

Tank equipment

Topic: Manufacturing and installation of tanks

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Manufacture and transportation of rolls of tank bottoms and walls

The rules for the installation of vertical cylindrical steel tanks for oil and petroleum products PB 03-605-03 provide for the factory manufacture and subsequent installation of sheet structures of tanks using the following technological methods:

- rolling method;
- the method of sheet assembly;
- combined method.

Vertical cylindrical steel tanks for oil and petroleum products.

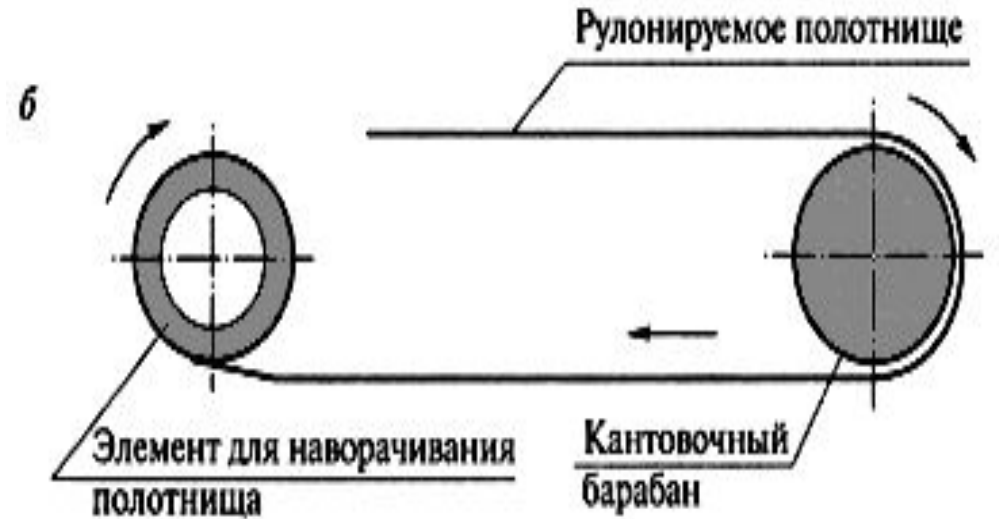
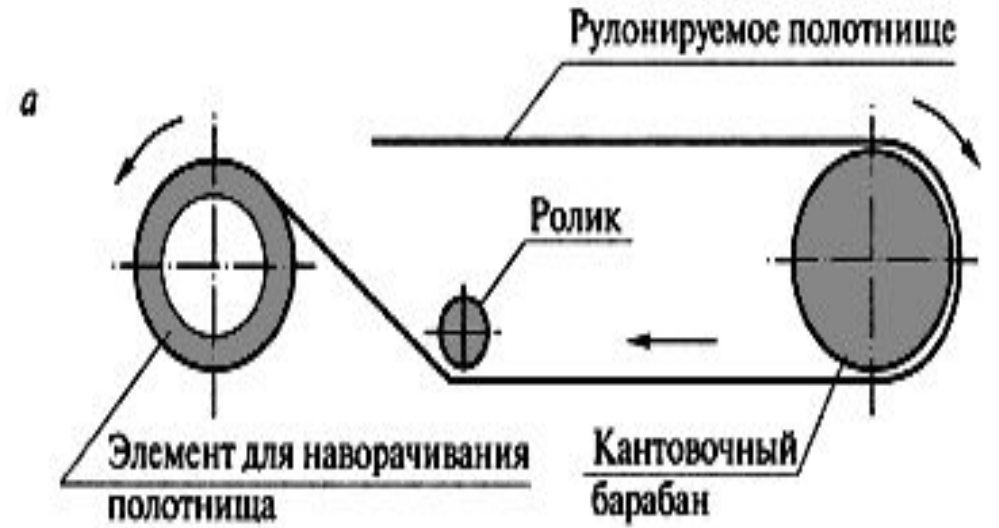
This standard establishes requirements for the design, manufacture, installation and testing of vertical cylindrical steel tanks with a nominal volume from 100 to 120,000 m³ used in the extraction, transportation, processing and storage of oil and petroleum products.

Does not apply to isothermal tanks (storage of liquefied gases), storage tanks for hot water and storage tanks for aggressive chemical products

- As the main method of construction of tanks, the method of rolling is adopted, in which the walls, bottoms, central parts of floating roofs and pontoons are supplied to the installation site in the form of rolled panels, and coatings, boxes of pontoons and floating roofs, rings of rigidity and other structures are enlarged elements.
- Tank designs must be delivered to the installation site with working documentation and certificates of the manufacturer with the application of the schemes of unfolding panels of walls and bottoms with the specified numbers of melting and certificates of each sheet.
- The materials used in the manufacture of tanks must be subjected to input control for their compliance with the requirements of design, regulatory and shipping documentation.

The panels must be assembled, welded, controlled and rolled up on special installations for rolling, operating according to two main schemes (with lower and upper folding).

Tank wall panels up to 18 mm thick can be made on installations with lower folding, and wall panels up to 16 mm thick can be made on installations with upper folding. The maximum thickness of the panels of tank bottoms, pontoon bottoms and floating roofs, the flooring of stationary roofs is 7 mm.

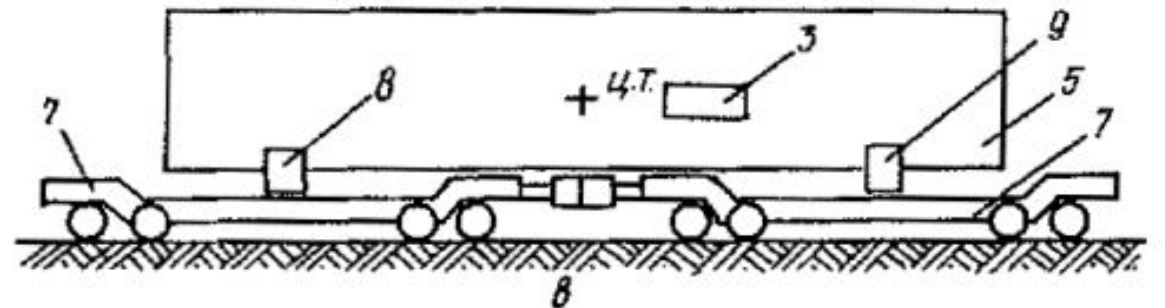
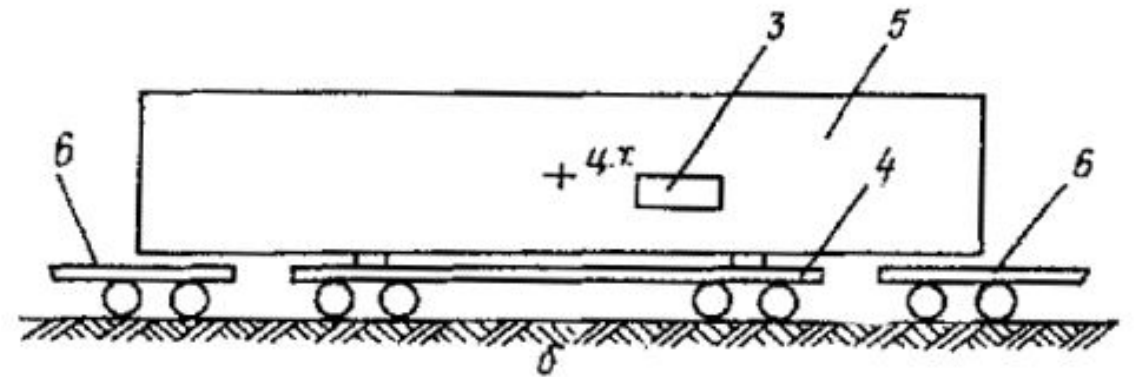
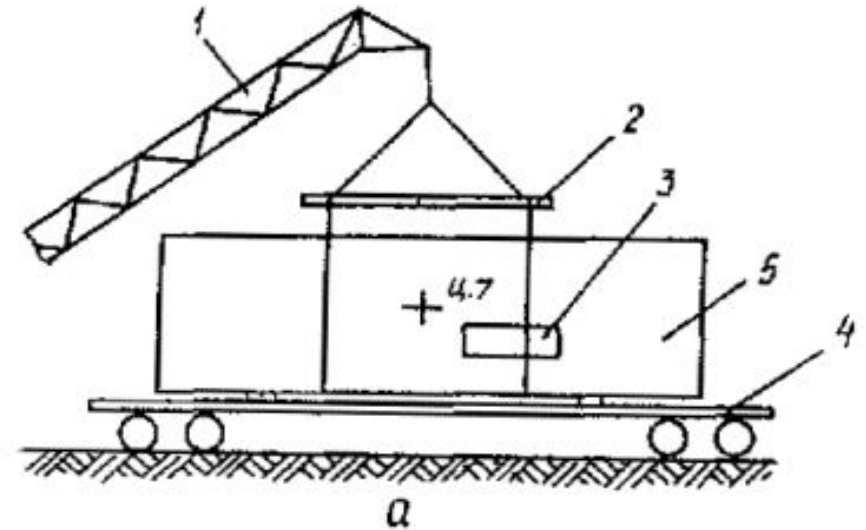


