United States Patent

[11] **3,627,079**

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[54] **ELEVATOR SYSTEM FOR MINE SHAFT**
9 Claims, 23 Drawing Figs.

[52] U.S. Cl. **187/12,** 187/20, 187/27, 187/94, 187/95, 182/178, 254/173
[51] **Int. Cl.** **B66b 9/06**
[50] **Field of Search** 187/10, 12, 21, 27, 28, 95; 254/173; 182/178

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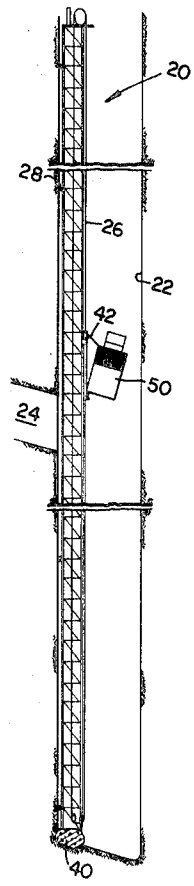
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Primary Examiner—Harvey C. Hornsby
Attorney—Owen, Wickersham & Erickson

ABSTRACT: An underground elevator system for mine personnel comprised of support mast formed from a plurality of prefabricated structural sections that are connected in an end-to-end arrangement and secured to one side of an excavated shaft. The mast includes an emergency escape ladder enclosed by removable wire mesh and a cab movable along and guided by one side of the mast, the cab being mounted thereon by means that can be adjusted to maintain it level despite the degree of mast incline. The cab is driven by cable hoist means mounted at the top of the mast and includes an overspeed-catching means and a slip-sensing safety means.



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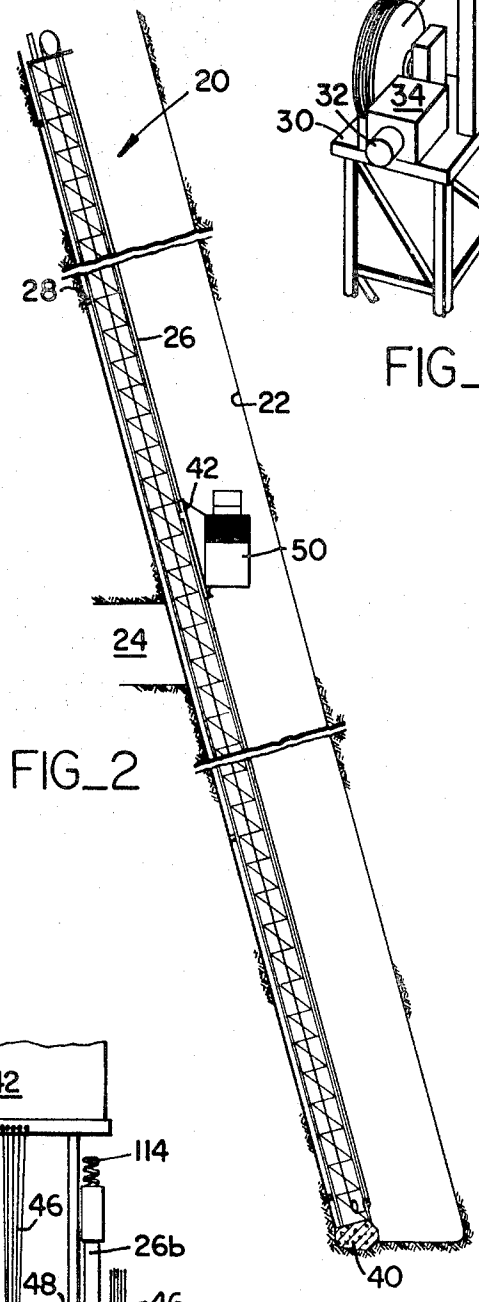


FIG_2

FIG_3

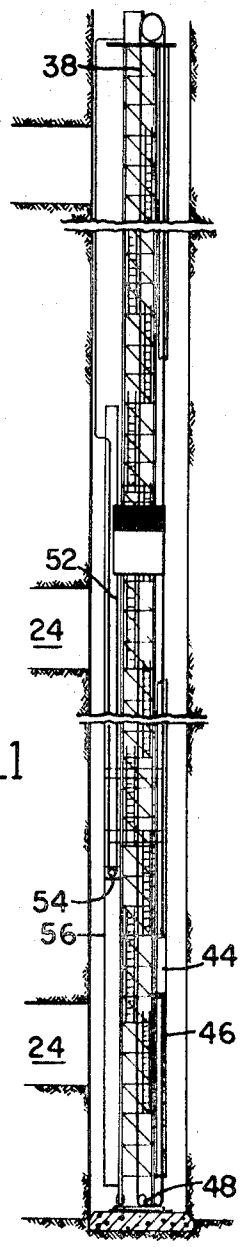


FIG_1

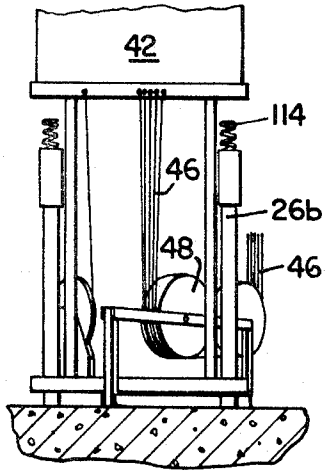


FIG_4

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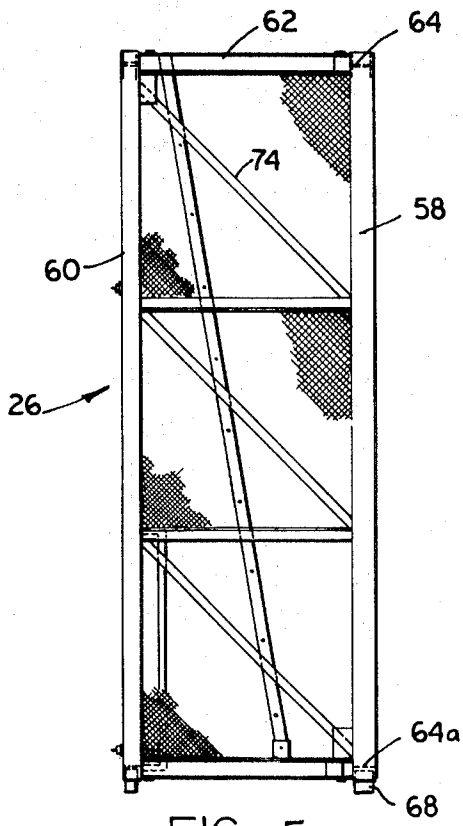


