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(71) Applicant: **Longinotti Meccanica S.r.l.**
50019 Sesto Fiorentino (Firenze) (IT)

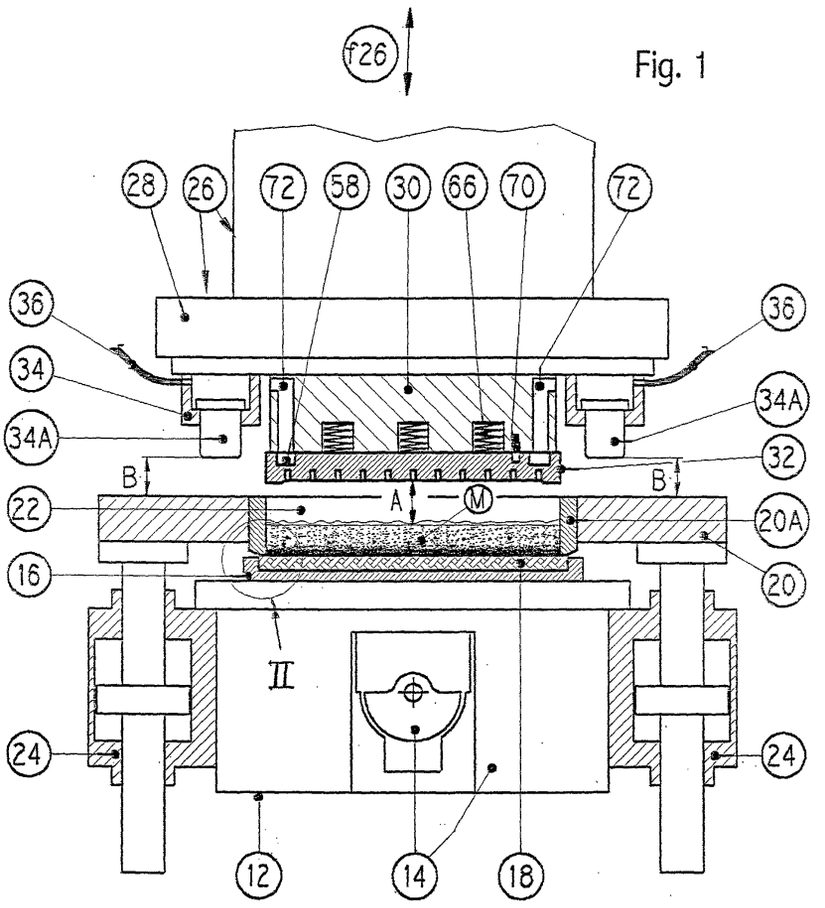
(72) Inventor: **Longinotti, Alfredo**
50133 Firenze (IT)

(74) Representative: **Mannucci, Michele et al**
Ufficio Tecnico Ing.A. Mannucci S.R.L,
Via della Scala 4
50123 Firenze (IT)

(54) Method and apparatus for producing single-layer tiles

(57) The material, which is based on cement, aggregate and water, is introduced into the mold when subjected to vibration with upward migration of aqueous phase, and a large fraction of the aqueous phase is removed by vacuum through a filtration spacer (40) provided in the pad (30, 32), before the pressing operation.

Fig. 1



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Description

[0001] In the manufacture of single-layer cement tiles, by means of molds with a rubber base, a frame laid on and pressed onto the base and pressing pads that advance into the frame, use is made of a mixture composed of granular material of various types and sizes, marble powder, cement and water. After mixing, the mixture is transferred to the press feeder, which pours approximately equal volumes of mixture into the mold cavities.

[0002] Traditional systems that are already known, for producing cement tiles, involves the use of at least partly dry material which is introduced into the mold after the better-quality material has already been poured in, and absorbs much of the moisture of the latter before the pressing operation. The tile obtained is also very thick, which nowadays is no longer acceptable.

[0003] The so-called single-layer solution avoids the abovementioned drawback, and the tile can be made thin enough, but the problem then arises of rapid disposal of the large amount of aqueous phase, in order to produce a molded tile that is strong enough for its subsequent treatment and handling. Reducing the water content by pressure from above and suction from below has not given adequate results as regards visual appearance, wear resistance or sufficient homogeneity of the physical characteristics of the pressed material.

[0004] The object of the invention is to solve all the problems indicated above and others, as will become clear in the course of the following text.

[0005] A first subject of the invention is an improvement to the method for producing single-layer tiles with pressing molds and pads, in which the material, which is based on cement, aggregate and water, is introduced into the mold and subjected to pressing with removal of a fraction of the aqueous phase via filtration spacers and the like. According to the invention, after a phase of vibration with consequent stratification of liquid migrating toward the top of the mold, there follows a phase of suction of liquid upward through a filtration spacer, before the pressing operation. By this means, not only are the abovementioned problems solved (as will be explained later), but it also becomes possible to make single-layer tiles with relief designs, by a simple modeling in negative form of the rubber base of the mold.

[0006] Advantageously, a limited pressing of the material is begun during the suction phase. In this way the flow of the liquid phase from the body of the material is made easy, thereby also avoiding the risk of cracks occurring, which can happen even at the end of the pressing operation.

[0007] A second subject of the invention is an improved apparatus for producing single-layer tiles of cement, aggregate and liquid, comprising molds with a rubber base, a frame laid on and pressed onto the base and one or more pressing pads actuated by a ram operated in such a way as to cause the pad or pads to enter the cavities of the frame, and means for filtering and removing some of the liquid phase. The apparatus also includes means for vibrating the mold and hence the material, which thus tends to stratify as the liquid phase migrates to the top. According to the invention, the apparatus has: vacuum suction means combined with the pad; and, on the lower surface of the or each pad, a board with a filtration structure through which the liquid phase is exhausted and through which the pad presses the material.

[0008] In practice said board combined with the or each pad comprises, on the active lower surface which is to act on the material to be pressed, a dense series of narrow channels communicating, with suction manifolds and pipes; and a series of filtration layers placed on said active lower surface of said board, so that the filtration of the exhausted liquid and the pressing action occur through these.

[0009] Said apparatus also advantageously includes drive means for the displacement of the pads that carry out the pressing, which drive means bring about a final slow descent for squeezing and exhaustion of the liquid phase, and subsequently the final pressing.

[0010] In an advantageous embodiment, the abovementioned drive means bring about:

- a rapid descent stroke of the pad almost as far as the surface of the vibrated material;
- while suction by the pad is on, a remaining slow stroke until low-pressure contact is made with the material, with exhaustion of a high percentage of water concentrated at the surface of the material;
- an increase in the pressure with prolonged exhaustion; and
- rapid raising of the pad.

[0011] The above mentioned drive means can apply successive stepwise increases in pressure, thereby reducing the pressing time.

[0012] The apparatus may also advantageously include supplementary forcing means that act on the frames of the molds to improve the seal between the base and the frame during pressing. These supplementary forcing means may be mounted on said ram which acts on the pads.

[0013] In one practical embodiment, the pad comprises two series of narrow channels formed by intersecting millings; and at the ends or elsewhere in said channels there are holes connected to a peripheral manifold, from which a plurality of connections lead to a vacuum source.

[0014] The filtration structure may include at least one reticular grid that forms a continuous support on the millings and forms a filter backing placed on the lower surface of the pad. Placed underneath said filter backing is at least one filter capable of retaining the solid particles of the mixture so as to trap them while the liquid phase is exhausted through the filter.

[0015] The vacuum suction means may also include suction passageways opening out at the sides to exhaust liquid phase which, during the pressing, tends to collect in the gap between the pad and the frame.

[0016] The present apparatus is very suitable for producing cement tiles in which the surface has designs with raised and sunken surfaces, which offer better strength and more attractive appearance than tiles produced by earlier methods. In the apparatus according to the invention, the rubber base of the mold or molds may indeed exhibit in negative form the design that is to appear on the visible surface of the tile.

[0017] In the present apparatus the or each pad advantageously comprises, for retention of the board (with the filtration structure) on the pad, magnetically-acting gripping means. This makes said board (which is underneath) easy to replace, for the purposes of periodical cleaning of the filtration structure and/or to replace it. Pins or similar locating means may be provided to center the board with respect to the pad. The magnetic action may be provided by electromagnets housed in the pad, that can be de-energized as required.

[0018] A clearer understanding of the invention will be gained from the description and attached drawing, the latter showing a practical non-restrictive example of said invention. In the drawing:

fig. 1 is a general cross section of the pressing station; and
fig. 2 is the detail indicated by arrow II in fig. 1, enlarged;
fig. 3 shows the board with the filtration structure, in an isolated cross section, enlarged;
figs. 4 and 5 show two enlarged details of fig. 3;
figs. 6 and 7 show two views of the board of the filtration structure, seen from beneath in the direction VI-VI and from above in the direction VII-VII as marked in fig. 3;
figs. 8, 9 and 10 show diagrammatically the board and tile in cross section, and an enlarged detail of the area indicated by arrow X in fig. 9;
figs 11, 12, and 13 show a variant of the mold in section and the relief-patterned tile formed by it in section, and a view taken on the plane XIII-XIII as marked in Fig. 12;
figs. 14 - 17 show in cross section the components of a jig for removing and fitting a filtration unit on the board, in easy operations;
figs. 18 and 19 illustrate a filter and filter backing and the board upside down for the operations to be carried out using the jig shown in figs. 14, 15 and 17; and
fig. 20 is a partial view of filtration components and bars for clamping them to the plate;
figs. 21X and 21Y are two graphs of pressure against time, in two possible operations;
fig. 22 shows a variant of the pad;
figs. 23 and 24 show two enlarged details of fig. 22; and
figs. 25 and 26 show two variants of the clamping bars.

As depicted in the accompanying drawing, at 12 is an assembly capable of vibration and resistance to the downward axial thrust in the pressure phase; this assembly 12 comprises a single or multiple mold which is characteristic of the formation of cement tiles and is used for so-called single-layer tiles. Several assemblies 12 are carried on a platform that rotates intermittently so that each of these assemblies is positioned in succession in the various operating stations. Shown at 14 is a vibrator of the type known per se and suitable for the function required of this vibrator, which will be explained later, for vibrating the assembly 12 at a phase prior to the actual pressing. 16 denotes a bed for the base of the mold, which also forms a containment surround for the single or multiple base 18 that defines the lower surface of the mold; the upper surface of the mold 18 may be smooth or three-dimensional, for the purposes explained later. The base 18 is made of an elastic material, especially a relatively hard rubber. 20 is a general reference for the frame which defines with the base 18 the cavity designed to take the cement and aggregate from which the tile will be formed. The frame 20 has an edge 20A designed to be pressed against the base 18 to prevent leakage from the cavity 22. The frame 20 may include two or more cavities 22 each with a base 18 and an edge 20A. Shown at 24 are cylinder-and-piston systems operating between the assembly 12 and the frame 20 to force the frame 20 and its edges 20A against the base or bases 18 to prevent leakage as mentioned above and to raise the frame relative to the base or bases 18 when the formed tile(s) are to be demolded. The foregoing essentially corresponds to the structures of conventional presses, which may also include a vibrator 14 and the necessary equipment to allow vibration of the assembly or assemblies 12 and of the frame 20 and hence of the base or bases 18 and of the walls of the cavity or cavities 22. The rotating platform on which the molds are carried moves cyclically a step at a time, so that with each step one cavity 22 is positioned underneath the pressing station, which comprises a ram 26 able to move vertically as indicated by the double arrow F26 for the pressing operation. The ram 26 includes a plate 28 fitted with the actual pad or pads 30 that are to fit into the cavities 22 for the pressing operation. Attached to the lower surface of the or each pad 30 is an easily removable board 32 having a filtration structure, through which the pressing operation is performed by the ram 26 of the pad or pads 30.

