# United States Patent [19]

**Fall et al.**

[11] **3,776,608**

[45] **Dec. 4, 1973**


[54] **CIRCULATING BALL BEARING SLIDE**


[75] Inventors: **Herbert S. Fall; Martin K. Fall; Maxwell S. Fall; Charles E. Scalf; Ronald D. Lambert; William D. York,** all of Indianapolis, Ind.

[73] Assignee: **Herbert S. Fall,** Indianapolis, Ind.



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[21] Appl. No.: **321,535**

[52] **U.S. Cl.** ..... **308/3.8,** 312/339

[51] **Int. Cl.** ..... **F16c 29/00**

[58] **Field of Search** ..... 308/3.8, 6 C; 312/334, 339, 340, 343, 341, 346, 347, 348



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| 3,679,275 | 7/1972 | Fall | 308/3.8 |
| 3,687,505 | 8/1972 | Fall & Lambert | 308/3.8 |



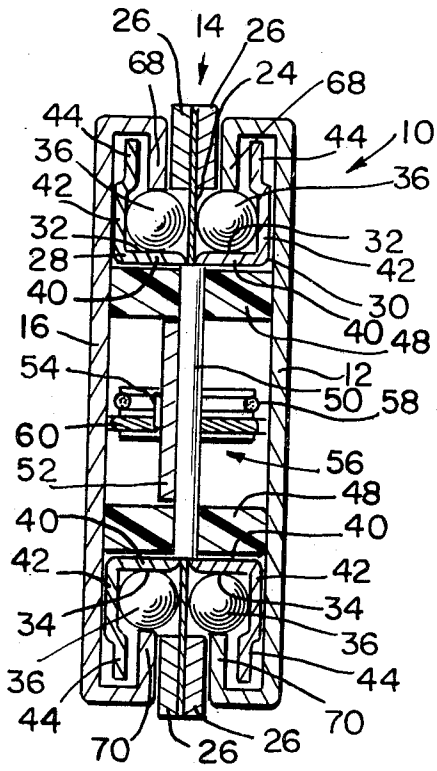
*Primary Examiner*—Manuel A. Antonakas
*Assistant Examiner*—R. H. Lazarus
*Attorney*—William R. Coffey



[57] **ABSTRACT**

A slide assembly comprising a relatively fixed elongated track member, a relatively movable elongated track member, and an intermediate elongated track member movable relative to the fixed and movable track members. The intermediate track member provides, at each of its upper and lower longitudinal edge portions and on opposite sides of a vertically and longitudinally extending center plane, longitudinally extending ball bearing raceways. End pieces at each end of the intermediate member provide a ball bearing passageway communicating between one of the upper raceways and the lower raceway on the opposite side of the center plane and another passageway communicating between the other upper raceway and the other lower raceway on the opposite side of the plane. Ball bearings substantially fill the raceways and their communicating passageways, and the fixed and movable track members include runner portions extending respectively into and engaging the ball bearings in the adjacent upper and lower raceways.