FIG-5

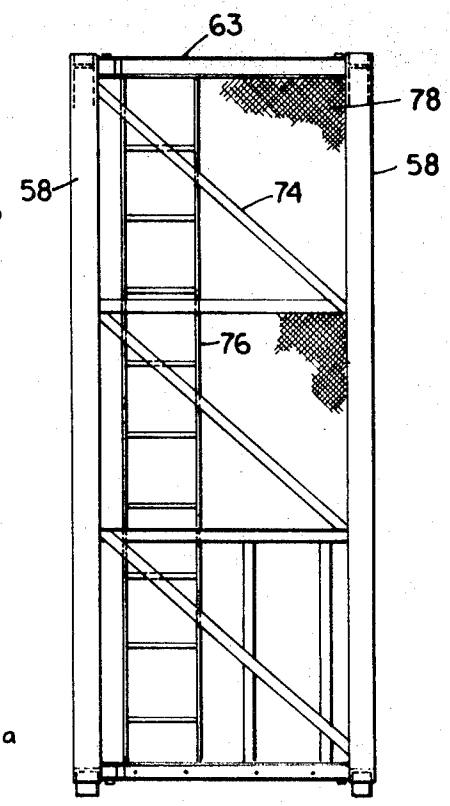


FIG-6

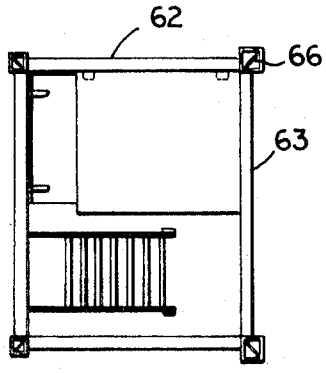


FIG-7

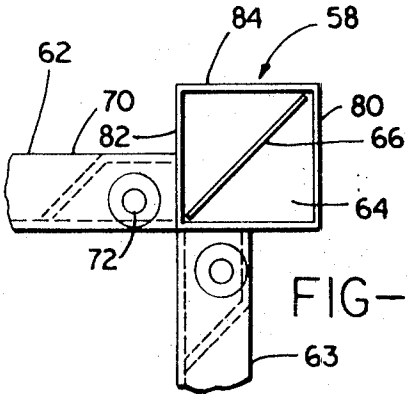


FIG-8

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FIG_9

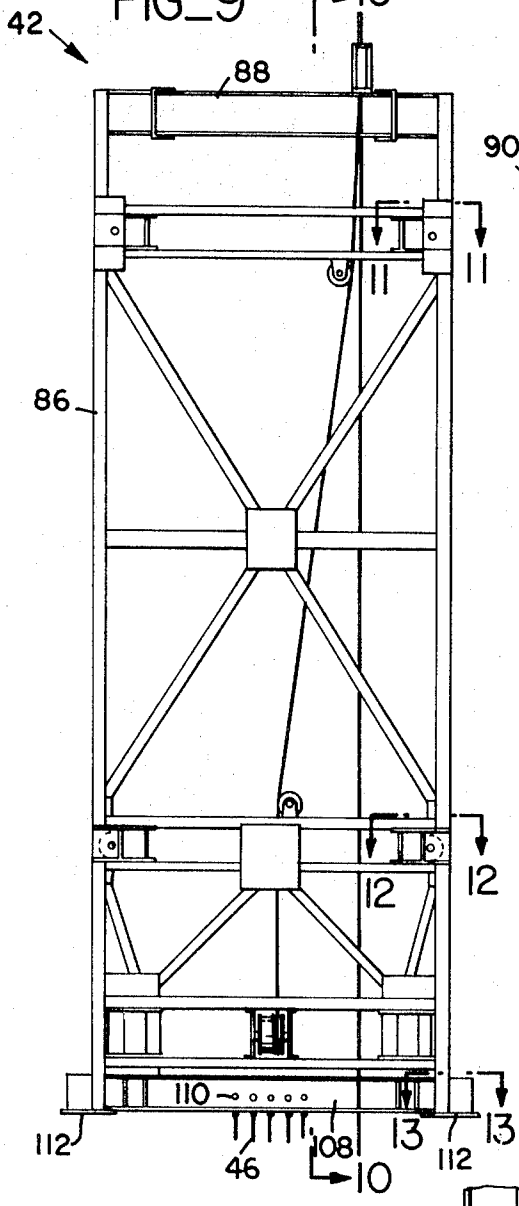


FIG_10

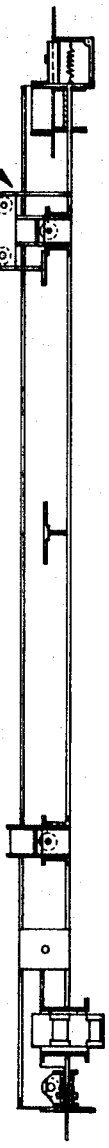


FIG_11

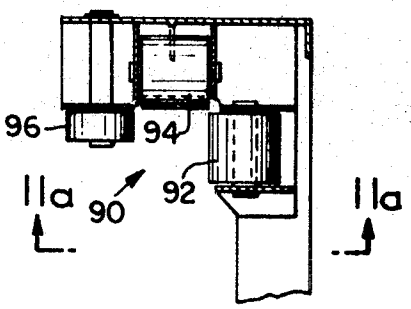


