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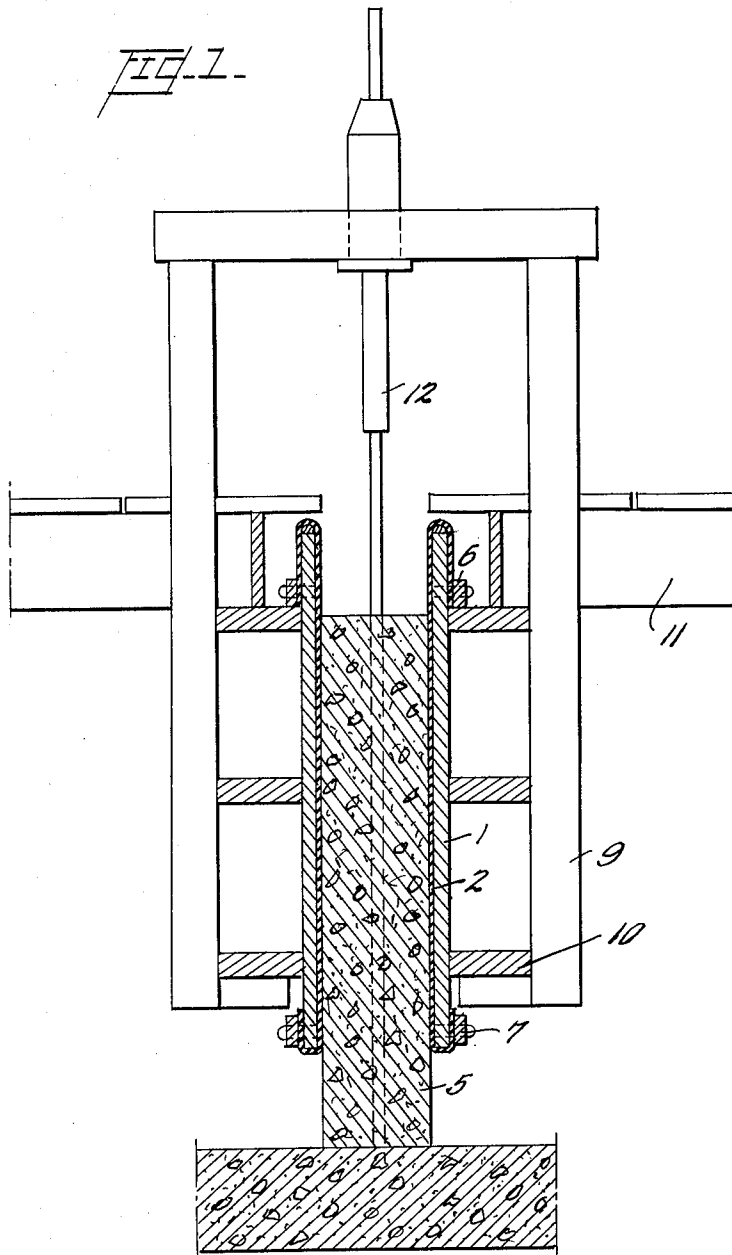
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MOLD ASSEMBLIES AND CASTING OF BUILDING STRUCTURES