TRANSPORTATION

Rolled structures up to 12 m high are transported on four-axle railway platforms with a lifting capacity of 60 tons (Fig. a) To transport rolls with a height of 18 m, it is advisable to use coupling-type railway conveyors with a lifting capacity of 120 tons (Fig. b)

Rolled structures with a height of 18 m can be transported on a railway four-axle platform with a lifting capacity of 60 tons with two platforms covering. In this case, it is necessary to ensure the simultaneous dispatch of several rolls, then each cover platform overlaps the ends of two rolls (Fig. b)

1 - self-propelled crane; 2 - unloading traverse; 3 - roll marking place; 4 - four-axle railway platform; 5 - roll; 6 - cover platform; 7 - coupling conveyor; 8 - fixed bed; 9 - movable bed



When loading onto railway platforms, the rolls should be placed on wooden beams and lined with wedges with joiner-treated fillets. The bars are laid on the platform traverses and should be located under the rings of shaft ladders or frames. The edge of the panel is directed downwards and is located below the horizontal axis of the lying roll at a distance of 800 mm, i.e. outside the zone of the roll attachment strip to the railway platform.

When loading onto coupling-type railway transporters, the rolls are placed in lodges located at a distance of 12.36 m from each other along the axes. The surface of the contact of the bed with the roll is lined with boards 1 m long and at least 30 mm thick, and the fastening of the roll to the bed is made with bandages made of strip steel using inventory screw ties.

Elements of tank structures (coating shields, elements of stiffening rings and support rings, boxes of pontoons and floating roofs, etc.) are transported on railway platforms and in gondola cars in special containers or without them and fixed by methods and means that exclude their deformation.

The mounting marking of structures must contain the factory order number and the symbol of the mounting element in accordance with the mounting diagram in the working drawings.

The mounting marking must be applied to the mounting elements in the places indicated in the working drawings. The mounting marking of the rolled elements should be applied on a label attached at the end of the roll to the element for wrapping, or applied with indelible paint in two diametrically opposite places on the inner or outer surface of the roll at a distance of no more than 500 mm from the end of the roll.

The mounting marking of elements of the same brand, fastened in a package, is allowed to be applied only on the extreme elements, while the number of elements in the package must be indicated.

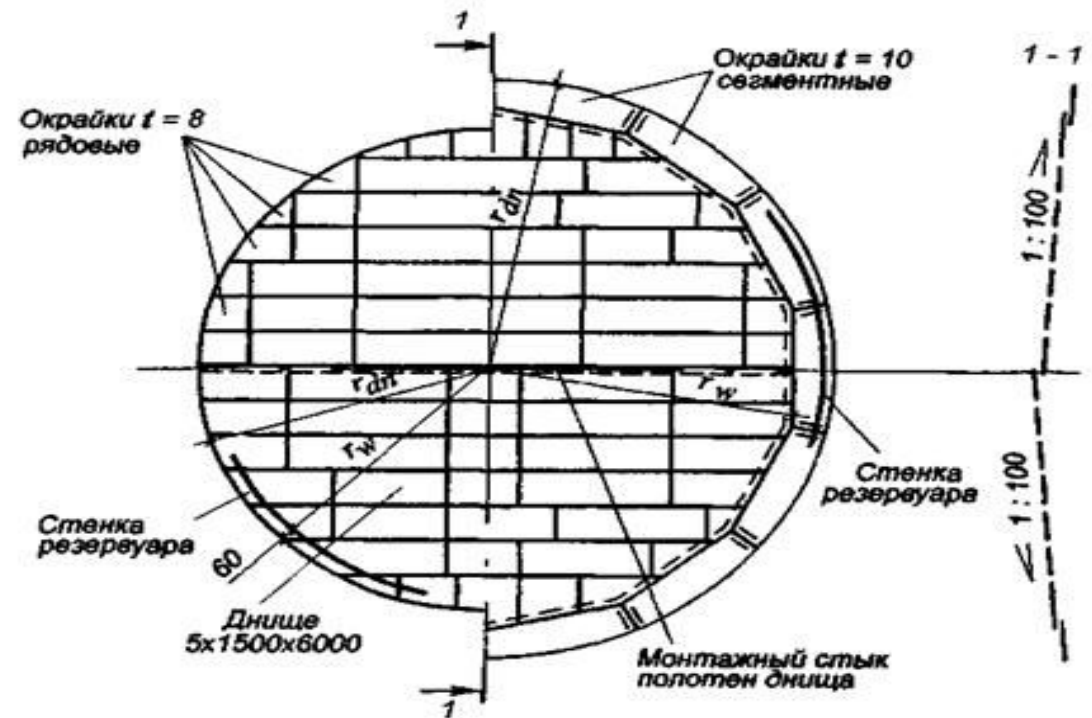
INSTALLATION OF THE BOTTOM AND THE CENTRAL PART OF THE FLOATING ROOF (PONTOON)

Installation of the bottom, consisting of the central rolled part and the edges, is carried out in the following sequence:

1) they are placed in the design position of the paintwork, controlling the correctness of their laying with the help of a marking device fixed in the center of the base. When installing tanks with a volume of more than 20,000 m³, the paint should be laid along a radius exceeding the design one by the shrinkage value of the ring of the paint after welding (10 — 15 mm), which should be provided for by the PP.

At the end of the assembly of the ring of the edges, it is necessary to check:

- the absence of fractures in the joints of the edges;
- absence of deflections and bulges;
- horizontality of the color ring;
- compliance of gaps in joints with design requirements;



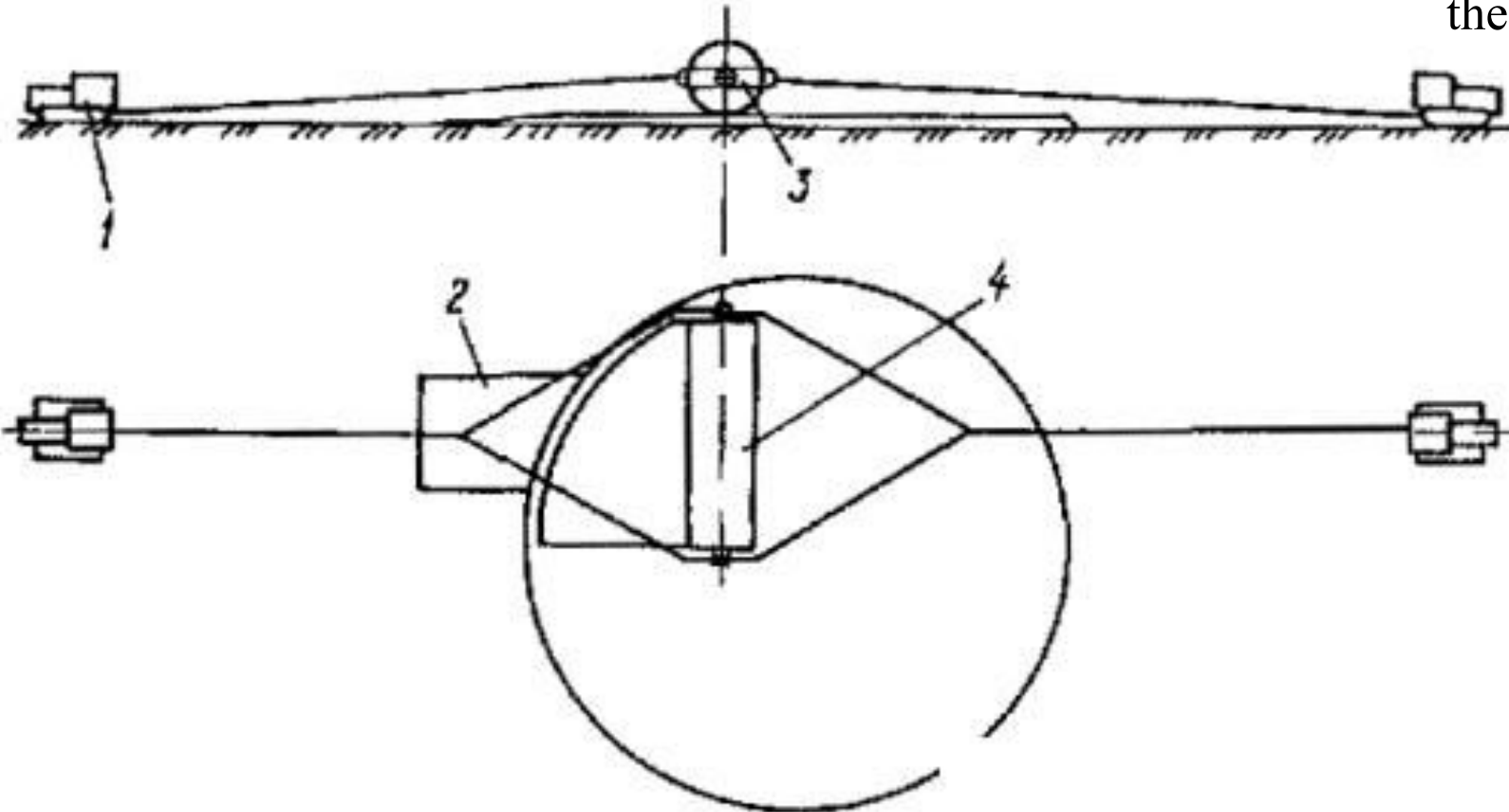
2) grab the assembled ring of nuts and weld the radial joints, observing the requirements of the PR and VSN;