FIG_11a

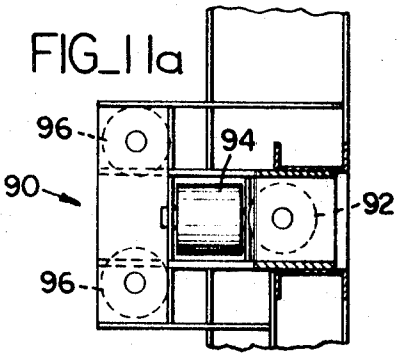


FIG_12

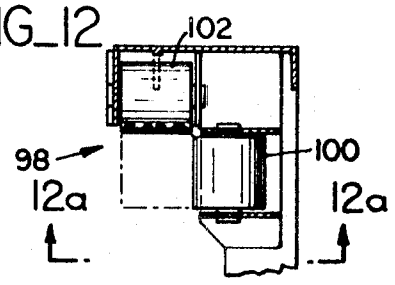
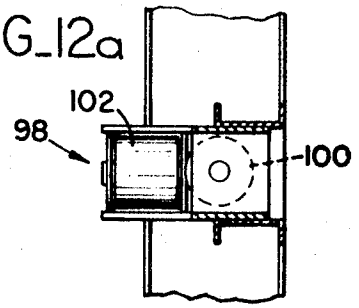


FIG_12a



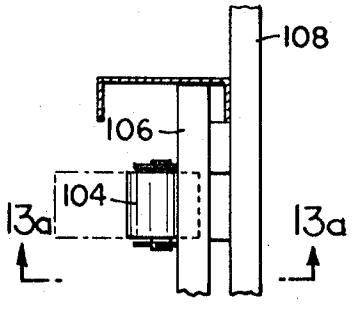


FIG_13

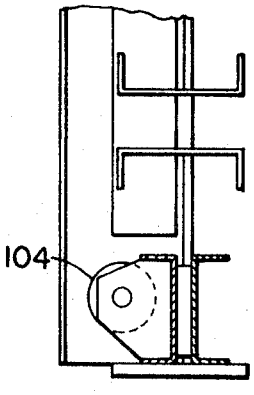


FIG_13a

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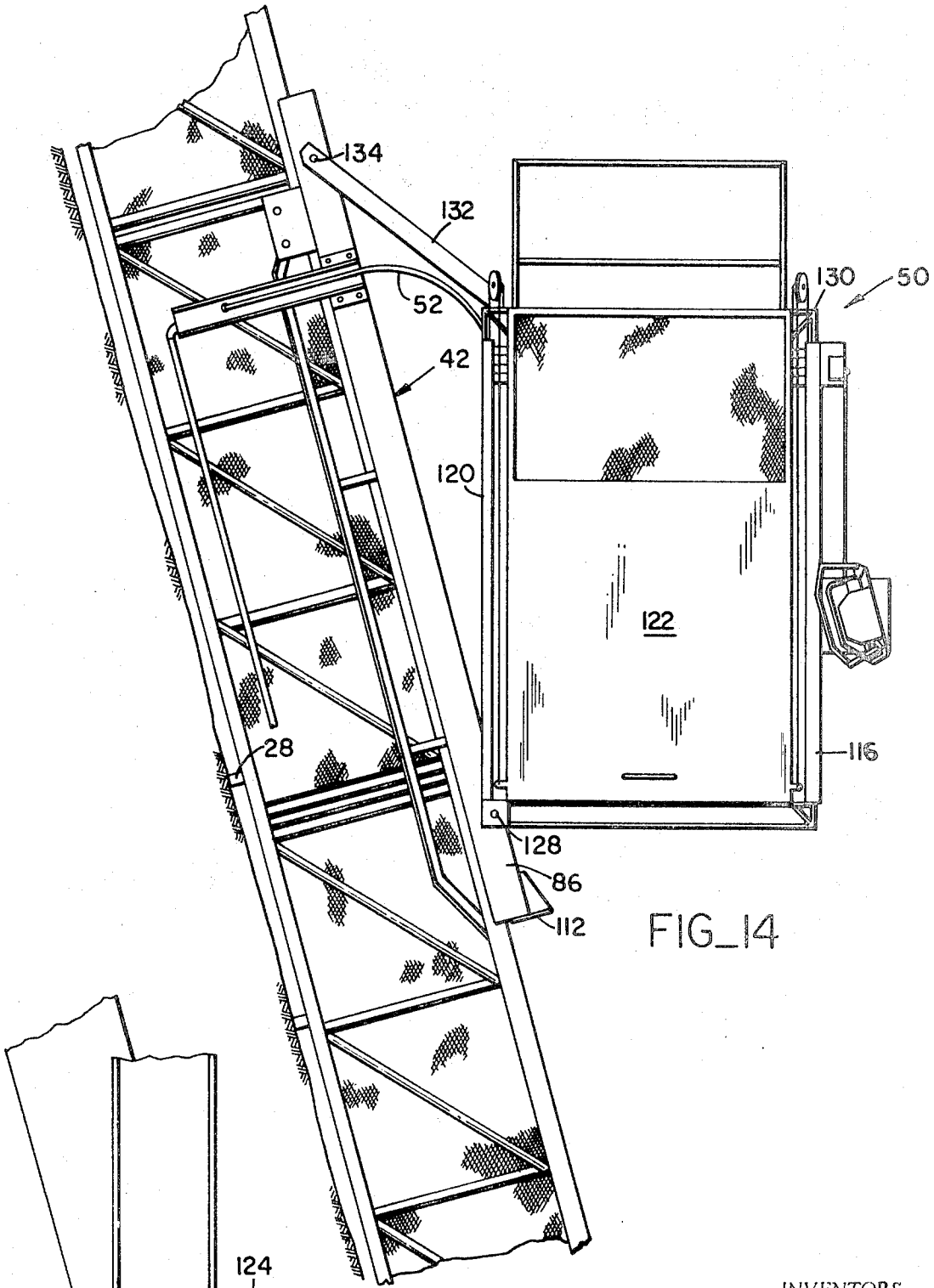


