilt rod end can be properly supported) without excessively reducing the thickness of the tilt rod or the gear wall as would be the case if the tilt rod socket extended through the tooth-bearing portion of a gear having the dimensional constraints imposed by the desired small width of the head rail. Socket **102** is so dimensioned that rotation of the gear **96** causes rotation of the tilt rod **24** therewith.

At its inner extremity, adjacent the toothed portion of the gear but on the same side thereof as the end of the gear through which the socket opens, the socket **102** terminates in a seat **104**. Engagement of the end of the tilt rod **24** with this seat within the socket prevents axial displacement of the tilt rod to the left as seen in FIG. **1**. Thus the seat **104** cooperates with the cord lock housing plate **84** to prevent undesired displacement of the tilt rod in either axial direction. The distance between plate **84** and the facing socketed end of gear **96** is less than the length of the tilt rod, so that the plate **84** prevents dislodgement of the tilt rod from the gear socket.

In the embodiment of FIGS. **2–5**, gear **96** is formed in two parts **106** and **108**, each being a molded integral rigid body of glass-fiber-filled plastic. Gear part **106**, which contains socket **102**, includes an enlarged outer end **110** (through which the socket opens) larger in external diameter than opening **93** in wall **91**, and shank **96***a* dimensioned to fit within opening **93**. Gear part **108** also has an enlarged outer end **114**, larger in external diameter than opening **92** of wall **90**, and a cylindrical shank **116** which fits within opening **92**. The inner end of shank **116** bears the gear teeth **98**, the outer diameter of which is equal to that of the remainder of shank **116** so as to be insertable through opening **92**, and has a small cylindrical central bore **118** for receiving, in press-fitted relation, a cylindrical projection **120** formed at the inner end of shank **96***a* of part **106**. It will be understood that in assembling the tilt mechanism **24**, the shanks of the parts **108** and **106** are inserted, in coaxial facing relation, through the opposed openings **92** and **93** of housing end walls **90** and **91**, until the projection **120** is tightly received within bore **118** and the enlarged portions **110** and **114** respectively abut the flared lips **94** of the two openings. The two parts **106** and **108** then constitute an effectively unitary gear body **96** which is prevented from axial displacement, relative to housing **86**, by the end enlargements **110** and **114**.

Also, in the embodiment of FIGS. **2–5**, the gear part **108** has an axial socket **122** of hexagonal cross-section opening through the outer end thereof, i.e. through the end of gear **96** opposite to socket **102**, and identical in dimensions and construction to the socket **102**, so that the tilt rod **24** may be inserted into either end of the gear, thereby permitting use of the tilt mechanism at either end of the head rail. In addition, enlarged end **114** of gear part **108** bears a radially outwardly projecting lug **124** which engages a cooperating projection **126** on housing end wall **90** to limit rotation of gear **96** (and of tilt rod **24**) in either direction. The lug **124** and projection **126** cooperatively constitute a stop arrangement for preventing excessive tilting motion of the tapes **16**.

It will be understood that, by appropriate selection of the angular orientation of the tape rolls **18** on tilt rod **24** in relation to lug **124**, i.e. during assembly, the blind slats may be made capable of tilting to a greater degree in one direction than in the other, if such is desired. Although a tilt rod of square or other grippable cross-section may be used, one advantage of using a hexagonal configuration for the tilt rod is that the hexagonal shape permits a greater number of different relative angular positions of the tape rolls and lug than does a rod of square cross-section. Another advantage of the hexagonal rod shape is that for a given rod thickness (minimum transverse dimension) and given external diameter of gear shank **96***a*, the minimum thickness of the socketed shank wall is greater than would be the case if the rod were of square cross-section.

Referring further to FIGS. **2–5**, the worm **100** is shown as journalled in top and bottom walls **127***a* and **127***b* of housing **86**, with its axis slanting forwardly and downwardly. The lower end **128** of the worm (which may be an integral metal element) is elongated, projecting through the head rail opening **88**, and has a depending wand **30** (FIGS. **1**) connected to it. Manual rotation of the wand turns the worm, driving gear **96** to rotate tilt rod **24** and tape rolls **18**, and thereby to tilt the slats **11** in a direction determined by the direction of wand rotation.