3) roll the bottom rolls onto the base along a specially arranged ramp in one of the following ways:

tractors, using devices fixed to the ends of the roll; by means of a rope covering the roll, the ends of which are fixed to tractors (tractor winches).

If there is a crane with the required lifting capacity on the mounting platform, the roll of the bottom is laid on the base by a crane using a traverse.

The construction of the ramp must ensure the preservation of the shape of the base and the concrete ring during the rolling of the rolls.



Deployment of tank bottom rolls with a special device

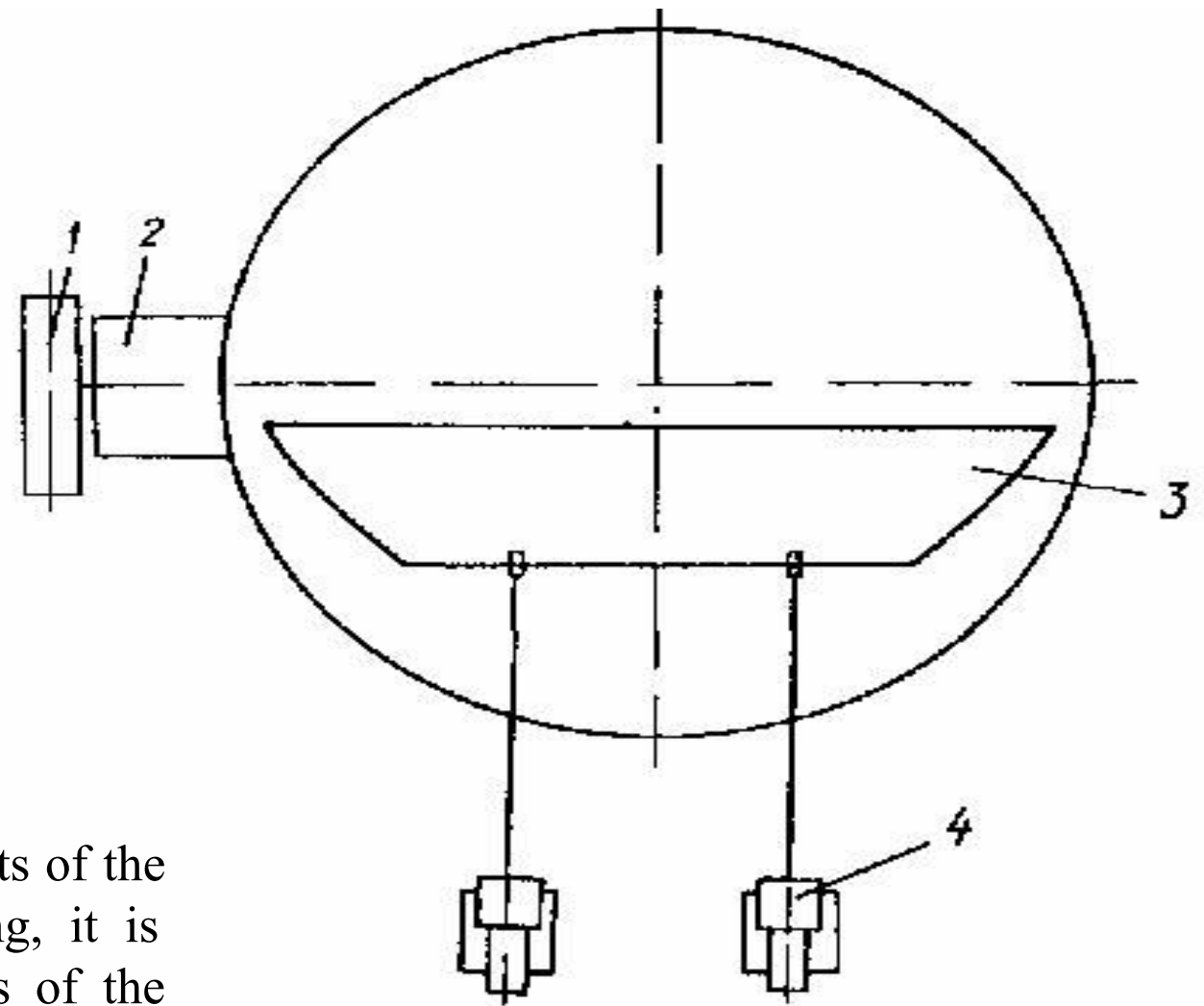
- 1 — tractor;
- 2 — ramp;
- 3 — attachment;
- 4 — bottom roll

If the traction force of the tractor (tractor winch) is not enough when rolling the rolls, then a polispast should be applied;

4) unfold the bottom rolls taking into account the least rolling of the rolls on one section of the base and then moving the unfolded panels to the design position, observing the following sequence:

- set the roll to its original position for deployment and cut the retaining strips;
- unfolding the outer panel, move it to a position close to the design. The rest of the panels are deployed in the same way;
- install the central panel in the design position.

5) weld the bottom in accordance with the requirements of the PPM ([Plan Preventive Maintenance](#)). Before welding, it is necessary to check: compliance with the dimensions of the bottom with the design; compliance with the dimensions in the overlapping joints, especially in places of double overlap; the location of the edges provided for by the project relative to the middle part of the bottom; the correct placement and cleaning of the tacks.