FIG_14

FIG_15

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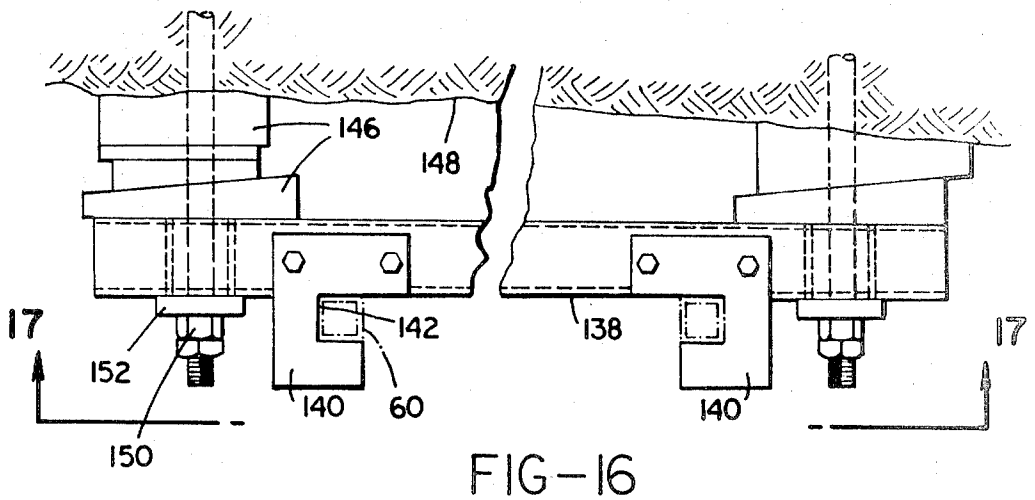


FIG-16

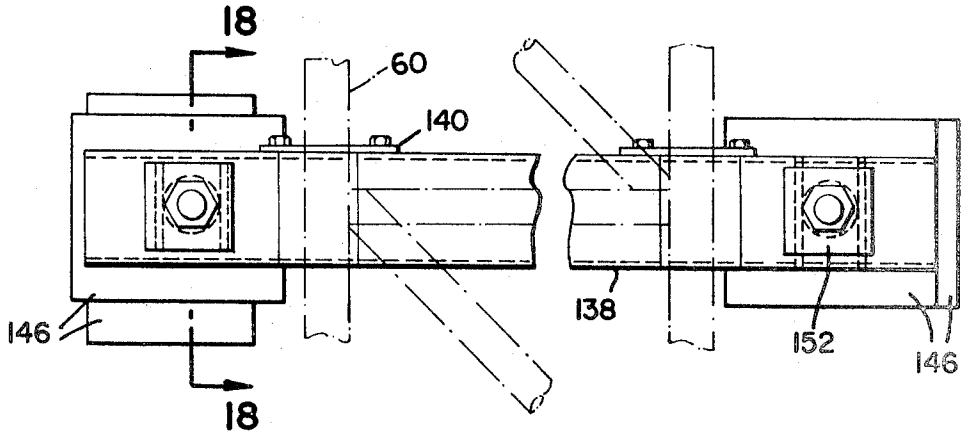


FIG-17

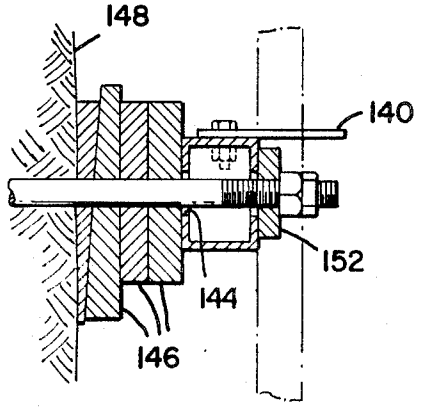


FIG-18

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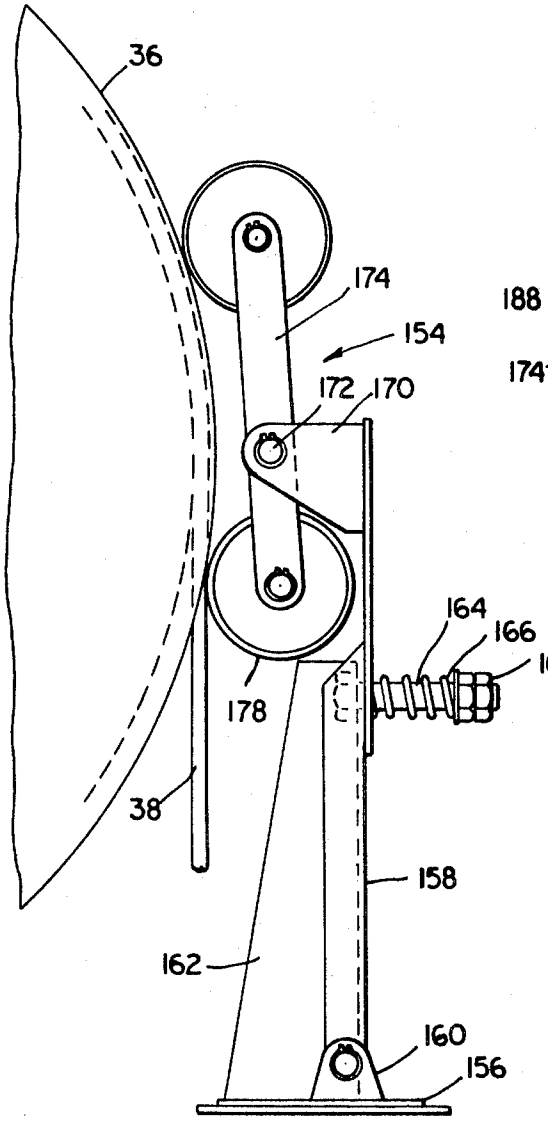


