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(54) **Method for building an outer wall**

(57) A method for building an outer wall to be provided with one or more frames, which outer wall comprises an inner cavity leaf, a cavity and an outer cavity leaf. First the outer cavity leaf (1) is built in brick around one or more timely placed temporary windows (2). Next, the temporary windows are removed and replaced with frames (4). Then, against the inside of the outer cavity leaf, insulation (5) is provided, if desired with allowance for an open cavity (6), and finally the inner cavity leaf (7) is provided. The outer cavity leaf is preferably manufactured from glued bricks while preferably Kapla frames are used that are hoisted in from outside and are mounted from inside. Providing the inner cavity leaf can be deferred until the completion phase of the building; for instance in the same pass as in which non-bearing inner walls are provided.

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Description

Field

[0001] The invention concerns a method for building an outer wall of a building to be provided with one ore more frames, which outer wall comprises an inner cavity leaf, a cavity and an outer cavity leaf.

Background

[0002] The façade of a house (in general: building) determines to a large extent the price (and the quality) of the house and also determines to a large extent the building time of the house. The house-separating walls and bearing end façades provide the floor-bearing function; they are part of the skeleton that is the first to be built. The longitudinal façade of semidetached houses and terraced houses (the bulk of house-building) is the most labor-intensive, building time-determining (only after the façade has been made rain- and wind-tight can internal building be started) and costly part of the house. Also, the longitudinal façade includes the most frames, which in the Netherlands are mostly made of tropical hardwood design. Those frames are normally bricked in at an early stage as a semifinished product and only glazed and painted in a late stage, often even after completion, because of the winter break of the painter.

[0003] The dominant technique of the longitudinal façade involves a structure with a brick-built outer cavity leaf, an air cavity behind it, and an inner cavity leaf (against which insulation material is attached). Constructionally, *inter alia* in taking up the wind load, inner cavity leaf and outer cavity leaf cooperate. For the outer cavity leaf, mainly brick is chosen, a typically Dutch choice. For the inner cavity leaf (except in prefab, which has only a small market share left), normally stony material is used, often 100 mm thick sand-lime brick blocks or elements, which, compared to the non-bearing inner walls, is a rather costly solution (100 versus 25 Euros per m^2).

[0004] The building process in the Dutch tradition is that the façade is built up from the inside out: first the inner cavity leaf is built (in the prefab variant, it is hoisted-in with the crane and mounted). Against the inner cavity leaf, at the places intended for the purpose, frames are placed (in prefab, the frames are sometimes already mounted in the inner cavity leaf). In the frame openings, often transparent foil is fitted to improve the labor conditions for completion of the building inside. Viewed in time, the placement of the frames proceeds concurrently with the fitting of insulation material against the inner cavity leaf, the fitting of the wall ties and the building of the outer cavity leaf. The craftsmen involved then stand outside, in all weathers, for a part on a (bricklaying) scaffold. Pointing and painting of wooden parts near the gutter are done from the same bricklaying scaffold. As a consequence, the scaffold stands in front of the façade for a relatively long time and impedes accessibility. Hence, all these operations on the façade are weather-dependent and often hinder planning.

[0005] Brickwork in the façade is typically Dutch and has many positive properties. The freedom in design, the freedom of choice as to shape and color, durability and the relatively low costs are the decisive reasons why buyers and architects are likely to prefer brickwork for decades to come. Traditional brickwork also has its limitations. The joint is the weakest link, both in construction and in durability and color uniformity. Visual ageing is virtually entirely due to the joint, and also the phenomenon of lime efflorescence is caused by the mortar joint.