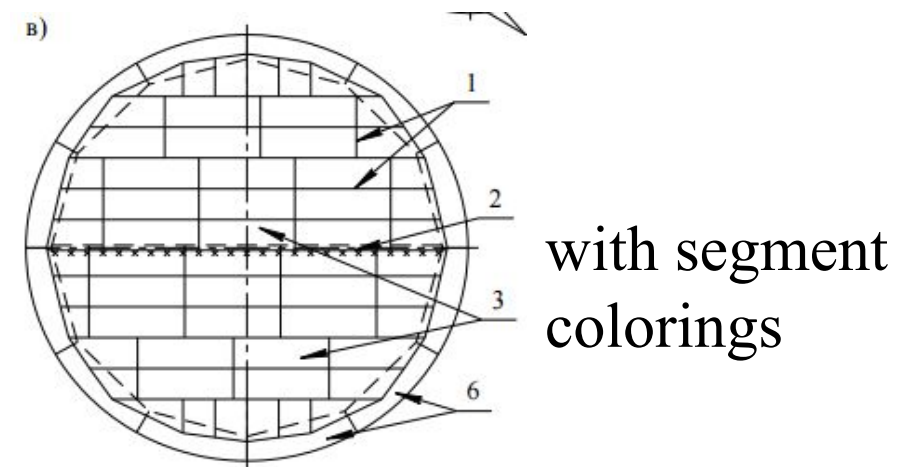
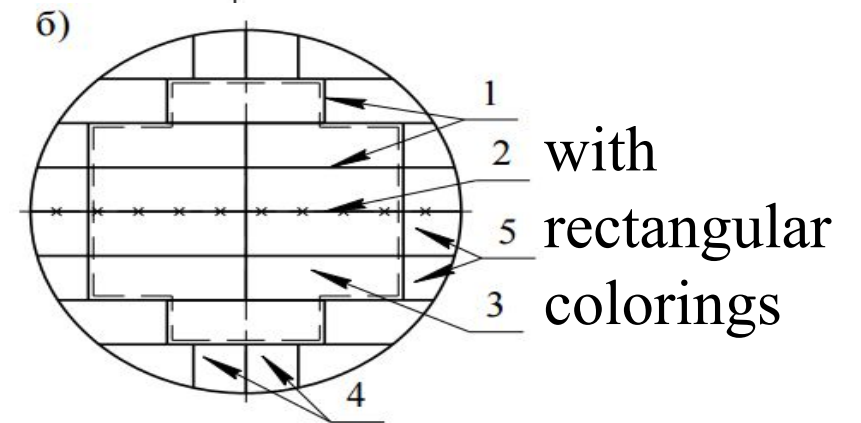
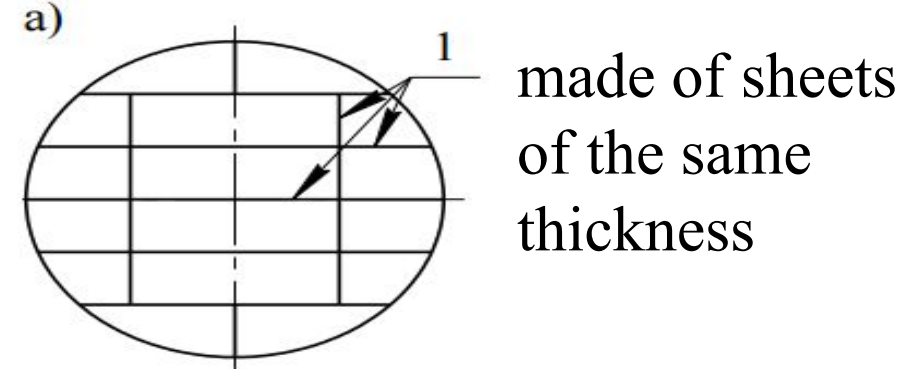


- 1 — initial position of the bottom roll;
- 2 — ramp;
- 3 — unfolded panel;
- 4 — tractor

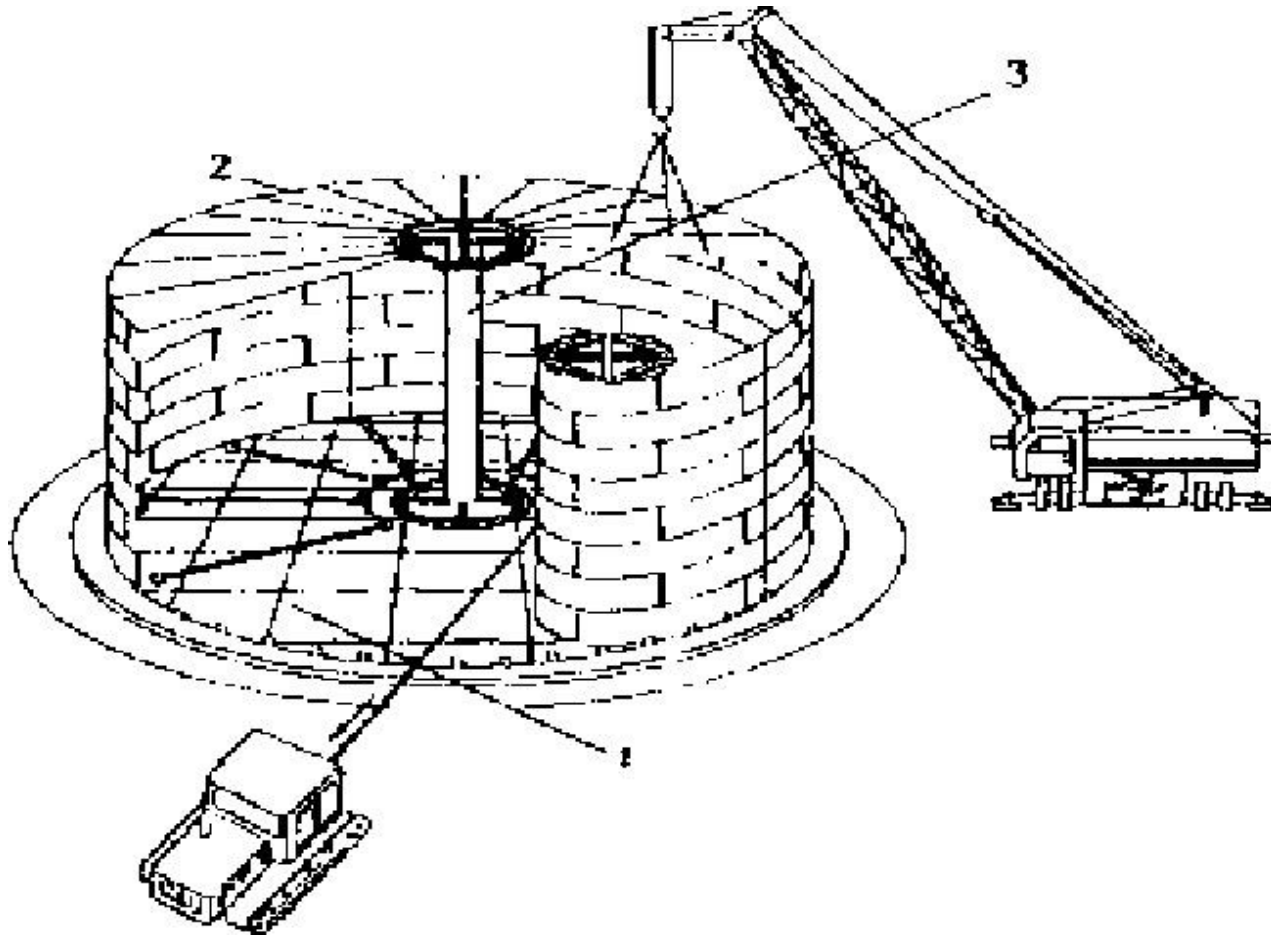
BOTTOM ASSEMBRY

it can be carried out in two ways: sheet or roll. The bottom is delivered to the work site in the form of factory-made rolled blanks. Installation is carried out by unfolding the rolls, followed by connecting them together with a one-sided overlap seam. The mounting joint connecting the individual panels must pass through the center of the opening of the structure so that the required conical shape of the structure can be obtained during installation (with a slight angle of inclination towards the center or vice versa). The seams of one panel in the place of the mounting joint must be shifted relative to the similar seams of the other panel by at least 100-150 mm. The minimum size of the overlap in the mounting joint is 30 mm, and is usually 50-60 mm.

- 1 – factory seams;
- 2 – mounting seams;
- 3 – sheets of the central part of the bottom;
- 4 – rectangular cross-section stains;
- 5 – rectangular longitudinal stains;
- 6 - segment stains



INSTALLATION SEQUENCE



Unfolding the wall roll

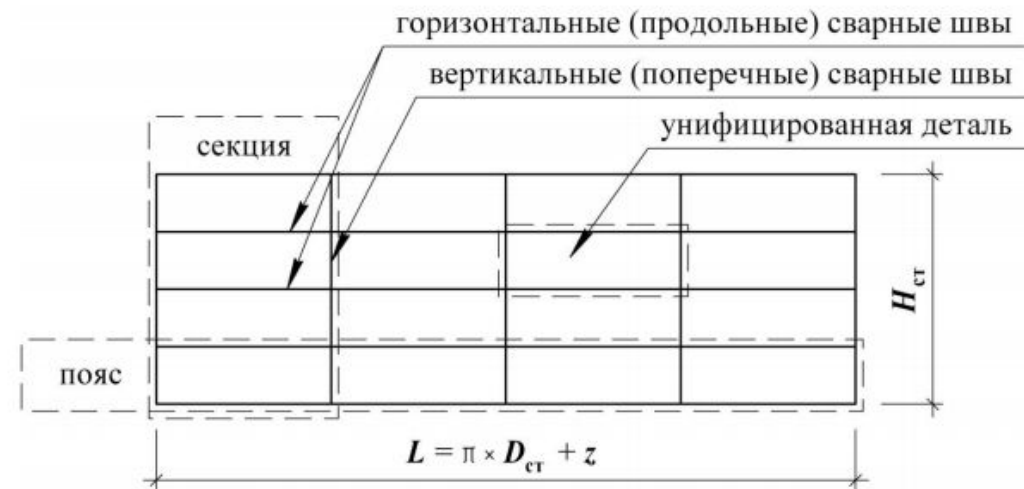
- ❖ Bottom deployment by two tractors
- ❖ Installation of the central mounting stand by crane
- ❖ Lifting the wall rolls with a crane and a pipelayer
- ❖ Deployment of wall rolls using a pipelayer with simultaneous installation of roof panels by crane