FIG-19

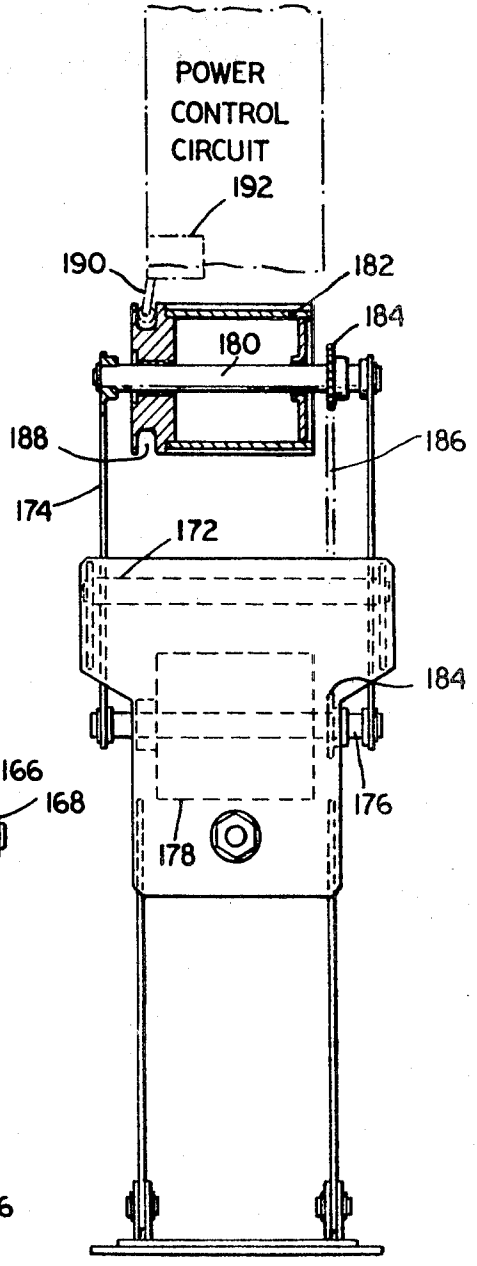


FIG-20

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ELEVATOR SYSTEM FOR MINE SHAFT

This invention relates to an improved elevator or vertical transportation system for installation in underground mine shafts and the like.

Timber beam construction has long been used for mine shafts and the like to provide the means to reinforce the shaft and support an elevator cage and its counterweight. Generally, such construction comprised a double compartment arrangement as required by mine safety standards, with one compartment housing the elevator or cage and the other compartment including provisions for an escape ladder in the event of a power failure. Such timber type construction had several disadvantages and created certain problems, because it was complicated, expensive and time consuming to install, as well as being vulnerable to fire and the other limitations inherent with wood. A general object of the present invention is to overcome these disadvantages while solving the problem of providing a mine hoist system having the required safety facilities.

Another object of the present invention is to provide a mine hoist system that can be erected quickly and easily with a minimum requirement for labor and equipment and, more particularly, one that can be prefabricated in sections and then assembled later within a shaft with the sections fixed to the walls of the shaft. The invention also provides a system wherein the mast sections themselves as well as other equipment for the hoisting system can be easily dismantled and moved elsewhere or modified and increased in size.

Still another object of the present invention is to provide a mine hoist system utilizing prefabricated metal mast sections in a mine shaft having strong, structural connector means capable of being anchored firmly in irregular shaft walls. The aforesaid connector means compensate for irregular surfaces of the shaft walls and thereby maintain longitudinal alignment of the mast or tower sections with sufficient accuracy to enable them to serve as guide rails for a vertically movable cage frame and a cab attached thereto.

Most underground mine shafts penetrate the ground at an angle close to a vertical line, but this angle may vary over a considerable range for different shafts. Since the mast within the shaft necessarily is oriented at the same angle as the shaft and the cab is movable on and guided by the mast, some means must be provided for attaching the cab to the mast so that the cab floor will be level. Another object of the present invention is to provide an adjustable connection between the cab and the mast that will allow the cab to assume a normal position as it moves up and down.

Yet another object of the present invention is to provide a slip sensing means on the cable drive system for the cab that will automatically arrest the cab if any slippage occurs when the cab is supposed to be stopped at any point on the mast.

The aforesaid and other objects are accomplished by a prefabricated tower or mast comprised of interconnectable sections that can be lowered into an underground shaft and then fastened together and also to a wall of the shaft to form a supporting structure for a movable cab. Each section in addition to providing the required structural strength includes an internal ladder and protective walls. When connected, the mast sections provide a complete, protected escape means from any level of the shaft. Structural members of the sections form rails to which are movably attached a cage frame that supports a personnel cab or freight platform. The cage frame is controlled by cables connected to a hoisting mechanism at the top of the mast and to a counterweight located at one side of the mast. The cab is operable by conventional controls through a control cable extending from the cab to the hoist mechanism at the upper end of the mast. The mast is easily installed and set up for operation and when necessary, it can be dismantled and moved to another location with a relatively small expenditure of time and labor.