[0019] In accordance with the drawing, supplementary forcing means 34 are provided alongside the plate 28 and next to the pad or pads 30, 32. These forcing means 34 consist in practice of cylinder-and-piston systems, in which the pistons have lower extensions 34A capable of making contact with the upper surface of the frame

20 to increase the vertical thrust on the frame and so increase the pressure of the edge or edges 20A against the base or bases 18 of the mold. The cylinder-and-piston systems 34 are supplied with pressurized fluid by hoses shown diagrammatically at 36. These supplementary forcing means 34 may also take other suitable forms.

[0020] When a mold as described reaches the pressing station underneath the ram 26, the pad or pads are lifted by an amount A relative to the surface of the material M contained in the cavity 22. The letter B denotes the distance between the extension 34A of the supplementary forcing means 34 and the upper surface of the frame 20.

[0021] The filtration board 32 mounted on the lower surface of the or each pad 30 is illustrated particularly in figs. 3 - 8. It is provided on its underside with a filtration surface 40 combined with a relatively high-vacuum suction system.

[0022] The filtration surface of the filtration layer or layers 40 must be able to exhaust liquid phase from the mixture M loaded into the cavity 22 but must also offer the possibility of pressing at high or even very high molding pressures and transmit the pressing force of the pad to the material M contained in the cavity 22. For this purpose, as illustrated in the drawing, the lower surface 32A of the filtration board 32 has two series of narrow intersecting channels 42, 44, which in practice are formed by milling. The channels occupy, at an appropriate density, practically the entire lower surface 32A of the filtration board 32 which is bound by a peripheral passageway 46. Placed against the surface 32A is a filtration layer 40 that comprises in particular a filter backing 40A in contact with the surface 32A, and the filter itself 40B which is designed to trap even very fine particles such as those of the cement which are present in the mixture and in the material which will form the tile. Whereas the filter backing 40A is circumscribed so as substantially to correspond to the surface 32A of the structure 32, the filter 40B projects beyond the surface 32A, that is to say with peripheral lips 40C projecting into the peripheral passageway 46. The peripheral passageways 46 are more or less precise housings for clamping bars 50 which clamp the peripheral lips 40C inside the peripheral passageway 46 and thus also define the tension of the filter 40B over the surface of the filter backing 40A and so stabilize the filtration assembly which covers the channels 42, 44. A suitable number of suitably positioned through holes 54 are provided in the peripheral passageways 46 for reasons described later.

[0023] At the intersections between the narrow channels 42 and the narrow channels 44, around the periphery 32A, are holes 56 connecting the channels 42, 44 to a peripheral manifold 58 recessed into the opposite surface of the filtration structure 32 from the surface 32A. Consequently all the narrow channels 42, 44 are in communication with the peripheral manifold 58. A plurality of holes 60 lead out from the said connecting holes 56 to depressions 62 on the peripheral lateral surface 32E of the filtration board 32, for the purposes indicated below of extracting water that accumulates between the frame and the board 32 which constitutes the active part of the pad 30.

[0024] The filtration board 32, with the components already described, particularly the filter, filter backing and bars 50, must be easily removable and easily connectable to the pad 30. To make this possible, it is advantageous to employ an electromagnetic clamping system using electromagnets 66 flush with the lower surface of the pad 30 and energized and de-energized by an external electrical control within easy reach. In this way the board 32 is held on the pad 30 by systems that are very simple to engage and disengage. To ensure that the filtration board 32 is central with respect to the pad 30 it is possible simply to provide pins 70 projecting for example from a pad 30 and fitting into corresponding holes with lead-in chamfers on the upper surface of the filtration board 32, that is on the opposite side from the surface 32A. Inside the pad 30, channels 72 lead to a vacuum source for creating suction through the spaces 72, 58, 56 and 42, 44 and on two the filtration layers 40A, 40B. The function of this system will be explained later.

[0025] The abovementioned suction can be applied permanently, if required, or cyclically with the frequency of the movements of the molds toward the pressing station and/or with the frequency of the lowering and rising of the ram 26 of the pad 30, 32.

[0026] The lowering of the pad or pads 30 will involve a relatively high approach speed (and withdrawal speed), whereas the terminal lowering speed will be very slow for the reasons indicated later until the pressed material M is suitably dehydrated.

[0027] The filtration structure 40 (40A, 40B) which must absorb a substantial part of the liquid phase from the relatively fluid mixture M of material loaded into the mold 16, 18, 20, 22, may require more or less frequent cleaning and even replacement. It must therefore be possible to remove the filtration layer 40 from the structure 32, either to clean it or replace the filtration layer 40B, which may be subject to relatively rapid deterioration.

[0028] For quick and easy removal of the filtration layer 40 from the board 32, or removal of the filtration layer 40, an apparatus is provided for carrying out this operation rapidly, particularly the operation of refitting a filtration layer with the help of the clamping bars 50 in the peripheral passageway 46.

[0029] As can be seen particularly in figs. 5 - 7, the through holes 54 enable the bars 50 to be expelled from the peripheral passageway 46 by inserting rods through them to push the bars out of the peripheral passageway 46. A solution of this kind is not described and illustrated because it is so simple to devise.

[0030] However, as regards the fitting of a filtration layer (consisting of the filter backing 40A and the filter 40B) with the aid of the bars 50, one possibility (see in

particular figs. 14 - 20) is to use a surround 80 with a seat 82 so that the surround can be placed on the board 32, upside down with respect to the position in which this board 32 is fitted against the pad 30. The inside surface 80A of the surround 80 correspond substantially to the outer wall of the peripheral passageway 46. The ends of the bars 50 are mitred, that is cut at 45°, so that the four bars 50 of one mold with the rectangular and in particular square cavity 22 can be mounted simultaneously within the surface 80A of the surround 80 where these bars can be held in a desired position by spring-action studs 84 (which may take the form of balls loaded elastically so as to project from the surface 80A) which are able to fit into depressions 50A on the outer surface of the bars 50. The bars 50 (of which there are four in the particular case of molds with rectangular cavity or cavities 22) are held in the surround 80 against a surface 80A. A pad 86 is provided to fit into the space defined by the inner walls 80A of the surround 80, and this pad is pushed into the walls 80A once the surround 80 has been pressed against the upside-down board 32 as shown in Fig. 19, and after the filter backing 40A and fine filter layer 40B have been laid on the surface 32A of the structure 32. Lowering the pad 86 lowers the bars 50 and deforms the peripheral lips 40C of the filtration layer 40B because of the internal edges of the bars 50, and forces the said clamping bars 50 and the said peripheral lips 40C of the surface of the fine filtration layer 40B into the peripheral passageway 46 of the filtration board 32, in a single quick operation which not only clamps and traps the filtration layer 40B and consequently the filter backing 40A against the surface 42A, but also tensions the said fine filtration layer 40B. This apparatus enormously simplifies and speeds up the replacement of the filtration layer 40B on a filtration structure 32, whether to allow the filtration layer to be cleaned or to replace a worn-out filtration layer with a new one, which may occur at quite frequent intervals.

[0031] By following the above account it is possible to produce a quite thin "single-layer" pressed cement tiles of a decidedly more desirable quality than has been possible to achieve with the equipment and systems known hitherto.

[0032] Figs. 5, 15 and 16 show in particular the morphology of the clamping bars 50 which have a surface 50C providing connection with the fine filtration layer 40B while the surfaces 50B of the bars 50 position themselves flush with the lower surface of the board 32. This has the effect of producing in the pressed tile MP a peripheral surface MP1 (fig. 10) that lends itself easily to the action of the means of expelling the tile from the frame 20, 20A. The central region MP3 of the surface of the tiles MP - which is on the opposite side from region MP2 formed by contact with the surface of base 18 - is slightly corrugated due to the morphology of the fine filtration layer 40B and may also include slight projections MP4 in a grid arrangement corresponding to the positions of the narrow grooves 42, 44 sunk into the board 32, where the filter and also the filter backing may deform slightly due to the high pressure with which the material of the tile is pressed. This helps with gripping the resulting single-layer tiles MP and makes it easy to control the thickness of the tiles for the final preparation of the surface MP2.

[0033] The upper surface of the base 18 may be flat when the visible surface of the tile must be flat, and in this case the tile may also be rubbed down; this may be done to increase the visibility of the larger particles of aggregate, which are of course concentrated near the surface MP2 bounded in the tile by the base 18.

[0034] The embodiment of the invention also makes it possible to produce single-layer tiles in which the surface that is to remain visible receives a series of relief designs rather than a completely flat surface. Figs. 11 - 13 show an arrangement in which the rubber base 118 (which is equivalent to the base 18 and supported like the latter by the bed plate 16) does not have the smooth surface but, in negative, on the surface intended to form the visible surface of the tile M1, a design in negative corresponding to the design which, in relief, it is wished to produce on the visible surface of the tile M1, as shown at MD. The relief design of the tile M1 may have a mainly flat surface, e.g. divided into a plurality of relief regions MR by intersecting grooves MS, as shown in figs. 12 and 13. In this case the region of flat surface of the reliefs MR of the visible surface of the tile may be rubbed down, in contrast to the surface which remains unpolished of the depressed region such as the grooves MS of this surface. Production of a single-layer tile of this kind is not possible with currently known equipment.

[0035] The features of the means described above will now be explained in greater detail.

[0036] It will be recalled that the assembly described comprises supplementary forcing means, such as 34, 34A, 36, to provide a better seal between the base 16 and the frame 20, 20A during the initial pressing. This is due to the fact that the mixture used contains a relatively high content of water, much of which can be removed quickly before the pressing and after the highly fluid mixture has been able to spread uniformly and can undergo stratification of the aggregate by vibration.