Filed Jan. 22, 1963

4 Sheets-Sheet 1



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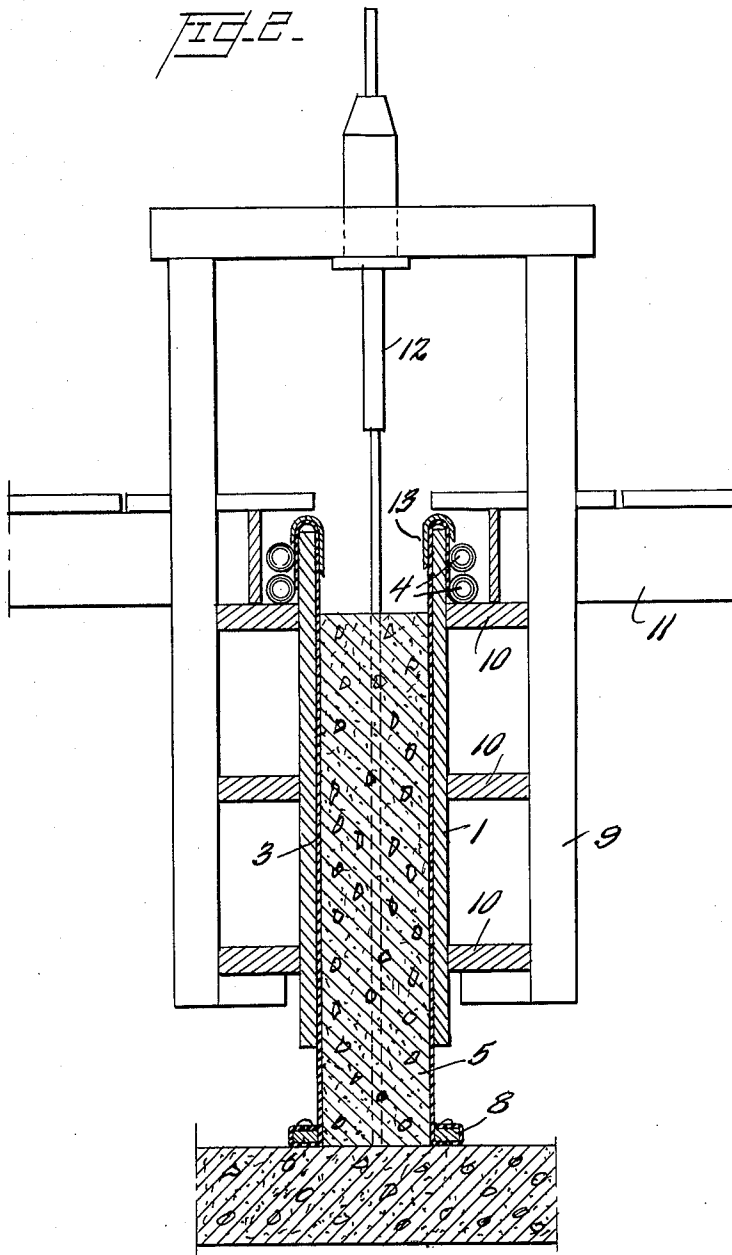
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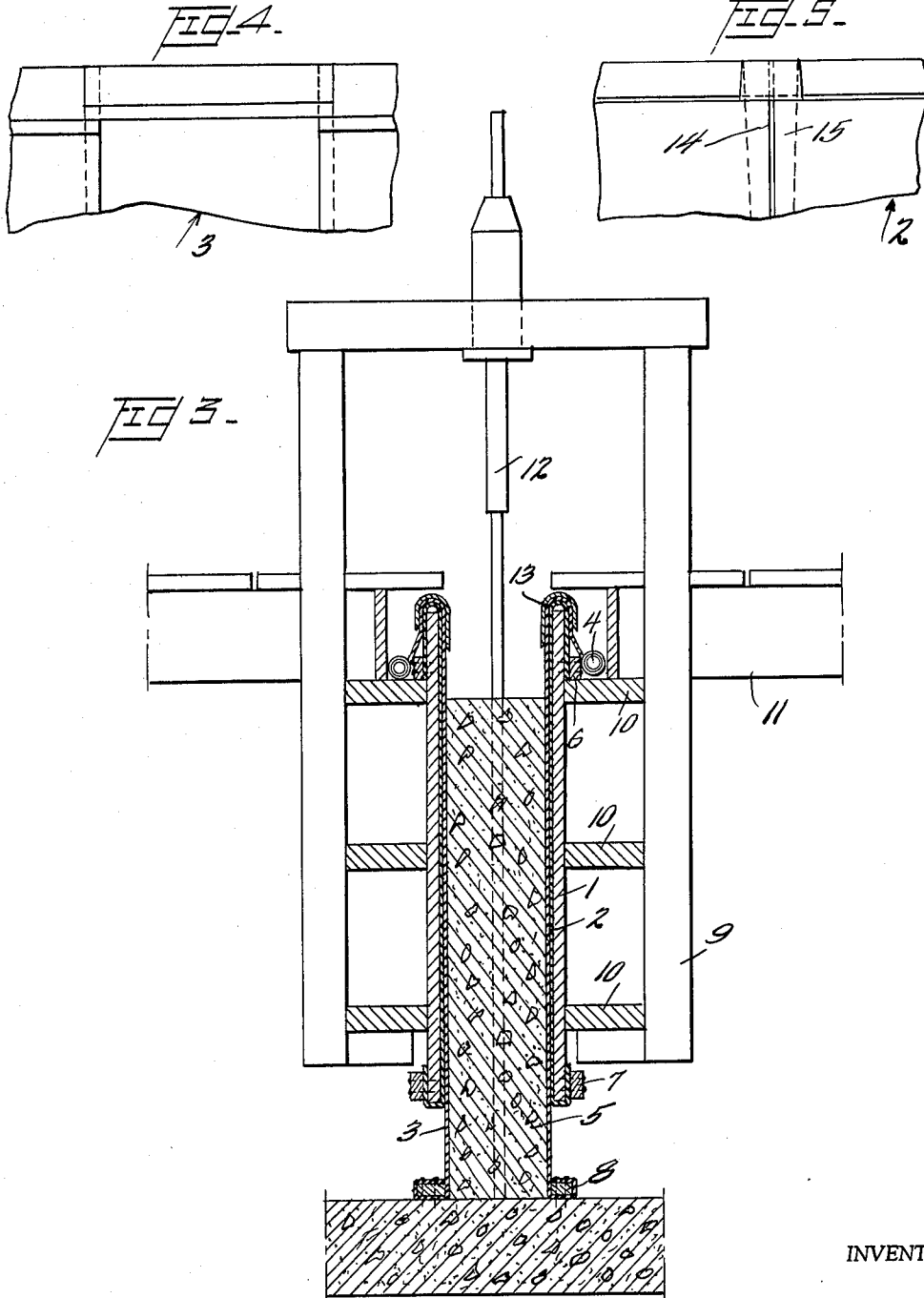
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4 Sheets-Sheet 3