Other objects, advantages and features of the present invention will become apparent from the following detailed description which is presented with the accompanying drawing, in which:

FIG. 1 is a view in front elevation showing an assembled mine shaft hoist system embodying the principles of the present invention;

FIG. 2 is a view in side elevation of the mine hoist system shown in FIG. 1;

FIG. 3 is an enlarged fragmentary view in perspective showing the power drive system at the upper end of the hoist system;

FIG. 4 is an enlarged fragmentary view in elevation showing the lower end of the mine hoist system according to the present invention;

FIG. 5 is a view in side elevation of one mast section for the mine hoist system shown in FIGS. 1 and 2;

FIG. 6 is a view in front elevation of the mast section shown in FIG. 1;

FIG. 7 is a top view of the mast section shown in FIG. 5;

FIG. 8 is an enlarged fragmentary plan view showing one corner of a mast section;

FIG. 9 is a view in front elevation of the cage frame for the mine hoist system according to the present invention;

FIG. 10 is a view in side elevation and in section taken along the line 10—10 of FIG. 9;

FIG. 11 is an enlarged fragmentary view in section taken along the line 11—11 of FIG. 9;

FIG. 11*a* is a view in section taken along the line 11*a*—11*a* of FIG. 11;

FIG. 12 is an enlarged fragmentary view in section taken along the line 12—12 of FIG. 9;

FIG. 12*a* is a view in section taken along the line 12*a*—12*a* of FIG. 12;

FIG. 13 is an enlarged view in section taken along the line 13—13 of FIG. 9;

FIG. 13*a* is a view in section taken along the line 13*a*—13*a* of FIG. 13;

FIG. 14 is a greatly enlarged view in side elevation showing a portion of a mast section with the cab attached thereto;

FIG. 15 is a further enlarged fragmentary view in elevation showing one connection of the cab on the cage frame;

FIG. 16 is an enlarged plan view showing the connectors for securing the mast sections to a shaft wall;

FIG. 17 is a view along line 17—17 of FIG. 16;

FIG. 18 is a view in elevation and in section taken along line 18—18 of FIG. 17;

FIG. 19 is an enlarged view in side elevation showing the slip sensing device on the power control section;

FIG. 20 is a view in front elevation and partially in section of the device shown in FIG. 19.

GENERAL DESCRIPTION

Referring to the drawing, FIG. 1 and 2 show a mine hoist assembly 20 embodying the principles of the present invention as it appears when installed in a typical mine shaft 22 that extends downwardly from a surface opening and interconnects mine drifts 24 at various levels. The mine shaft may be formed by any conventional excavation method and has generally a rectangular cross section. As shown, the shaft enters the ground at an angle to the vertical, as is common in shaft mining, but the present mine hoist is adaptable for installation in shafts inclined as much as 40° to the horizontal. Generally, the mine hoist assembly comprises a plurality of prefabricated mast or tower sections 26 that interconnect together in an end-to-end arrangement and are fixed by anchoring means 28 to one wall of the shaft. The upper mast section 26*a* forms a support platform 30 for a power drive unit which, as shown in FIG. 3, includes an electric motor 32 connected through a suitable transmission and control unit 34 to a winch or traction sheave 36 to which a series of lifting cables 38 are attached. The lower mast section 26*b* is supported at the bottom of the shaft in a body of concrete 40, unless the surrounding rock material is sufficiently stable to serve the same purpose. The intermediate mast sections 26 between the top and bottom sections 26*a* and 26*b* are all structurally identical and are

interconnected to form the complete tower or mast of the desired height.

Connected to and movable up and down the mast is a cage frame **42** to which are attached the lifting cables **38** from one side of the traction sheave **36**. As shown in FIG. **2**, the same cables from the other side of the traction sheave extend down the shaft and are connected to the upper end of a counterweight **44**. For hoists over 300 feet high, a series of compensating ropes **46** are fixed to the lower end of the counterweight **44** and extend downwardly and around a series of compensating rope sheaves **48** supported in the base mast section **26***b*, as shown in FIG. **4**. From the latter sheaves these compensating ropes extend upwardly and are fixed to the lower end of the cage frame.

Attached to the cage frame **42** is a cab **50** for carrying personnel which is adjustable in its position so that it can remain level despite the slope or incline of the mast sections **26**. The cab contains operating controls which preferably are similar to those in automatic passenger elevators thereby making the hoist operable by any personnel and eliminating the need for a special hoist operator. Details of such control systems are available in the prior art and will not be described herein since they do not comprise part of the present invention. A control cable **52** from the cab controls extends through a control cable trolley **54** that is movably supported in a trolley rail **56** fixed adjacent to one side of the connect mast sections **26**. This trolley rail extends from approximately the midheight of the mast to near its base. From the trolley the control cable extends upwardly to the power drive unit. Thus, as the cab moves up and down on the mast, the control cable is kept straight and under tension and thus free from entanglement with surrounding structure.

THE MAST SECTIONS 26

As shown in FIGS. **5–7**, each mast section **26** is comprised of pairs of upright front and rear structural members **58** and **60** which are parallel, spaced apart and connected by suitable cross beam members **62** and **63** at their upper and lower ends. Preferably these upright members have a square tubular cross section and at their upper and lower ends each has a transverse plate **64** or **64***a*. The plates **64** at the top ends are each provided with a diagonal slot **66** while the plates **64***a* at their bottom ends have similarly oriented vertical aligner plates **68** which are fixed so that they extend below the ends of the upright members. Thus, when one mast section **26** is placed on top of another section the aligner plates **68** at the lower ends of the upper section fit within the slots **66** of the lower section and maintain the two connected sections **26** and their upright members in perfect alignment. The cross beam members **62** at the upper and lower ends of each section, as shown in FIG. **8**, have horizontal flange portions **70** that are flush with the transverse end plates **64** and **64***a* of the upright members. These flange portions have bolt holes **72** at predetermined locations near their ends which automatically align and match with similar holes on adjoining sections when the guide plates **68** are inserted within the slots **66** as described. Bolts (not shown) through these holes **72** are then easily inserted and tightened to hold the adjoining mast sections firmly together.

Additional diagonal reinforcing members **74** are used to interconnect the upright members **58** and **60** and strengthen each mast section. Extending from the lower end to the top end of each section, preferably at a slight angle to the vertical, is a ladder **76**. On the sides of each mast section between the two front upright members and between the front and rear upright members on both sides are panels **78** of a suitable wire mesh material such as expanded metal mesh. This provides a protective shield around the mast for anyone using the emergency ladder. The wire mesh panels are secured by suitable fasteners and are thus easily removable so that access to the ladder can be readily accomplished at any point along the mast.