[0037] The seal between the or each cavity of the mold - defined by the frame and by the rubber base or bases 18 - is provided initially by the (relatively limited) closing force exerted by the two cylinder-and-piston systems 24 (which are normally pneumatic) which subsequently are also used to raise the frame 20, 22 with the tile formed inside it, for demolding purposes. The force of the cylinder-and-piston systems 24 is adjustable to provide the correct limited specific pressure between the metal part and the rubber in the regions of mutual contact. This ensures that the elastomer of the base 18, which undergoes this limited closing force during the vibration phase, has an acceptable life. The greater closing force is applied by the supplementary forcing means 34, 34A only during the final pressing with the pad 30,

32.

[0038] Once the fluid mixture M is poured in, it is vibrated by the vibrator 14 (at variable frequency) with the assembly 12 of the frame 20, 20A, the cylinder-and-piston systems 24, the rubber base 18 and its bed 16 with the containment surround.

[0039] The main purpose of the vibration is to homogenize and level the material, but it also has other very important functions, including:

A) to move the larger-size particles of the mixture down to the bottom of the cavity 22;
B) to perform a fairly effective deaeration of air bubbles trapped in the mixture; and
c) to raise to the surface a large part of the water of the mixture, used to achieve the necessary fluidity for leveling but not required for the cement to cure.

[0040] At the end of the vibration the mixture is level, with high density of aggregate in the bottom region of the material M and with a layer of water on the surface.

[0041] The vacuum in the pipes 72, in the manifold 58 and in the narrow grooves 42, 44 may always be on and certainly must be on during the lowering of the pad 30.

[0042] Once the still-fluid mixture M has been leveled, the ram 26 of the pressing unit is lowered, using an initial fast stroke B, where B = A - 5 mm (approximately); at this point the extensions 34A on the pistons of the supplementary forcing means 34 are bearing on the frame, increasing the closing force between the frame 20, 20A and the base 18 around the perimeter of the frame (this force having initially been provided only by the cylinder-and-piston systems 24). The force of the cylinders 34 remains the same even when the pressing unit continues to descend. The approach stroke A between the filtration layer 40B of the board 32 and the upper surface of the material M (leveled by the vibration) is fast for the approach section B = A - 5 mm, whereas for the final 5 mm the approach is very slow, so that the filtration layer 40B can settle gradually on the material M and can initially exhaust the film of water formed during the vibration. The specific bearing pressure on the material M must be low - roughly 10 - 20 kg/cm^2- for the following reasons: prior to compaction, the mixture is extremely fluid and behaves, as regards the distribution of pressure in all directions, in accordance with Pascal's Principle but, roughly speaking, at only about 50% compared with the same mass of water only; basically, pressing vertically at 200 kg/cm^2 produces lateral forces of approximately 100 kg/cm^2, but this value tails off gradually as the water is removed, until a compact tile is left, and the residual lateral forces that are left are only those due to the elasticity of the material; these forces are subsequently necessary to provide adhesion between the frame 20, 20A and the material of the pressed tile, during the lifting phase for demolding.

[0043] Given the above conditions, with suction, low-pressure squeezing and pausing for a few seconds in this condition, most of the excess water is exhausted during this phase. The mixture thus rapidly loses the fluidity which would have been harmful during the high-pressure phase. The supplementary forcing means 34, 34A serve to prevent the water escaping between the frame 20, 20A and the rubber base 18 due to the pressures caused by the mixture while it is still very fluid. The large specific pressure due to the means 34, 34A is limited to the pressing time only, to avoid damage occurring rapidly to the elastomer of the base 18, especially during the vibration. The approach to the material at low pressure also serves to level the mixture in the various cavities not so much in the sense of making the upper and lower surfaces of the mixture parallel with each other, but in the sense of distribution of the various particles of the aggregate.

[0044] It is worth pointing out here that the mixture is metered by discharging quantities of mixture from cylindrical nozzles in the cavity or in the various cavities 22 of the mold which are usually, square shaped; for example, cups with a diameter of approximately 180 to 200 mm are used to supply a 400 x 400 mm cavity; dropping the material from a height of approximately 200 to 300 mm causes it to assume a more or less obtuse pyramid shape in the cavity due to the drop and the angle of friction in the material; the vibration causes the material to move in the directions of the center lines of the square and even further along the diagonals; but a larger percentage of larger-sized particles always tend to remain near the center. By approaching the material at low pressure as taught by the invention, when the material is still very fluid, the result is greater homogeneity of the particles and of the material as a whole.

[0045] On completion of the low-pressure squeezing phase, the pad 30, 32 pressure is increased, thereby compacting the material under the new, higher pressure.

[0046] When the pressure phase is completed, the pressure ram 20, with the pad 30 and the board 32, rises again, detaching the board 32 from the pressed tile, and demolding can be carried out.

[0047] The system described is suitable for producing single-layer tiles in which the upper and lower surfaces are parallel. The tiles are then adjusted for thickness from the upper side, that is the side MP2 as indicated in Fig. 10 (where molding took place through the filtration layer 40) in order to correct small defects of thickness and/or parallelism, and then the tiles are rubbed down on the opposite side and polished. It should be pointed out that the rubbed-down and polished side - which will become the side that is walked on and hence subject to wear - is the side where most of the larger particles were deposited. The visual appearance of the product after rubbing down is therefore more pleasing because the visible surface consists for the most part of these particles; if the upper molded side were used as the rubbing-down or polishing surface (and hence the side that would take the traffic), it would be small particle-sized,

highly dispersed chips, and a predominance of dust and fine material that would be ground on the surface, giving a much less attractive appearance. What is more, wear would be accelerated, due to there being less of the tough aggregate here.

[0048] The molding system and apparatus described are also suitable for making single-layer tile with designs comprising depressions and reliefs, whether rough (as in paving bricks, imitation stone etc.) or tiles carrying a design which are then rubbed down, always leaving a few millimeters for the impression of the design, as illustrated in figs. 9 and 10. The molding technique for these products is the same as described above, the only variant being that the rubber base 18 is replaced with that of the type exemplified at 118, which has the same external measurements but in the interior shows a negative impression of the design which it is wished to produce.

[0049] The presence of the filtration layer 40A, 40B and in particular of the fine filter 40B demands a certain care to maintain the filtration function. This can be done using the apparatus and following the operations explained below with reference to figs. 14 - 20.

[0050] The board 32, which is easily removed from the pad 30 of the press by switching off the electromagnets, is placed upside down, that is with the surface 32A and the peripheral passageway 46 uppermost, the bars 50 and the used filtration layer having been removed. The cleaned filter backing 40A, or a new filter backing is then laid on the surface 32A of the board 32 and a filter 40B is placed on the filter backing 40A, making it central with respect to the surface 32A and to the passageway 46. The surround 80 is fitted onto the board 32, and the bars 50 are inserted into the surround 80 so that they catch the spring-action studs 84 which locate the reference points 50A on the bars. The pad 86 is now inserted into the surround 80 until it meets the bars 50 and pushes them into the passageways 46. The bars 50 thus descend in parallel until they meet and fold the lips 40C of the filter 40B; as they continue to descend, the bars 50 and the lips 40C are forced into the passageway 46; the friction which is generated in the descent, between the bars 50 and the lips 40C of the filter 40B is such that the filter 40B is stretched tightly across the filter backing 40A and is clamped around all four sides between the bars 50 and the inner wall of the peripheral passageway 46 of the board 32.

[0051] Fitting having been completed, the board 32 and the bars 50 define on the underside - when the board 32 is fitted to the pressing pad 30, the well-defined shape which creates the peripheral lower surface MP1 of the finished tile, on which the demolding pad can act. There is no change to the projecting regions MP3 and MP4 defined by the filter 40 which are raised above the surface of the region MP1 and enable easy adjustment of the tile, to make it flat and of uniform thickness, which is the ideal condition to be able to rub it down and polish it properly and lay it correctly in its final position.

[0052] As already described, the holes 60 communicating with the holes 56 containing the vacuum due to the manifold 58 and the pipes 72 open out on the lateral edges 32E of the board 32, in depressions 62. The purpose of these holes 60 is also to carry away the water which tends to escape, during the initial squeezing and during the final pressing, between the board 32 of the pressing pad 30 and the frame 20, 20A due to the clearance around the edge, which, though limited (approximately 0.25 mm), is nonetheless present.

[0053] The presence of the filtration layer 40A, 40B and especially of the fine filter 40B demands a certain care to maintain the filtration action. This can be achieved using the apparatus according to the invention and the operations explained below with reference to figs. 14 - 19.

[0054] The features of the press as described above should be highlighted in order to demonstrate the advantages achieved and achievable, by appropriate programming of the various operating phases.

[0055] The phase of squeezing and compacting the mixture - after it has first been vibrated in the seat 18, 20A - takes place entirely in one station, so almost the whole period of one cycle is related to the movement of the pressing part.

[0056] The technology to produce the tiles, combined with a significant throughput, can be put into practice as follows (see also the diagram in fig. 21X):

AA) the entire pressing unit 26, 28, 30, 32 descends at the maximum speed permitted by the hydraulic power available through a distance equal to the stroke A minus 2 or 3 mm. The vacuum is already active in the pressing board 32.

BB) the material arrives underneath the press, having been vibrated and leveled in the previous stations. The vibration has caused the larger chips to migrate downward, while at the top are mostly the fine chips and a film of water that has been formed by this settling out of the mixture (it will be remembered that the visible surface of the tile when laid is the surface MP2 in fig. 10 which is in contact with the base 18).

CC) the descent continues at slow speed and low pressure until contact is made with the material. The slow speed is to prevent the water from tending to escape from the mold and also, as the suction pad rests on the mixture at low pressure, it can draw off most of the water present on the surface.

DD) contact is maintained with the material at low pressure for long enough to remove 70-80% of the water in the mixture.

EE) at the end of the low-pressure suction period, the pressure on the material is gradually increased by slowly lowering the pressing part.

FF) maximum pressure is maintained briefly.

GG) the entire pressing unit is raised again to the starting position.

[0057] Fig. 21X is a diagram showing time against pressure. In the diagram: T is the total pressing time; T1 the period during which the board 32 is approaching the mixture; T2 the total initial suction time; T5 the time to reach the maximum pressure P4; T6 the pause time at maximum pressure; P1 the lower pressure reached in the time T1 plus the time for the ramp R of achieving the pressure P1.

[0058] The vacuum in the board 32 is maintained throughout the pressing phase. In this way, water can be removed from the surface of the mixture plus water that tends to accumulate between the board 32 and the rim formed by the edges 20A; this water is removed through the lateral holes 60, 62 of the board 32, with high vacuum but with low throughput due to the limited passageways.

[0059] The vacuum and hence the suction can also be maintained while the unit is rising again and throughout the period of rotation of the mold-carrying table and for the subsequent descent. This enables two functions to be achieved: the first is that by increasing the passageways, the throughput that allows transfer of water from the various manifolds to the low-pressure container is greatly increased; and the second is that this airflow through the filter also has a continuous self-cleaning effect on the filter.

