

SPECIFICATION

Accelerated hardening of concrete

The present invention relates to a method of shuttering and accelerated hardening of concrete cast in large-sized assemblies forming monolithically part of the work to be executed, allowing the shuttering to be dismantled in a time less than or equal to 13 hours after casting, and the concrete to be heated free from any evaporation in an insulated enclosure to a temperature between 50 and 80°.

According to the invention there is provided Apparatus for the shuttering of concrete, which apparatus comprises a pair of roller tracks, a pair of gantries located on the roller tracks for movement along the roller tracks, each of the said gantries including a rigid framework supporting at least two shuttering panels orientated generally longitudinally of the roller tracks, and at least one, generally horizontal shuttering panel, all of the said shuttering panels being releasably connected to the rigid framework to form a rigid structure, and at least a part of the area of the shuttering panels being heated, a pair of end shuttering members each of which comprises at least one transverse shuttering panel which is connected to the horizontal and longitudinal shuttering panels of a respective one of the said gantries, at least a part of the area of the end shuttering members being heated, a transverse roller track for supporting each of the said end shuttering members extending between the longitudinal roller tracks, the said end shuttering members being orientated in the roller tracks for the formation of a space in which a wall is to be constructed, between the respective transverse shuttering panels, the gantries and the said end shuttering members being supported on the longitudinal and transverse roller tracks, respectively, by a plurality of screw jacks adapted to permit adjustment of the orientation of the gantries and the end shuttering members with respect to the roller tracks, the screw jacks associated with the longitudinal roller tracks being so arranged as to be at all times supported by the respective roller track, and screw jacks associated with the transverse roller track being so arranged as to be capable of being raised out of engagement therewith to allow longitudinal movement of the end shuttering members in a direction parallel to the longitudinal roller tracks.

The optimum temperature for the concrete is 65°. The concrete acquires compression resistance reaching 65% of that which corresponds to natural hardening over a period of 28 days at 18°.

The rise in temperature of the concrete takes place in 5 to 8 hours, the concrete then being maintained at a substantially constant temperature so as to being the total period of treatment to about 13 hours, this period not forming a limiting element of the invention since it is possible, in some cases, particularly when it is desired to effect two work cycles per 24 hours, to

bring the total period of treatment down to 6 hours.

The concrete hardens without evaporation because it is enclosed between impermeable shuttering surfaces and is protected on its free face by a movable air-tight and insulating device, e.g. an air-tight and thermally insulating composite formed from an impermeable envelope enclosing a heat-insulating material.

The process is implemented by means of a shuttering device having a heated shuttering surface and formed by good heat-conditioning material carefully insulated on the outside.

The shuttering surface may be heated by a network of electric resistances suitably disposed on the face opposite the concrete at a suitable distance for ensuring uniform heating, and protected by heat-insulation means. It may also be heated by direct contact of a heating fluid with the reverse side of the shuttering surface arranged in the form of a chamber or in the form of a closed circulation volume. In this case, heat insulation, if it is necessary, is transferred to the face of the circulation volume in contact with the outside.

If the surface of the shuttering wall is heated by electric resistances, the spacing therebetween is advantageously between 0.8 times and twice the thickness of the concrete to be treated if this latter is heated only on one face, and between one and three times the half-thickness if it is heated on both faces.

According to a preferred embodiment of the invention, the gantries are adaptable to a variety of spans, and the gantries are movable along running tracks by means of screw jacks fitted with balls or jacks fitted with pivoting rollers.

The running track forms a rigid template carefully adjusted with respect to the plane and levelled before positioning of the gantries in accordance with the geometrical data of the plan of the work to be executed. This adjustment is effected while the shuttering is in service on D day on an additional running track assembly provided for this purpose and placed in the position where the shuttering is to be used on D day + 1 so that the positioning and the adjustment of the gantries on the running track become automatic, contact being established between the gantries and the running track during casting of the concrete thanks to the arrangements of the invention which guarantee the absolute fixity of the assembly and respect of the plan.

Elementary shuttering panels may be assembled together by means of pins ensuring levelling of the shuttering surfaces and clamping of the assembly. These symmetrical and movable pins do not comprise any key or detachable part.

Electric control and regulation connection boxes may be disposed at chosen points allow heating resistances to be supplied with power in accordance with the norms chosen for hardening of the concrete.