As shown in the cross-sectional view of FIG. **8**, the front upright members **58** of each mast section **26** are larger in cross section than the rear upright members **60** and they extend outwardly from the sides of the interconnecting frame members **62** and **63**. Thus, on each front upright member there are front and rear parallel surfaces **80** and **82** and a planar outer side surface **84**, all of which extend its full length. These three surfaces thus provide guide means for retaining the cage frame **42** on the mast as it moves up and down.

THE MAST-ANCHORING SYSTEM

The mast sections are attached to one wall of the shaft by means of rockbolts **136**. While various types of rockbolts may be used depending on the nature of the material surrounding the shaft, a preferred structural arrangement for anchoring the mast sections using rockbolts is shown in FIGS. **16** to **18**. Generally, it comprises a structural cross beam **138** having a box type cross section to which are attached a pair of retaining plates **140**. The latter are hook-shaped in plan form and fit around the rear upright members **60** of a mast section **26**, the upright members fitting into the pockets **142** of the retainer plates **140**. Spaced outwardly from the retaining plates on the beam are openings **144** through which the rockbolts extend. When the mast is erected, the rockbolts **136** are first set in drilled holes in the shaft wall at the proper spacing. The beam **138** is then placed in position with the retaining plates hooked around the mast members **60** and the rockbolts extending through openings **144** in the beam. Timber blocks and wedges **146** are placed between the beam **136** and the shaft wall **148** to take up excess space. Anchor nuts **150** which bear against channel-shaped washer plates **152** are attached to the end of each rockbolt. With the mast and beam adjusted to the proper position using the shims **146** where necessary, the anchor nuts are then tightened to secure the mast sections to the shaft wall.

THE CAGE FRAME 42

The cage frame **42**, as shown in FIGS. **9** to **13**, is fabricated from structural steel members in a conventional manner and comprises essentially a pair of parallel, spaced apart side members **86** interconnected by suitable supporting cross members **88**. Spaced downwardly from the top end of each side member is an upper connector **90** for holding the cage frame on a front mast member **58**. As shown in FIGS. **11** and **11***a*, these upper connectors are comprised of a pair of front and side rollers **92** and **94** which are rotatably mounted on the cage frame so that their axes are at right angles to each other and their surfaces will engage the front and side surfaces **80** and **84** of a front mast member **58**. A pair of third or rear rollers **96** which are narrower than the front roller **92**, are spaced from it so as to engage the rear surface **82** of the front mast member. Each upper connector thus surrounds a front mast member on three sides and thereby holds the cage frame on the mast. Spaced upwardly from the lower end of the cage frame are a pair of lower connectors **98** as shown in detail in FIGS. **12** and **12***a*. Each of these lower connectors comprises a pair of rollers **100** and **102** which are mounted on the cage frame with their axes at right angles to each other, thereby positioning the rollers so that they engage the front and side surfaces **80** and **84** of the front mast members **58**. Another pair of rollers **104** as shown in FIGS. **13** and **13***a* are preferably mounted on a bottom cross beam **106** at the lower end of the cage frame **42** and are positioned to engage the front surface of the front mast members. The cross beam **106** is attached to but spaced from a similar cross beam **108** and mounted transversely between these two beams are five pins or bolts **110** to which the ends of the compensating ropes **46** are attached. Fixed to the opposite ends of the cross beams **108** and **110** are a pair of circular plates **112** that serve as contact pads for engaging a pair of bumper springs **114**. The latter springs are mounted at the bottom end of the mast section as shown in FIG. **4**.

THE CAB 50

The cab is essentially a fabricated steel frame **116** mounted on a platform **118** to which walls **120** of sheet metal and/or heavy wire mesh material are attached. The walls are held in place by any suitable fasteners that allow them to be easily removable when desired. Both a vertical sliding door on one side and horizontal swinging doors on the other side may be provided as well as an escape hatch in the ceiling on the cab. In accordance with an important feature of the invention the cab is attached to the cage frame **42** by means of removable pins and a linkage that allows the cab to remain level despite an angle of incline on the mast. As shown in FIGS. **14** and **15**, the cab frame **116** is reinforced at one end of a bottom frame member **124** by a plate **126** which is bored to receive a lower pin **128**. A corresponding bottom frame member on the other side of the cab is similarly bored to receive another lower pin. These two lower pins **128** are axially aligned and extend through similarly aligned bore holes located near the lower end of the outer longitudinal members **86** of the cage frame. At the top of the cab are a pair of top frame members **130** that are provided with axially aligned bores for receiving a pair of pins (not shown) each of which also extends through one end of a link **132**. The other ends of both of these links are connected by a pair of pins **134** that extend through aligned bores near the upper end of the cage frame. The holes near opposite ends of the links **132** are spaced apart so that the cab will assume a normally level position when the links are attached to the cage frame. For different angles of the shaft and thus the mast installed therein, the distance between the holes for the pivot pins in the links **132** can be varied so that the cab will be level. Links with a series of alternate holes can be provided to provide for cab level adjustment.