[0060] A variant can be considered at point "DD" above, with the aim of increasing production by reducing the length of time spent removing water at low pressure. In this variant the hydraulic system uses a proportional-control maximum-pressure valve operated by an electronic system which modifies phase "DD" in the following manner: the unit rests at low pressure on the material as described in "DD", but in this case, rather than remaining stationary at the initial pressure, the user has the option of programming a number of increasing steps of pressure (see fig. 21Y), which are applied for predefined lengths of time and reached via ramps of different shapes. It will be clear that for the various different mixtures, the most appropriate program will be selected for correct squeezing.

[0061] Fig. 21Y is a second diagram of the above variant, for comparison with that of fig. 21X. This second diagram shows: at T the total pressing time; at T1 the approach time; at T2 the total initial suction time; at T3 the second suction time; at T4 the third suction time; at T5 the time to reach maximum pressure; and at T6 the dwell time at maximum pressure. The following are indicated: at R1 the ramp to the pressure P1; at R2 the ramp to the pressure P2; and at R3 the ramp to the pressure P3. P1 is the first pressure, P2 the second pressure, P3 the third pressure, and P4 the maximum pressure.

[0062] In certain cases a variant can also be considered at point "GG" above. Before raising the pressing unit, once the high-pressure time is finished, the vacuum in the suction board 32 is broken during the rising time only, and rising is as described at "GG".

[0063] In accordance with other alternatives to the previous alternative - with more limited effects - the vacuum can be left on at all times in the board 32 but, after the high-pressure time is finished, the board is raised a distance of 1 to 2 mm, and held for a brief period in this position to allow external air to enter the space between the rim 20, 20A and the board 32, where there is a very limited peripheral clearance, before the said board completes its rise.

[0064] In an especially suitable embodiment of the board illustrated in figs. 1 - 5 (and also in the variant, figs. 22 - 24, which will be described later), the channels 42 and 44 are of a width such that the filter 40B and the filter backing 40A can withstand its bending loading . The pitch between the various lines may be chosen for all the various sizes of tiles, to achieve a ratio of approximately 3:1 between the suction surface and the passageway cross section across the lines to provide the suction. The depth of the channels 42 and 44 may be chosen to ensure prolonged operation without clogging. The holes 56 may have a diameter and be of a number such as to achieve, between the suction surface and the passageway through these holes, a ratio of approximately 20:1.

[0065] Of particular importance is the operation of the system for centering the pad 30 relative to the board 32, which is designed to be replaced frequently (for cleaning and for frequent replacement of the filter and filter backing) and it is therefore also important to have centering between the board 32 (for fitting to the pad 30) and the rim 20A of the frame 20, in order to minimize the clearance between these two components, without having to check the centering every time a clean board is fitted. To this must be added the necessity of preventing the ingress of moisture into the electromagnets 66, which clamp the pad 30 and the board 32 together.'To this end, use is made of locating pins with lead-in profiles and corresponding seats to center the rim 20A of the or of each frame 20 and the assembly comprising the pad 30 and the board 32.

[0066] Figs. 22 - 24 show as variant the addition, between the board 32 and the pad 30, of a spacer, that is a plate 100, for the purposes and functions specified below.

[0067] The water removed by the board 32 through the filtration layer 40, 40A, 40B, the lines 42 and 44 and the holes 56 is all conveyed into the manifold 58 from where it is exhausted through the holes 72 at the edge of the pad. During the molding phase, the water may tend to escape from the manifold 58 or accumulate toward the center of the pad. Water heading out creates no problem, but water heading into the center may reach the electromagnetic elements 66 for the clamping. Even though these elements 66 are protected by resin, it is sensible to prevent water getting into them. For this purpose a metal plate 100 is interposed between the pad 30 and the board 32. Said plate 100 is fixed by a series of screws 101 to the board 32, and two locating pins 102

are also inserted to ensure precise centering of the two components 100 and 32 relative to each other. These pins 102 may be coaxial with the pins 70 (fig. 23) or possibly even integral with each other. The board 32 is provided with a peripheral passageway 103 containing an O-ring to prevent water migrating toward the center between the two components 100 and 32. The plate 100 contains four holes 105 in the same position and of the same diameter as the holes 72 present in the pad 30. Each of said holes 105 is completed by a seal 106. In the surface of the plate 100, in the interior of the four holes 105, is a peripheral passageway 107 for an O-ring, for further protection against water getting at the electromagnets 66. Each of these electromagnets 66 also has a guard 66A, which may advantageously form an annular passageway 66B able to trap any moisture that may have managed to get in, to ensure that it cannot reach the electromagnet.

[0068] The plate 100 also has locating holes for receiving the pins 70 of the pad 30, in order to bring about, together with the pins 102 or equivalent, precise mutual centering between the pad 30, the plate 100 and the board 32. Centering pins are as usual provided to locate the frame or frames 20, 20A centrally with respect to the pads. The magnetic attachment occurs between the pad 30 and plate 100, but because of the fixing screws 101, the board 32 is also locked centrally with respect to the pad.

[0069] The plate 100 also contains holes 54A corresponding to the holes 54 in the board 32 so that, using special pins, the surrounds 50 can be removed from above without having to take the plate 100 off the board 32. Only when a large amount of sediment has formed in the manifold 58 will it be necessary to remove the plate 100 from the board 32 for cleaning. With this solution the possibility that the water could travel from the manifold 58 to the magnets 66 becomes practically zero.

[0070] Figs. 25 and 26 show possible variations on the embodiment of the bars 50 of the first illustrative embodiment.

[0071] In the assembly of the pressing board 32, the surface that forms the surface MP3, which is on the underside when the tile is laid in its final position, but in practice is the upper surface on which the pressure is applied under the conditions of fig. 10, is formed by the peripheral edge 32C of the board 32, the surfaces 50B and 50C of the bars 50 of the surround, and the visible part of the filter 40B (see fig. 24). All these parts are in contact with the wet mixture needed to produce the tile. During the process, the surface of the filter 40B is kept sufficiently clean by the continual passage through it of exhausted air and water drawn from the mixture. The edge 32C is made of metal (steel with special anti-wear treatments). The wet material could tend to cling to this with the successive pressing phases; this does not happen purely because the surface 32C is extremely small. Instead the surfaces 50B and 50C of the bars 50 are necessarily larger, in order to clamp the filter 40 to the board 32. For this reason the surround formed by the bars 50 does not need to be wholly made of metal, so as to discourage lumps of material of the tile sticking to the surround defined by the bars 50.

[0072] To prevent this, two versions of the bars 50 have been produced, as illustrated in figs. 25 and 26. The two solutions have in common the circumstance that the part which comes into contact with the wet mixture is made of an elastomer which, as it compresses slightly when the pressure is applied and relaxes when the pressure is removed, has a detaching effect and therefore a continuous self-cleaning effect. The solution shown in fig. 25 is made by reducing the metal part 150A, which is made of brass or stainless steel in a U shape, and making two chamfers to facilitate the insertion of the surround into the board; while the elastomer 150B is vulcanized on this metal part 150A to the desired shape. The equivalent solution shown in fig. 26 involves vulcanizing the elastomer 250B on a metal support 250A (which is only there for stiffening purposes), to give geometrical shape identical to the previous solutions. In the form shown in fig. 26, the elastomer 250B completely surrounds the metal part 250A so that it cannot be detached during handling, which is a continuous operation of fitting and removing the filter.

[0073] In fig. 25 the elastomer 350B only partly covers the metal part 350A, so it is vulcanized adhesively on this metal part.

[0074] It will be understood that the drawing shows only an example purely as a practical demonstration of the invention, which may be varied in the same shapes and arrangements without thereby departing from the scope of the concept on which the invention is based. The presence of any reference numbers in the appended claims is for the purpose of facilitating the reading of the claims with reference to the description and drawing, and does not limit the scope of protection represented by the claims.

Claims

1. Method for producing single-layer tiles with pressing molds and pads, in which the material, which is based on cement, aggregate and water, is introduced into the mold and subjected to pressing with removal of a fraction of the aqueous phase via filtration spacers and the like, said method being **characterized in that**, after a phase of vibration with stratification of liquid migrating toward the top of the mold, there follows a phase of suction of liquid upward through a filtration spacer, before the pressing operation.

2. Method according to claim 1, **characterized in that** a limited pressing of the material is begun during the suction phase.

3. An apparatus for producing single-layer tiles of cement, aggregate and liquid, comprising molds with a rubber base, a frame laid on and pressed onto the base and one or more pressing pads actuated by a ram operated in such a way as to cause the pad or pads to enter the cavities of the frame, liquid-phase filtration means, and means (14) for vibrating the mold and hence the material, which thus tends to stratify as the liquid phase migrates to the top; said apparatus being **characterized in that** it comprises vacuum suction means (42, 44, 56, 58, 72) combined with the pad (30); and, on the lower surface of the pad, a board (32) with a filtration structure (40) through which the liquid phase is exhausted and through which the pad (30) presses the material.

4. Apparatus according to claim 3, **characterized in that** the board (32) of the or each pad (30) comprises, on the active lower surface which is to act on the material to be pressed, a dense series of narrow channels (42, 44) communicating with suction manifolds (56, 58) and pipes (72); and filtration layers (40A, 40B) placed on the active lower surface of the board (32) of the pad, so that the filtration of the exhausted liquid and the pressing action occur through these.

5. Apparatus according to at least claim 3, comprising drive means for the displacement of the pads that carry out the pressing, **characterized in that** said drive means bring about a final slow descent for squeezing and exhaustion of the liquid phase, and subsequently the final pressing.

6. Apparatus according to at least claims 3 and 5, **characterized in that** said drive means bring about:

- a rapid descent stroke of the pad almost as far as the surface of the vibrated material;
- while suction by the pad is on, a remaining slow stroke until low-pressure contact is made with the material, with exhaustion of a high percentage of water concentrated at the surface of the material;
- an increase in the pressure with prolonged exhaustion; and
- rapid raising of the pad.

7. Apparatus according to claims 5 and 6, **characterized in that** said drive means bring about successive stepwise increases in pressure, thereby reducing the pressing time.

8. Apparatus according to at least claim 3, **characterized in that** it comprises supplementary forcing means (34, 34A) that act on the frames (20) of the molds to improve the seal between the base and the frame during pressing.

9. Apparatus according to claim 6, **characterized in that** said supplementary forcing means (34) are mounted on said ram (26) on which the pad or pads are mounted.

10. Apparatus according to claims 3 and 4, **characterized in that** the pad comprises: two series of narrow channels formed by intersecting millings (42, 44); at the ends or elsewhere in said channels (42, 44), holes (56) connected to a manifold (58), in particular a peripheral manifold; and connections (72) between a vacuum source and said peripheral manifold (58).