In a preferred embodiment of the invention, there may be brought in contact with the reverse side of the shuttering face air and hot gases

produced by a source the temperature and delivery rate of which are controlled, and which act in a closed volume whose contacts with the outside are subject to the overall control established with respect to the results to be obtained in so far as the strength of the concrete at the end of treatment is concerned.

Heat insulation of the shuttering, when there is need for it in accordance with the method of heating adopted, is protected outwardly from dampness and generally from anything which might adversely affect its qualities.

A particular embodiment of heated shuttering for building works allowing orthogonal bearing walls and floors designed in accordance with the invention to be simultaneously cast will be described hereafter by way of example, purely as an indication and in no wise limiting, with reference to the accompanying drawings in which:—

Fig. 1 is a perspective view of a gantry.

Figs. 2a and 2b are views respectively in elevation and in vertical section of a heating panel of the gantry shuttering equipped with electric resistances.

Fig. 2c is a cross-sectional view on a larger scale.

Fig. 3 is an enlarged sectional view along the line III—III of Fig. 1.

Fig. 4 is an enlarged partial elevational view of the base of the gantry shuttering.

Figs. 5a and 5b are partial enlarged views showing the assembly of two gantry shutters respectively in vertical and horizontal section.

Fig. 6 is a perspective view of an insulating material panel for covering and lagging the free faces of the concrete.

Fig. 7 shows an example of heating the shuttering by means of hot gas produced by combustion of a gas in the closed space formed by the tunnel blanked off at both ends.

Fig. 8 shows one example of heating the shuttering by means of hot air produced outside the tunnel by combustion of a fuel such as gas-oil or similar and pulsed inside in the upper part then taken again at the lower part to be recycled.

Fig. 8a shows in a top view an example of assembly of three tunnels of gentries forming one phase.

Fig. 9 shows in perspective the arrangements adopted for casting a transverse wall according to the invention in monolithic fashion.

Figs. 9a and 9b show side views of two embodiments of an end shuttering member.

Fig. 9c shows in a top view another embodiment of the running track for the end shuttering member.

Figs. 10 to 12 shows three examples of building structures able to be produced monolithically using end shuttering members.

Figs. 13 and 14 show the arrangements for making the gentries adjustable in span, the gantry having respectively its minimum and maximum span.

Figs. 15a and 15b show respectively in

elevation and in a top view the assembly of the running track elements.

Fig. 16 shows the arrangement adopted for shuttering bays or simple openings in walls and for stopping these latter at their ends.

Figs. 16a and 16b show, on a larger scale, and respectively in a front view and vertical sectional view the securing of the device of Fig. 16 to the vertical wall of a shutter.

Fig. 17 shows the arrangements used for sealing at the time of casting frames of openings in the walls.

Fig. 18 shows the arrangements provided for the outer gable shuttering at the end of a building.

Figs. 18a and 18b shows on a larger scale and respectively in a vertical sectional view and in elevation the fixing of the brackets of Fig. 18.

Fig. 19 shows the safety device adopted in addition to the normal fixing by pinning in the concrete slab for brackets which, on the outside of the building, allow the gentries to be brought out, this device being designed so that it has of necessity to be placed by the workmen before any gantry can be brought out.

Fig. 19a is a section along line a—a of Fig. 19.

Fig. 19b is a corresponding top view.

The shuttering in form of gantry 1 comprises two resistant semi-elements 1a and 1b the identical frames of which are pressed one against the other and may slide so as to be adapted to different spans; the half frames are locked on a zone which may be in the center 2 of the span by means of a device allowing the shuttering to be moved laterally by means of a tension rod 2a.

On the resistive frame are fixed by means of bolts shuttering and heating panels 3 comprising hollow sections 4 forming elements of rigidity assembled at their ends to flat elements 5 forming the resistant periphery of the panel (Fig. 2a); in the case where the panels are heated by an electric resistance 6, this latter is advantageously placed inside the hollow sections 4, it passes from one to the other through holes provided for this purpose at the ends thereof which also allow the return and the closing of the resistance at a connection and control point 7 connected to the general power supply. (Fig. 2b).

The electrically heated shuttering panels are lagged on the side opposite the concrete by means of an insulating material 8 disposed against the shuttering plate and the stiffeners and is protected by a thin wall 9 fixed at several points to the panel (Fig. 2c).

The shuttering may have any form whatsoever, this being fixed by limits of weight and space.