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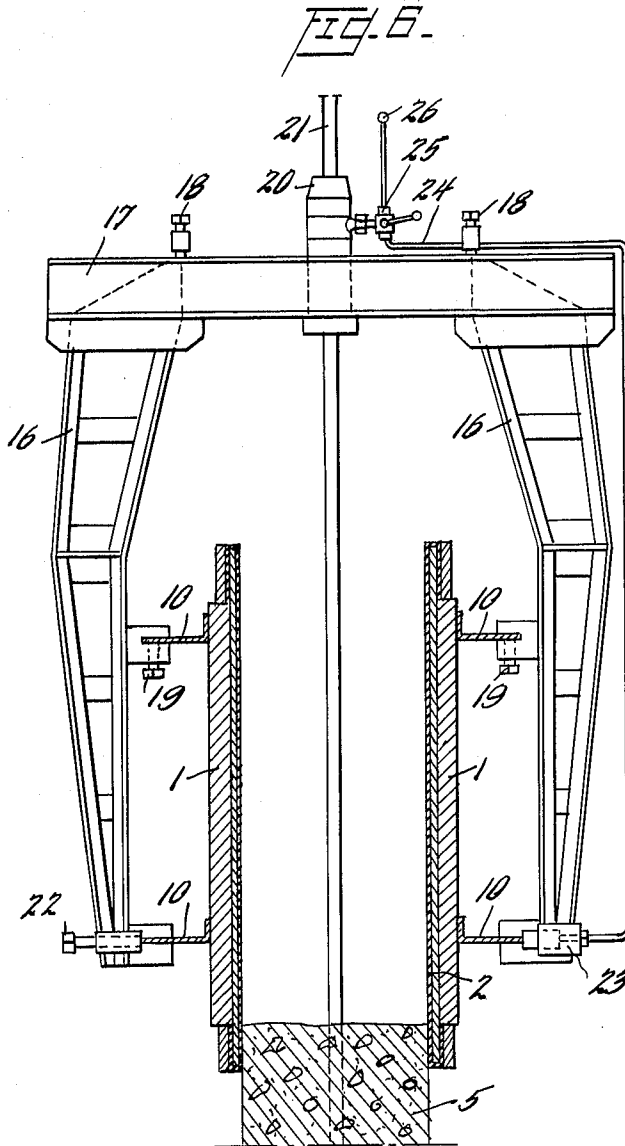
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4 Sheets-Sheet 4



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MOLD ASSEMBLIES AND CASTING OF BUILDING STRUCTURES

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4 Claims. (Cl. 249—33)

This invention is concerned with casting of building structures and particularly with improvements in mold assemblies, their use and their controlled adjustment.