11. Apparatus according to at least claim 3, **characterized in that** said series of filtration layers (40) comprises at least one robust reticular grid (40A) forming a filter backing placed on the board (32) of the pad, and at least one thin filter (40B) capable of retaining the solid particles of the mixture.

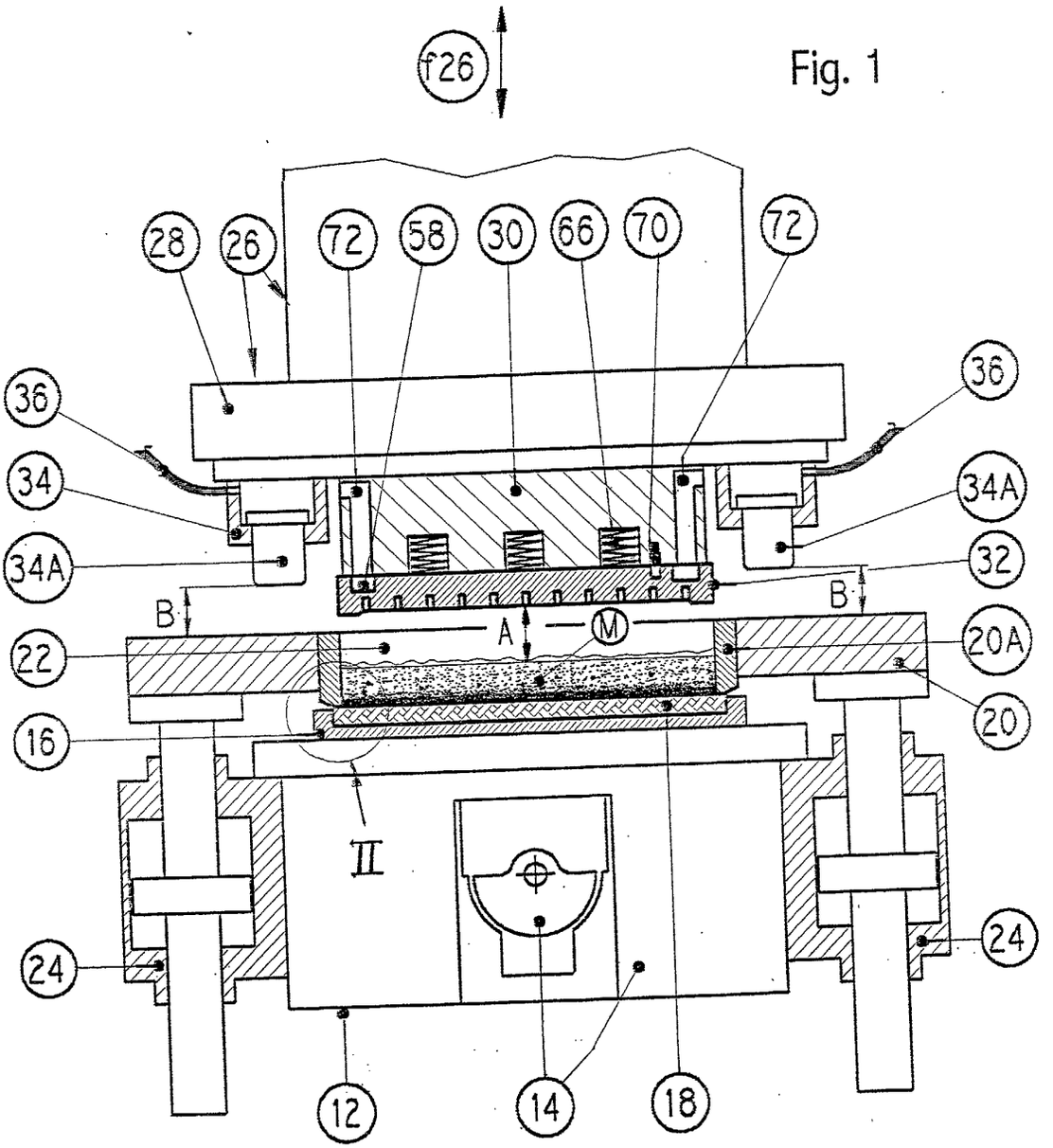
12. Apparatus according to at least claim 3, **characterized in that** said vacuum suction means also include suction passageways (60) opening out at the sides for exhaustion of liquid phase collected during pressing between the pad and the frame.

13. Apparatus according to at least claim 3, **characterized in that** the rubber base (118) of the mold or molds exhibits in negative form the design that is to appear on the visible surface of the tile.

14. Apparatus according to at least claim 3, **characterized in that** the pad (30) of the or each mold comprises, for retention of the board (32) with the filtration structure, magnetically-acting means; pins or other locating means being provided to center said portion.

15. Apparatus according to claim 14, **characterized in that** said magnetically-acting means consist of electromagnets (66) housed in the pad (30), and **in that** an electrical control energizes and de-energizes said electromagnets (66).

16. Method and apparatus for producing single-layer tiles; the whole as described and as illustrated by way of example in the accompanying drawing.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34A
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B
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M
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20A
20
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II
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14
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Fig. 1

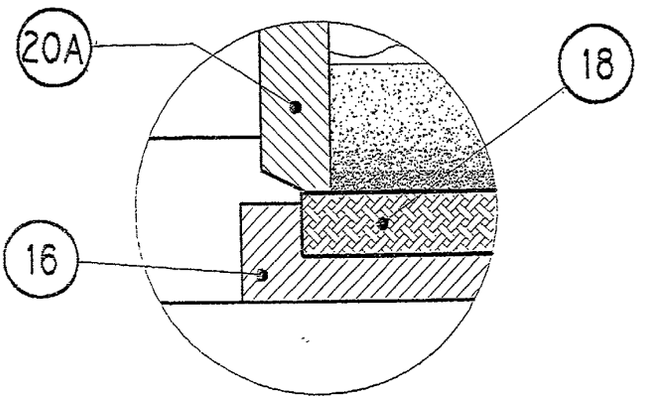

20A
18
16

Fig. 2

Fig. 3

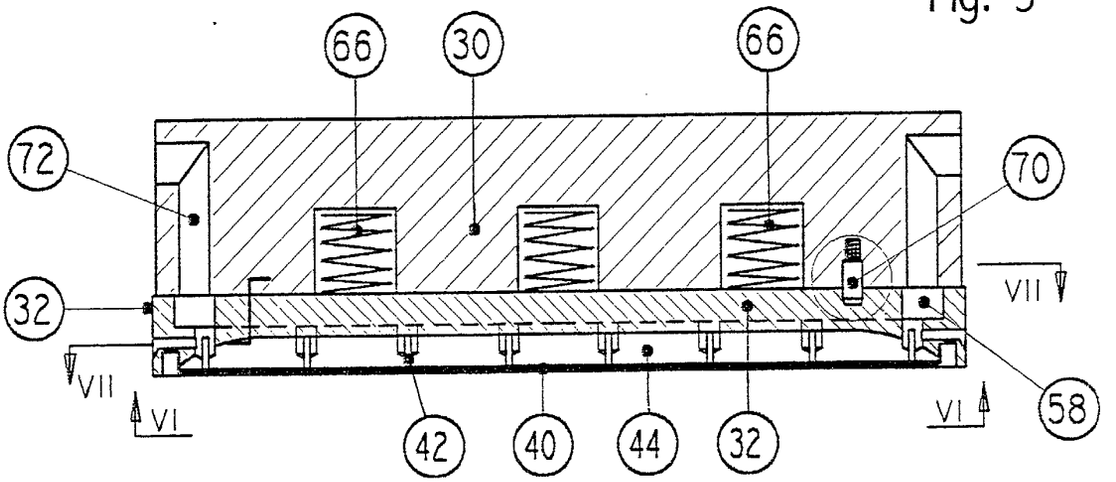


Fig. 4

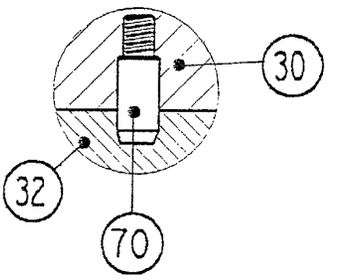
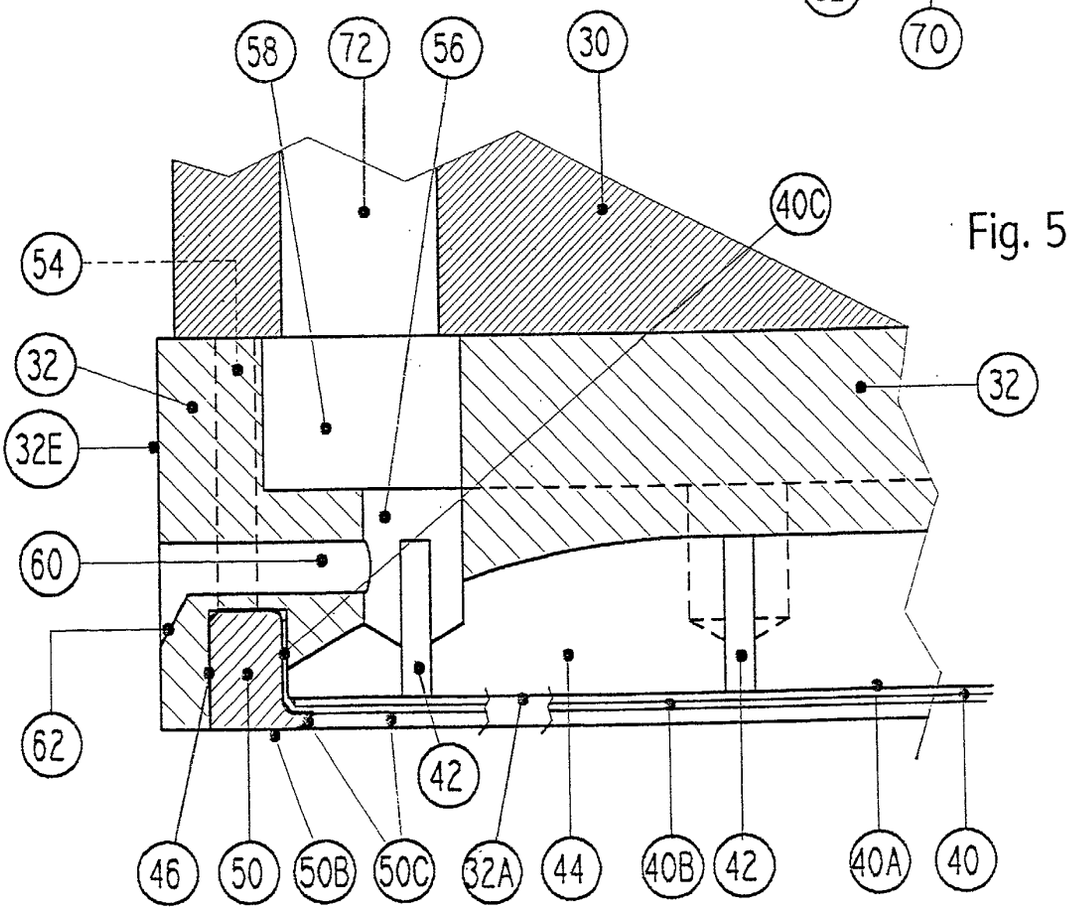