[0006] Summarizing, the features of the Dutch method of building the longitudinal façade in house-building are:

- Building process from the inside to the outside
- Frame is typically of the brick-in type of frame, with direct contact between frame and brickwork
- Frame is a semifinished product, is glazed and painted only in a late stage of completion and is therefore made of environmentally unfriendly tropical hardwood design
- Inner cavity leaf — at least prior to and during the erection of the outer cavity leaf — has a wind bearing function and must therefore be made of thick, heavy and costly design
- Use of an air cavity provides for secure moisture barrier;
- The outer cavity leaf is mostly constructed of brickwork.

[0007] Two new technologies have been developed, which have meanwhile conquered a small but steadily growing market share in house-building:

1. Gluing brick
(see e.g. http://www.knb-baksteen.nl/publicaties/publicatie_35.htm)

■ As in traditional bricklaying, here too, cement is used as binder. The glued joint is appreciably thinner than before and is recessed about 8 mm; use is made of special tools, as a result of which pointing is omitted. The gluing is in fact super-bricklaying whereby the bricklayer arrives at the end result in one operation.

■ The technique often involves somewhat higher costs per m^2 of wall because of the still limited number of bricklaying companies that have much practical experience and because of the extra architectural possibilities, which architects proceed to exploit immediately.

■ Leaving open the head joint (width of joint in this case too about 4 to 5 mm) does not visually present any drawback, but does promote the ventilation function of the air cavity (and has a favorable effect on the labor factor)

■ Pointing, with all its quality limitations, has been eliminated

- The strength of the glued construction increases significantly (strength no longer limited by the joint; the stone quality is decisive)
- When looking at the glued façade, what one sees is virtually exclusively brick, so that the color intensity increases strongly.
- Early color ageing and lime efflorescence are things of the past.
- Because of the thin joint, 92 instead of 75 bricks are used per m^2 of wall
- Meanwhile, there have been several manufacturers who have adapted the size of the brick to the new technique (two ends plus joint = stretcher). The additional costs due to more sawing work are thereby reduced.

2. Use of ready-made installable (Kapla) frames (see for instance http://www.kapla.nl/):

- A ready-made frame (glazed, painted and fitted with sealing and fastening means) is supplied by the joinery industry (50 % added value) in a late stage of finishing the building (5 weeks before completion).
- Hoisting-in is done with the crane, about two houses on a day
- A development has been realized which is especially aimed at arranging in a practical manner for the façade opening (both in the inner cavity leaf and in the outer cavity leaf) to correspond to the frame dimensions.
- An additional advantage of the method is that there is no longer any contact between outside brickwork and the wooden frame; an important source of wood rot has thus been eliminated.
- The most important attack on the frame (damages in the shell construction phase; weathering winter unpainted) has been eliminated. Painting and glazing are done at the joiner's under optimum conditions, with, for instance, an ensured layer thickness of the paintwork.
- The last-mentioned two points make it possible, without great risks, not to use tropical hardwood anymore but to use European pine, while maintaining GIW guarantee (unique).
- In the shell construction phase, temporarily a cheap and recyclable temporary window is bricked in; the working conditions inside are thus made acceptable at an early stage.
- The building process at the construction site is strongly simplified.

[0008] Summarizing, the following holds true of the present state of the art:

1. In the current building process, work proceeds from the inside out, so that building the inner cavity leaf, placing the frames and insulating:

- are in the critical path
- are weather-dependent with consequences for labor conditions
- are executed outside and hence entail quality risks

2. For the bricklaying process, usually traditional brickwork is opted for:

- constructionally relatively weak
- less durable joint connection
- color ageing-sensitive pointing
- sensitivity and uncontrollability of brickwork quality
    - o size of the burrs
    - o moisture bridges to insulation material

3. Utilization of brick-in frames (in the inner cavity leaf) has the following disadvantages:

- fragmented execution involving many disciplines
- in the critical path in planning
- little or no room for buyer wishes (must choose early)
- quality risk (damage in shell construction/weathering winter unpainted)
- durability risk because of direct contact with outside brickwork
- non wind-balanced air cavity, with resultant sensitivity to moisture leaks along the frame