Gantry 1 rests on a U-shaped running track 10 tied at 11 (Fig. 1); the gantry is adjusted with respect to the plane and levelled by means of four screw jacks 12 provided at the end thereof with a ball 13 imprisoned in a cavity (Fig. 4); these screws are mounted at the base of the half-elements 1a and 1b of the gantry. This device allows the vertical removal of the shuttering by operating screws 12, longitudinal movement in the running track 10 and lateral movement for

transverse removal of the shuttering.

The cylindrical body of jack 12 is tangential in the shuttering position to one of the flanges 10a of the running track 10, a mobile pin 14 is tangential to the other flange 10b so that the gantry shuttering 1 is perfectly locked to the running track which serves as a template therefor during casting.

The adjacent shuttering panels 3 are centered and assembled by pins 15 not comprising any removable part; these pins each cooperate with two facing guide sleeves 16 and 17 respectively integral with each of the vertical edges 5 of panels 3 to be assembled (Fig. 5). Pin 15 provided with an operating handle 15a penetrates while ensuring centering into sleeves 16 and 17; the handle is then folded back 90° and locked behind a lug 18 integral with the panel. Conversely, for removal of the shuttering with the handle raised by 90°, pin 15 may be knocked rearwardly out of sleeve 17 while completely freeing the joint 19 between the two panels; by rotating it 90° it is then locked in this position in front of lug 18, as shown with a broken line in the drawing; the pin may be withdrawn if need be by pivoting it 180° in the direction opposite the locking direction. It may then slide rearwardly escaping from a travel stop 20 integral with the panel and free itself from sleeve 16 which normally serves as a support therefor.

The elementary gantry shuttering 1 is supplied, in the case of heating by electricity, by means of a connection from a transformer or from a distributor fitted with control and automatic regulation devices.

The lagging of the concrete on its faces is obtained by panels of insulating material covered with an impermeable and resistant coating; these panels may be formed from hinged elements foldable on themselves, able to be manipulated by hand, or by large-sized elements supported by a large rigid frame able to be manipulated by means of a lifting device.

One embodiment of such a panel 21 (Fig. 6) comprises a cover 22 made from an impermeable plasticized fabric divided by transverse welds 23 into compartment 24 of about 0.50 m in width in which rigid insulating panels are inserted of an approximate length of 1.20 m, the cover then being sealed hermetically by longitudinal welds 26; the cover between two compartments 24 must have a length L just sufficient to allow the compartments to be folded alternately one on the other when they are removed which facilitates handling and sorting, this flexible joint L, between two adjacent compartments 24, also allowing the effective length of the insulating panel 21 to be well adjusted to that of the concrete to be covered.

In the case where the shuttering is heated by a hot fluid flowing in contact with the reverse side wall of the shuttering in a closed volume, the shuttering panels 33 of the gantry shutterings are not lagged and one example of a possible application of this principle can be given below.

Fig. 7 shows a succession of gantries assembled forming the shuttering 3 for a building bay in the form of a tunnel; two blanking off panels 27 are placed at both ends of this tunnel thus defining a closed space 28 inside which gases and hot air are produced by means of burners 29 supplied with an appropriate fuel gas; the operating conditions and the operating time of these burners are controlled automatically from a thermostat placed at a chosen point on one of the gantries and a timer comprising an adjustable program. Burners 29 are connected together in a usual way by a gas supply pipe 30 and a remote control wire not shown they are also connected to a box 31 containing the control and programming device connected to the thermostat as well as the electro-magnetic valve forming the safety and stop cock; box 31 controlling the heating of each tunnel is supplied with fuel from a heater 32 fed from a storage tank 33 and a supply pipe 34, and with electric current by a connector connected to the power supply of the site.

In this case, the shuttering panels are not lagged, only the end 35 and gable panels being lagged; the lagging is then identical to that used in the electric heating embodiment (Fig. 8a).

The blanking off panels 27 are provided with adjustable orifices for admitting combustion air and discharging the excess of hot gases, with an inspection window for checking from the outside the operation of the burners and an access door for the case where maintenance work is necessary.

Fig. 8 shows another embodiment according to which the hot air is produced outside the closed volume 28 by a generator 36 supplied with gas-oil, then is pulsed into a light tube 37a having a number of blowing nozzles 38 so as to obtain good distribution of the heat in the closed volume. A second light tube similar to the preceding one and comprising orifices 39 is placed on the floor; it serves for collecting and drawing the cooled air towards the generator in which it is again heated so as to be reintroduced into the closed circuit, a heat regulating means allowing the heating cycle to be controlled and adjusted at will.