Fig. 5



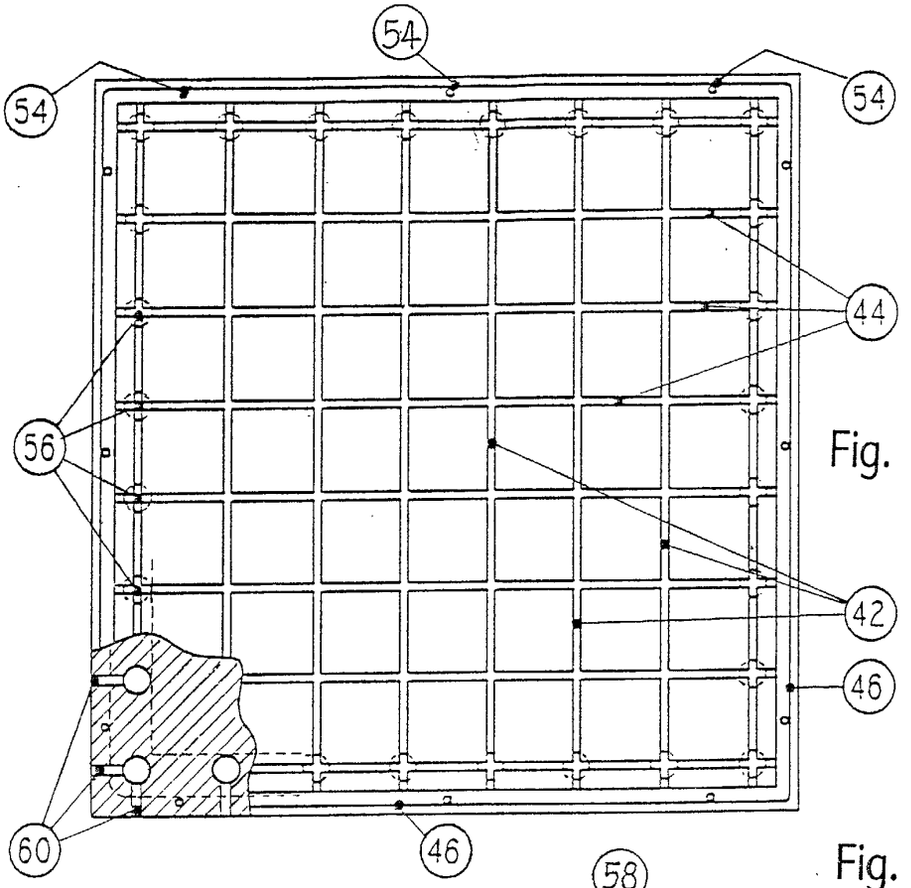
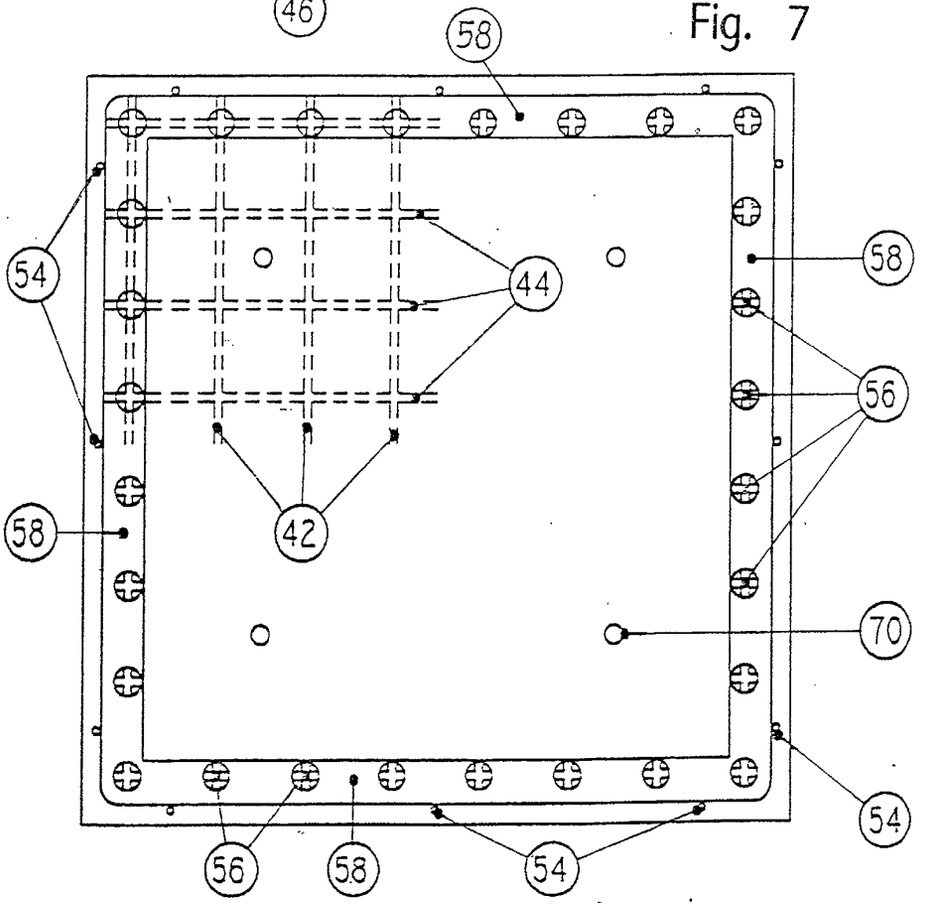


