United States Patent

[11] 3,591,123

[72] Inventor **Andrew D. Edwards**
Box 563, Mossyrock, Wash. 98564

[21] Appl. No. **751,192**
[22] Filed **Aug. 8, 1968**
[45] Patented **July 6, 1971**

[54] **FORMING METHOD AND APPARATUS**
9 Claims, 7 Drawing Figs.

[52] **U.S. Cl.** **249/10,** 249/20, 254/106
[51] **Int. Cl.** **E01g 5/12,** B66f 1/00
[50] **Field of Search** ..... 254/105-—107, 89; 25/131; 249/10—12, 20, 189, 192, 193; 264/33, 34

[56] **References Cited**

UNITED STATES PATENTS

2,845,685	8/1958	Lovgren	249/192
3,071,837	1/1963	Ceretti	249/10
3,222,750	12/1965	Kimball	25/131
3,437,305	4/1969	Cury	249/10

Primary Examiner—Othell M. Simpson
Assistant Examiner—David R. Melton
Attorney—Graybeal, Cole & Barnard

ABSTRACT: Plural form wall panels are horizontally successively joined together by vertical slide joint means. Alternate panels are disconnected from hardened concrete, are raised vertically by hydraulic rams carried by the intermediate panels until portions of such alternate panels are above the hardened concrete, and are resecured to the concrete at the higher level. The intermediate panels are thereafter disconnected, pulled upwardly to the new level by the rams, and are resecured to the concrete at the higher level in horizontal alignment with the alternate panels.

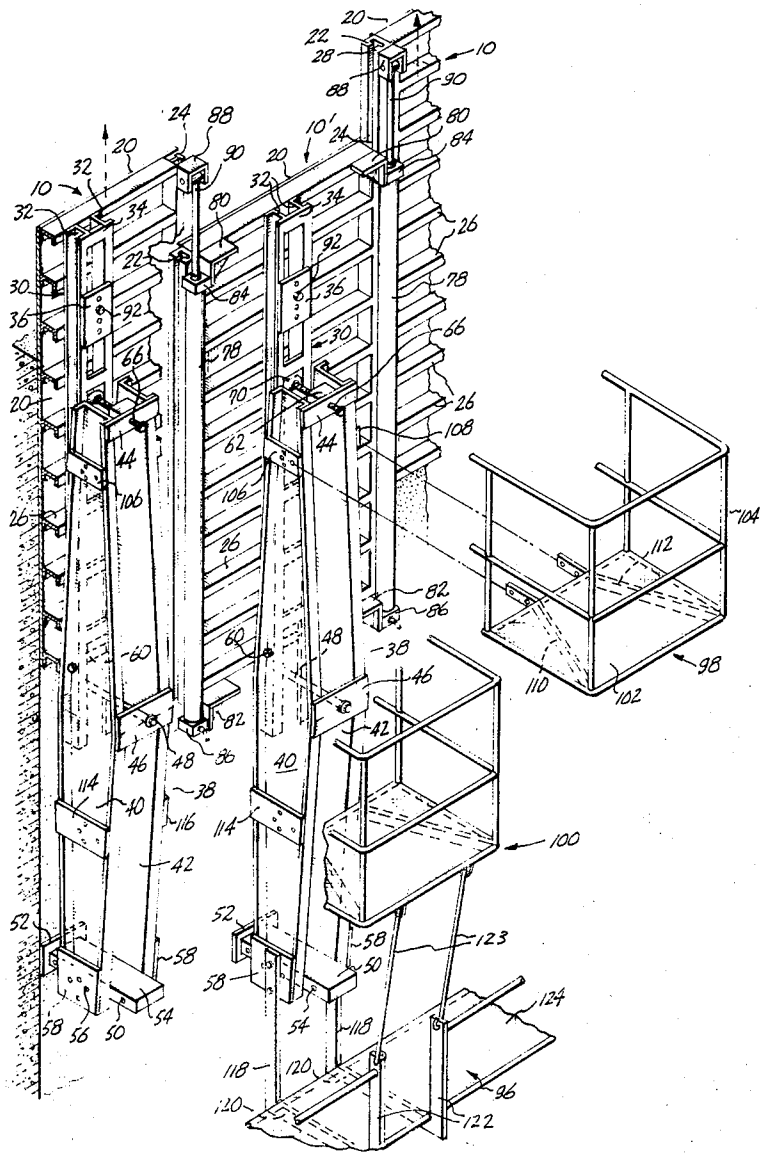


Fig. 1.