**21 Claims, 13 Drawing Figures**



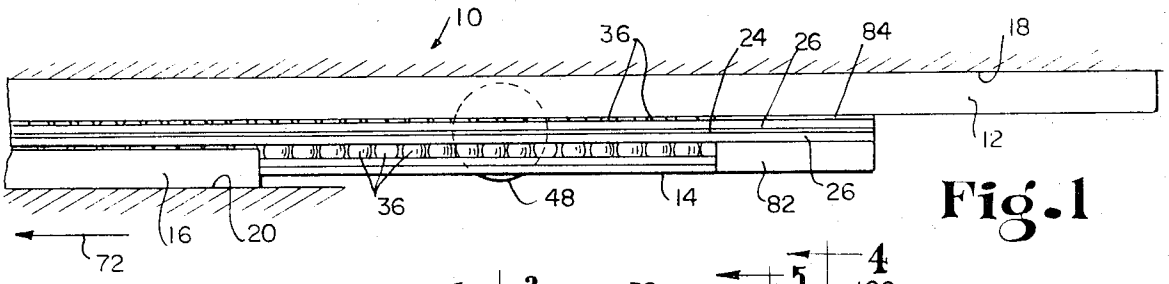



Fig.1

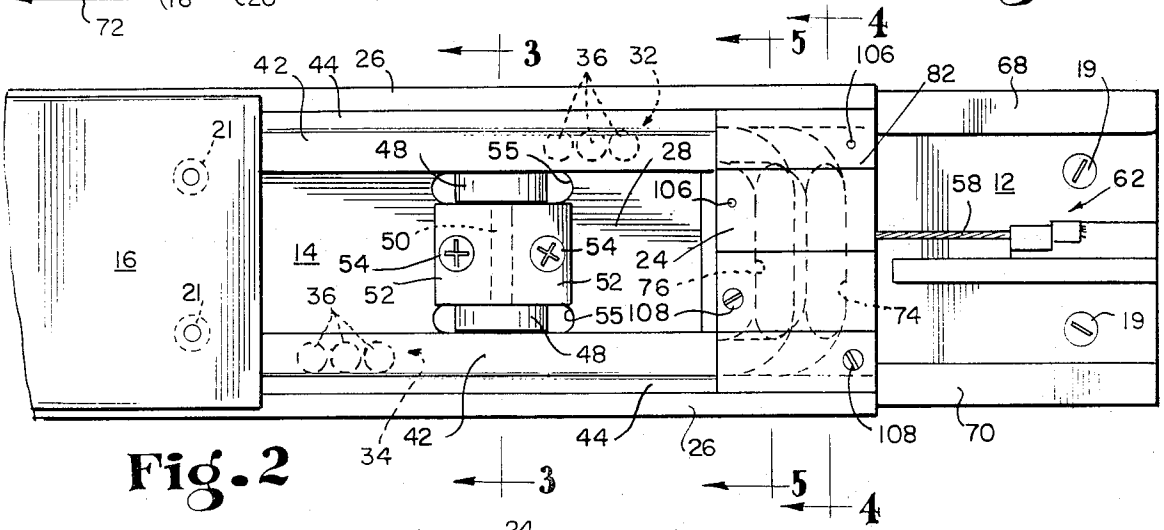



Fig.2

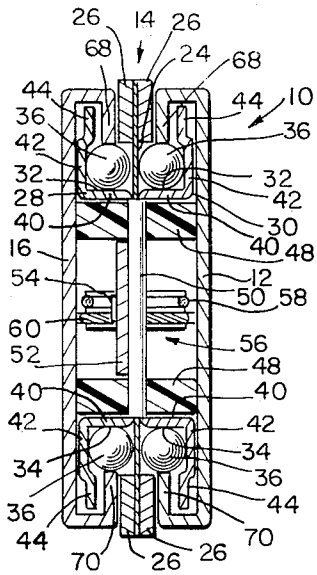



Fig.3

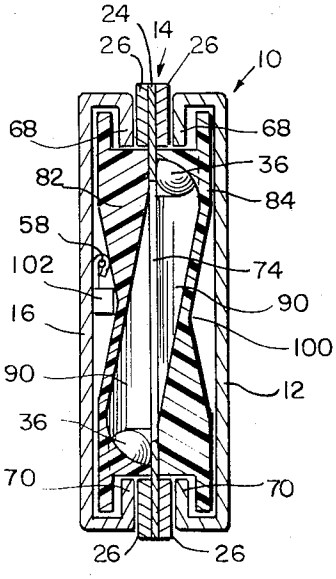



Fig.4

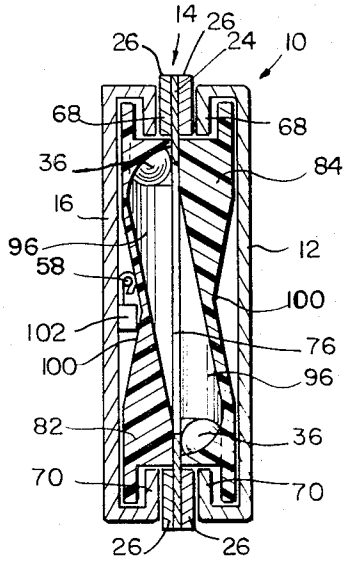



Fig.5

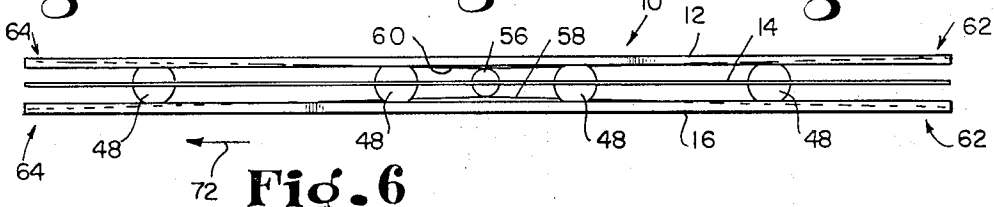



Fig.6

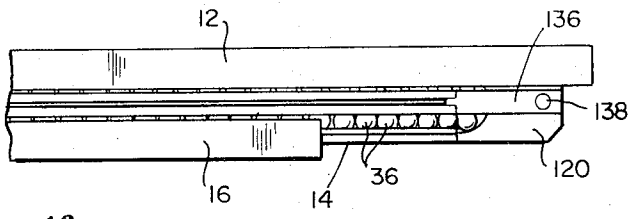



Fig. 11

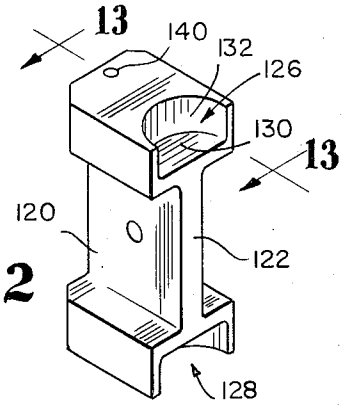



Fig. 12

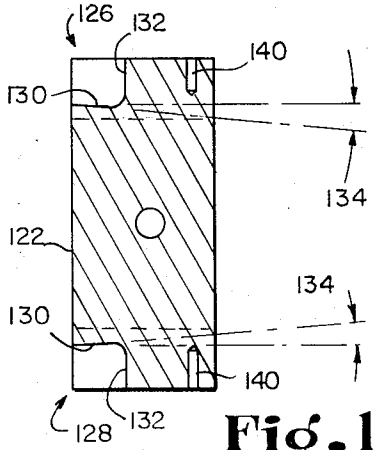



Fig. 13

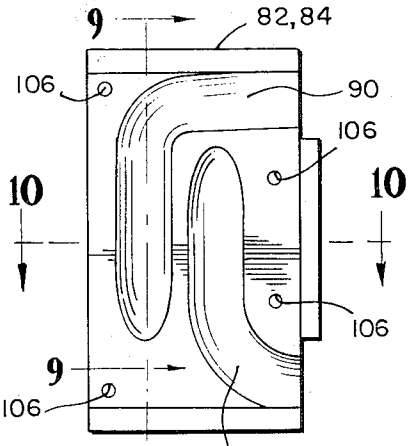



Fig. 8

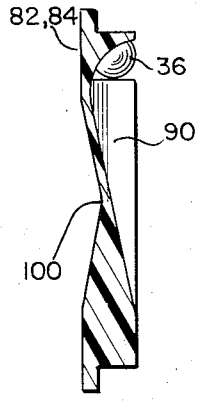



Fig. 9

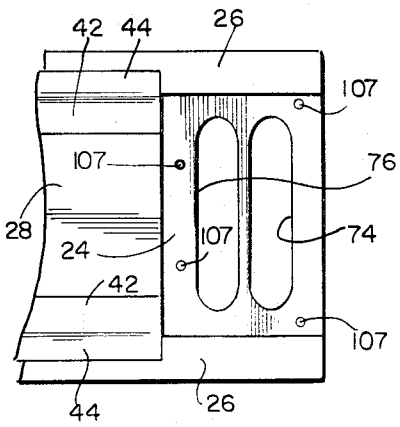



Fig. 7

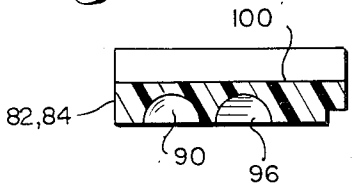



Fig. 10

# CIRCULATING BALL BEARING SLIDE

The present invention relates to drawer slides, and more particularly to circulating ball bearing drawer slides of the type shown in U.S. Pat. No. 3,059,978 issued Oct. 23, 1962 on an application by Mr. Herbert S. Fall.

Circulating ball bearing drawer slides have been on the market for several years now and have been used movably to support relatively heavy loads. For instance, circulating ball bearing slides are particularly suited for movably supporting drawers in cabinets filled with electronic gear. Such slides are attractive because they provide great load-carrying capacity while occupying a minimum amount of space in a horizontal direction. Of course, the circulating ball bearings are an ideal means for reducing friction, thereby to make it much easier to move the supported load rectilinearly.