In accordance with the invention, it is also possible to cast simultaneously two orthogonal systems of bearing walls and slabs, which presents a major interest in the construction of perfectly monolithic structures resisting earthquakes.

There is disposed (Fig. 9) between the normal shuttering elements 1 of a bay or gantries 1, at the location of the cross wall 40 which is to be constructed, two end shuttering members 41 facing each other and spaced apart by the thickness of wall 40 to be cast and which, by their periphery, are exactly connected to panels 3 of gantries 1 of which they form the extension, these end shuttering members 41 resting on a special running track 100.

End shuttering members 41 are each formed by two indeformable elements 41a each resting on a special running track 100, comprising two

longitudinal members 100a connected by a transverse member 100b, by means of jacks, the lateral jacks 12 being of the same type as those for gantries 1, jacks 12a situated under the transverse part being special and being able to be raised completely so as to allow the shuttering to be moved along the roller tracks 100a.

Elements 41a are separated by a gap allowing lateral removal of the shuttering and normally closed by an upper horizontal wedge 42a and a vertical wedge 42b; the upper wedge 42a can be moved aside obliquely for removing the shuttering and the vertical wedge 42b can be moved aside horizontally to free the required space, the two elements 41a being drawn together by means of a tension rod 2a similar to that for the gantry shuttering 1. The reciprocal uniform sliding of the two elements 41a is provided by guide forming shafts generally three in number but being able to be reduced to two if the end shuttering member 41 is very narrow, the tension rod being placed at the center of gravity of the three guides. End of travel stops limit the movement in both directions.

Each of the elements 41a is formed from a framework and panels similar to those of gantries 1 but simply adapted to their size. The end shuttering members 41 have the normal assembly members of the gantries.

The depth of the end shuttering member 41 may vary according to the need and in particular they may be thin without departing from the scope of the invention (Fig. 9b). They then have jacks 12a only under the transverse part; in this case, so as to ensure their balance during shuttering removal and translation, they are provided with pivotable and retractable props 43 carrying a jack 12b which gives them after sloping the balance required for their removal and translation.

The special running track 100 is formed from two straight elements 100a of appropriate length connected on the one hand to the standard running track 10 and on the other hand to an element made from two equal parts forming the transverse running track 100b. In the center, the joint between the two elements 100b is chamfered so as to facilitate removal of the two half parts by a pivoting movement about the center; the elements forming the special running track 100 are locked together and two oblique crosspieces 44 as well as a transverse crosspiece 11 maintain by triangulation the indeformability of the assembly as well as the connection with the standard running track 10.

Another embodiment shown in Fig. 9c is used for small spans when the central part 100b is in a single piece.

In accordance with the invention, systems of bearing walls such as shown in Figs. 10 to 12 may be constructed monolithically, this statement not being limitative.

Still in accordance with the invention, the gantries may have an adjustable span so as to be able to be used for different types of construction during the period of their amortization.

In accordance with the invention, the minimum

span (Fig. 13) is obtained with the upper sliding frame 45 pushed right up so that the right-hand half-frame 45a touches the vertical panel 3a of the left-hand half-frame 45b and vice-versa. By spacing the two half-frames apart until there only remains room for locking at their ends, the maximum span is obtained (Fig. 14); intermediate panels 3b should then be inserted between the two fixed upper panels 3a. Thus can be obtained at will any span between the two maximum and minimum limits; the tension rod 2a being telescopic as well as the cross-pieces 11 of the running track 10.

One of the features of the invention is the great dimensional accuracy which can be obtained in the construction of building works; this is obtained particularly because of the reference formed by the running track, the assembly of the elements of this latter having to be and to remain very accurate.

Fig. 15 shows the way in which this condition can be fulfilled.

In accordance with the invention, one of the ends of the U iron 10 forming the running track is provided with a male washer 46 fixed on each side of the flanges 10a and 10b of the U iron on the outside, a half of each of these two washers projecting beyond the end of the U iron; the other end of the running track to be assembled is provided in the same position, in a piece 47 added to the outside of each of flanges 10a and 10b of the U iron, with a semi-cylindrical female housing 46a having the same diameter as the washer 46. During connection of the two elements, the washers 46 penetrating into their housing 46a provide lateral centering and strict centering in height of the two elements of the running track, and these latter are held in this position by the end plate 48 of the tie rod 11 (Fig. 15b) having pierced therethrough two holes 49 into which penetrate studs 50 carried by the ends of the elements of the running track. The penetration of the washers 46 into their housings 46a is facilitated by chamfered vertical land 46b. The assembly is thus rigidly locked.