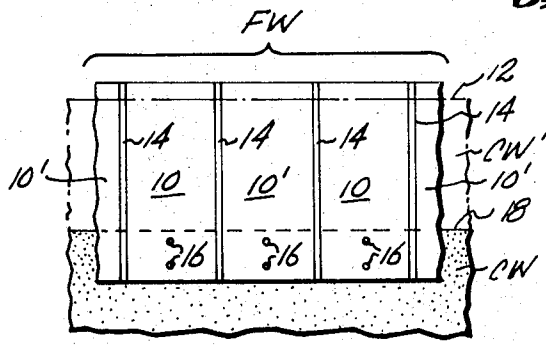


Fig. 2.

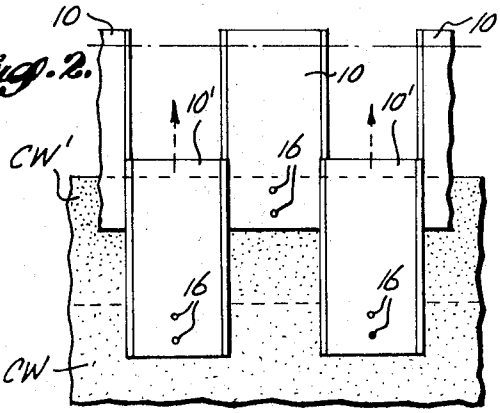
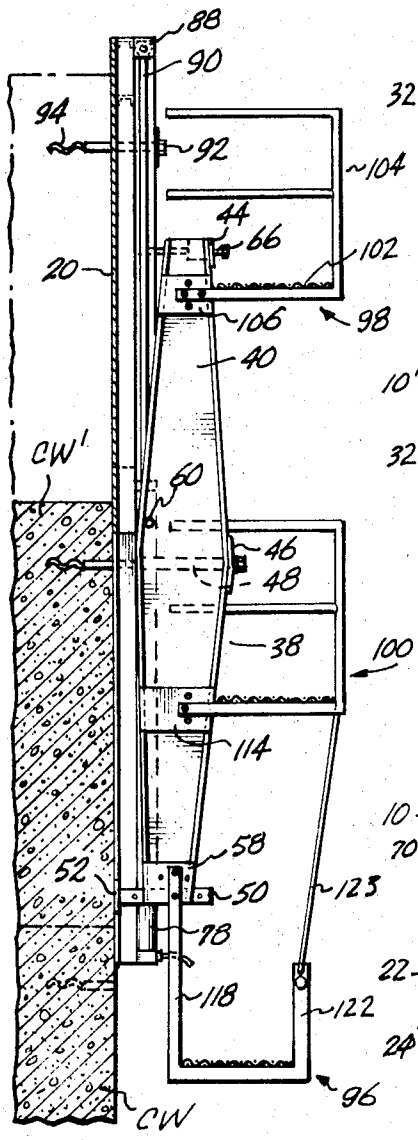
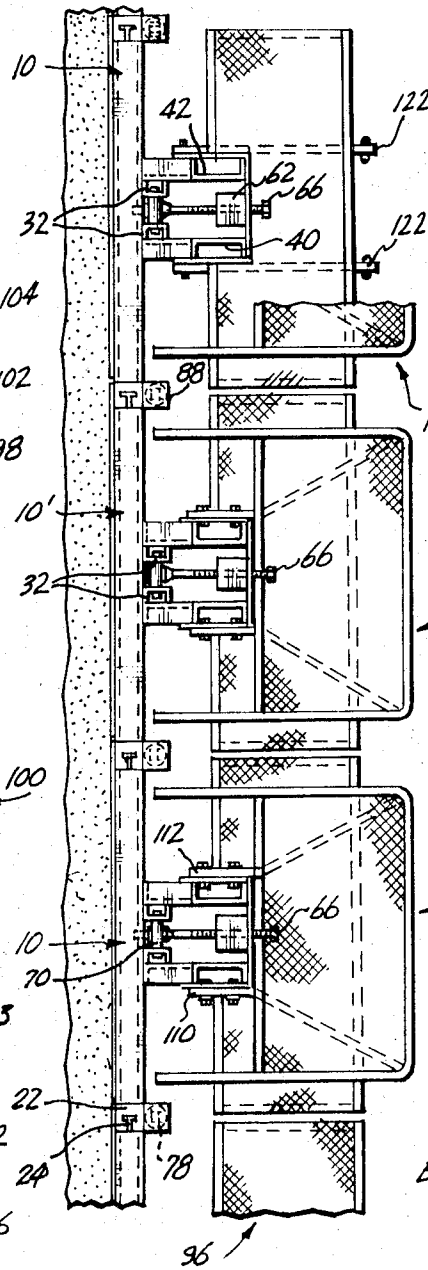


Fig. 3.





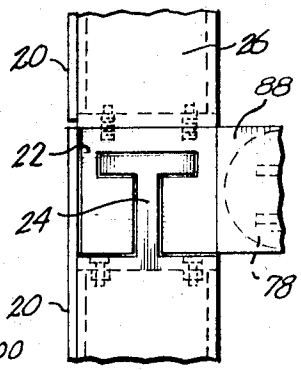


Fig. 5.

Fig. 4.

INVENTOR
ANDREW D. EDWARDS
BY Strayhorn, Cole & Barnard
ATTORNEYS

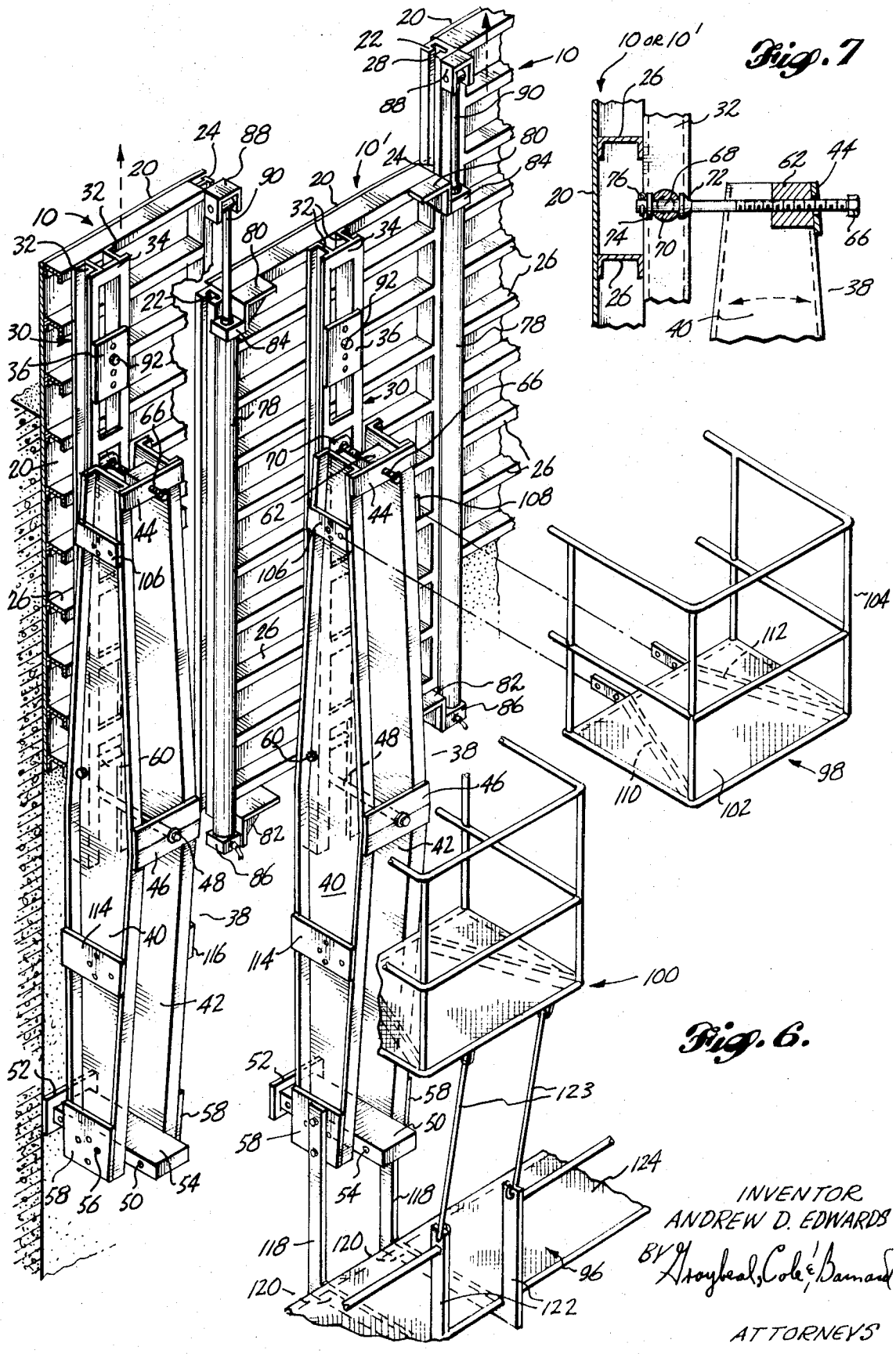


Fig. 7

Fig. 6.

INVENTOR
ANDREW D. EDWARDS
BY Stoughton, Cole & Barnard
ATTORNEYS

FORMING METHOD AND APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a new technique of raising a form wall which is adapted to form a concrete structure in a succession of lifts or pours, each on top of the last, and to specific form wall structure.

2. Description of the Prior Art

It is common practice to pour large concrete walls, such as around dams and canal locks, for example, in a plurality of lifts. Firstly, the lowest section is poured. An interval of time is allowed for the setting of the concrete and then the form walls are moved upwardly and a second lift is poured on top of the first lift. This procedure is repeated over and over again until the concrete structure is completed. The customary method of raising the vertical form walls involves the steps of grabbing ahold of a large section of the form wall by means of an overhead lifting device, then disconnecting the entire section from the hardened concrete, then operating the lifting device to raise the section upwardly to the new level, and then resecuring the wall section to the concrete at the higher level. This technique is quite hazardous to the men who must work below the quite large wall section while either detaching or securing it to the concrete. The operator of the overhead lifting means is remote from such workmen and due to its size and weight the wall section tends to want to swing and/or twist while it is being moved. Both of these factors affect the amount of control the operator can have over wall section movement. Regardless of the amount of care employed it is quite easy for the wall section to either strike and injure a workmen standing in a limited space on a scaffold or the like, or to force him off the scaffold. Also, there have been instances where such wall sections have been dropped, resulting in the deaths of many workmen in its path, and considerable damage to machinery and/or building structures below.

Brynoldt U.S. Pat. No. 2,096,159 discloses a form wall assembly for constructing large concrete structures in a plurality of vertical lifts which includes a truss extending across the concrete structure, such truss supporting large wall sections on each side of the concrete structure. This patent is not addressed to the problem of raising the form wall sections.

Gattnar et al. U.S. Pat. No. 3,085,787 discloses forming apparatus comprising relatively large form wall sections which are supported on, and travel vertically upwardly along, steel guide poles which are embedded in the concrete wall itself.

SUMMARY OF THE INVENTION

According to the present invention the problem of handling the form wall sections in a safe manner is solved by dividing the form wall sections horizontally into a plurality of panels. Adjacent panels are coupled together by vertical slide joint means. Following the hardening of a pour, the alternate panels are disconnected from the hardened concrete, are raised vertically until the greater portions thereof project above the hardened concrete, and are resecured to the concrete at the higher level. Thereafter, the intermediate panels are disconnected from the concrete, are moved upwardly to the higher level and back into horizontal alignment with the alternate panels and are resecured to the concrete.

Preferably the panels are moved by hydraulic thrust rams which are interconnected between adjacent panels. In preferred form the cylinder portions of a pair of hydraulic thrust rams are connected to side edge portions of the intermediate panels, with the pistons of such rams directed upwardly. The upper or free ends of the pistons are connected to brackets extending outwardly from upper corner portions of the alternate panels. With the alternate panels disconnected and the intermediate panels secured to the concrete, hydraulic fluid delivered to the cylinders below the pistons force both the pistons and the alternate panels connected thereto upwardly. When the raised alternate panels are secured to the concrete and the intermediate panels are disconnected, a reverse flow of the fluid results in a retraction of the pistons and the intermediate panels being pulled upwardly. Owing to this manner of operation the form wall of this invention can accurately be termed a "climbing form wall."

Further aspects of the invention reside in more specific features of the illustrated embodiments which are hereinafter described and later claimed.

BRIEF DESCRIPTION OF THE DRAWING

In the illustrations like letters and numerals refer to like parts, and:

FIG. **1** is a diagrammatic view of a fragmented portion of a form wall typifying the invention, with the panels which make up the form wall shown in horizontal alignment and each secured to a hardened portion of the concrete wall ready to support a new pour;

FIG. **2** is a view similar to FIG. **1**, but of the assembly shortly after a new pour, and showing the alternate panels moved up and secured to the hardened new pour and the intermediate panels ready to themselves be moved up into alignment with the alternate panels;

FIG. **3** is a vertical sectional view of a typical embodiment of the form wall taken through one of the panels and the concrete wall;

FIG. **4** is a fragmentary top plan view of a portion of said form wall, said portion comprising three full panels and fragmented portions of two additional panels, all of which panels are of like construction except for hydraulic ram placement;

FIG. **5** is an enlarged fragmentary top plan view taken in the region of one of the slide joints;

FIG. **6** is a fragmentary isometric view of a portion of the form wall, with some parts thereof broken away and other parts thereof in spaced relationship to their assembled positions, for clarity of illustration; and

FIG. **7** is a fragmentary side elevational view, with some parts in section, taken near the upper end of one of the brace beams.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIGS. **1** and **2** diagrammatically illustrate both the essential method steps and the essential structure of the invention. FIG. **1** shows a hardened portion CW of the concrete wall and a fragmented showing of the form wall FW secured to the hardened portion CW and in position to support a new pour of concrete up to a new level **12**. The panels **10**, **10'** are interconnected by slide joint means **14**. Herein the term "slide joint means" means a joining or connecting structure which permits substantially relative movement between the two parts being connected only lengthwise of the panels. The lower portions of the panels **10**, **10'** overlap the upper portion of the hardened wall CW and are secured thereto by bolts **16**, or the like. The greater portion of each panel **10**, **10'** projects upwardly above the upper level **18** of the hardened concrete CW a distance slightly higher than the height of the next pour.

Following hardening of the new pour CW' the alternate panels **10** are disconnected from the hardened concrete CW and are moved upwardly to a higher position and in such higher position are connected to the now hardened concrete CW'. Thereafter the intermediate panels **10'** are likewise disconnected and moved up (FIG. **2**) into positions between the panels **10**, to complete the form wall at the higher level. In this manner no panel **10**, **10'** is ever completely disconnected from the panels **10**, **10'** which flank it, and during all movement the entire wall is always secured to concrete. Consequently, there is no chance of the panels **10**, **10'** falling and killing or injuring workmen, or damaging property below. In a sense, the form wall "climbs" up the concrete wall it is helping to form.

Although not illustrated it is to be understood that the form wall is accompanied by a like or similar form wall spaced from it to establish the opposite side of the concrete wall.

In the preferred embodiment each panel **10, 10'** comprises a rectangular piece of sheet metal **20** which presents a clean surface towards the concrete. The sheet metal is backed by vertical edge beams **22, 24**, and a plurality of interconnecting horizontal beams, some of which are designated **26** in the drawing. By way of typical and therefore nonlimitive example, the sheet metal may be 3/16-inch plate material, and the horizontal beams **26** may be lengths of 2-inch by 4-inch channel stock. One vertical edge beam **22** is formed to include a T-channel, and the other vertical edge beam has a T shape in cross section and is sized to be rather snugly but slidably received in the T-channel **28**.

A vertical reinforcement beam **30**, hereinafter referred to as a "strongback," backs up each panel **10, 10'** and is secured to the horizontal beams **26** of the panel, generally at the midportion of each panel **10, 10'**. The strongbacks **30** are shown to be constructed from a pair of channel beams **32** place web-to-web, but spaced apart, and interconnected at their outer flanges by means of straps of plate material **34, 36**. As will be evident, the strongbacks **30** give the panels **10, 10'** a considerable amount of added stiffness.

A second and larger vertical beam **38**, hereinafter termed as a "cantilever," is secured to each panel **10, 10'** generally rearwardly of the strongback **30**. Each cantilever **38** is a composite beam formed from a pair of spaced-apart, outwardly opening side channels **40, 42** which are interconnected by horizontally disposed spacer straps **44, 46**. The side channels **40, 42** are spaced apart a distance slightly greater than the width dimension of the strongbacks **30**. The cantilevers **38** are secured to the concrete by means of she bolts **48** which extend through cross straps **46** at the midportions of the cantilevers **38**. An adjustable support shoe **50** is provided at the lower end of each cantilever **38**. The support shoes each include a flat pad **52** at its forward end which directly contacts the concrete. The shoes **50** may be in the form of box beams through which a plurality of transverse passageways **54** have been formed, so such passageways **54** can be selectively used to receive a bolt-type fastener **56** which adjustably secures the member **50** to a pair of sideplates **58** provided at the lower ends of the channels **40, 42**.

The cantilevers **38** are connected to the panels **10, 10'** at two locations. The lower location is near the midportion of the cantilever **38**, and the connection is in the nature of a horizontal pin **60** which extends through both the web portions of the strongback channels **32**, and the web portions of the strongback channels **32**, and the web portions of the cantilever channels **40, 42**. The pin **60** forms a pivotal connection, so that the cantilever **38** may be moved relatively forwardly towards or rearwardly from the associated strongback **30** at its upper end. The second connection of the cantilever **38** to its panel **10** or **10'** is at the upper end of the cantilever **38**. As best shown by FIG. **7**, a tapped block **62** in the nature of a large nut is firmly secured to the upper end portion of the cantilever **38**, immediately forwardly of the spacer strap **44**. The block **62** receives the threaded portion of an adjustment bolt **64** having a head **66** on the end thereof remote the panel **10** or **10'**. The opposite end of the bolt **64** may include a round swivel portion **68** which extends through and loosely fits within a transverse opening formed in a transverse pivot pin **70**, extending between the side channels **32** of the strongback **30**. A button **62** is formed on the bolt **64** immediately rearwardly of the pin **70**. A washer **74** is slipped over the portion of bolt **64** which extends forwardly of the pin **70**, and a cotter key **76**, or the like extends through the forwardmost end portion of the bolt **64** and holds the bolt **64** in place. As will be evident, when the adjustment bolt **64** is turned by a wrench such bolt **64** is free to turn in the opening provided for it in pin **70**, and as it turns the nut block **62** and the upper end of the cantilever **38** are moved relatively towards or away from the panel **10** or **10'**, depending upon the direction the bolt **64** is turned.

In operation, the cantilever **38** is connected by means of the she bolt **48** to the concrete, and the bracing shoe **50** is properly adjusted. Thereafter, the adjustment bolt **64** is rotated for the purpose of establishing the correct attitude of the panel **10** or **10'**. The pin **70** is free to turn about the horizontal axis, so that the lean of the adjustment bolt **64** can change as required.

Another principal aspect of the invention involves a particular manner of moving the panels **10, 10'**. As best shown by FIG. **6**, the cylinder portions **78** of a pair of side-placed hydraulic rams are each connected top and bottom to the intermediate panels **10'**. By way of typical and therefore nonlimitive example, corner brackets **80, 82** may be secured to each corner of the panel **10'** on the rearward side thereof, such brackets to include vertical side portions to which the end portions **84, 86** of the cylinders **79** can be connected. Corner brackets **88** are attached to the upper corners of each alternate panel **10**, and the upper ends of the piston portions **90** of the thrust rams are pivotally connected to the brackets **90**, e.g. in the manner illustrated.

In operation, following the hardening of a pour, all direct connections to the concrete of the alternate panels **10** and their cantilevers **38** are released. If necessary the panels **10** are wedged (e.g. by offcentrics) or are in some other manner slightly separated from the concrete so that any seal between the two is broken. Thereafter, fluid pressure is supplied to the lower ends of the cylinders **78** and return lines from the upper ends of such cylinders **88** are opened. In this fashion the alternate panels **10** and their cantilevers **38** are moved upwardly until the location for each she bolt **48** is adjacent the she bolt fitting in the concrete which was previously occupied by an upper she bolt **92** (FIGS. **3** and **6**). The she bolts **48** are then reinstalled at such upper positions for the purpose of securing the now raised panels **10** once again to the concrete. At all times during their movement the panels **10**, and the cantilevers **38** connected thereto, remained anchored to the concrete by means of their connection to the still secured panels **10'**, by means of the slide joints **22, 24** and the thrust rams **78, 90**.

Following securement of the alternate panels **10** to the concrete at the higher level, the she bolts **48, 92** for the intermediate panels are disconnected, and if necessary such panels are pried loose from the concrete. The direction of fluid flow to the thrust rams **62** is reversed so that such rams will then operate to pull the intermediate panels **10'** upwardly into a new position of alignment with the now anchored alternate panels **10**. Thereafter, the she bolts **48** for the intermediate panels are attached at the prior locations for the she bolts **92**. At this time the major portions of all panels **10, 10'** project upwardly beyond the upper surface of the last pour.

One of the further steps necessary before making the next pour is the installation of the she bolts **92** and the placement of new pigtail anchors **94** thereon, so that when the new pour is made the new anchors **94** will be in a position to harden and be firmly anchored in the new pour.

Preferably, each panel **10, 10'** carries a depending section **96** of a finishing scaffold, an upper and intermediate caged scaffolds **98, 100** for use by personnel when manipulating the she bolts **48, 92** and the adjustment bolt **64**.

The upper scaffold **98** is shown to comprise a deck **102** and a three-sided tubular bar fence **104** extending upwardly from the deck **102**. Scaffold **98** is secured to upper side portions **106, 108** of the cantilever **38** by means of a pair of lower support beams **110, 112**. The inner ends of the beams **110, 112** are spaced apart an amount equal to the width dimension of the cantilever **38** in the region of the mounting plates **106, 108**, and then the diverge apart as they extend outwardly towards the outer corners of the scaffold **98**. The forward ends of the tubular bars forming the fence **104** are not connected to the panel **10, 10'**, because the panel **10, 10'** must be free to move relative to the upper end portion of the cantilever **38**.

The intermediate scaffold **100** may be similar in construction to scaffold **98**, but is bolted to a lower set of sideplates **114, 116** on the cantilever **38**.

The section **98** of the finishers scaffold is shown to be supported at the front by a pair of arms **118** which depend

downwardly from the bottom sideplates **58** on the cantilever **38**. Arms **118** are portions of U-shaped members, each also including a horizontal support beam **120** and a rearwardly positioned vertical post **122**. A deck **124** extends across and is secured to the support means **120**. A horizontal guardrail may be secured to upper portions of the post **122**. Tension members **123** may interconnect posts **122** and scaffolds **100**.

The upper scaffold **98** is used during those periods when the she bolt **92** is either installed or removed, or the adjustment bolt **64** is being manipulated. The intermediate staging **100** is used whenever it is necessary to install or remove the she bolt **48**. The finishing scaffold is used by concrete finishers only during those periods when all the panels **10, 10'** are horizontally aligned. The scaffold sections **98** are open ended, but during the periods of panel alignment they together form a substantially continuous scaffold immediately below the panels **10, 10'**.

One particular advantage of making the scaffolds **98, 100** of cage form, and of depending only a section of the finishing scaffold from each panel **10, 10'**, is that it makes it possible to establish a determinable finite maximum loading which must be carried by each she bolt. The scaffolds **96, 98, 100** can be made from relatively lightweight structural materials so they of themselves add little weight to the panel unit of which they are a part.

The foregoing description is for the purpose of providing an understanding of the invention. The following claims serve to measure the scope and limits of the invention.

What I claim is:

1. In a form wall, a plurality of panels, vertical slide joint means horizontally successively interconnecting said panels, and fastener means for directly securing each panel to the concrete structure being formed, independently of the other panels, each slide joint means allowing free vertical movement of an unsecured panel relative to a secured neighboring panel.

2. In a form wall, a plurality of panels, vertical slide joint means horizontally successively interconnecting said panels, and fastener means for directly securing each panel to the concrete structure being formed, independently of the other panels, and vertically oriented thrust means interconnected between adjacent panels for causing the movement of the panels.

3. The combination of claim **2**, wherein said thrust means comprises at least one cylinder connected to each intermediate panel, and a piston in said cylinder including an upwardly extending piston rod, with a first fluid chamber being formed below the piston, a second fluid chamber being formed above the piston, and means for attaching the upper end of the piston rod to an upper portion of an adjacent alternate panel.

4. The combination of claim **3**, wherein each intermediate panel is provided with a pair of cylinders, one at each side thereof, and the means for connecting the upper end of the piston rods to the adjacent alternate panels comprises corner brackets at the upper corners of the alternate panels.

5. In a form wall, a plurality of panels, vertical slide joint means horizontally successively interconnecting said panels, and fastener means for directly securing each panel to the concrete structure being formed, independently of the other panels, and a vertical beam disposed rearwardly of each panel and including a lower portion depending below the panel, a support means at the lower end of said beam in force-transferring relation to hardened concrete below the panel, pivot means connecting a midportion of the beam to said panel, and adjustable connector means interconnecting between the beam and the panel substantially at the upper end of said beam, for moving the panel toward, or away from the upper end of the beam.

6. In a form wall, a plurality of panels, vertical slide joint means horizontally successively interconnecting said panels, and fastener means for directly securing each panel to the concrete structure being formed, independently of the other panels, and at least one work platform secured to at least some of said panels, on the side thereof directed away from the concrete.

7. In a form wall, a plurality of panels, vertical slide joint means horizontally successively interconnecting said panels, and fastener means for directly securing each panel to the concrete structure being formed, independently of the other panels, said fastener means comprising bolts securable to anchors set into the concrete, and including at least one bolt insertable through a lower portion of each panel.

8. In a form wall, a plurality of panels, vertical slide joint means horizontally successively interconnecting said panels, and fastener means for directly securing each panel to the concrete structure being formed, independently of the other panels, and means for raising certain of said panels, following removal of the fastener means for directly securing them to the concrete, while at least some of the other panels are still fastened to the concrete.

9. The combination of claim **8**, wherein said fastener means comprise bolts securable to anchors set into the concrete, and include at least one bolt insertable through a lower portion of each panel.