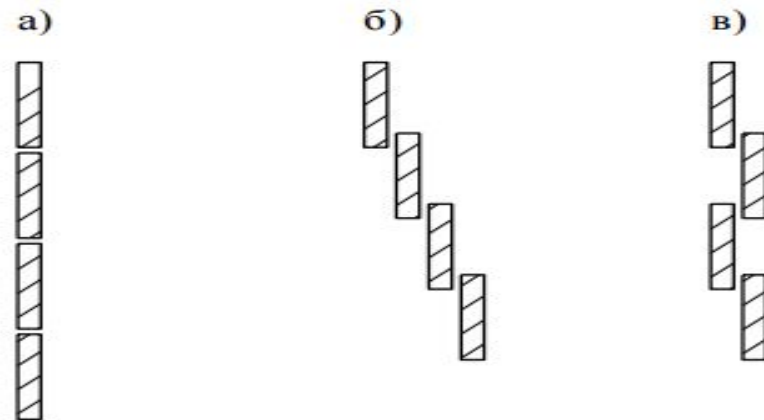
INSTALLATION OF THE VST WALL

In most cases, the cylindrical wall is assembled from individual sheets measuring 6000×1500 mm (5990×1490 mm after the edges are edged). Other parameters of 6000×2000 mm, 8000×2000 mm wall sheets are also possible. The position of the sheets in the wall is taken in such a way that the long side of each individual sheet is directed horizontally.

Horizontal rows of wall sheets are called belts. Each individual belt consists of sheets of the same thickness. The thickness of the belts is determined by calculation and, as a rule, increases from the upper belts to the lower ones (corresponding to the law of hydrostatic pressure distribution)

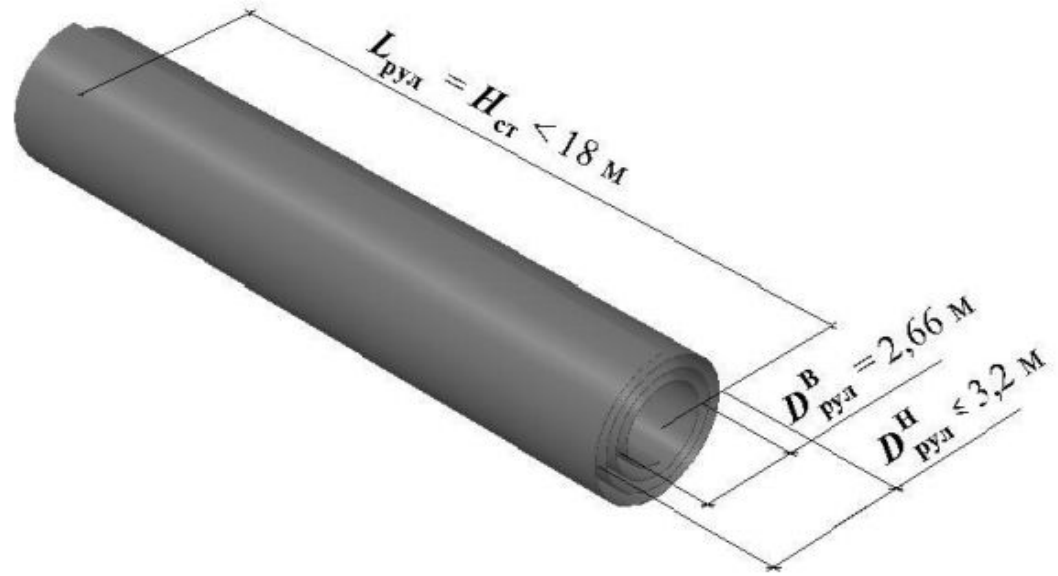


All the connections of the sheets in the belt are made butt-to-butt. The belts can be connected to each other butt-to-butt or overlap in a telescopic or stepwise order



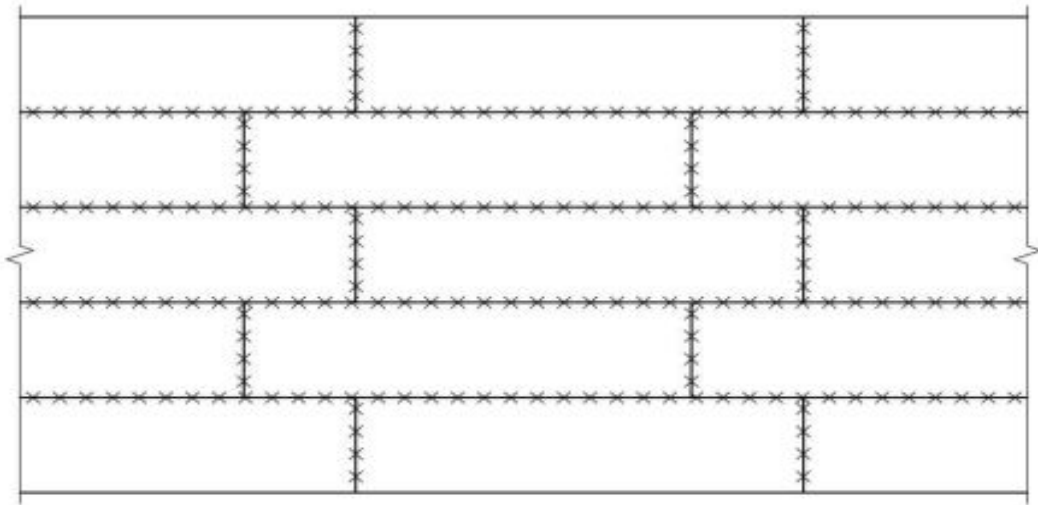
а) – встык; б) – телескопическое; в) – ступенчатое

Installation of a cylindrical wall can be carried out in two ways: sheet or roll. The maximum thickness of the rolled sheets is limited to 16-18 mm. The width of the wall panel is limited to 18 m according to the manufacturing conditions on the roll equipment. The length of the panel should be no more than 66 m under the conditions of transportation by rail (the outer diameter of the panel wrapped on the frame, taking into account the permissible looseness of the winding, should be no more than 3.2 m), and the total weight of one roll is up to 60 tons. The difference in the thickness of adjacent sheets should be no more than 2 mm under welding conditions without beveling the edges of the sheets.