Crosspiece 11 which carries at each of its ends a similar plate 48 ensures in addition the exact spacing of the two lines of the running track the end of the crosspieces is designed to resist the hammer blows which their positioning requires at each operation; it comprises a solid metal piece 51 projecting from the tube which is struck, which protects the tube which would otherwise be rapidly crushed.

The apparatus of the invention may include shuttering elements delimiting the reveals and lintels of bays or doors and allowing if need be the positioning and automatic sealing of door or window frames. These elements, adjustable in width, are designed to be mounted between the rows of gantries or between the gantry row and end panel.

Fig. 16 shows in detail the component elements required for reserving a simple opening in the wall.

Two vertical U-shaped uprights 52, each carrying two fixing arms 53, are positioned by a movement from bottom to top by means of an indented bracket 54 on two special bolts 55

5 partially screwed into a threaded part 56 reserved in the vertical wall of the shuttering panel 3 (Fig. 16b). After placing the first vertical upright 52 the bolts 55 are tightened; its position is thus accurately ensured. The second upright 52 is then

10 positioned in the same way and the two uprights are connected at their upper part by a U-shaped crosspiece 52a of an appropriate length placed therebetween. After placing the counter shuttering, casting of the concrete is carried out.

15 To dismantle the shuttering, one operates inside the tunnel against which the vertical uprights 52 have been fixed, bolt 55 is unscrewed by the end 55a of its shank shaped in a hexagon and it is pushed so that it falls into the spaced

20 reserved for the opening where it is recovered, which frees the corresponding gantry for dismantling. After all the gantries have been dismantled, one of the uprights 52 is removed by a pivoting movement, then the upper crosspiece

25 52a and then the second upright, the assembly with bolts 55 being ready for further use.

Fig. 17 shows the special device for reserving an opening in a wall and the positioning of a self-sealing frame made from metal, wood or any other

30 material. A rigid frame made in two parts sliding with respect to each other by means of guide and slide forming arms 57 and a double acting tie-rod 58 serves as a template 59 for the fixed frame 60 to be sealed in the wall, the fitting and the fixing of

35 the template to the shuttering panel 3 taking place in the same way as detailed in Fig. 16. To withdraw the template 59 when removing the shuttering, central tie-rod 5 is retracted so as to be able to remove it in a single piece and replace it in

40 a new frame 60 to be sealed by expanding it by means of the tie-rod actuated in the reverse direction.

Fig. 18 shows the special arrangements provided for shuttering the outside of the gable

45 wall 61 of a building.

The shuttering of gables 61 is achieved on the inner face by means of the vertical shuttering panels 3 of gantries 1 juxtaposed in twos or threes by means of longitudinal assembly elements and

50 on the outer face by means of lagged flat panels 3a, spaced from panels 3 by the thickness of the wall to be cast and also juxtaposed in twos or threes by means of longitudinal assembly elements.

55 The shuttering panels 3a rest on a running track 102 fixed to a bracket 62 which is attached to the wall by a special coach-screw 63 screwed into a buried metal helical fitting 64 sealed in the concrete during the preceding phase and which

60 offers considerable resistance to tearing away. The bearing points of bracket 62 on the wall are located by wedges 65 so as to determine an accurate and invariable lever arm. The bracket supports an access walk-way for the workmen

65 from which, for dismantling and when the

assembly is held by the crane, the workmen may remove and recover the fixing bolts 63. Walk-way 66 is then raised by a level and placed on waiting coach-screws 63 screwed into the helical fittings 64

70 which have just been sealed in the preceding phase, the placing of the walk-way being facilitated by an indentation 62a provided for this purpose in each flange 62. The coach-screws 63, having a collar 63a bearing against the outer wall of the brackets

75 are tightened down from the walk-way. The gable shuttering panel 3a can then be positioned from this walk-way, fixed to the panel 3 of gantry 1 which faces it by means of interlocking pins 67 balancing the thrusts of the concrete, then the

80 crane can be freed. Then in the upper part of the gable panels 3a, in holes provided for this purpose, there are disposed false coach-screws 63b carrying their helical fittings so that these latter are automatically sealed during the casting of the

85 concrete. The shuttering panel 3a being adjusted with respect to the plane and levelled, fittings 64 are placed exactly at the desired place for executing the next phase. The shuttering panel 3a supports in the upper part a walk-way 66a

90 ensuring the safety and the circulation of the personnel. Removal of the shuttering takes place by manoeuvring in the opposite direction. Service walk-ways are disposed bracket-wise between

95 two floors already cast so as to allow the gantries to be freed after release, every time that the following casting phase requires recovery with the crane. For this, these walk-ways have effective overall widths greater than the length of a gantry and they each support a running track 103

100 forming an extension of running track 10 of the corresponding gantry.