In circulating ball bearing drawer slides of the type shown in U.S. Pat. No. 3,059,978, the ball bearings circulate about closed-loop raceways or paths. Such slides include a first elongated track member, a second elongated track member generally parallel to the first track member, and a third elongated track member disposed between and generally parallel to the first and second track members. This third member provides, at each of its upper and lower longitudinally extending edge portions, a pair of laterally spaced apart, longitudinally extending ball bearing raceways, one raceway adjacent the first track member and one raceway adjacent the second track member. Conduit means at each end of the third track member provide passageways continuing the raceways around the ends of the third track member. The first and second track members provide longitudinally extending runners which extend respectively into the adjacent upper and lower raceways to engage the ball bearings therein. Thus, when the second and third track members are moved relative to the first track member, the ball bearings circulate along the raceways and through the passageways on the third track member. This operation is disclosed in the said U.S. Pat. No. 3,059,978.

As the ball bearings circulate, the ball bearings leaving the ends of the raceways must, of course, move laterally. It has been discovered that slides having heretofore unexpectedly increased load-life characteristics can be obtained by constructing the said conduit means at the ends of the third track member such that the ball bearings moving through the conduit means move vertically out of load bearing contact with the runners on the first and second track members when the ball bearings are moving transversely around the ends of the third track member. The manner in which this is accomplished, in accordance with the present invention, will be discussed in detail as this description progresses.

It has further been discovered that the load-life characteristics of circulating ball bearing slides may be significantly increased and friction decreased by placing rollers on the third track member, i.e., the intermediate track member, which rollers rollably engage the first and second track members to keep them from moving or twisting out of their respective vertical planes. Preferably, as will be more fully explained hereinafter, such rollers are journal mounted on the said third member to be adjacent the upper and lower raceways.

It has also been discovered that the load-life of circulating ball bearing slides can be significantly increased by providing means for synchronizing the movement of the intermediate member with the movable member. For instance, if the said first track member is attached to the frame of the cabinet and the second track member is attached to the drawer, it is desirable for the third track member to move relative to the cabinet in the same direction that the second track member moves and at one-half the velocity of the second track member. In accordance with the present invention, this is accomplished by a cable drive system of the type disclosed in U.S. Pat. No. 3,687,505 issued Aug. 29, 1972 on an application by Messrs. Maxwell S. Fall and Ronald D. Lambert.



Other objects and features of the present invention will become apparent as this description progresses.

To the accomplishment of the above and related objects, this invention may be embodied in the forms illustrated in the accompanying drawings, attention being called to the fact, however, that the drawings are illustrative only, and that change may be made in the specific constructions illustrated and described, so long as the scope of the appended claims is not violated.

In the drawings:

FIG. **1** is a fragmentary plan view of a slide constructed in accordance with the present invention;

FIG. **2** is a fragmentary elevational view of the end of the slide shown in FIG. **1**;

FIGS. **3, 4** and **5** are, respectively, sectional views taken along the lines **3—3, 4—4** and **5—5** in FIG. **2**;

FIG. **6** is a somewhat diagrammatical top view of the entire slide;

FIG. **7** is an enlarged fragmentary end view of the intermediate track member of the slide;

FIG. **8** is an elevational view of one of four identical end pieces used on the intermediate track member to provide passageways connecting opposite upper and lower raceways;

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

FIG. **10** is a sectional view taken along the line **10—10** in FIG. **8**;

FIG. **11** is a fragmentary top view of an end portion of a different embodiment of the present invention;

FIG. **12** is a perspective view of the passageway providing end pieces for the intermediate track member of the embodiment of FIG. **11**; and

FIG. **13** is a sectional view taken along the line **13—13** in FIG. **12.**

Referring now to the drawings and particularly FIGS. **1–10,** it will be seen that the circulating ball bearing slide, indicated generally by the reference numeral **10,** comprises a relatively stationary track member **12,** an intermediate track member **14,** and a movable track member **16.** As indicated previously, the stationary track member **12** may be rigidly fastened to the frame **18** of a cabinet by means such as the illustrated screws **19** (FIG. **2**). The movable track member **16** may be rigidly fastened to a drawer **20** by means such as screws, the holes for which are indicated at **21.**

The intermediate track member **14,** in the illustrative and preferred embodiment, includes a vertically and longitudinally extending center member **24** which may be a strip of steel or aluminum or some other desired material formed as will be discussed hereinafter. The center member **24** defines a vertically and longitudinally extending center plane with reference to which the slide **10** is preferably symmetrical in cross section. In the illustrative embodiment, strips **26** are welded or

otherwise securely fastened to opposite sides of the center member **24** to extend longitudinally along the upper and lower longitudinal edges of the center member. These strips **26** serve to retain the ball bearings in the raceways as will be discussed hereinafter.