THE SLIP-SENSING DEVICE 154

As part of the power drive and control system a slip-sensing means **154** is provided on the upper mast section **26***a* which detects any slippage of the lifting cables **38** on the traction sheave **36**. As shown in FIGS. **19** and **20**, this device is mounted on a platform **156** adjacent to the traction wheel and comprises an arm **158** which is pivotally connected at its lower end to a bracket **160** fixed to the platform. Extending upwardly from the bracket and in line with the arm is a stationary member **162** to which is fixed a bolt **164** that extends horizontally through the arms. A coil spring **166** surrounds the bolt with one end of the spring being retained by a nut **168** on the end of the bolt. The opposite end of the spring bears against the arm, thereby urging it in one direction toward the traction wheel. At the upper end of the pivotal arm is a bracket **170** supporting a pin **172** to which is pivotally connected a pair of links **174**. At their lower ends the links rotatably support a shaft **176** to which is attached a lower contact roller **178**, and at their upper ends these links **174** support another shaft **180** to which is fixed an upper roller **182**. The upper roller normally turns with its shaft when it is free to do so, but if the roller is restrained while the shaft **180** is turned, the roller **182** will tend to move axially on the shaft. The lower roller **178** is positioned to bear directly against one lifting cable **38** extending from the traction wheel while the upper roller **182** is positioned to engage the traction wheel itself. Both of the shafts **176** and **180** are provided with small sprocket wheels **184** which are connected by a small continuous chain **186** so that the rotation of the two rollers is normally the same, as when there is no slippage of the cable on the traction wheel. The upper roller has an annular groove **188** near one end within which rides the arm **190** of a limit switch **192**. The latter, which may be any suitable type that is commercially available, is connected in the power control circuit of the hoist drive.

The operation of the slip sensing cutoff device should be apparent from the foregoing description. If slippage of the lifting cable **38** contacting the lower roller **178** occurs, the lower roller will rotate faster than the upper roller **182**. Since the two roller shafts **176** and **180** are connected by a direct chain drive **186** the upper shaft **180** will be driven by the lower roller **178** and its shaft **176** and thus the upper shaft will rotate faster than the upper roller. This causes the upper roller **182** to move axially on its shaft and thereby actuates the limit switch arm **190** that rides in the groove of the upper roller.

As stated previously the control system for the cab or elevator may be of any suitable type that is commercially available. In addition, the system may include the usual safety provisions such as a suitable overspeed catching device. From the foregoing it should be apparent that the present invention provides a unique mine hoist that may be erected with a minimum of labor in a relatively short time. The only on site construction jobs are the assembly of the mast sections and their attachment to a shaft wall. Yet, the system has the versatility and safety features of much more complicated and expensive permanent mine elevator installations.

To those skilled in the art to which this invention relates, many changes in construction and widely differing embodiments and applications of the invention will suggest themselves without departing from the spirit and scope of the invention. The disclosures and the description herein are purely illustrative and are not intended to be in any sense limiting.

We claim:

1. A combined elevator and escape passage for installing in a mine shaft comprising:
   - a plurality of prefabricated mast sections each having parallel spaced apart front and rear longitudinal members connected by crossmembers;
   - means on the ends of said longitudinal members for connecting said mast sections together in longitudinal alignment;
   - means for securing said rear longitudinal members to one wall of the mine shaft;
   - cage frame means movably mounted on said front longitudinal members;
   - a cab extending outwardly from said cage frame and means for adjustably connecting said cab to said cage frame for keeping it in a level position for varied angular positions of the mast sections;
   - each mast section including a ladder located within the cross-sectional area defined by said longitudinal members, and wall means attached to said longitudinal members to provide a protected escape passage; and
   - power control means mounted on a top mast section including lifting cables connected to said cage frame means for moving it up and down on said connected front longitudinal members of said mast sections.

2. The elevator system as described in claim 1 wherein said front longitudinal members on each mast section have a flat sided cross section, aligner means fixed in the ends of said longitudinal members for maintaining the longitudinal members of adjoining mast sections in alignment.

3. The elevator system as described in claim 1 wherein means for connecting said mast sections together includes aligner means comprising transverse plates fixed to the ends of said longitudinal members, an edge mounted plate fixed to each said transverse plate at one end of each mast section, and slots in said plates located at the other end of said mast section; and bolt means through said cross members of adjoining mast sections adjacent said longitudinal members.

4. The elevator system as described in claim 1 wherein said adjustable means comprises a pair of fixed pivotal connections between the lower end of said cab and the cage frame and a pair of links each pivotally connected at one end to said cage frame and at the other end to the upper end of said cab.

5. The elevator system as described in claim 1 wherein said means for securing said rear longitudinal members to the shaft wall comprises a transverse beam, hook means on said beam for engaging said rear longitudinal members, a pair of spaced apart rock bolts adapted to be embedded in the shaft wall, and means for securing the ends of said rock bolts to said transverse beam.

6. The elevator system as described in claim 1 wherein said power control means on said upper mast section includes a traction wheel, motor means and means drivingly connecting said motor means to said traction wheel, a counterweight, cable means extending around said traction wheel and connected at opposite ends to said cage frame and to said counterweight.

7. The elevator system as described in claim 6 wherein slip-sensing means adjacent said power control means for sensing any relative slippage of cables on said traction wheel.

8. The elevator system as described in claim 7 wherein said slip-sensing means comprises means contacting said traction wheel and a cable thereon and responsive to a differential movement between them for deactivating said power control means.

9. An elevator system for installation in a mine shaft comprising:

a plurality of prefabricated mast sections each having parallel spaced apart front and rear longitudinal members connected by cross members;

means on the ends of said longitudinal members for connecting said mast sections together in longitudinal alignment;

means for securing said rear longitudinal members to one wall of the mine shaft;

cage frame means movably mounted on said front longitudinal members;

a cab attached to said cage means;

power control means mounted on a top mast section including a traction wheel, motor means and means drivingly connecting said motor means to said traction wheel, a counterweight and lifting cables extending around said traction wheel and connected at opposite ends to said cage frame and to said counterweight for moving the cage frame up and down on said connected front longitudinal members of said mast sections;

and slip-sensing means adjacent said power control means for sensing any relative slippage of cables on said traction wheel, said slip-sensing means comprising a pair of first and second rollers mounted on a pair of spaced apart first and second shafts, respectively, means for supporting said shafts so that said first roller engages said traction wheel and said second roller engages a cable that extends around said traction wheel, chain means drivingly connecting said shafts, means on said first shaft for causing axial movement of said first roller whenever its rate of rotation is less than that of said shaft, and means on said first roller for actuating a switch to stop said power control means when said first roller is caused to move axially.

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