Fig. 19 shows a device serving in addition to the normal fixing means for securing brackets 68 of said walk-ways in the slab, by means of a pin,

105 for the case where this latter is defective or for any other cause. This safety means is designed so that it must necessarily be placed in position before any gantry can be moved out.

It is essentially formed by an arm 69 hinged

110 to a transverse pivot 70 mounted at its ends in two bearings 71 and 72 integral respectively with the flange 103b of running track 103 and flange 73a of a section 73 fixed to bracket 68.

This arm presents in the vicinity of its end a

115 bore 74 engageable on the stud 50 carried by the end of the elements of running track 10 when said arm is folded down, thus locking reciprocally the two running tracks 10 and 103 while being retracted below their upper level, thus allowing

120 the gantries to be freed.

In the raised position, arm 69 bears on a stop preventing it from pivoting rearwards, and it is then in the path of the low crosspieces 76 of the gantries (Fig. 19a), thus preventing their removal.

125 To remove a gantry, it is then necessary to fold back arms 69 (Figs. 19 and 19b) and to engage them on studs 50 of the running track 10, which provides safety locking of the service walk-ways. The end of arm 69 comprises a reinforcement

130 on which the workmen apply hammer blows for

engaging bore 74 on stud 50 of the running track.

It will moreover be understood that numerous modifications may be made to the different embodiments of heating shuttering described above with reference to the accompanying drawings, within the scope of the appended claims.

CLAIMS

1. Apparatus for the shuttering of concrete, which apparatus comprises a pair of roller tracks, a pair of gantries located on the roller tracks for movement along the roller tracks, each of the said gantries including a rigid framework supporting at least two shuttering panels orientated generally longitudinally of the roller tracks, and at least one generally horizontal shuttering panel, all of the said shuttering panels being releasably connected to the rigid framework to form a rigid structure, and at least a part of the area of the shuttering panels being heated, a pair of end shuttering members each of which comprises at least one transverse shuttering panel which is connected to the horizontal and longitudinal shuttering panels of a respective one of the said gantries, at least a part of the area of the end shuttering members being heated, a transverse roller track for supporting each of the said end shuttering members extending between the longitudinal roller tracks, the said end shuttering members being orientated in the roller tracks for the formation of a space in which a wall is to be constructed, between the respective transverse shuttering panels, the gantries and the said end shuttering members being supported on the longitudinal and transverse roller tracks, respectively, by a plurality of screw jacks adapted to permit adjustment of the orientation of the gantries and the end shuttering members with respective roller track, and screw jacks associated with the longitudinal roller tracks being so arranged as to be at all times supported by the respective roller tracks, and screw jacks associated with the transverse roller track being so arranged as to be capable of being raised out of engagement therewith to allow longitudinal movement of the end shuttering members in a direction parallel to the longitudinal roller tracks.

2. Apparatus as claimed in Claim 1, wherein each of the said end shuttering members has the form of an end gantry including a rigid framework supporting, in addition to the transverse shuttering panel, two longitudinal shuttering panels and a horizontal shuttering panel, which are connected on one side to the transverse shuttering panel and on the other side to the longitudinal and horizontal shuttering panels; respectively, of the associated first-mentioned gantry, all of the said shuttering panels of each end gantry being releasably connected to the rigid framework of the said end gantry to form a rigid structure and at least a part of their area being heated, each of the end gantries being also supported on the longitudinal roller tracks by a plurality of screw jacks.

3. Apparatus as claimed in Claim 1 or Claim 2,

wherein the screw jacks associated with the longitudinal roller tracks contain a captive ball adapted to rest on the said longitudinal roller track.

4. Apparatus as claimed in any one of the preceding claims, wherein locking pins are provided for the location of the shuttering panels, the locking pins being adapted for cooperation with guide sleeves in the periphery of the shuttering panels.