Fig. 6

Fig. 7



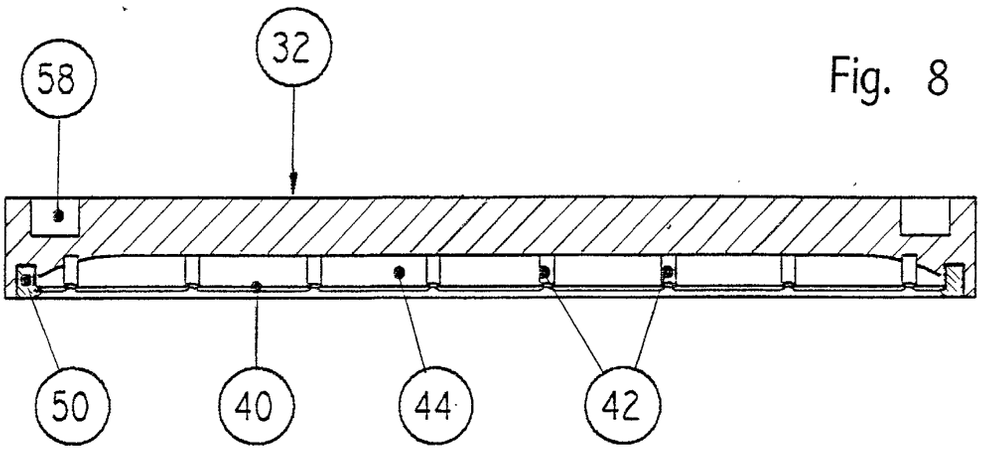


Fig. 8

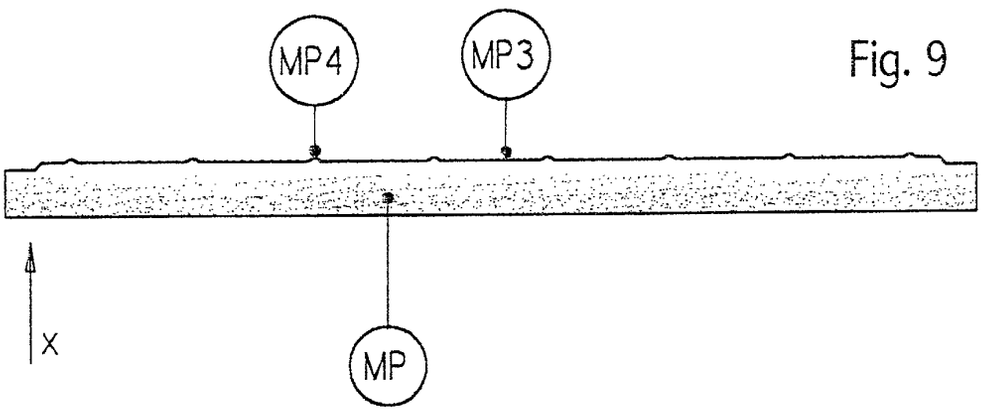


Fig. 9

Fig. 10

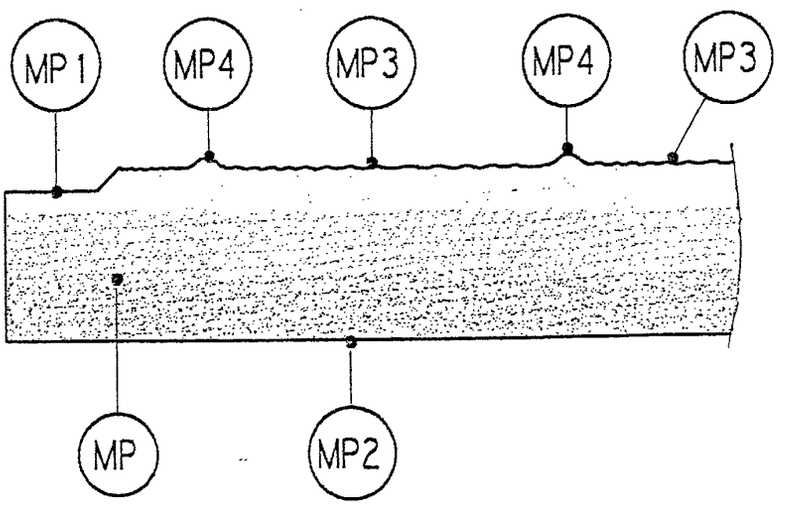


Fig. 11

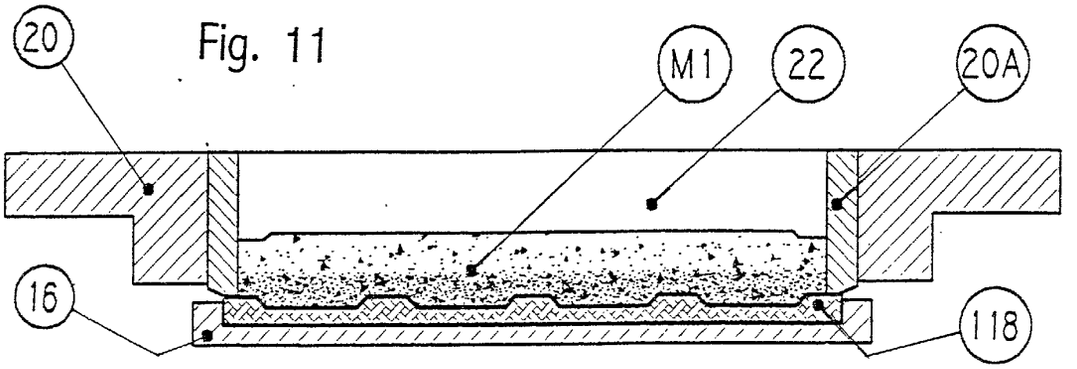


Fig. 13

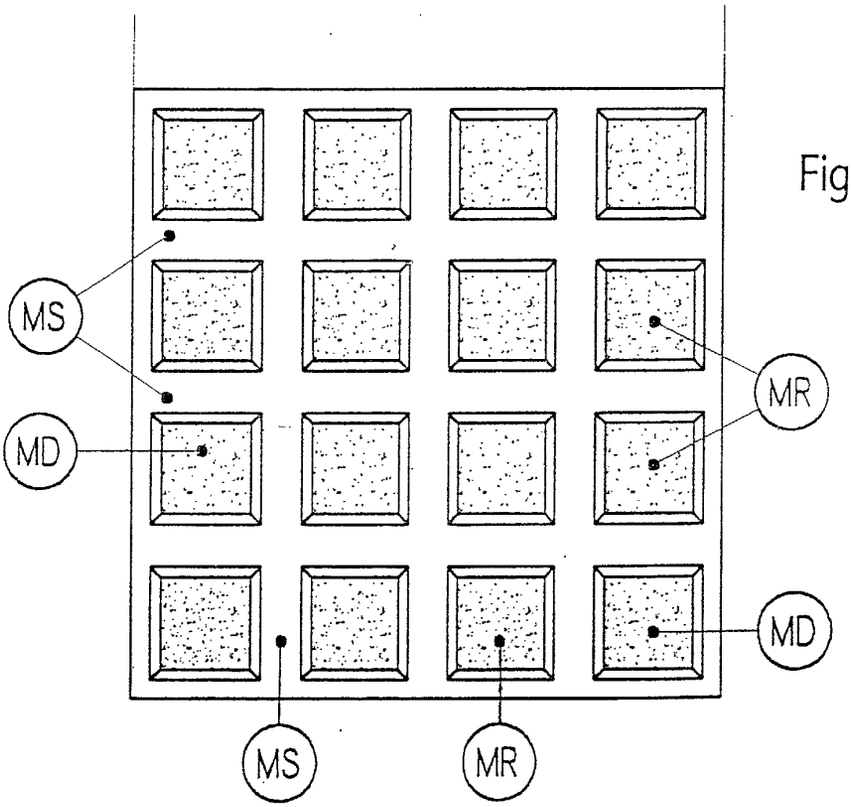


Fig. 12

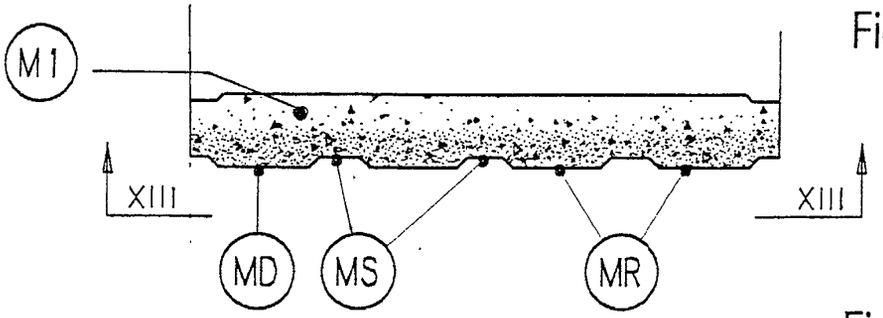


Fig. 14

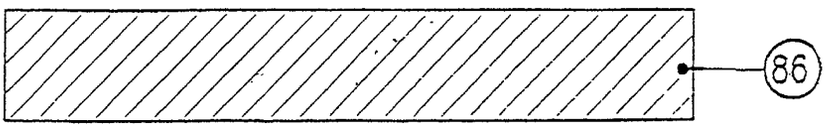


Fig. 15

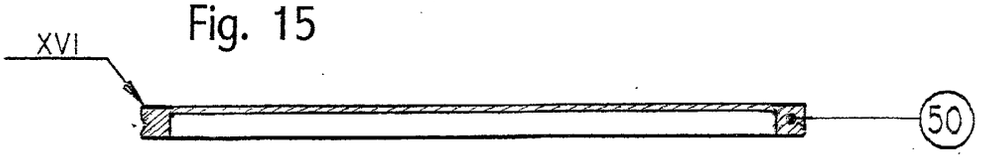


Fig. 16

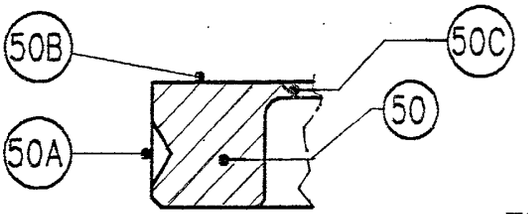
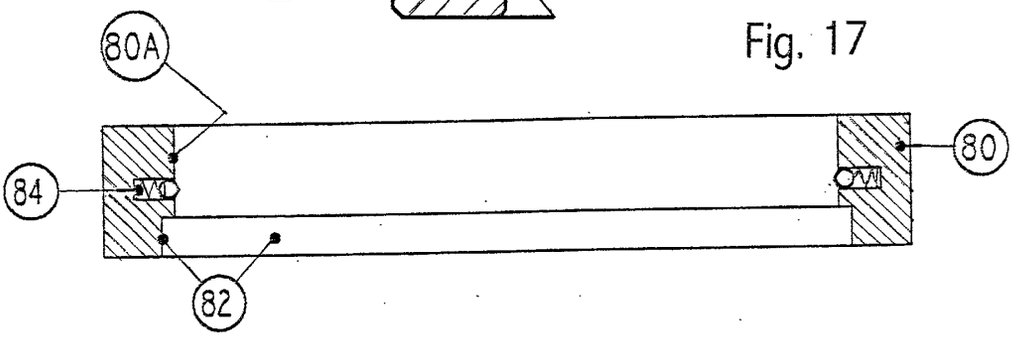


Fig. 17



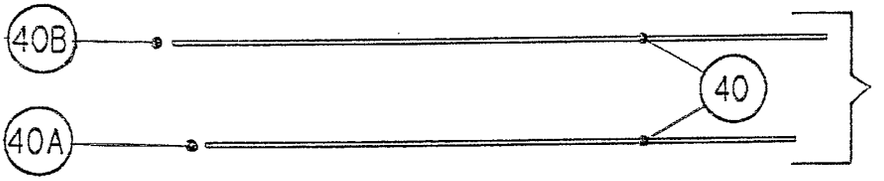
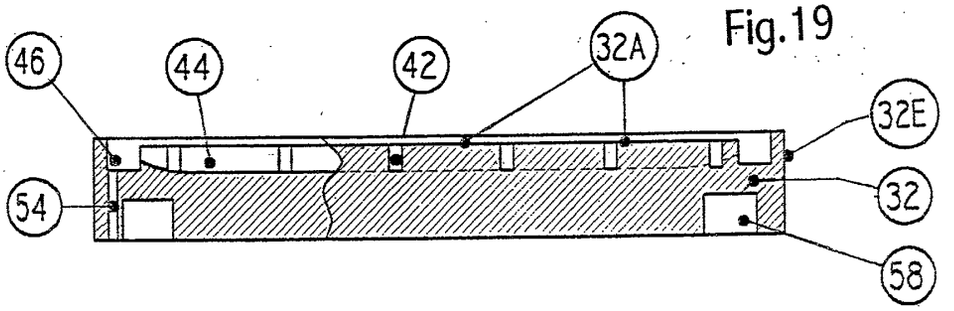