4. The inner cavity leaf takes partially care of the wind-bearing function

- thick (loss of space)
- heavy (costs and provisions in the floor/foundation)
- limited freedom in choice of material
- costly

<u>Summary</u>

[0009] The object of the present invention is to obviate the above-indicated problems and disadvantages by providing a method for building an outer wall to be provided with one or more frames, which outer wall comprises an inner cavity leaf, a cavity and an outer cavity leaf, the method comprising the following steps:

a. The outer cavity leaf is built in bricks around one or more timely placed temporary windows;
b. The temporary windows are removed and replaced with frames;
c. Against the inside of the outer cavity leaf, insulation

(5) is applied, if desired with allowance for an open cavity (6);

d. The inner cavity leaf (7) is provided.

[0010] Preferably, the outer cavity leaf is manufactured from mutually glued bricks, while furthermore, as frames, preferably Kapla frames are used.

[0011] Below follows a discussion and further elucidation of the invention.

<u>Exemplary embodiment</u>

[0012] Figures 1 and 2 schematically show phase 1 of the method according to the invention, Fig. 1 showing the vertical cross section thereof, Fig. 2 the horizontal cross section.

[0013] Figures 1 and 2 show an outer cavity leaf 1, a temporary window 2, a wooden section 3, a Kapla frame 4, insulation 5, an open cavity 6, an inner cavity leaf 7 and a windowsill/bottom rail 8.

[0014] In the figures, the following construction phases are distinguished, which will be discussed below:

- Phase 1: Building outer cavity leaf 1 in bricks around a temporary window 2 (suspended from a wooden section 3).
- Phase 2: Removing temporary window 2 and installing Kapla frame 4..
- Phase 3: Providing insulation 5 including open cavity 6.
- Phase 4: Providing inner cavity leaf 7 and windowsill/bottom rail 8.

[0015] Phase 1: Building outer cavity leaf in bricks around a temporary window In the new sequential order of building, after the readying of the bearing construction (skeleton), consisting of house-separating floor-bearing walls and the floor-bearing supporting inner cavity leaves of the end façade, the outside brickwork is made immediately.

[0016] The outside brickwork is carried out according to the gluing technique, as a result of which the outer leaf has sufficient strength by itself to take care of the wind-bearing function. Even glued work with open head joints can be used (faster building, price advantage and better ventilation of the later air cavity).

[0017] In the outside brickwork, openings are left, in which later, shortly before completion, the then ready-made frames (glazed and painted) fit. That façade opening is obtained by bricking-in a temporary window, with dimensions that are circumferentially 6 mm greater than the later frame. The function of this temporary window is:

- providing for the proper dimensioning
- providing for the proper size of the frame opening
- providing a stop for the bricklayer who bricks it in in the manner in which traditionally a brick-in frame is dealt with.
- providing for an inner environment in the house at an early stage, so that the activities inside can be carried out under proper labor conditions.

[0018] The temporary window is relatively cheap and, if so desired, it can be designed in recyclable materials.

[0019] The temporary window can be placed in several ways. It can be positioned beforehand by the surveyor, or during the bricklaying process (at the moment when the bricklayer is at the height level of the underside of the temporary window). The first method seems to be obvious. What may be opted for, especially in the case of very large frame openings, is a wooden section that transmits the wind load acting on the frame, also definitively, to the superjacent and subjacent floors. See the wooden section in Fig. 2.

[0020] Placing this section and the temporary window is part of the surveyor's task. The bricklayer merely bricks up and does not have any responsibility for the proper position of the later frame in the façade (nor do he and the pointer spill onto it anymore).

[0021] The bricklayer, just as traditionally, stands on the outside of the house, for a part on a bricklaying scaffold. In the glued execution, which is essential here, there is no pointing. As soon as the bricklayer has carried out his work to the required height, the bricklaying scaffold can be removed, unless the contractor wants to use the bricklaying scaffold also for constructing the gutter and wants to use it as a safety provision against falling for the roofer. So there is no pointer involved in the work anymore. The bricklayer provides the end product in a single pass.