A modified form **22′** of the tilting mechanism is illustrated in FIGS. **6–10**. In this modified mechanism, a rigid metal housing **130** (fixedly mounted on the web **14***a* of head rail **14** in register with the aforementioned opening **88**) has parallel spaced vertical end walls **132** and **134** each formed with a central circular opening **136** or **137** defined by an inwardly flared lip **138**. The openings **136** and **137**, which are disposed in coaxial relation to tilt rod **24**, serve as bearings for an elongated, generally cylindrical gear **140** having a central toothed portion **142** and a socketed end or shank portion **144** (receiving the end of the tilt rod) arranged in succession along a horizontal axis coincident with that of rod **24**.

Mechanism **22′** of FIGS. **6–10** differs from the mechanism **22** of FIGS. **2–5** in being adapted to be operated by a cord **31**. To this end, it includes an axially horizontal worm **146** journalled in front and rear walls **148** and **150** of housing **130** so as to mesh with the teeth of gear portion **142** to constitute an anti-backlash worm and gear system. The shank **152** of worm **146**, at its forward end, is fixedly connected to a friction pulley **154** over which cord **31** is looped; as shown, pulley **154** is formed with tapered internal ribs **156** for gripping the cord **31** to prevent slippage of the cord relative to the pulley. The two ends of the cord project downwardly from the pulley through a grommet **158** held by a downwardly projecting portion **160** of housing **130**. When one end or the other of cord **31** is pulled manually, worm **146**

is rotated through pulley **154**, driving gear **140** to tilt the slats **11**.

In the mechanism **22'** of FIGS. **6–10**, there is also shown a modified form of the gear element. As best seen in FIG. **8**, this gear **140** comprises an integral metal (e.g. zinc) body **162**, having an enlarged end **164** outside the housing **130**, smooth cylindrical shank **144** projecting into the housing through opening **137** of end wall **134**, and toothed portion **142** within the housing, bearing eight gear teeth **142***a* with an outer diameter (from crown to crown of the teeth) equal to that of shank **144**. Beyond portion **142**, a reduced-diameter portion **166** of body **162** projects through opening **136** in housing wall **132** and is closely surrounded by a molded plastic sleeve **168** which seats rotatably in opening **136**. Outwardly of wall **132**, the sleeve has an enlarged flange **168***a* which cooperates with the enlarged gear end **164** to prevent axial movement of the gear relative to the housing. The outer extremity of gear portion **166** is hollow, and as shown at **170**, is spun over a washer **172** to hold the washer against the outer face of sleeve **168** and to retain the gear body **162** and the sleeve in assembled relation. As will be apparent from FIG. **8**, the gear body and sleeve are initially assembled by insertion (toward each other) through the respective housing openings **137** and **136**. It will be understood that the illustrated orientation of the tilter gear element may be reversed; i.e. the gear element may be assembled in reverse (end for end) to provide alternate end blind tilting action.

Formed coaxially within shank **144** is a socket **174** of hexagonal cross-section, opening through gear end **164** for receiving the end of tilt rod **24**, and terminating (within the housing, but short of toothed portion **142**) in a seat **176** which prevents axial displacement of the tilt rod, i.e. in cooperation with fixed plate **84**. This socket is so dimensioned that the tilt rod, when inserted therein, rotates with gear **130**. As in the case of gear **96** described above, the arrangement of the socket **174** in axially displaced relation to the toothed portion **142** in gear **140** enables provision of requisite tooth depth, and reception of a tilt rod of desired thickness, in a gear structure of restricted external diameter, without undue reduction in thickness of the gear wall portion surrounding the socket, to afford the combined advantages of adequate strength and small size.

Also as in FIGS. **2–5**, the enlarged gear end **164** may bear a lug **180** disposed for cooperation with a stop projection **181** formed on housing wall **134**, to limit rotation of the tilt rod **24** in either direction by the tilting mechanism **22'**.