Fig. 18

Fig.19



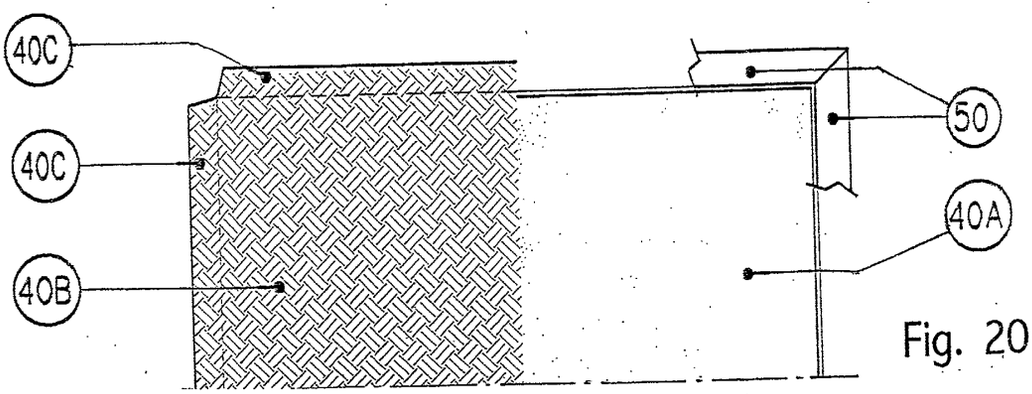


Fig. 20

Fig. 21 x

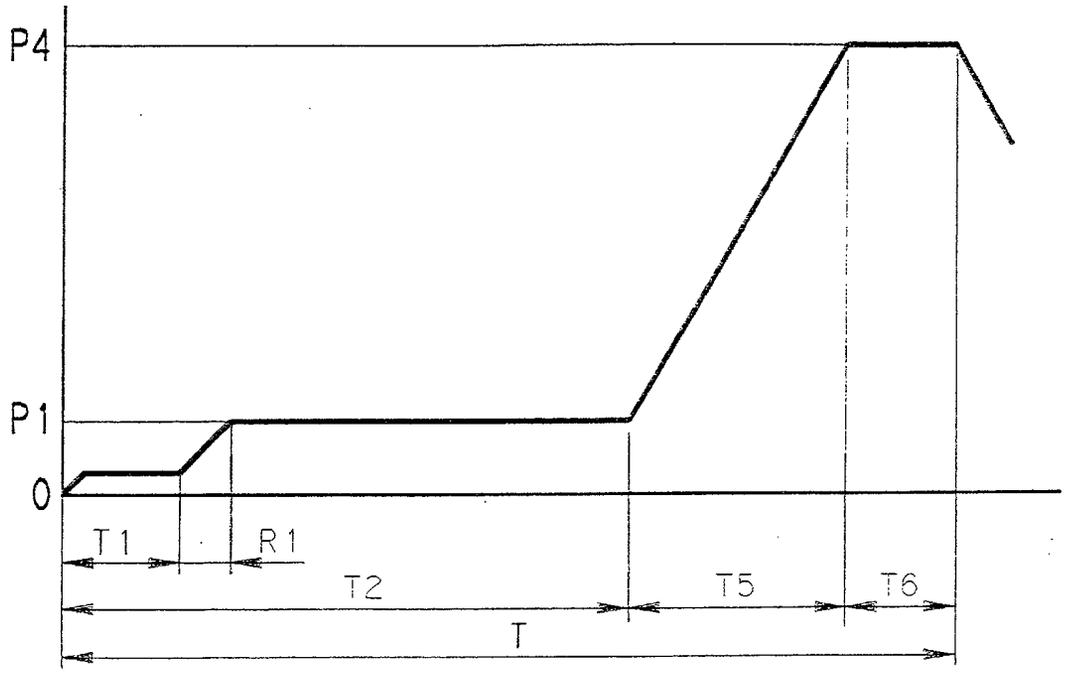


Fig. 21 y

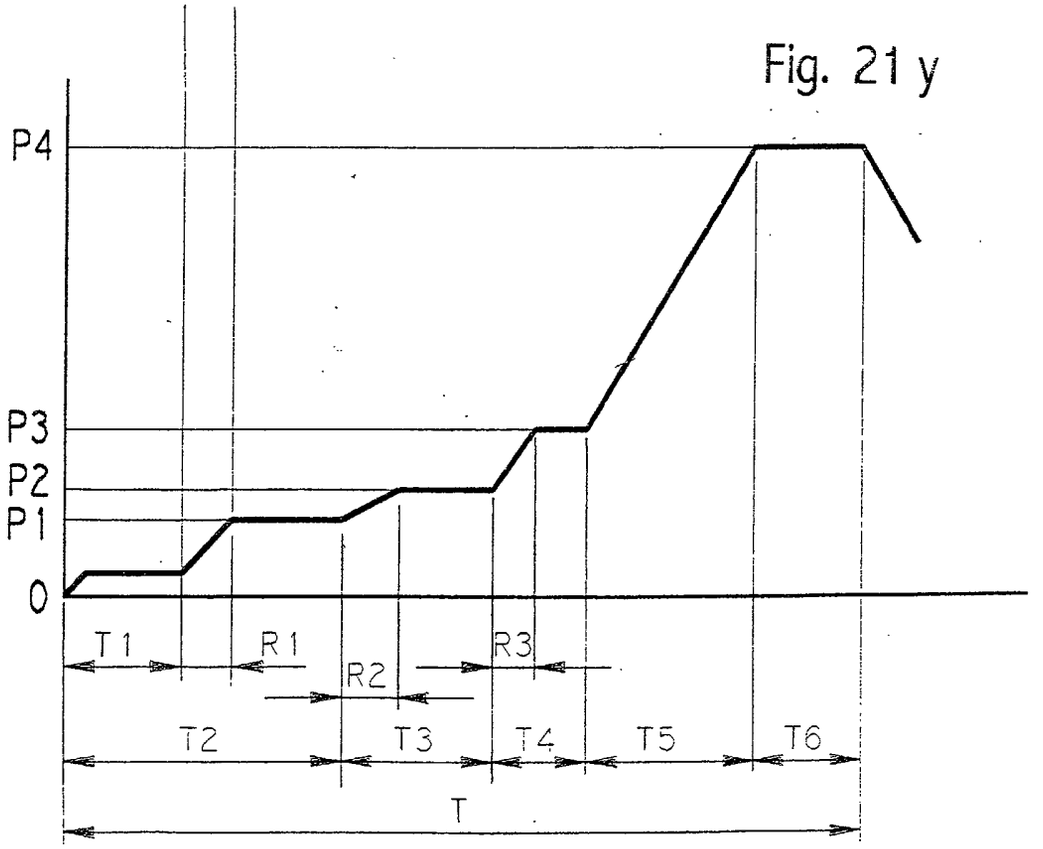
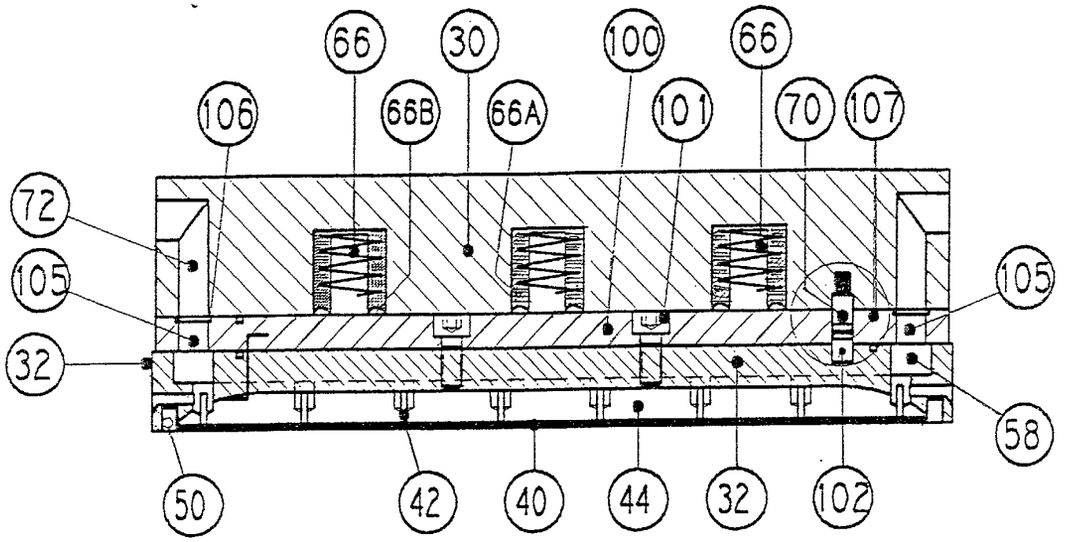


Fig. 22


66
30
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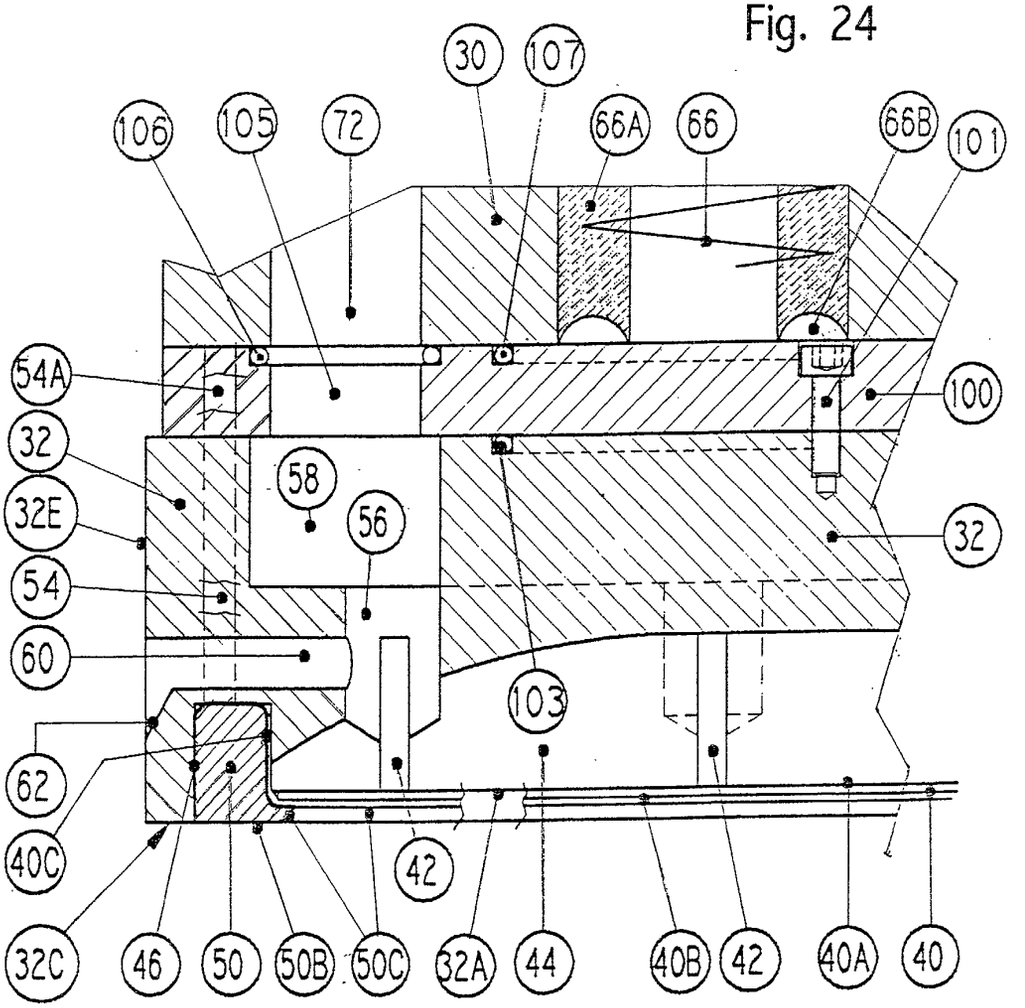
44
32
102

Fig. 24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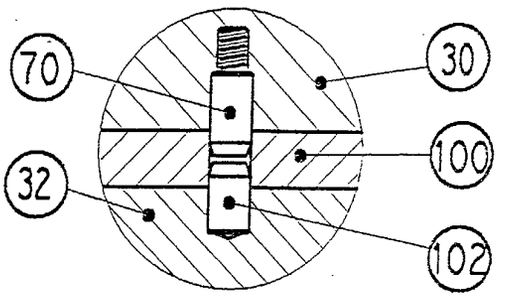
40A
40

Fig. 23



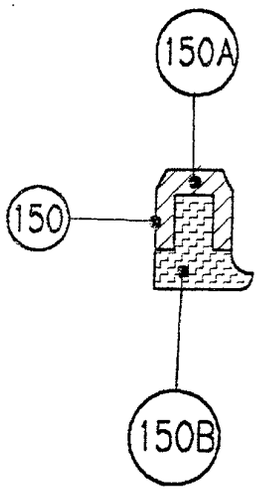


Fig.25

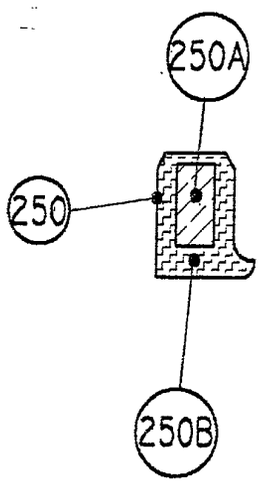


Fig. 26