[0022] The gluing work, like the traditional brickwork, is in the critical path and is at risk of delay owing to rain and wind. The gluing work starts earlier than traditionally because there is no need to wait for:

- the inner cavity leaf to be built
- insulation to be provided (also from the outside on the building scaffold, in all weathers)
- the frame to be surveyed and the frame to be hoisted in.

[0023] The gluing work requires less time than traditional bricklaying because:

- gluing has no limitations due to "floating"
- pointing has been eliminated

[0024] Phase 2: Removing temporary window and installing Kapla frame.

By the end of completion of the building, the frame is installed. Normally, the temporary window is removed first. From inside, the steel connecting shoes are detached. The temporary window is pulled inside and then comes clear. It is discarded in its entirety to be disassembled and possibly recycled. The frame opening is now ready for the frame to be installed in it.

[0025] The frames, which have been made by the same joinery as the temporary windows (which prevents dimensional errors cropping up), are supplied ready-made. They are glazed, painted, provided with fastenings, any ventilation provisions, sealing straps for airtightness against the later inner leaf and moisture barriers at the future air cavity. There is even a possibility of integrating into the frame the ledge function (normally a separate ledge of baked material which is afterwards mounted under the wooden windowsill). The sill of the frame is then made of plastic concrete, provided with a drip ledge at the front and with a tenon for the connection with the frame wood of the posts of the windows (owing to the tenon, that connection is above the sill and is thus much less exposed to rainwater dripping off). In other words, the durability and the quality of the frames are a category better than the quality of the traditional brick-in frames.

[0026] The frames are supplied on the day when they are mounted, on special racks, with the mounting side facing outwards. This saves a storage operation and prevents storage damage (and vandalism). In preparation, suction cups are applied to the glass of the frame, at the bottom end. On the standards from floor to floor, steel shoes are provided which provide for the vertical support. These shoes were also of service in the positioning of the temporary window. In the case of high frames without parapet, a fall-out protection is arranged to protect the fitter.

[0027] The frames are hoisted into the frame opening with a crane and special (existing) hoisting tools. With the crane, the frame is held in vertical position in front of the frame opening. The fitter is on the inside of the house in front of the frame and can guide the frame by way of the suction cups when it is being hoisted in. The wooden standards from floor to floor provide the stop, and the temporary vertical support is provided by the earlier-described shoes on the vertical standards. The fitter checks the positioning and secures the frame. He disconnects the hoisting tool, so that the crane can proceed to fetch the next frame. The frame is then fine-positioned and secured from the inside with rust-proof braces against the outside brickwork (the braces are first fitted to the frame with woodscrews and then with tap bolts to the outside brickwork). For the sake of clarity: there is no surveyor needed anymore because the dimensions are already determined by the frame opening.

[0028] Mounting proceeds at a high speed (about 10 minutes per frame). The order of work probably proceeds from one house to the next. Two houses (with 30 to 40 frames) a day can be placed. With brick-in frames, it is impossible to mount the whole house at once because placing the frames proceeds from the bricklaying scaffold. As a consequence, brick-in frames stand on the construction site for a long time and are installed bit by bit. Surveying is thus broken up as well. Surveying and traditional frame installation then take about 60 man-minutes per frame, which implies a considerable saving.

[0029] After this mounting operation, the house is wind- and rain-tight.

[0030] Phase 3: Providing insulation 5 including open cavity 6.

The sequential order of building depends on the type of inner wall that has been chosen and especially on whether that inner wall is to be installed before or after the provision of the cement deck floor:

- gypsum block inner walls (and also gypsum board inner walls) come onto the cement deck floor
- gas concrete panels come onto the rough floor for the cement deck floor

[0031] The most common inner wall is the gypsum block wall. What is then preferred is a sequential order of building whereby the deck floor is already provided prior to the frames (prevents staining). In that case, insulating starts directly after the frame is mounted.