During the last decades slip mold casting has developed into a commonly adopted working procedure within the building industry. At first slip mold casting was believed to be useful substantially only for simple monolithic constructions, for example, silos or the like, but gradually a rational mechanization of the mold lifting equipment has been broadening the range of practical building within which slip mold casting may be employed successfully. Nevertheless there have remained certain technical and practical difficulties that have up to now oftentimes made slip mold casting impossible.

In order that satisfactory results may be achieved with the known slip mold assemblies the casting operation, usually vertical casting, has to be performed substantially continuously. This means for most of the bigger buildings that the casting has to go on day and night, thus implying shift work. The only possibility of preventing the mold from getting stuck to the cast building element—which is usually made of concrete, artificial stone or similar material—is to keep the mold moving; as a rule interruptions of more than half an hour, or in some cases up to about two hours, cannot be tolerated. This of course is a great drawback as it does not permit interruptions of work over night, during holidays, spells of bad weather etc., and moreover even while casting is going on special precautions have to be taken for guarding against involuntary interruptions. For this latter purpose the work has to be carried out under the constant supervision of special-trained persons who will be able to take the right action in case something goes wrong during the casting, for instance in the operation of lifting the slip mold, and moreover the general demands for ensuring a quick supply of all kinds of reserve equipment for, for example, concrete mixers and concrete elevators must necessarily be very high. All these circumstances involve increased expense as well as difficulties in the practical performance of slip mold casting operations, with the result that up to now this method which is so advantageous in itself has often not been utilized where, in principle, it could have been employed.

The effect of the above-indicated disturbing factors is overcome by the present invention. One of the objects of the invention is, thus, to provide improved mold assemblies which will permit interruptions to a far greater extent, without the risk that the mold adheres too firmly to the building element, which is being cast, and without involving any major difficulties in re-starting the casting operation after a longer interruption.

Another object of the invention is to provide improved mold assemblies for producing cast building elements having special predetermined surface properties.

Still another object of the invention is to provide improved mold assemblies permitting either continuous casting or stepwise casting as desired.

Furthermore, it is an object of the invention to provide improved mold assemblies with control devices for positioning the mold walls relatively each other in a desired manner.

A further object is to provide improved mold assem-

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blies equipped with special means for eradicating any visible "seams" or markings along the interface line between a part of a building element cast during a first operation and a new part cast afterwards, for example, after a longer interruption.

These and other objects and advantages of the invention will become apparent in the course of the following description.

According to one embodiment of the invention, a mold for casting building elements, preferably of concrete, artificial stone or similar material, is provided with a lining consisting of one or more sheets of elastic material of for instance rubber, and/or one or more substantially inelastic sheets of, for instance, plastics, paper or textile material, this lining being interposed between the inner wall portions of the mold and the building element which is being cast in said mold. This lining which preferably covers the entire interior face of the mold walls may consist of for instance one or several sheets of rubber attached to the mold at least at the advance (upper) end thereof and preferably also at the rear (lower) end. According to another embodiment, the lining comprises one or several sheets of a comparatively inelastic material, for example, plastics, textile fabric, paper etc., such sheets being wound each on one roll arranged so as to permit each sheet to be rolled off progressively along the cast element, each roll being for this purpose mounted at the outer side of the mold at the advance end thereof so as to be displaceable together and synchronously with the mold; the rolled-off portion of said sheet or sheets will then extend from the roll over the foremost edge of the mold wall, as seen in the direction in which the mold is advanced, then further along the interior face of the mold wall, and the rolled-off end of the sheet is fixed outside the rear end edge of the mold, close to the cast element. In both cases, the arrangement of this lining will permit interruptions in operation without any danger that difficulties will arise when the mold is to be moved on again after having remained in the same position for a prolonged time during which, for instance, the concrete may have set. In both cases, the concrete will not adhere to the mold wall but instead to the lining, and the friction between the lining and the mold wall will be less than the friction between the lining and the concrete. If the lining consists, for example, of the above-described rubber sheet the re-starting of the advance movement (usually lifting) of the mold after a longer period of standstill will proceed as follows: At first, a sliding occurs between the wall of the mold and the rubber sheet, and this involves stretching of the elastic sheet beginning at the foremost end portion. The stretching of the rubber sheet brings about a reduction of its cross section, and this in combination with the pulling action itself will cause the sheet to be progressively disengaged from the concrete element, starting at the foremost end of the mold, and, thus, to be drawn off the element. The demand of energy or power for this progressive disengagement is very small as compared to that which would be required for drawing off the mold itself from the concrete. Moreover, during the standstill period moisture has been kept back in the concrete, due to the action of the surrounding rubber, to a far greater extent than if there were no such lining. This effect is of great help in enabling the casting to be continued without formation of a technically and aesthetically unsatisfactory transition zone between the old and the new portion of the element. The same moisture-retaining and transition-improving effect is obtained with a lining comprising a rolled-off plastics sheet, with a concomitant improvement of the quality of the concrete due to its hardening taking place in the presence of retained water. Also in this case it will be noted that no major consumption of extra energy is involved with