Dimensions of the rolled wall panel

min $8t$



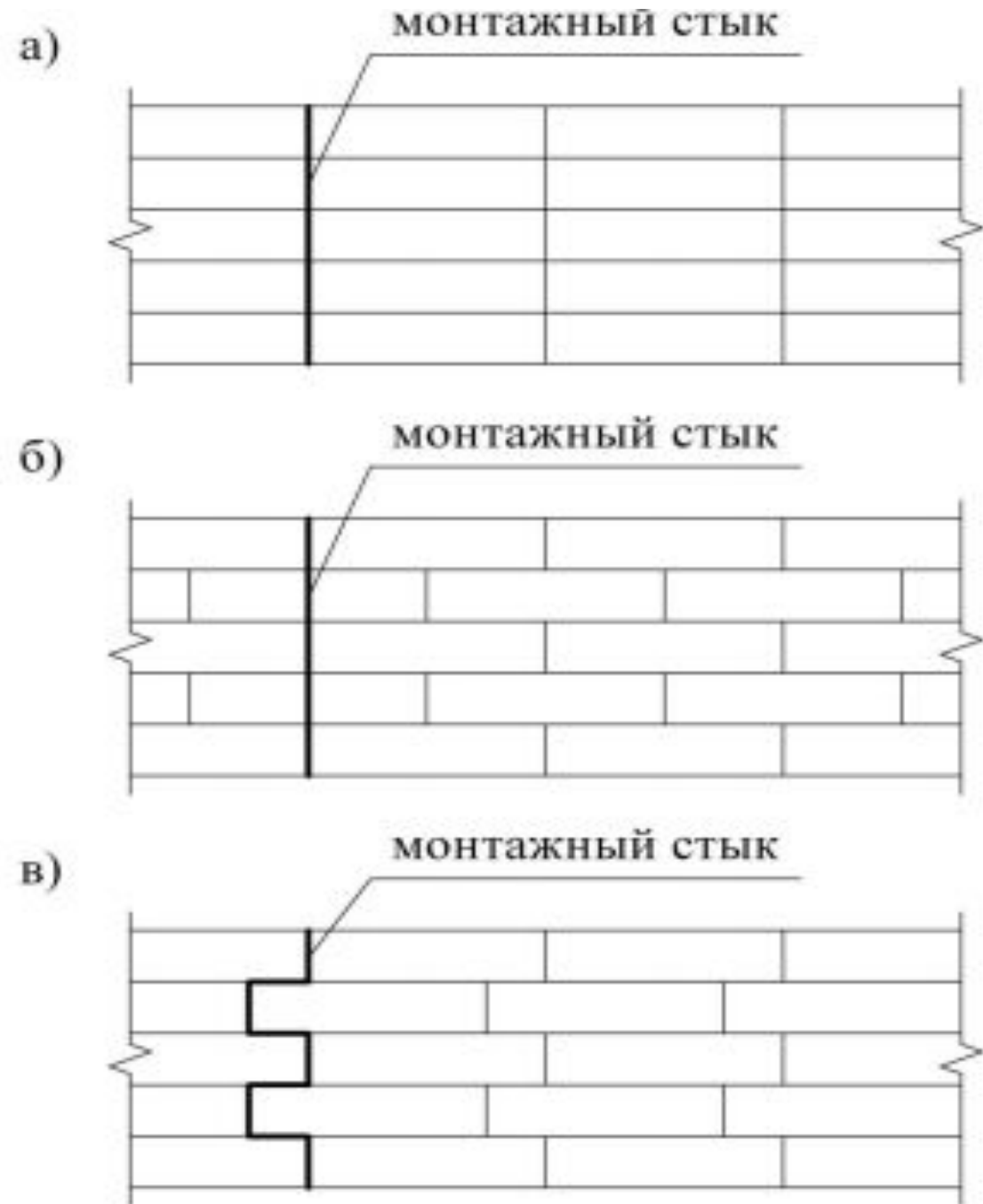
Layout of wall sheets for the sheet mounting method

The layout of the cylindrical wall surface can be made using various options. For the sheet mounting method, the layout can be very diverse, but at the same time it is necessary that in any case the vertical welded joints of the sheets in adjacent wall belts are shifted relative to each other by an amount of $8t$, where t is the thickness of the underlying belt

For tanks of class II and III, vertical factory and mounting butt joints without displacement are allowed during the manufacture of the wall from rolled panels.

Sometimes other types of layout are used. In all cases, the mounting connections of the rolls are made butt-to-butt or overlap.

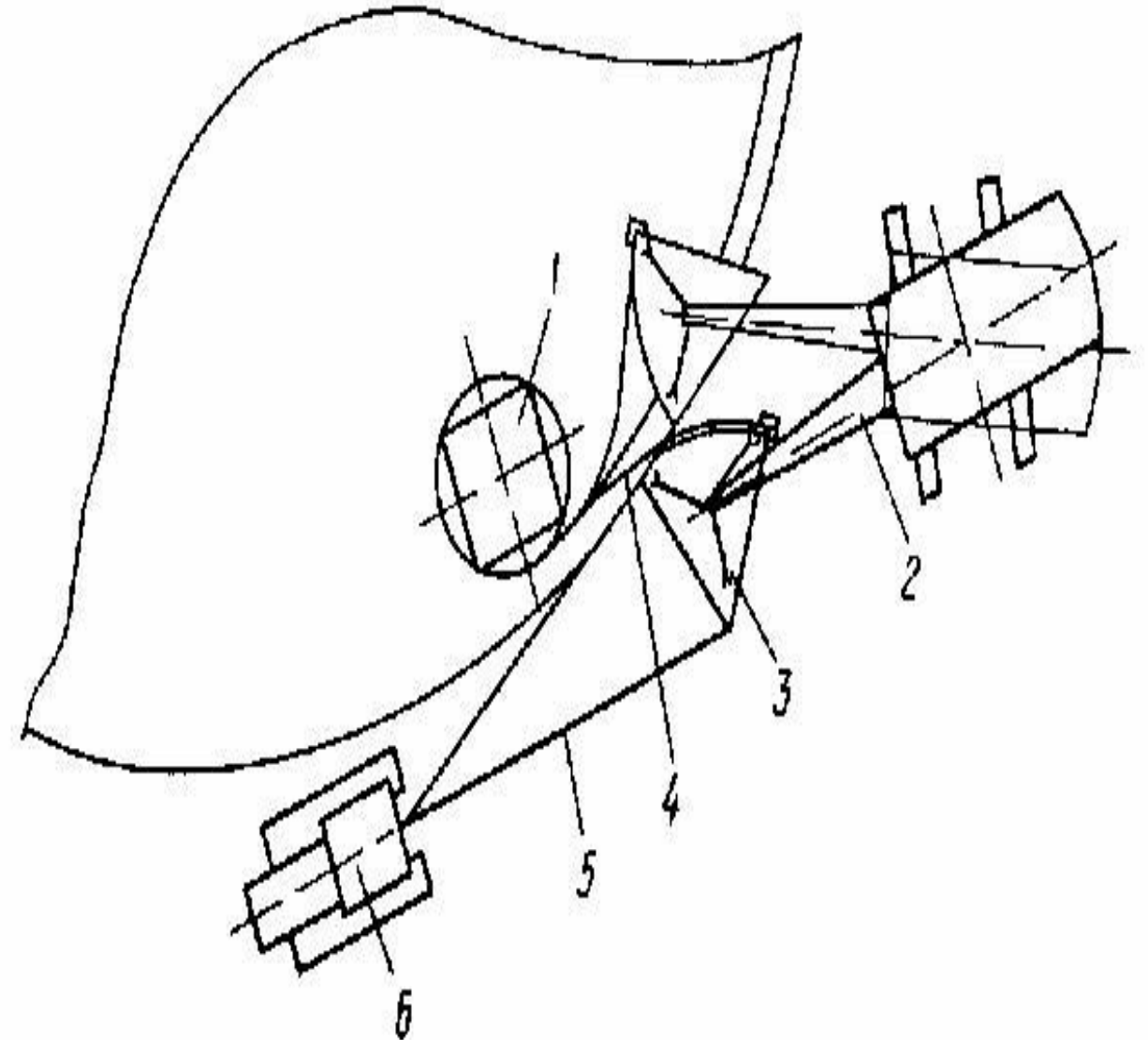
Recently, the docking of rolls using so-called "toothed" joints has been mastered, although with such a docking, the complexity of the mounting joint device increases significantly