The center member **24** is sandwiched between vertically and longitudinally extending side members **28, 30** which may be, for instance, formed of strip steel or strip aluminum. These side members **28, 30** may be spot welded or otherwise securely fastened to the center member **24.** Preferably, the members **24, 26, 28, 30** will be welded together to provide a strong, unitary member having great structural strength in all directions, but particularly in the vertical direction.

The upper and lower longitudinally extending edge portions of the side members **28, 30** are formed to provide, on opposite sides of the center member **24,** a pair of laterally spaced apart, longitudinally extending upper raceways **32** and a pair of laterally spaced apart, longitudinally extending lower raceways **34.** Ball bearings **36** substantially fill these raceways and their connecting passageways to be hereinafter described. As best seen in the sectional view of FIG. **3,** each raceway **32, 34** is formed by a horizontally outwardly and longitudinally extending floor section **40** and, from the distal edge of this floor section, a vertically extending wall section **42,** the distal edge portion **44** of which is disposed inwardly toward the center member **24.** It will be appreciated that this distal edge portion **44** cooperates with the adjacent strip **26** to keep the ball bearings **36** from moving vertically out of their raceways. That is, the distance between each distal edge portion **44** and the adjacent strip **26** is less than the diameter of the ball bearings **36** such that the ball bearings are prevented from moving vertically out of the raceways **32, 34.** It will be seen that the upper and lower edge portions of the center member **24** adjacent the strips **26** separate the raceways **32, 34.**

One of the objectives of the present invention is to hold the outer track members **12, 16** for movement in fixed vertical and longitudinally extending planes relative to the intermediate track member **14.** In the illustrative and preferred embodiment, this stabilizing of the track members is accomplished by means of a plurality of rollers **48** journal mounted on the intermediate track member **14** for rotation about vertically extending axes lying in the vertically and longitudinally extending center plane defined by the center member **24** of the track member **14.** In the illustrative embodiment (FIG. **6**), there are four pairs of longitudinally spaced apart rollers **48,** each pair including an upper roller **48** adjacent the raceways **32** and a lower roller **48** adjacent the lower raceways **34.** As best seen in FIG. **3,** the outer peripheries of the rollers **48** roll against the inner surfaces of the track members **12, 16.** The rollers **48,** which preferably are plastic and cylindrical in shape as illustrated, are effective to prevent racking or twisting of the track members **12, 14, 16.** This feature adds significantly to the load-life capacity of the slide **10,** and reduces friction caused by twisting of members **12, 14** and **16.**

The rollers **48** of each pair may be journal mounted on a vertically extending axle **50** which may be welded or otherwise securely fastened to an axle plate **52** which is secured to the intermediate track member **14** by means such as the illustrated screws **54.** Of course, the intermediate track member **14** must be provided with cutouts, such as are indicated at **55** (FIG. **2**), to accommodate the vertically spaced apart rollers **48** and the axle **50.**

Pulley means, indicated generally by the reference numeral **56** in FIG. **3,** is journal mounted on the intermediate track member **14** for rotation about a vertically extending axis. Flexible strands **58, 60** are trained about this pulley means **56** and connected to the track members **12, 16** to provide a driving connection between the three track members. Particularly, in the illustrative embodiment, as viewed in FIG. **6,** the ends of the strand **58** are connected to the adjacent right-hand ends of the track members **12** and **16** as indicated at **62** while the ends of the strand **60** are connected to the adjacent left-hand ends of the track members **12, 16** as indicated at **64.** This arrangement provides a driving connection such that, when the track member **16** moves in the direction of the arrow **72** relative to the track member **12,** the intermediate track member **14** also moves in the direction of the arrow **72,** but at one-half the velocity of the track member **16.** Then, when the track member **16** is moved back in the direction opposite to the arrow **72,** the track member **14** moves in the same direction but at one-half the velocity. The purpose of the synchronizing cable drive is to make sure that, when the movable track member **16** moves, the intermediate track member **14** moves a proportional distance. This simultaneous synchronized movement prevents uneven wear of the raceways and ball bearings, thereby increasing the load-life capacity of the slide.