5. Apparatus as claimed in Claim 4, wherein each of the said pins includes an operating handle which can be locked behind a catch fixed to the panel.

6. Apparatus as claimed in any one of the preceding Claims wherein the roller track is constituted by a plurality of U-shaped sections joined in end to end relation, one of the said joined ends being provided with a washer projecting from the said end and adapted to cooperate with a corresponding recess in the other roller track.

7. Apparatus as claimed in Claim 6, comprising a spacer for the pair of roller tracks, and wherein each section of the roller track comprises a stud for engagement with an end of the spacer after assembly of the track.

8. Apparatus as claimed in any one of Claims 1 to 7, including means for casting an opening, including two elongate U-shaped posts for shuttering the vertical sides of the opening; having fixing arms attached thereto and extending laterally therefrom, bolts being provided for securing the fixing arms to a threaded portion provided in the vertical part of the shuttering panel.

9. Apparatus as claimed in Claim 8, wherein the end of the stem of bolts is shaped in "six flat" form, so that it can be loosened from the interior of the opening.

10. Apparatus as claimed in any one of the preceding Claims including a device for reserving an opening in a wall and fitting a sealed frame, the said device having two parts for supporting respectively the sides of the opening, the two parts being adapted to slide relative to one another by means of lateral arms forming a guide and a slide, and a double-action tie bolt, the lateral arms having means for the attachment and fixing of the device to a shuttering panel.

11. Apparatus as claimed in any one of the preceding Claims characterized in that catwalks are positioned in brackets between two already cast floors in order to release the gantries after form stripping.

12. Apparatus as claimed in Claim 11, wherein the catwalks have a useful length outside the building which is greater than the length of a gantry and have in each case a U-shaped roller track assembled in the extension of the roller track of the corresponding gantry.

13. Apparatus as claimed in Claim 12 wherein the roller track of the catwalks have a safety device consisting of an arm articulated on a transverse shaft carried by the catwalk roller track, the said arm having in the vicinity of its end a bore



engaging bore 74 on stud 50 of the running track.

It will moreover be understood that numerous modifications may be made to the different embodiments of heating shuttering described above with reference to the accompanying drawings, within the scope of the appended claims.

CLAIMS

1. Apparatus for the shuttering of concrete, which apparatus comprises a pair of roller tracks, a pair of gantries located on the roller tracks for movement along the roller tracks, each of the said gantries including a rigid framework supporting at least two shuttering panels orientated generally longitudinally of the roller tracks, and at least one generally horizontal shuttering panel, all of the said shuttering panels being releasably connected to the rigid framework to form a rigid structure, and at least a part of the area of the shuttering panels being heated, a pair of end shuttering members each of which comprises at least one transverse shuttering panel which is connected to the horizontal and longitudinal shuttering panels of a respective one of the said gantries, at least a part of the area of the end shuttering members being heated, a transverse roller track for supporting each of the said end shuttering members extending between the longitudinal roller tracks, the said end shuttering members being orientated in the roller tracks for the formation of a space in which a wall is to be constructed, between the respective transverse shuttering panels, the gantries and the said end shuttering members being supported on the longitudinal and transverse roller tracks, respectively, by a plurality of screw jacks adapted to permit adjustment of the orientation of the gantries and the end shuttering members with respective roller track, and screw jacks associated with the longitudinal roller tracks being so arranged as to be at all times supported by the respective roller tracks, and screw jacks associated with the transverse roller track being so arranged as to be capable of being raised out of engagement therewith to allow longitudinal movement of the end shuttering members in a direction parallel to the longitudinal roller tracks.

2. Apparatus as claimed in Claim 1, wherein each of the said end shuttering members has the form of an end gantry including a rigid framework supporting, in addition to the transverse shuttering panel, two longitudinal shuttering panels and a horizontal shuttering panel, which are connected on one side to the transverse shuttering panel and on the other side to the longitudinal and horizontal shuttering panels, respectively, of the associated first-mentioned gantry, all of the said shuttering panels of each end gantry being releasably connected to the rigid framework of the said end gantry to form a rigid structure and at least a part of their area being heated, each of the end gantries being also supported on the longitudinal roller tracks by a plurality of screw jacks.

3. Apparatus as claimed in Claim 1 or Claim 2,

- 65 wherein the screw jacks associated with the longitudinal roller tracks contain a captive ball adapted to rest on the said longitudinal roller track.