Wall ties are drilled in the inside of the brickwork exactly at the height of the seam in the insulation boards (sheet material or mineral wool). Where necessary, spacers are arranged on the insulation material in order to reliably obtain a continuous air cavity. The insulation boards pass in front of the floors and are tightly fitted against the frame. While traditionally the bricklayer applies insulation there and walls it up immediately, as a result of which a check is difficult and possible only for a short time, there is now sufficient time for inspection; cold bridges can be corrected and air leaks can be remedied.

[0032] There is now an air cavity which, alongside the frames, has an open communication with the outside air and there is no contact between frame wood and brick. What has been realized, in short, is a durable frame connection and a well-vented air cavity that has been reliably and completely insulated on the inside.

[0033] The provision of the insulation is now done from the inside. The fragile insulation boards are not blown to pieces and cannot get wet anymore in the building phase (and so cannot collapse under the moisture weight). The contractor is free to choose who fits the insulation. In any case, this is not the bricklayer. The work can be carried out by the gypsum block fitter, but also by a carpenter or a specialist trained for the purpose.

[0034] Phase 4: Providing inner cavity leaf and windowsill/bottom rail.

The architect and the contractor are free in their choice of the inner cavity leaf. Its wind-bearing function has been eliminated. Accordingly, the function is not any different from that of the normal non-bearing inner walls, except that the inner cavity leaf needs to be finished on one side only.

[0035] As a rule, therefore, it is chosen to use the same product that is used for those inner walls, since in that case the work can be done by the same people and in the same pass as the non-bearing inner walls.

[0036] Instead of the traditional wind-bearing inner cavity leaves of stony material of a thickness of 100 mm or more, now it may be chosen to use:

- gypsum blocks 70 mm thick, the most common non-bearing inner wall
- gas concrete storey-high panels 70 or 100 mm thick
- dry lining walls of Fermacell or Metal Stud. These non-bearing inner walls are 70 mm thick (two boards with 50 mm insulation material between them), but if they are used for the inner cavity leaf, the thickness is reduced to the single board thickness, being about 10 mm. In this case, the insulation is not fitted until after the installation of the extremely thin steel or thin wooden standards on which the boards are screwed later.

[0037] Presently, in the inner cavity leaves, readily, simultaneously with the other walls, provisions for the technical installation can be included, as is for instance proposed in patent specification NL1026944. In the reversed building order, the time of fitting the technical installation has been shifted markedly towards completion. This is of great importance because buyers often know only in a late stage of building where exactly the electrics installation is desired.

[0038] The above-mentioned inner cavity leaves are not only thinner, yielding a gain of space, more square meters on the same parcel, or a house slightly smaller on the outside with savings on the floors, the roof and foundation.

[0039] The saving of costs on the inner cavity leaf is considerable. The wind-bearing inner cavity leaves cost about 100 Euros (in situ brick construction) to 120-150 Euros (prefab concrete and wooden skeleton) per square meter, while the new choice is between products of between 20 and 30 Euros per square meter. (Terraced house has about 30 m^2 of inner cavity leaf).

[0040] If it is chosen to use an inner cavity leaf of the same material as the non-bearing inner walls, and building is done in the same pass as the inner walls, which is very obvious, a whole pass is eliminated in planning, and the building time of the house is shortened (by some days to some weeks) and hence also construction site costs are reduced.