The upper and lower longitudinal edge portions of the track members **12, 16** are formed to provide longitudinally downwardly and upwardly extending runners **68, 70** which, respectively, extend into and engage the ball bearings **36** in the upper and lower raceways **32, 34.** It will be appreciated that the runners **68, 70** are disposed in the spaces between the distal edge portions **44** and the strips **26** of the raceways. As described in the U.S. Pat. No. 3,059,978 cited above, loads placed upon the movable track member **16** are transmitted by the ball bearings and the intermediate track member **14** to the relatively fixed track member **12.** Movement of the track member **16,** in accordance with the present invention, is accompanied by circulation of the ball bearings **36** in the raceways **32, 34.**

In the illustrative and preferred embodiment, the opposite end portions of the intermediate track member **14,** and particularly the center member **24** of that track member, are formed to provide a pair of apertures **74, 76.** As best seen in FIGS. **2** and **7,** these apertures **74, 76** are longitudinally spaced apart and vertically elongated with the upper and lower ends of the apertures being adjacent the planes of the upper and lower raceways **32, 34.**

In accordance with the present invention, conduit means are provided at each end of the intermediate track member **14,** each conduit means providing a ball bearing **36** passageway communicating between the upper raceway **32** adjacent the track member **12** and the lower raceway **34** adjacent the track member **16** and another ball bearing **36** passageway communicating between the upper raceway **32** adjacent the track member **16** and the lower raceway **34** adjacent the track member **12.** In the illustrative embodiment, this conduit means includes, at each end of the intermediate track member **14** and on opposite sides of the aper-

tured center member **24**, end pieces **82, 84** which may preferably be identical. Each end piece **82, 84** is formed to include an outer passageway **90** which communicates with the outer aperture **74** and an inner passageway **96** which communicates with the inner aperture **76**. Particularly, the vertically extending portions of the passageways **90, 96** are respectively in registry with the apertures **74, 76** when the end pieces **82, 84** are assembled on opposite sides of the end portion of the center member **24**.

Referring to FIGS. **4** and **5**, it will be seen that the mating passageways **90** and outer aperture **74** provide communication between the upper raceway **32** adjacent the track member **12** and the lower raceway **34** adjacent the track member **16** (FIG. **4**) while the mating passageways **96** and the inner aperture **76** provide communication between the upper raceway **32** adjacent the track member **16** and the lower raceway **34** adjacent the track member **12**. The ball bearings, therefore, move vertically as well as horizontally through the center plane of the intermediate track member **14** as the ball bearings move about the ends of the track member **14**.

The end pieces **82, 84,** and particularly their passageways **90, 96,** are proportioned and designed such that, the ball bearings **36** leaving the ends of the upper and lower raceways **32, 34** move, respectively, vertically downwardly and upwardly to be out of load bearing contact with the runners **68, 70**. Thus, no load is being applied to the ball bearings when they must move vertically and horizontally through the passageways **90, 96** and apertures **74, 76**.

Each of the end pieces **82, 84** is provided with a depression **100** in its exterior side, which depression provides clearance for the strands **58, 60** as well as the mechanical stops, such as indicated at **102,** which limit the longitudinal movement of the track members. Further, illustratively, each end piece **82, 84** is provided with apertures **106** for use in mounting the end pieces to the intermediate track member which is provided with registering apertures **107**. Fastening elements, such as the screws **108,** may extend through these apertures **106** and **107** to fasten the end pieces to the intermediate track member.

Referring now to FIGS. **11, 12** and **13,** another preferred embodiment of the present invention will be discussed, this embodiment including end pieces **120** fastened to opposite ends of the intermediate track member **14** to provide passageways communicating between the raceways provided by the intermediate track member **14**. The end pieces **120,** only one of which is shown, are provided with abutment faces **122** which abut against the track member **14**. The end pieces **120** may be welded or otherwise securely fastened to the track member **14** as disclosed in U.S. Pat. No. 3,059,978 cited above. Each end piece **120** is formed to provide upper and lower passageways **126, 128**. The upper passageways **126** provide communication between the upper raceways on the intermediate track member **14** and the lower passageways **128** provide communication between the lower raceways on the intermediate track member. Each passageway **126, 128** includes a floor **130** and a peripherally and vertically extending wall **132**.

As best seen in FIG. **13,** the floor **130** of the passageway **126** is inclined downwardly at an angle of approximately 5° to 10° indicated at **134** while the floor **130** of the passageway **128** is inclined upwardly at a similar angle **134**. Particularly, the floors **130** of the passageways **126, 128** are inclined downwardly and upwardly, respectively, from the ends of the floors of the upper and lower raceways of the intermediate track member so that the ball bearings moving through the passageways are moved vertically out of load bearing contact with the downwardly and upwardly extending runners of the track members **12, 16** when the ball bearings are moving transversely around the ends of the intermediate track member. That is, the end pieces **120** are proportioned and designed such that the circulating ball bearings **36** are moved out of load bearing engagement with the downwardly and upwardly extending runners of the track members **12, 16** when the ball bearings move through the passageways **126, 128.** Thus, in accordance with the present invention, a load is applied to the ball bearings **36** only when they are moving longitudinally along the raceways **32, 34** and not when they are moving transversely about the ends of the intermediate track member **14**.