4. Apparatus as claimed in any one of the preceding claims, wherein locking pins are provided for the location of the shuttering panels, the locking pins being adapted for cooperation with guide sleeves in the periphery of the shuttering panels.

5. Apparatus as claimed in Claim 4, wherein each of the said pins includes an operating handle which can be locked behind a catch fixed to the panel.

6. Apparatus as claimed in any one of the preceding Claims wherein the roller track is constituted by a plurality of U-shaped sections joined in end to end relation, one of the said joined ends being provided with a washer projecting from the said end and adapted to cooperate with a corresponding recess in the other roller track.

7. Apparatus as claimed in Claim 6, comprising a spacer for the pair of roller tracks, and wherein each section of the roller track comprises a stud for engagement with an end of the spacer after assembly of the track.

8. Apparatus as claimed in any one of Claims 1 to 7, including means for casting an opening, including two elongate U-shaped posts for shuttering the vertical sides of the opening, having fixing arms attached thereto and extending laterally therefrom, bolts being provided for securing the fixing arms to a threaded portion provided in the vertical part of the shuttering panel.

9. Apparatus as claimed in Claim 8, wherein the end of the stem of bolts is shaped in "six flat" form, so that it can be loosened from the interior of the opening.

10. Apparatus as claimed in any one of the preceding Claims including a device for reserving an opening in a wall and fitting a sealed frame, the said device having two parts for supporting respectively the sides of the opening, the two parts being adapted to slide relative to one another by means of lateral arms forming a guide and a slide, and a double-action tie bolt, the lateral arms having means for the attachment and fixing of the device to a shuttering panel.

11. Apparatus as claimed in any one of the preceding Claims characterized in that catwalks are positioned in brackets between two already cast floors in order to release the gantries after form stripping.

12. Apparatus as claimed in Claim 11, wherein the catwalks have a useful length outside the building which is greater than the length of a gantry and have in each case a U-shaped roller track assembled in the extension of the roller track of the corresponding gantry.

13. Apparatus as claimed in Claim 12 wherein the roller track of the catwalks have a safety device consisting of an arm articulated on a transverse shaft carried by the catwalk roller track, the said arm having in the vicinity of its end a bore



which engages when it is lowered on a stud carried by the end of the gantry roller tracks, whilst passing beneath their upper level.

14. Apparatus as claimed in Claim 13, wherein the said arm, in the raised position, bears on an integral stop member of the catwalk roller track, thus preventing its rearward tilting and it is then located on the path of the low cross-members of the gantries, consequently preventing the extraction of the latter.
15. Apparatus as claimed in any one of Claims 1 to 14, comprising thermally insulated exterior shuttering panels for the pinion wall of a building resting on a U-shaped roller track fixed to a bracket carrying an access catwalk, attached to the wall by a draw bolt screwed into a concealed metal helical lining in the concrete.
16. Apparatus as claimed in any one of Claims 1 to 15, wherein the shuttering panels are heated by electrical resistors.
17. Apparatus as claimed in Claim 16, wherein the electrical resistors are associated with hollow sections of the shuttering panels.
18. Apparatus as claimed in Claim 16 or Claim 17 wherein the electrically heated shuttering panels are thermally insulated on the side opposite to the concrete by an insulating material placed against the shuttering sheet and stiffeners and protected by a thin wall fixed at a number of points to the panel.
19. Apparatus as claimed in any one of Claims 16 to 18 wherein the resistors are spaced apart by

from 0.8 to twice the thickness of the concrete, if heat is applied at only one face, and from one to three times the half-thickness, if heat is applied at both faces.

20. Apparatus as claimed in any one of Claims 1 to 15 wherein the shuttering panels are heated by contact between a heating fluid and the back of the shuttering surface.
21. Apparatus as claimed in any one of the preceding Claims wherein at least one of the said end shuttering members is provided with supporting props the screw jacks associated with the longitudinal roller tracks being mounted on the said props.
22. Apparatus as claimed in Claim 21, wherein the props are pivoted to the end shuttering members.
23. Apparatus as claimed in Claim 1 for the shuttering of concrete substantially as hereinbefore described with reference to and as illustrated by any one of the accompanying drawings.
24. A method for the shuttering of concrete which method comprises casting concrete using shuttering as claimed in any one of the preceding Claims.
25. A method as claimed in Claim 24 for the shuttering of concrete substantially as hereinbefore described.
26. A concrete construction produced by a method as claimed in Claim 24 or 25.