[0041] The use of the present invention thus makes it possible to combine the favorable aspects of two recently introduced innovations. To that favorable combination, the use of a reversed building order as described above is then added. With the following results:

- Shorter building time owing to

  ■ the use of ready-made frame that falls outside the critical path
  ■ elimination of the separate pass for the inner cavity leaf
  ■ insulation being removed from the critical path
  ■ elimination of pointing

- Higher quality

  ■ owing to the use of Kapla frame
  ■ owing to the choice of gluing as bricklaying technique
  ■ owing to insulation being provided from the inside, being executed independently of the brickwork and allowing inspection for a longer time
  ■ owing to the provision of the inner cavity leaf from the inside, with optimum choices of water barrier (especially upper side of frame), of air seals around the frame, and execution in conditioned circumstances

- Different moment of Kapla frame placement

  ■ placement before inner cavity leaf and insulation are provided (and not as with traditional Kapla after the placement of the inner cavity leaf)
  ■ dimensioning of inner cavity leaf is eliminated; dimensioning derives from the frame

- Cheaper.
  While gluing still costs more than traditional bricklaying (despite the elimination of pointing), this drawback is amply compensated by:

  ■ shorter building time
  ■ transition from expensive heavy to appreciably cheaper inner cavity leaf
  ■ Kapla is in itself already cost-neutral; now, also dimensioning of the inner cavity leaf has been eliminated
  ■ Two costly parts of the Kapla method have been eliminated

    - the Kapla strip that is needed for dimensioning of the inner cavity leaf
    - the Kapla assembly bushes that are needed for positioning the frame and the connection of the frame with the outer cavity leaf

- depending on the design: gain of space

  ■ the inner cavity leaf is traditionally 100 mm thick.
  ■ Narrower air cavity because of gluing and because work is done from the inside (expected gain 20 mm)
  ■ With a metal-stud inner cavity leaf, the gain of space is greatest (70 mm per fagade), but also with gypsum blocks there is still a gain of space of 30 mm per façade

- Freedom in design

  ■ freedom of choice regarding the inner walls
  ■ more possibilities for placing technical installation, even by the end of the completion phase

■ ledge function is integrated

Claims

1. A method for building an outer wall to be provided with one or more frames, which outer wall comprises an inner cavity leaf, a cavity and an outer cavity leaf, **characterized by** the following steps:

- the outer cavity leaf (1) is built in brick around one or more timely placed temporary windows (2);
- the one or more temporary windows are removed and replaced with frames (4);
- against the inside of the outer cavity leaf, insulation (5) is applied, if desired with an open cavity (6) intervening;
- the inner cavity leaf (7) is provided from inside.

2. A method according to claim 1, wherein the outer cavity leaf is manufactured from mutually glued bricks.

3. A method according to claim 1, wherein the frames are Kapla frames, which are hoisted in from outside and are mounted from inside.

4. A method according to claim 1, wherein the provision of the inner cavity leaf is deferred until the completion phase of the building in question.

5. A method according to claim 1, wherein the inner cavity leaf is provided in the same pass as in which non-bearing inner walls of the building in question are provided.