The ball bearings **36** are prevented from moving vertically out of the passageway **126, 128** by retainer plates **136** fastened to the upper and lower ends of the end pieces **120** by means such as screws **138** which thread into tap holes **140** in the end pieces.

Slides constructed in accordance with the present invention have significantly improved load-life capacities. A pair of slides **10** constructed in accordance with the embodiment of FIGS. **1–10** are able movably to support loads of 450 lbs. for more than 25,000 cycles of 18 inches extension. A cycle is defined as one complete cycle of movement of the track member **16,** 18 inches from its retracted position to its projected position and then back to its retracted position. This achievement is significant when the length, width and height of the slide **10** is compared to other slides having similar load-life capacities. The slide **10,** when retracted, is approximately 26 inches long, 1⅛ inches wide and 3⅛ inches tall.

What is claimed is:

**1.** A slide assembly comprising a first elongated track member, a second elongated track member generally parallel to said first track member and a third elongated track member disposed between and generally parallel to said first and second members, each said track member having upper and lower longitudinally extending edge portions, said third track member providing, at each of its upper and lower longitudinally extending edge portions, a pair of laterally spaced apart, longitudinally extending ball bearing raceways, one raceway adjacent said first track member and one raceway adjacent said second track member, conduit means at each end of said third track member providing a ball bearing passageway communicating between the upper raceway adjacent said first track member and the lower raceway adjacent said second track member and another ball bearing passageway communicating between the upper raceway adjacent said second track member and the lower raceway adjacent said first track member, and ball bearings substantially filling said raceways and their communicating passageways, said first and second track members including longitudinal portions extending respectively into and engaging the ball bearings in the upper and lower raceways adjacent said track members.

2. The assembly of claim 1 including roller means journal mounted on said third track member rollably to engage said first and second track members.

3. The assembly of claim 1 in which said third track member defines a vertically and longitudinally extending center plane parallel to said raceways, and including a plurality of rollers journalled on said third track member rollably to engage said first and second track members, the journal axes for said rollers being vertically extending and parallel to said center plane.

4. The assembly of claim 3 in which said rollers include at least two longitudinally spaced apart pairs of rollers journalled on vertical axes lying in said center plane such that the outer periphery of each roller engages said first and second track members, the rollers of each pair being vertically spaced apart to be adjacent, respectively, said upper and lower raceways.

5. The assembly of claim 1 including pulley means journalled on a transverse axis on said third track member, and flexible strand means anchored to said first and second track members and trained about said pulley means to establish a driving connection between said track members whereby, when one of said first and second track members is held stationary and the other of said first and second track members is moved in either direction longitudinally, the third track member will be moved in the same direction and at one-half the velocity.

6. The assembly of claim 1 in which said third track member is formed such that said laterally spaced raceways at said upper and lower edge portions are on opposite sides of and parallel to a vertically and longitudinally extending center plane.

7. The assembly of claim 6 in which said third track member is formed to provide, at each of its ends, a pair and another of apertures therethrough, said conduit means including, on each side of each end of said third member, block means providing a passageway leading downwardly from the raceway disposed thereabove to one of said apertures anda other passageway leading upwardly from the raceway disposed therebelow to the other of said apertures.

8. The assembly of claim 7 in which said apertures of each pair are vertically elongated and longitudinally spaced apart.

9. The assembly of claim 6 in which said third track member includes a pair of longitudinally and vertically extending side members and a longitudinally and vertically extending center member sandwiched between said side members, the vertical center of said center member lying in said center plane, the upper and lower longitudinal edges of each side member being formed to provide outwardly extending floor sections and vertically extending wall sections bounding said upper and lower raceways, the upper and lower longitudinal edges of said center member providing the inner vertically extending wall sections for said raceways.

10. A slide assembly comprising a relatively fixed elongated track member having upper and lower longitudinal edge portions, a relatively movable elongated track member having upper and lower longitudinal edge portions, an intermediate elongated track member generally parallel to and disposed between said fixed and movable track members, said intermediate track member having upper and lower longitudinal edge portions and being longitudinally movable relative to said fixed and movable track members, said intermediate track member defining a vertically and longitudinally extending center plane and providing, at each of its upper and lower longitudinal edge portions and on opposite sides of said center plane, longitudinally extending ball bearing raceways, means at each end of said intermediate member for providing a ball bearing passageway communicating between one of said upper raceways and the lower raceway on the opposite side of said center plane and another passageway communicating between the other said upper raceway and the other lower raceway on the opposite side of said center plane, and ball bearings substantially filling said raceways and their communicating passageways, the upper and lower longitudinal edge portions of said fixed and elongated track members extending respectively into and engaging the ball bearings in the adjacent upper and lower raceways.