the re-starting after a longer interruption, as the mold slide smoothly along the sheet or sheets. Upon such re-starting, the sheets are simply rolled off further until the concrete element has been cast to its desired length, whereupon at first the mold and then the plastics sheet are removed, said sheet being very easily torn away from the concrete. A plastics material which is very suitable for this purpose and readily available is polyethylene, and preferably such a polyethylene or other plastics sheet should have a thickness corresponding to gauge 10. The plastics sheet should not be too stretchable. The plastics sheet when progressively rolled off will also provide the advantage that in operations for casting, for example, house walls it will at the same time form a layer covering window and door openings. In this function it eliminates the necessity of taking such special measures and steps for covering these openings as are otherwise required, especially during cold seasons of the year, in order to supply sufficient heat to prevent the concrete from freezing.

In both of the above-described cases, that is, with either rubber sheets or plastics sheets along the mold walls, concrete elements will be obtained with a very good surface texture not ordinarily obtained when slip mold casting is employed, at least not without time-consuming and expensive finishing treatments of the concrete surface which are superfluous when casting is carried out with the improved mold assemblies according to this invention.

When large building structures such as walls of houses are cast it is as a rule necessary to employ a plurality of sheets placed adjacent one another. Preferably they are arranged with a certain amount of mutual overlapping, and moreover it will be advisable to then cover the overlap juncture line with a strip on that side of the sheets which is to face the cast element.

Particularly good results are obtained with a lining which comprises a combination of types of sheets. This lining thus could comprise (i) one or several sheets of elastic material, for example, rubber, lying against the inside of the mold walls, and (ii) one or several sheets of substantially inelastic material, for example, plastics, textile, paper or the like, which are mounted for being rolled off progressively along and in contact with the cast element.

The lining according to the present invention moreover has the advantage that the mold after completion of the casting operation need not be subjected to a lengthy cleaning treatment for being liberated from adhering concrete, as was often required in conventional casting methods. Thus the mold may be used again immediately for a next casting operation, without being taken apart, cleaned and re-assembled.

According to a further improvement of the mold assemblies contemplated by the present invention, the mold is provided with a mechanism for controlling and adjusting the distance between the lower portions of the mold walls. A mold provided with such control means is particularly advantageous when used alternatively and as desired either for slip mold casting in an ordinary manner, or for a somewhat modified casting procedure as described below. The invention also comprises such a modified method for vertical casting of building elements, with the aid of a mold according to the various embodiments described above. According to this modified method, the casting is carried out stepwise, the mold being for each step filled with a casting material such as concrete, cement, artificial stone masses or the like; preferably during this filling operation the lower portions of the mold walls are urged together by means of the control or adjusting mechanism, to the effect that the two mold walls are maintained in substantially parallel relationship against the action of the downwardly increasing pressure exerted by the mass of the casting material. After the filling the mass is allowed to set or become rigid so as to become self-supporting, that is, so as to acquire sufficient strength

to permit the mold to be lifted again. When the first casting step has thus been completed the mold is lifted for initiating the next step; the lifting length may be the same as or less than the height of the mold walls. Such separate steps may be repeated as often as desired until the building element such as for instance a house wall has been built up to the desired height, whereupon the mold is taken away. The surface of the element will then as a rule have a texture corresponding to the surface texture of the lining, but as mentioned above it is possible, when desired for special purposes, to produce concrete elements having small stones etc. visible at their surface.

This stepwise casting method with the novel mold according to the invention eliminates the necessity of using heavy, storey-high steel molds of the type employed up to now. For instance, a storey of 2.70 m. may be cast in three 90 cm. steps, and the carcass flooring may be cast afterwards. The control mechanism for adjusting the position of the mold walls may for instance comprise adjusting screws or may be driven hydraulically. This mechanism is of particularly great importance in stepwise casting operations of the above-described kind. It will be noted that when an ordinary mold without said control or adjusting mechanism is filled with the casting material the pressure is greatest near the bottom so that the lower parts of the mold walls often tend to be urged apart and the distance between the walls consequently will be somewhat less at the top than at the bottom. In conventional casting operations of the more or less continuous type such a conic orientation of the walls may be desirable as it may actually assist in diminishing the "grip" in which the mold is held by the cast element. When a lining is used as according to the invention it will also sometimes be desirable to maintain at least a certain degree of conicity when the casting is carried out in accordance with the ordinary sliding method. In these cases, the adjustable control mechanism is set to exert only little compressive force on the lower mold wall portions or even so as to release them entirely. However, if the mold is to be used in performing the above-mentioned stepwise method or, sometimes, if the casting is interrupted as described above, it is desirable that the control mechanism be set to hold the lower portions of the mold walls together in a manner such that the walls as a whole are maintained substantially parallel. In this manner the control mechanism counteracts any less desirable side-effect that may otherwise sometimes be obtained with the step method, namely that in the cast element produced every casting step may be marked out visibly, with thickened portions above every boundary line between two successive steps. With the aid of this control or adjusting mechanism the step method can be carried out in a particularly satisfactory manner, and in actual practice this method has been found highly advantageous because, among other things, the carcass flooring may be cast afterwards. As compared to such methods as are employed for building so-called "element houses" (houses composed of prefabricated units) the casting methods moreover have the general advantage of avoiding vertical junctures which in turn give rise to formation of interstices due to shrinkage.

When the mold is employed for stepwise casting it will be suitable to loosen the grip of the aforesaid control mechanism after completion of the last step so as to release the lower portions of the mold walls, whereupon the mold is taken away. When necessary such a release may be effected also after completion of any one or all of the preceding steps, whereupon the mold is lifted while sliding along the cast element to the desired position for the next step, and the control mechanism is again set to hold the lower portions of the mold walls together before filling with fresh casting material is started.

With a mold equipped with said control or adjusting mechanism the lining may be employed in any of the embodiments described above, and may be fastened to the mold in the manner as described; for instance, the

mold assembly may comprise an elastic sheet lining of the type described above, alone or in combination with the substantially inelastic lining member. If elements having large surface areas are to be cast—as is often the case—the lining will suitably be a composite lining and if desired be provided with a strip along the overlap juncture line, as described above.

The elastic lining may, for example, consist of a rubber cloth the elasticity of which is suitably such as to allow about 2–30%, preferably about 2–20% elongation before rupture. Rubber cloths reinforced with fabric, preferably of nylon or other plastics, have been found particularly advantageous due to their good properties as regards resistance to wear and weather. Elastic linings or other materials such as elastic polyethylene foils may also be used.

Some preferred embodiments of the invention are illustrated in the attached drawings, in which:

FIGS. 1–3 each show a section through a partially cast concrete wall and a mold employed for the casting, with appertaining supporting and lifting means. FIGS. 4 and 5 are partial views of composite sheets to be used as linings. FIG. 6 shows a sectional view smaller to those of FIGS. 1–3, with a control mechanism according to the invention for adjusting the distance between the lower end portions of the two mold walls.

Referring at first to FIG. 1, it will be seen that the assembly comprises a mold 1 for vertical casting of a concrete wall 5, said mold being equipped with rubber cloths 2 forming a lining between the walls of the mold and the concrete wall 5 which is being cast. The rubber cloths 2 consist of a plurality of mutually overlapping rubber sheets and cover the inner wall portions of the mold entirely. The mold is supported within a framework 9 by means of mold supporting belts 10 and is carried upwardly by means of a lifting mechanism (a so-called climbing jack) 12 together with a platform 11 for the operating and supervising personnel.