IN summary, then, as in the embodiment of FIGS. **2–5** the two parts **106** and **108** together constitute gear means comprising elongated, generally cylindrical structure having first and second shanks or shank portions respectively journalled in the housing end walls and a toothed portion intermediate the two shanks or shank portions, so in the embodiment of FIGS. **6–10** the body **162** and sleeve **168** cooperatively constitute gear means comprising elongated, generally cylindrical structure having a first shank **144** (on body **162**) and a second shank (constituted by sleeve **168** which is mounted on body portion **166**) respectively journalled in the housing end walls and a toothed portion **142** (also on body **162**) intermediate the two shanks. In each embodiment, the two shanks or shank portions respectively provided by the two parts of the structure (i.e. parts **106** and **108**, in FIGS. **2–5**, and body **162** and sleeve **168**, in FIGS. **6–10**) respectively have enlarged outer ends, to prevent axial displacement of the structure relative to the supporting housing when the structure is assembled therewith; and in each embodiment, the two-part construction of the structure facilitates such assembly by enabling insertion of the two parts respectively through the opposed end wall openings of the housing.

While a blind having two tapes, tape rolls and cradles has been shown, a larger number of these elements may be provided (spaced along the head rail) if desired to provide added support for very long slats. Additional lift cords, also accommodated within lock mechanism **28**, may be used. If the number of tapes exceeds the number of points of lift cord attachment to the bottom rail, the rollers **60** may be omitted from those cradles through which no lift cord passes. The positions of the tilting and cord lock mechanisms may be reversed, or both may be placed adjacent the same end of the head rail, although with loss of feature of positive retention of the tilt rod against axial displacement by the cooperation of the gear socket and plate **84**.

It is to be understood that the invention is not limited to the features and embodiments hereinabove specifically set forth but may be carried out in other ways without departure from its spirit.

We claim:

1. In a venetian blind assembly having slats tiltably supported by tapes, in combination,

a. a head rail;

b. a tilt rod, extending within and longitudinally of said rail and operatively connected to the tapes, for tilting the slats by rotation of the tilt rod about its axis;

c. means, mounted in said head rail, for supporting said tilt rod for rotation about its axis within said head rail;

d. an elongated, generally cylindrical gear, disposed in coaxial relation to said tilt rod at one end thereof, said gear comprising

i. a first shank portion having a socket formed coaxially therein and opening at one end thereof for receiving said one end of said tilt rod and engaging the same such that rotation of the gear effects rotation of the tilt rod, said socket terminating inwardly in a seat within said shank portion, and

ii. a second portion, disposed in side-by-side relation to said shank portion along a common axis therewith, bearing on its outer periphery a plurality of gear teeth, said socket terminating short of the position of said teeth along said common axis;

e. housing means mounted in said head rail for rotatably supporting said shank portion of said gear;

f. a worm journalled in said housing means in meshing relation to said gear teeth for driving said gear; and

g. manually movable means connected to said worm for rotating said worm;

wherein the improvement comprises:

h. said gear further including another shank portion disposed on the side of said second portion opposite to said first portion coaxially therewith;

i. said housing comprising opposed fixed walls having coaxial openings in which said shank portions of said gear are respectively journalled;

j. said second portion including said gear teeth having an external diameter equal to the minimum external diameter of said first portion; and

k. each of said shank portions projecting through the housing wall in which it is journalled and being enlarged externally thereof for preventing axial displacement of said gear relative to said housing.

2. A blind as defined in claim **1,** wherein said gear comprises a first body including one of said shank portions and a second body interfitting with said first body and including said second portion and the other of said shank portions, said second portion including said gear teeth having an external diameter equal to the minimum external diameter of said other shank portion, and said bodies being respectively inserted through said housing wall openings into interfitting relation to each other.

3. A blind as defined in claim **1,** further including a stop plate fixedly mounted in said head rail adjacent the end of said tilt rod remote from said gear for arresting axial displacement of said tilt rod away from said gear.