INSTALLATION OF VERTICAL SEAM, WALL CLOSURE

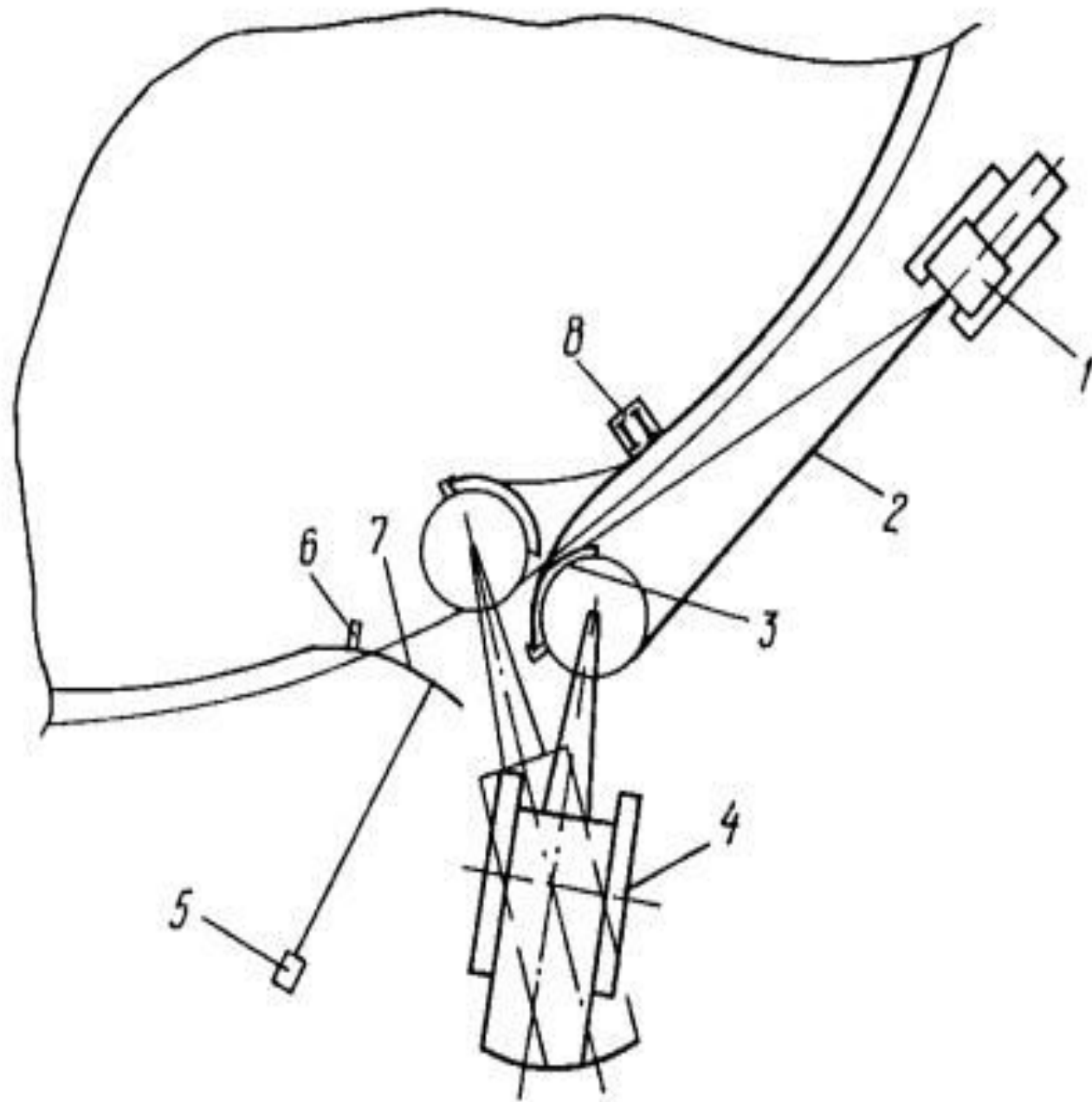
Before closing the mounting joints of the unfolded panels, the walls form the ends of the panels that have significant residual deformations from rolling. As a rule, wall panels with a thickness of 8 mm or more are formed. Shaping is carried out by a tractor with the help of special devices. In the case when it is required to form one or two belts of the wall panel, it is recommended to use a bending sector as a device

- 1 — wall roll;
- 2 — crane;
- 3 — bending sector;
- 4 — shaped section of the panel;
- 5 — traction rope;
- 6 — tractor



When forming the panel, a special device is used throughout the height, made of a roll frame with bending templates installed on it

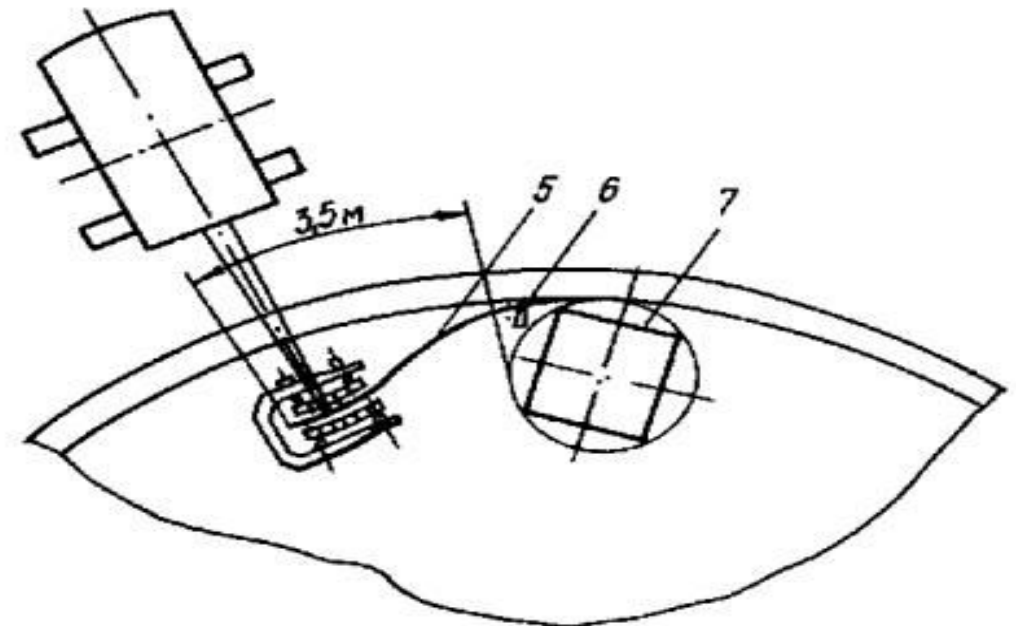
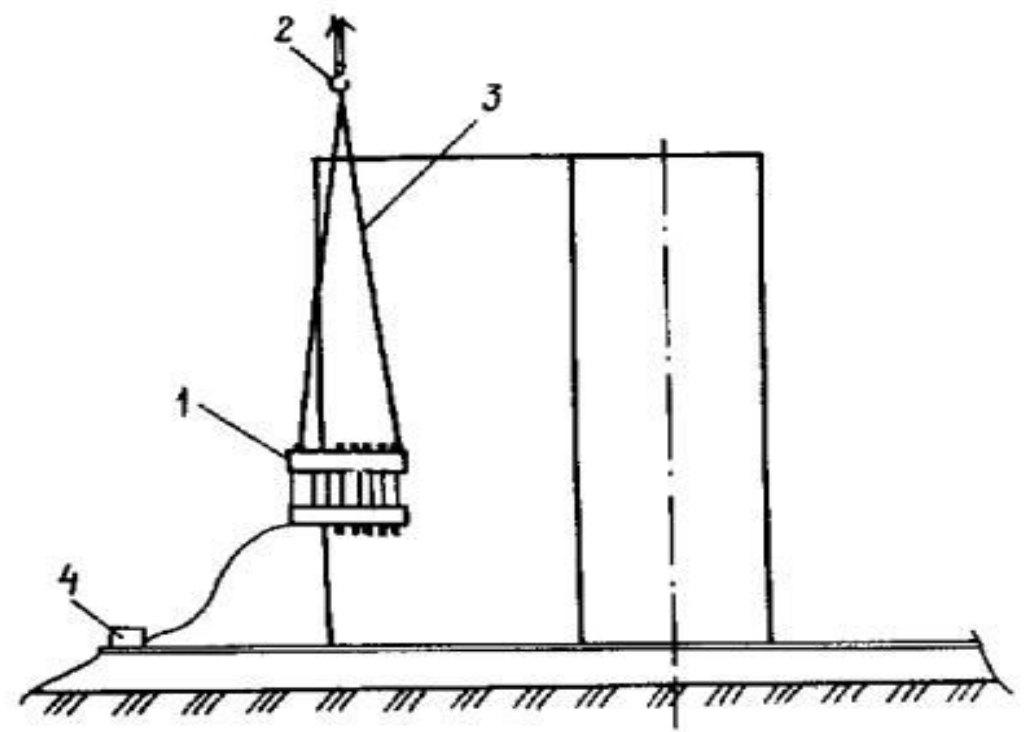
- 1 - tractor;
- 2 - traction rope,
- 3 - device for shaping;
- 4 - crane,
- 5 - ground anchor;
- 6 - stop;
- 7 - shaped section of the panel;
- 8 - stand-stop



When forming the end sections of the wall panels, a mechanized method of straightening by a hydraulic device of the structure can be applied Tallinn Polytechnic Institute.