The upper and lower ends of rubber cloths 2 extend round the upper and lower edges respectively of the mold 1 and are fastened by means of bolts or nails or other suitable attaching means 6 and 7 to the outer side of the mold in the vicinity of each edge. While casting is going on, the mold 1 may be lifted successively by means of the climbing jack 12 while sliding along the concrete wall 5 which during this operation does not come into contact with the mold walls themselves but only with the lining. If working is discontinued either on purpose, for example, for laying a carcass flooring or on the occasion of a holiday, or involuntarily, due to deficiencies in any working detail or equipment, the concrete which is starting to set or harden adheres to the rubber cloths 2. As explained above, such adhesion will not involve any major difficulty because when the lifting is started again the elastic rubber is stretched, starting at the top, with a concomitant reduction of the thickness of cloths 2; the adhered concrete is thus scaled off and the mold and lining can come loose without any substantial resistance. When during this operation the rubber slides along concrete wall 5 it bestows a finely textured and regular surface on said wall, at the same time blotting out the boundary line between the old, previously cast portion of the wall element and the new portion. Thus interruption may be made whenever desired, and this is a considerable advantage also inasmuch as it permits one and the same group of operating staff to attend alternatively to the (slip) mold casting procedure and to casting carcass floorings.

In the embodiments shown in FIGS. 2 and 3, there are provided plastics sheets 3 instead of (FIG. 2) or in combination with (FIG. 3) the rubber cloths 2. Usually a plurality of mutually overlapping sheets 3 are provided along each mold wall and are progressively rolled down each from a separate roll 4 mounted outside the upper

end of mold 1, the sheets being all the time in direct contact with the concrete wall 5 while this wall is increasing in height. The rolls 4 are carried on the supporting belts 10 so that they are lifted together with these belts, the platform 11 and the mold 1, by means of jack 12. At their lowermost end the plastics sheets 3 are fastened in a fixed position by means of bolts or the like, designated by 8, in a manner such that they will come to lie against the concrete wall 5. From rolls 4 they extend over the upper edges of mold 1 where they are maintained in position by plates or brackets 13 in order to prevent objectionable sliding; in the embodiment illustrated in FIG. 3, the brackets or plates 13 enclose at the same time also the upper turned-over portions of the rubber cloths 2 attached to the mold by nails 6 and 7. Of course all or any of the bolts 6, 7 and 8 may be replaced by other fastening means. Preferably these bolts or other means are of such construction that they will readily permit an unfastening of the sheets. Further, it will be obvious that the sheets 3 shown in FIGS. 2 and 3 might well be textile or paper webs, for instance, instead of sheets or webs made of plastics material.

As the mold 1 slides upwardly the sheets 3 are rolled off at the same rate and form a sealing film around the concrete wall 5, thus protecting the wall from a too rapid escape of moisture and at the same time forming a good protective covering for vicinal window openings or the like. When the lifting movement is interrupted, then, also the roll-off feed from rolls 4 is interrupted—and at any time later on it can simply continue, without any resistance, when the casting and mold lifting operation is started again.

For such large surface areas as are usual in casting operations of this type the sheets or rubber cloths are as a rule not made in one piece but consist of a plurality of composed parts preferably overlapping as shown in FIG. 4 for a sheet 3 to be rolled off along the concrete element. FIG. 5 shows a composite rubber cloth 2 which is doubled back at its upper edge for being fastened by means of bolt 6 (FIGS. 1 and 3) at the outer side of the outer side of the mold. On that side of the cloth which is to face the concrete element the juncture line 14 between the two parts is covered by an elastic strip 15 preferably also consisting of rubber. In FIG. 5 the strip 15 is shown to have an increasing width towards the upper end thereof, that is, toward the foremost end as seen in the direction of the mold sliding movement, so that it has a shape somewhat like an elongated trapezium. The purpose and function of this strip is to sweep away any traces or marks that might be made by juncture 14 in the concrete surface during the upward sliding movement of the rubber cloth. For optimum effects these strips 15 should be made comparatively thin, preferably with decreasing thickness towards each lateral side thereof.