6. An outer wall, manufactured according to the method according to one or more of the preceding claims.

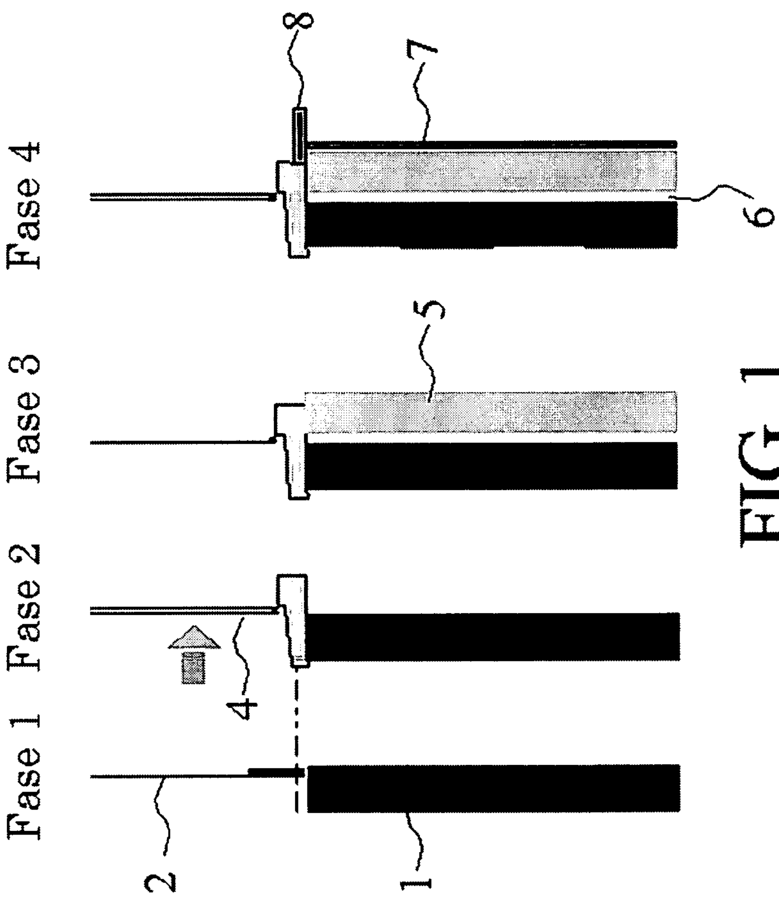

FIG. 1

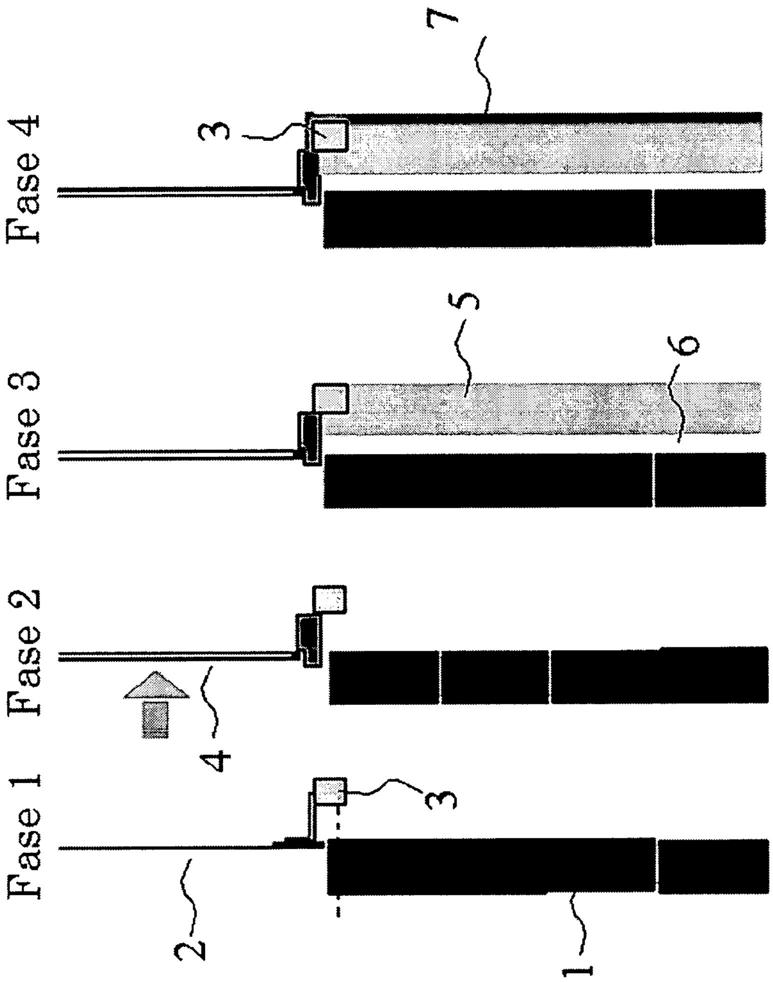

FIG. 2

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- NL 1026944 **[0037]**