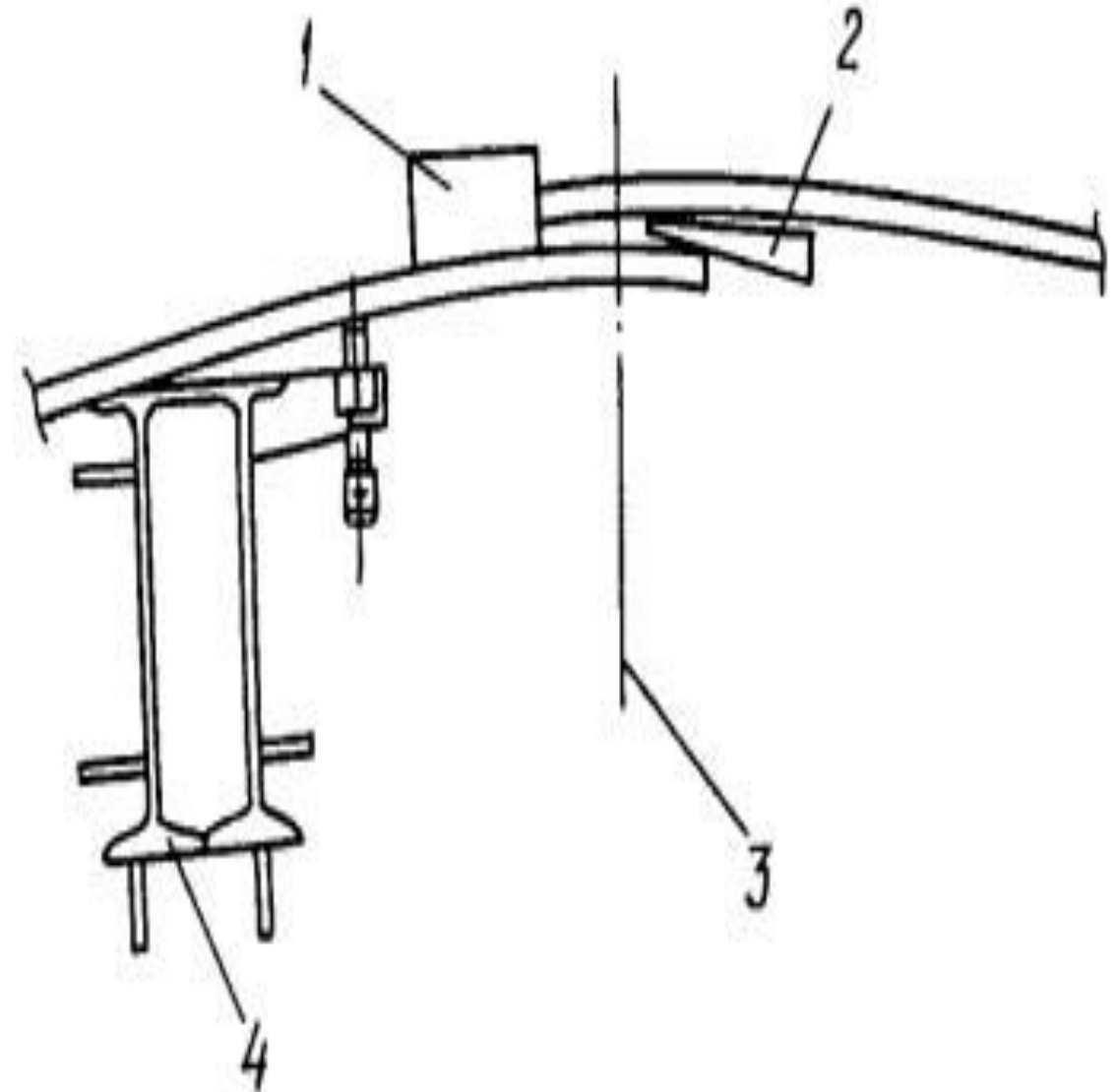
When forming, the ends of the panels at a length of 3 m should not have elements of a support ring or an annular platform.

Shaping is considered completed if, after its completion, the end section of the panel occupies a position close to the design one.



After forming, the overlap is cut off with the cutting of the edge and the joint is finally assembled with the design gap on the potholders with some output of the assembled joint outside the design curvature of the tank by the amount provided for by the PPM, so that after welding the mounting joint, the angular deformations do not exceed the tolerances given in the project and VST (departmental building codes) For this purpose, a device is used that ensures the output of the joined sections of the panels to the required position. After welding, quality control of the welded joints, correction of defects and re-inspection, all mounting fixtures are removed from the wall panel in the area of the mounting joint.

- 1 - a limiting plate;
- 2 - a wedge;
- 3 - the axis of the vertical mounting joint;
- 4 - a device for closing



INSTALLATION OF THE ROOF. SEQUENCE. STAGES

Low pressure tanks with a fixed roof, depending on the coating design, can be:

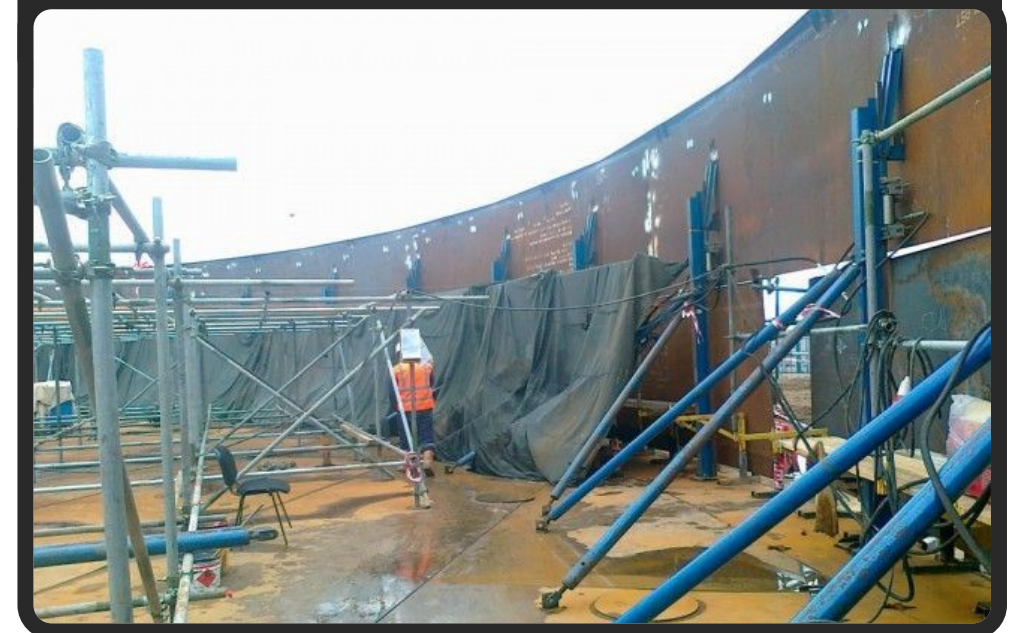
- with a frame roof, with or without a central pillar (conical or spherical);
- with a frameless roof and a central rack (hanging, "momentary roof").

Stationary roofs are supported on the tank wall (on the annular element of rigidity) and the central rack, or only on the wall (spacer system). For a spherical roof, only a spacer structure is used.

The frameless roof is used for small snow loads (up to 1.5 kN/m²) and small volumes (up to 5000 m³)

THE METHOD OF SHEET ASSEMBLY

As a rule, tanks with a volume of up to 20,000 m³ are manufactured by the method of sheet assembly. It is a manufacturing - rolling of the bottom, walls, roofs of sheets, without first welding them together. Individual sheets are delivered to the construction site, where the sheet assembly of the VST elements is fully carried out. In addition to sheet assembly and roll assembly of tanks, there is a method of building up and lifting belts on jacks.





METHODS OF INSTALLATION WELDING OF TANKS

- ❖ - mechanized arc welding with a melting electrode in carbon dioxide shielding gas;
- ❖ - automatic arc welding with a melting electrode under the flux;
- ❖ - automated welding with forced seam formation with powder or activated wire.
- ❖ - mechanized arc welding with self-protective powder wire;
- ❖ - mechanized arc welding with self-protective powder wire in a protective gas environment;
- ❖ - manual arc welding.

When welding in winter, it is necessary to systematically control the temperature of the metal and, if the calculated cooling rate of the weld metal exceeds the permissible value for this steel grade, it is necessary to organize preliminary, accompanying or post-welding heating of the edges to be welded. The required temperature and the heating scheme must be defined in the PPR. When heating the edges, the metal should be heated to the full thickness on both sides of the joint to a width of 100 mm. The heating temperature control should be carried out with thermal paints, thermal pencils, contact thermocouple thermometer, optical pyrometer. When welding in winter, regardless of the air temperature and steel grade, the edges to be welded must be dried from moisture.

QUALITY CONTROL OF THE ASSEMBLY OF STRUCTURES

Types of quality control of welded joints:

- ❖ mechanical testing of welded joints of witness samples;
- ❖ visual inspection of all welded joints of the tank;
- ❖ measuring control using templates, rulers, plumb lines, geodetic instruments, etc.;
- ❖ control of tightness (impermeability) of welds using samples of "chalk-kerosene", vacuum chambers, excess air pressure or color flaw detection;- physical methods
- ❖ to detect the presence of internal defects: radiography or ultrasonic flaw detection, and to control the presence of surface defects with a small opening
- ❖ magnetography or color flaw detection;
- ❖ hydraulic and pneumatic strength tests of the tank structure.