Turning now to FIG. 6, the walls of mold 1 carrying a lining 2 are attached to supporting belts 10 extending along the entire mold. The control or adjusting mechanism as here shown comprises a U-shaped yoke serving to lift the mold and at the same time to urge the two mold walls together at their lower end portions. The vertical shanks 16 of the yoke are adjustably connected to a pair of yoke beams 17, and locking screws 18 are provided to lock the yoke shanks in a desired position. The upper belts 10 may be locked to the yoke shanks by means of locking screws 19. A climbing jack 20 with a climbing rod 21 is provided for lifting the mold.

Each yoke may be pre-stressed as required for taking up the pressure of the concrete when the mold is filled. For this purpose, at least one of the two yoke shanks 16 is attached to the lowermost mold supporting belt 10 in a manner such as to permit movement transversely of the mold direction. By establishing a cotter effect between belts 10 and shanks 16 when the mold has been lifted so much that only a minor portion of its lower

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end encloses the previously cast wall part 5 the yokes are pre-stressed due to the yoke shanks being bent outward elastically in proportion with the magnitude of the cotter effect applied.

A simple embodiment of this pre-stressing device is shown by way of example at the lower end of yoke shank 16 to the left in FIG. 6. The device consists of a screw 22 which can be screwed in with abutment against the supporting belt 10, the shank of the yoke thus being forced outward.

To the right of FIG. 6 a different embodiment is illustrated according to which the yoke shank has been provided with a hydraulic jack 23 which is by way of an oil conduit 24 connected to a shiftable two-way valve 25 at the climbing jack 20. All the climbing jacks 20 employed in the mold equipment are connected to a common hydraulic pump through a communicating oil conduit 26. By shifting valves 25 it is thus possible to establish either communication between jacks 20 and the hydraulic pump or between jacks 23 and said pump. In this manner a simultaneous pre-stressing of all the yokes may be achieved, with the further advantage that the pre-stressing will be exactly the same on all the yokes employed in the equipment. The pre-stressing force is directly proportional to the shiftable hydraulic pressure. By connecting jacks 23 and jacks 20 each to one main conduit which communicates with a central two-way valve at the hydraulic pump the shifting operation may be simplified still further.

When the molds according to the present invention are employed for casting building structures it is possible to obtain completely clean surfaces which will not require any extra treatment, for example, before application of paint, due to the fact that the casting can be carried out without any anti-adhesive agents such as oil or wax.

It should be noted that the adjustable mold structure instead of being provided with a lining 2 attached as shown in FIG. 6 may be provided with any other of the lining equipments, fastening, holding and rolling means as illustrating in FIGS. 1-5.

Furthermore, it will be appreciated that the invention is not in any way limited to the preferred embodiments shown in the figures and described above but that many modifications may be made, as will be readily understood by those skilled in the art, without transgression of the spirit and scope of this invention as defined in the claims.

We claim:

1. A mold assembly for casting building structures, comprising a mold having at least one flat wall for cast-

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ing a face of a building element, means for repeatedly forcing said mold into sliding movements along the face of the element being cast, said mold having a lining comprising at least one sheet of elastic material extending along the interior face of each wall of said mold, each elastic sheet being fixed relative to its respective wall at a position forward of said building element, considered in the sliding direction, and being free of fixation to its wall adjacent said element whereby upon forward movement of said mold, any tendency of said element to adhere to said sheet causes tension, and attenuation of said sheet to release said sheet from said element.

2. A mold assembly according to claim 1, and in which said lining comprises a plurality of elastic sheets.

3. A mold assembly for casting building structures, comprising a mold having two opposite flat walls for casting a face of a building element therebetween, means for repeatedly forcing said mold into sliding movements along the faces of the element being cast, said mold having linings comprising at least one sheet of elastic material extending along the interior face of each of said walls of said mold, each elastic sheet being fixed relative to its respective wall at a position forward of said building element, considered in the sliding direction, and being free of fixation to its wall adjacent said element whereby upon forward movement of said mold, any tendency of said element to adhere to said sheet causes tension, and attenuation of said sheet to release said sheet from said element.

4. A mold assembly according to claim 3, in which said linings comprise a plurality of elastic sheets.

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