4. In a venetian blind assembly having a plurality of tapes, slats tiltably supported by said tapes, a bottom rail suspended by said tapes beneath said slats and a lift cord secured to the bottom rail at spaced points for lifting said bottom rail, in combination,

a. aa head rail;

b. a plurality of rolls respectively secured to the upper ends of said plurality of tapes within said head rail;

c. means, supported by said head rail, for engaging and supporting each of said rolls within said head rail for rotation about a common axis extending longitudinally of said head rail;

d. a tilt rod, extending through and beyond said rolls coaxially therewith, supported by and engaging said rolls such that rotation of said rod rotates said rolls;

e. means for locking said lift cord in a selected position, fixedly mounted within said head rail adjacent one end of said tilt rod, said locking means including a fixed plate facing said one end of said tilt rod for arresting axial displacement thereof toward said locking means;

f. gear means for rotating said tilt rod, comprising elongated, generally cylindrical structure having first and second shanks and a toothed portion intermediate said shanks aligned in succession along said common axis, said first shank having a socket formed coaxially therein and extending only within said first shank, said socket opening through an end of said first shank and terminating in a seat within said first shank, said toothed portion bearing gear teeth on its outer periphery, said socket receiving and engaging a second end of said tilt rod for rotation therewith and said seat arresting axial displacement of said tilt rod toward said gear, said socket terminating short of the position of said teeth along said common axis, and said toothed portion including said teeth having an external diameter equal to the minimum external diameter of said first shank;

g. a housing fixedly mounted in said head rail and rotatably supporting said first and second shanks of said gear means;

h. a worm journalled in said housing in meshing engagement with said teeth of said gear means for driving said gear means; and

i. manually movable means connected to said worm and depending from said head rail for rotating said worm;

j. said first and second shanks respectively projecting beyond said housing in opposite directions and respectively having enlarged ends external to said housing for preventing axial displacement of said gear means relative to said housing.

5. A blind as defined in claim **4,** wherein said gear means structure comprises a first body including one of said shanks, a second body including the other of said shanks and said toothed portion, said toothed portion including said teeth having the same external diameter as said other shank one of said bodies further including a portion interengaging with the other of said bodies for holding said bodies in coaxial relation; and wherein said housing includes opposed end walls having coaxial circular openings through which said bodies are respectively inserted.

6. A blind as defined in claim **5,** wherein said tilt rod and said socket are hexagonal in cross-section.

7. A blind as defined in claim **4,** wherein each of said tapes comprises a pair of flexible stringlike tape elements each having a free upper end with a ferrule secured thereto; and wherein each of said rolls comprises

i. a molded rigid plastic body including a cylindrical shank with an axial bore for receiving and engaging said tilt rod, and a central flange projecting radially of the shank, said flange having two peripheral notches, the upper ends of both elements of a tape being respectively inserted in said notches with said ferrules disposed on one side of said flange, said flange further having a radial projection positioned in opposed relation to said notches; and

ii. a molded rigid plastic cap press-fitted over said flange from said one side thereof for enclosing the ferrule-bearing ends of the tape elements, said cap having an end with a central opening through which said shank projects, said cap further having a skirt with a notch receiving said radial projection.

8. In a venetian blind assembly including

a. a plurality of tapes each comprising a pair of flexible stringlike tape elements each having a free upper end with a ferrule secured thereto;

b. a plurality of slats tiltably supported by said tapes;

c. a bottom rail suspended by said tapes beneath said slats;

d. a lift cord secured to the bottom rail at spaced points for lifting the bottom rail;

e. a head rail;

f. a plurality of rolls respectively secured to the upper ends of said plurality of tapes within said head rail;

g. means, supported by said head rail, for engaging and supporting each of said rolls within said head rail for rotation about a common axis extending longitudinally of said head rail;

h. a tilt rod, extending through and beyond said rolls coaxially therewith, supported by and engaging said rolls such that rotation of said rod rotates said rolls;

i. means for locking said lift cord in a selected position; and

j. manually operable means for rotating said tilt rod;

the improvement which comprises:

k. each of said rolls comprising a molded rigid plastic body including a cylindrical shank with an axial bore for receiving and engaging said tilt rod, and a central flange projecting radially of the shank, said flange having two peripheral notches, the upper ends of both elements of a tape being respectively inserted in said notches with said ferrules disposed on one side of said flange, said flange further having a radial projection positioned in opposed relation to said notches; and

l. each of said rolls further comprising a molded rigid plastic cap press-fitted over said flange from said one side thereof for enclosing the ferrule-bearing ends of the tape elements, said cap having an end with a central opening through which said shank projects, said cap further having a skirt with a notch receiving said radial projection.

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