11. The assembly of claim 10 including a plurality of rollers journalled on said intermediate track member rollably to engage said first and second track members, the journal axes of said rollers being parallel to said center plane.

12. The assembly of claim 11 in which said track members extend horizontally, said rollers including at least two longitudinally spaced apart pairs of rollers journalled on vertical axes lying in said center plane such that the outer periphery of each roller engages said fixed and movable track members, the rollers of each pair being vertically spaced apart to be adjacent, respectively, said upper and lower raceways.

13. The assembly of claim 10 including pulley means journalled on a transverse axis on said intermediate track member, and flexible strand means anchored to said fixed and movable track members and trained about said pulley means to establish a driving connection between said track members whereby, when said movable track member is moved in either direction longitudinally, the intermediate track member moves in the same direction and at one-half the velocity.

14. The assembly of claim 12 including pulley means journalled on a transverse axis on said intermediate track member, and flexible strand means anchored to said fixed and movable track members and trained about said pulley means to establish a driving connection between said track members whereby, when said movable track member is moved in either direction longitudinally, the intermediate track member moves in the same direction and at one-half the velocity.

15. The assembly of claim 10 in which said intermediate track member is formed to provide, at each of its ends, a pair of apertures therethrough, said conduit means including, on each side of each end of said intermediate track member, block means providing a passageway leading downwardly from the raceway disposed thereabove to one of said apertures and another passageway leading upwardly from the raceway disposed therebelow to the other of said apertures.

16. The assembly of claim 15 in which said intermediate member includes a pair of longitudinally and vertically extending side members and a longitudinally and vertically extending center member, the vertical center of which lies in said center plane, the upper and lower longitudinal edges of each side member being formed to provide outwardly extending floor sections and vertically extending wall sections bounding said upper and lower raceways, the upper and lower longitudinal edges

of said center member providing the inner vertically extending wall sections for said raceways.

**17.** The assembly of claim **16** in which said apertures of each pair are formed in said center member.

**18.** The assembly of claim **17** in which said apertures are vertically elongated and longitudinally spaced apart.

**19.** A slide assembly for supporting vertically applied loads comprising a first horizontally elongated track member, a second horizontally elongated track member generally parallel to said first track member, a third horizontally elongated track member disposed between and generally parallel to said first and second members, each said track member having upper and lower longitudinally extending edge portions, said third track member providing, at each of its upper and lower edge portions, a pair of laterally spaced apart, horizontally and longitudinally extending ball bearing raceways on opposite sides of a vertically and longitudinally extending center plane, conduit means continuing said raceways around the ends of said third track member and through said center plane, ball bearings substantially filling said raceways and said conduit means, the upper and lower edge portions of said first and second track members providing downwardly and upwardly longitudinally extending runners extending respectively into said upper and lower raceways on the adjacent side of said center plane to engage said ball bearings therein, said conduit means being proportioned and designed to move said ball bearings vertically out of load bearing contact with said runners when said ball bearings move transversely around the ends of said third track member.

**20.** The assembly of claim **19** in which said conduit means provides, at each end of said third track member, a passageway extending between one of said upper raceways and the lower raceway on the opposite side of said center plane and another passageway extending between the other said upper raceway and the other said lower raceway on the opposite side of said center plane.

**21.** The assembly of claim **19** in which said conduit means includes, at each end of said third member, means providing upper and lower passageways connecting, respectively, said upper and lower raceways, each said passageway curving about the end of said third track member, said means being proportioned and designed such that said upper passageways include a floor inclining downwardly from the adjacent ends of said upper raceways and said lower passageways include a floor inclining upwardly from the adjacent ends of said lower raceways.

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# UNITED STATES PATENT OFFICE
# CERTIFICATE OF CORRECTION

Patent No. 3,776,608 Dated December 4, 1973

Inventor(s) Herbert S. Fall, et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 65, "llustrative" should be -- illustrative --.

Column 7, line 36, (Claim 7, line 3) delete "and another"; line 40, (Claim 7, line 7) "anda other" should be -- and another --.

Signed and sealed this 23rd day of April 1974.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents