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(54) **A press for the production of pieces requiring for their industrial processing a preforming step with low expenditure of forces and a final high pressure.**

(57) A hydraulic press with a vertical axis for the production, by a dry process using suitable flowing powders, of articles which require a pre-shaping operation, an intermediate pressure and a final high pressure.

The press includes a revolving table (6) with at least three movable lower punches (7).

During the first step, the powder is supplied by a batching and preforming device (5) which acts directly on the movable punch (7), and runs through holes (28) in the chamber between counter-punch (27) and the elastic membrane (52) of the movable punch (7).

The preforming device (5) also includes a hydropneumatic cylinder with a double-acting adjustable-stroke annular piston (66) for precompressing the article.

During the second step, the final pressing stage occurs by means of an isostatic pressing punch (9) in cooperation with the lower movable punch (7), and during the third stage the discharging of the article takes place.

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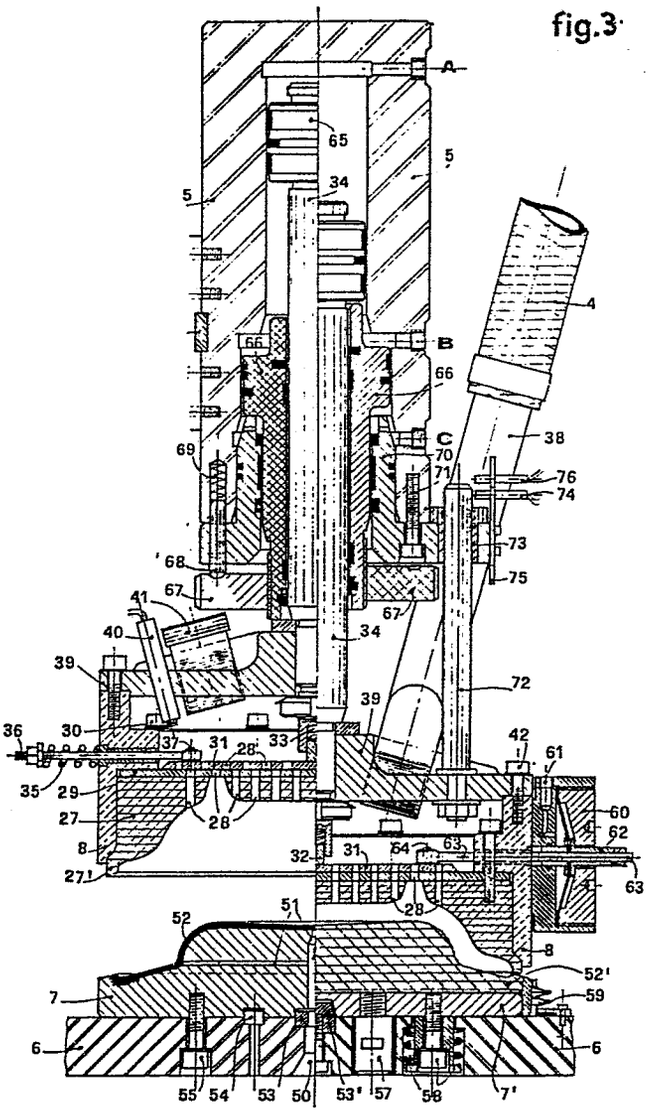
fig.3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A PRESS FOR THE PRODUCTION OF PIECES REQUIRING FOR THEIR INDUSTRIAL PROCESSING A PREFORMING STEP WITH LOW EXPENDITURE OF FORCES AND A FINAL HIGH PRESSURE

This invention relates to a press particularly suitable for the manufacture of pieces and items of any shape, profile, depth and thickness, such, for example, as plates, cups, salad bowls, vases, special tiles having irregular shape and surfaces, particularly shaped small parts or mechanical elements, etc., all of which are obtained by pressing into shapes ceramic, refractory, metal, light alloy-based powders and other powders especially suitable for said processing operations for which, due to peculiar, technical and technological, very significant features involved, an automatic preforming step is required in order to obtain a finished product as perfect as possible wheil reducing to a very minimum essential any further operations for finishing the product or correcting defective pieces as is the case at present with corresponding productions using less improved methods than does this invention.

As one non restrictive example of the improvements our invention is capable of achieving in the various branches of the art concerned, the following is a description of the invention

as applied to the ceramic manufacture of plates, cups, pieces of fittings and the like.

As is known, in recent years such products have also been produced on presses of vertical or horizontal axis that are supplied with ceramic atomized mixtures containing 1.5 to 7 % of H_2O. Powder is admitted to the dies of said presses which may be of either the isostatic type or the metal type with a covering provided thereon.

Said covering on the surfaces contacting the powdery substance to be pressed, is in the form of a membrane or a skull-like cap made of synthetic elastomer or a metal powder based material to which plastic, high strength bonding agents are added.

Unfortunately, the above-mentioned processing methods suffer from some imperfections and involve limitations for the user, which hinders wide-spread use of said new futuristic technology otherwise far more attractive, under saving and automatization aspects, than the conventional method using plaster molds.

In fact, on a vertical axis press equipped with a rotary table supporting the isostatic dies, the ceramic powder to be pressed is supplied through an adjustable volume batcher from which said material is deposited, in bulk, onto the concave membrane that will produce the profile of the rear, i.e. the foot side of a plate.

A shaped scraper approximately reproducing the profile of

the visible side of a plate is caused to rotate axially above the material discharged from the batcher to spread it throughout the surface of the underlying shaped membrane so that said material is given said profile of the visible face of the piece to be pressed. At that time, the rotary table is given a 90° rotation to bring the isostatic lower punch containing said preshaped ceramic material, to a position below the upper punch that is to form the visible face of the plate.

Said pressing punch is moved at a high speed, by an hydraulic jack, into contact with the material to be pressed, whereupon said punch continues its downwards stroke at a low speed to perform precompression and deaeration of the material. Then, the above-mentioned jack is locked in said position in order to create opposition against hydraulic counterpressure from the lower isostatic punch thereby to achieve the final pressing operation.

Once the pressing step is carried out, the upper punch is moved back to its upper starting position and the rotary table is imparted a further 90° rotation to bring the pressed piece, that is still resting on the lower punch membrane, to a position below a suction-cup arm that will move it away in a direction toward a deburring, trimming and sponging or moping unit associated with said press.

The press being a rotary table type of press, it is to be understood that each press station involves one specific operation of the press cycle corresponding to that station.

What is described herein-above will work very well when

such plates are to be produced as those of the "plane" or flat type, i.e. shallow plates.

When soup plates, i.e. deeper plates than the former, are produced, then things become complicated in that not in all cases is distribution of the powder to be pressed satisfactory due to the tendency of the dropping powder to collect in the middle of the bottom of the isostatic membrane, if the sides of a deep plate tend to be more vertical in shape than horizontal.

This drawback considerably reduces production of the above-mentioned press, while, for the same reason, possibility of producing salad plates, tea- and coffee-cups, bowls, and any other deep-edged or -walled articles, namely articles tending to be vertical in shape, is practically excluded.

Another serious disadvantage of the unfavourable situation as exemplified above is that it limits production of shapes other than round ones. However, the market demand is for a greater variety of patterns involving more and more fancy and odd profiles.

In fact, the shaped, centrally rotating scraper that provides for pre-shaping the powder to be pressed does not enable it to be, for example, used for such square, oblong and, at any rate, irregular shapes, as are in general required for complementary pieces involved in the composition of commercial crockery sets.

An alternative press to the above discussed press, which is the most wide-spread and accepted press at present for producing

pressed crockery, is an horizontal axis type of press in which the powder is supplied and the pressed piece is discharged in a substantially vertical direction.

This press mounts dies provided with one or more recesses that are aligned on the same axis. Said recesses can receive convex and stationary punches on the one hand and, on the other hand, concave punches that are movable since they are connected with the cross-slide of the press. Contour shapes and internal profiles of said convex and concave punches are substantially infinite in number and different from one another, and this even in one and the same die mounted in one of said horizontal presses.

The supply of the ceramic powder to be pressed takes place, as already said, by gravity in a vertically conveyed manner. The arrangement is very simplified as compared with that of the previously described press, since both the volume batcher and the shaping scraper are dispensed with.

The die unit of said press comprises, as an example, a convex punch fast on the press structure which reproduces the profile of the visible face of a plate; said stationary punch is located in a ring means that is firmly secured to the movable die of the press. Said movable die and, thus, said ring means, are provided with a central groove through which a powder to be pressed can flow.

The movable concave punch, that is secured to the press cross-slide, reproduces the rear of a plate, i.e. the 'foot' side thereof.

Thus, the working cycle takes place as follows:

- the movable die is entirely set back so as to permit the convex stationary punch to stand out in front of it,
- in this position, the stationary punch closes the groove in both the die and the recess-forming ring, thereby to prevent the powder from flowing therethrough,
- the automatic cycle is started upon feeding of the concave movable punch which is positioned at a precise distance to the stationary convex punch,
- the movable die moves forward to entirely enclose, besides the stationary punch already located therein, also a portion of the movable punch that is rigidly held in the above-described position,
- by this operation, an internal chamber to said recess is created and is bounded, peripherally, by the die ring and the opposing concave and convex faces of the two punches facing one another,
- upon said moving forward of the die, the groove in this latter is simultaneously cleared by the stationary punch to permit flowing therethrough of the powder to be pressed which will fill up the chamber formed by the two facing punches thereby to achieve charging of the die unit in a preformed manner corresponding to the final profile of a plate to be pressed,
- when filling operation is completed, the movable die is caused to partially recede in order to stop flowing-in of the powder by means of the stationary punch.

In a simultaneous manner, the powder contained in the space bounded by the two opposing punches is kept confined peripheral-

ly to thereby create the pressing conditions,

- when the pressing operation is achieved, the movable die, with the associated convex stationary punch inside it, is moved back to its starting position, and the movable concave punch, wheil being moved back to its starting position, releases the pressed plate which drops by gravity onto an underlying chute means arranged to convey the plate away from the press.

As it should be apparent, this very simple and practical method permits overcoming many of the above-mentioned limitations inherent in the described vertical presses, but it does not eliminate the problems encountered by the manufacturers, and even it gives rise to some further difficulties that are described below by way of illustration.

In fact, said die-system produces considerable burrs that are to be removed from the pressed plate by further difficult operations which cause the produced pieces to undergo peripheral stresses with increased number of rejections being involved.

Attempts at obviating this disadvantage by using improved dies, both of the isostatic type and provided with additional counter-punches, did not prove satisfactory, practically.

Moreover, it has been found that density of the pressed piece does not appear to be uniformly distributed in this latter since, because of the powder flowing by gravity, the coarse and heavy grains in the powder tend to accumulate on the bottom side of the die, while the small and light particles appear to be concentrated at the top side thereof.

This may be accepted for production of soft-paste, tough earthen plates, whereas for thin and transparent porcelain the above-mentioned disadvantages become v e r y apparent and make for the product to fall in value.

As already mentioned, when pressing operation is completed, said pieces are caused to drop onto an underlying chute means which does not always perform its function in a very efficient manner.

In fact, any broken pressed pieces tend to accumulate on the chute together with lost powder from the recesses in the die unit, all of which will sometimes hinder production to such a point that the line has to be stopped in order to clear the chute. Moreover, not in all cases may the pieces be let to drop onto the chute, and this is, for example, true with some types of bulky, very heavy oblong plates of which 20 + 30% will undergo cracking already at the press level.

Said horizontal press, wheil being suitable for producing salad plates, is entirely unsuitable for the production of tea- and coffee-cups, which would collide with one another while falling to the underlying chute to make for more and more rejections etc...

Finally, most delicate mechanical parts, such as the pressing piston, the columns and the cross-slide will, even though well protected, undergo considerable damage within a short period of time, since powder tends to deposit on, and stick to, the greased surfaces to create a very efficient emery-

ground zone for early wear. This phenomenon also occurs on vertical axis presses, but the unfavourable effect is in this case less significant because of the powder tending to deposit on the press bed or cross-members so as to spare, at least in part, the main piston and the uprights.

Having recognized and classified some of the most striking disadvantages that are encountered on widely used presses to-day, the following is a description of the present invention whose main object is to radically clear up all of the above-mentioned difficulties.

The above and further objects that will appear below, are attained by the invention which provides an hydraulic press of vertical axis, equipped with a rotary table or, as an alternative, a roundabout of movable punches which, in addition to perform their main function that is to form one face of a piece, also serve as the means for transporting the plates during the further steps provided by the automatic cycle of the press.

The powder to be pressed is supplied through a known system comprising a vacuum-motor pump by which powder is constantly delivered to a small bin arranged above the press. Said bin is connected by one or more flexible pipes to a batching and preforming system according to the invention which acts directly on the movable punches, these latter being, at each time, positioned axially below said preforming batcher.

Following to batching and preforming of a piece, the movable

punches are moved to a position axially below a pressing unit which in addition to an hydraulic piston of adequate sizes, also includes a pressing punch for pressing the counter-face of a piece, the punch being attached to the above-mentioned piston.

Once the pressing operation is completed, the movable punches are, again in succession, positioned under a suction-cup arm that will pick up a pressed plate to deposit it onto turn-plates associated to a finishing or trimming machine placed alongside the press.

The above-mentioned batching, preforming, pressing, discharging and finishing operations are conducted simultaneously by the use of one or more die-units, depending on the different sizes, shapes and profiles of the pieces to be produced, by adequate setting up of the same press each time.

Further features and advantages of the invention will appear from a reading of the following detailed description of an hydraulic vertical press, together with the different complementary systems combined thereto, for the ceramic production of plates, cups, vessels, special pieces, etc., which press is shown, by way of a non restrictive example, on the accompanying drawings, in which :

- Figure 1 is a front view of the press, the finishing machine and the auxiliary and complementary units according to this invention.

- Figure 2 is, on an enlarged scale, a vertical sectional view

of a batching, preforming and precompressing unit which is used according to the invention for the production of plates, said unit being shown when at rest.

- Figure 3 is, on an enlarged scale, the same view as above showing the batching, preforming and precompressing unit when in the preformed filling condition of a powder to be pressed, according to the invention.

- Figure 4 is, on a true scale, a vertical sectional detail view showing the counter-punch and the movable lower punch when precompressing step has taken place, according to the invention.

- Figure 5 is a true scale, vertical, sectional view of a pair o punches, namely an upper, concave, isostatic punch provided with membrane, and a lower, convex, semirigid, movable punch; the assembly being shown at the time when pressing operation has been performed according to the invention.

- Figure 6 shows, in sectional view, a preforming and precompressing unit for octagonal vessels, on the left; and, on the right, a pair of corresponding punches with swollen, lower skull-like cover, according to the invention.

- Figures 7 to 12 schematically show the steps for performing one operating cycle of a vertical press according to the invention.

Referring now to figure 1, there is shown at 1 a feeder unit

for supplying a powder to be pressed; 2 is a relay-bin with an associated control means 3 for constant level of a powder to be pressed; 4 is a flexible means connecting the relay-bin to the batching and forming unit 5; 6 is a revolving table carrying the movable punches 7; 56 is an electro-valve with a movable nozzle for blowing compressed air into the punch 7; 9 is an upper punch of the rigid, covered type or, as an alternative, the isostatic type, secured to the movable piston rod of a pressing piston 10, which bears against, and is rigidly connected to, a stationary, upper cross member 11; 12 is a press bedplate with, located therein, the uprights 13 that support the stationary cross member 11 to form, together therewith, the strong pressing structure; 14 is a controlled valve for rapid pre-filling and discharging of oil into and from the pressing piston 10 in cooperation with reservoirs 15 arranged on the stationary cross member 11; 16 is a pressure booster unit that is utilized by both the pressing piston 10 -when rigid and covered types of upper punches are used- and the upper isostatic punch, if this type of upper punch is used as an alternative to the rigid type, for performing final pressing; 17 is an oleodynamic centralized station, equipped with motor pump, reservoir , exchanger and usual auxiliary equipment, which delivers low pressure oil to the servo-mechanisms employed in the automatic operation of the press; 18 is a suction-cup arm for sucking-up pressed piece 19; 20 designates the turnplates of a finishing or trimming machine 21 that is provided with one or more sponging or moping units 22 by which a pressed piece is acted upon to be trimmed at its periphery; 23 is an arm carrying a suction-cup to which vacuum is supplied through a flexible pipe 24 connected to a vacuum pump (not shown); 25 is a discharge belt for discharging the pressed and finished pieces.

As is apparent from figure 1, a determinative feature for the vertical press of the invention to achieve a production that is widely expanded in both shapes and profiles, is the provision of the batching and preforming unit for the pieces to be pressed combined to a proper choice of the types of dies particularly suited to this end.

More specifically and as shown in the enlarged scale view of figure 2, the above unit essentially comprises a housing 8 inside which a counter-punch 27 is located, said counter-punch 27 having a profile that, unlike the cases known, does not correspond to that of the finished piece. This profile will, in fact, be defined both on a preliminary study level and by subsequent pressing and backing operations carried out on it on a trial basis.

Possible modifications to be made to the prototype profile of counterpunch 27 will, indeed, be decided on a laboratory level whenever the backed piece should not possess such dimensional and appearance features as may be required by a prospective user of the die.

Thus, modifications may be made, for example, to a plate foot by the use of an increased or decreased amount of the powder concentrated at that point, by only working on the profile of the counter-punch when, although the final profile and tickness having been respected, the plate foot would not show the same uniform density as is achieved everywhere on the remainder of the finished piece.

The movable punch 7 practically remains, in such cases, un-

changed since, taking into account possible shrinkage and deformation of the pieces to be obtained, it must produce the required profile in a true manner.

Said counter-punch 27 is made of an elastic material having well defined properties which allow for compliance of a protruding end 27' of said counter-punch when, during preforming and precompressing of the soft material firmly held between said counter-punch and the punch 7, said end 27' will be caused to bear, while being swollen, on the inclined peripheral plane of said punch under pushing effect of piston 65.

Due to the surface of said counter-punch 27 being elastic in nature, this results in a self-cleaning property of said surface which will prevent scale formation usually experienced when rigid, not heated surfaces are used.

The above-mentioned counter-punch has through-holes 28 provided at given locations on its surface, which serve the main purpose of permitting the powder to be pressed to pass, at a predetermined time, from an upper chamber in housing 8 to a lower chamber that is defined, each time, by the counter-punch 27 together with a corresponding punch 7.

The locations, number and sizes of said holes 28 will vary according to the general shape, profile, thickness and sizes of what it is desired to press.

Thus, for each individual piece or object to be produced with this system, there will be a precise, corresponding counter-

punch of provided, which is properly perforated so as to meet the particular requirements involved.

Any corrections to the counter-punch will be carried out either by removing excess material from predetermined locations on its profile using suitable tools, or by adding material thereto in the form of previously produced strips or sheets that are bonded, at the required places, to the counter-punch material.

Then, a proper radiusing or smoothing of the thus corrected surfaces will be effected.

In order to support the counter-punch 27 in an adequate centered manner during the powder preforming and precompressing step subsequent to the filling step, a metal, e.g. stainless steel support 29 is provided.

Said support, which is also provided with holes formed therein in one and the same operation as the holes in the underlying counter-punch, is rigidly anchored to said counter-punch by having the elastic material of this latter directly molded on said support that has been previously treated so as to achieve high strength bonding together of the two parts. Therefore, the support 29 and the counter-punch 27 together form one integral body. This integral body is rigidly retained inside the housing 8 by the aid of screw means 30 which make for easy interchange or substitution thereof according to different requirements.

Placed over the support 29 is a movable plate 31 that serves

the purpose of obturating the holes 28 during certain stages of the press cycle, such, for example, as that shown in fig. 2.

In fact, should said movable plate 31 - which is of stainless steel and provided with holes in the same manner as the underlying plate 29 and counter-punch 27 - not be provided, powdery material would be lost through said holes 28 to contaminate the surrounding atmosphere and preventing operation of the press.

Said obturator 31 is held in contact with the support 29 by means of a sliding block 32, for example, of teflon, that is acted upon by a spring means 33 secured to the end of a piston rod 34 associated to the forming and precompressing piston 65.

The obturator 31 is constantly acted upon and held in place by a spring means 35 and an associated tie bar 36 which is, in turn, firmly secured to the obturator 31 by the aid of a pin 37 such that, even in absence of electric power, an adequate closure of the holes 28 can be ensured.

As it should be appreciated, an evenly distributed layer of the powder to be pressed is created over the entire surface of the obturator 31 and is enclosed within the upper chamber of the housing 8.

Constant supply of the powder to be pressed is ensured, as mentioned herein before, by the combination of the feeder means 1 with associated bin means 2; the level control device 3 for safe control in case of absence of powder to be pressed; one

or more flexible pipes 4, figure 3, the corresponding ends 38 of which (figure 3) are rigidly connected with a flange 39 that is, in turn, rigidly secured to the piston rod 34 of piston 65.

The lower extremity of said pipe ends 38 dictate the maximum level limit for the powder contained and distributed within the upper chamber of housing 8.

Whenever said maximum level drops because of the powder moving down to the lower chamber from the upper chamber, the maximum level is automatically reset, without any particular control means being to be provided for, due to the flowing powder running by gravity.

Where no powder to be pressed should be available in the upper chamber of housing 8 due to an obstruction occurring in the flexible pipes 4 and the rigid pipes 38, then, even if in presence of consent from the capacitive sensor 3 provided on relay-bin 2 and ensuring existence of material, the automatic cycle of the press will immediately be stopped since the capacitive sensor 40 controlling the internal minimum level in the upper chamber of housing 8 will warn of this emergency situation.

Stopping of the press will also occur if, at an intermediate time between two cycles of the press, the flexible pipes 4 and rigid pipes 38 are not able to ensure timely reset of the maximum powder level in the upper chamber 8 due to an excessive and, thus, higher powder consumption, as a result of an excessively high production rate of the press.

Therefore, the capacitive sensor 40 must always be positive in response, which means that minimum level is safely ensured.

A filter 4 is provided to ensure free air circulation inside the upper chamber of housing 8.

Where a fluidization or pressurization of the powders in the upper chamber of housing 8 should be essential in order to speed flowing of the material contained therein, then a diaphragm valve will be provided within said upper chamber to shut off the filter when very high pressure condition will require it.

In addition to the above-described elements, figure 2 also shows, in its entirety, the batching and pre-forming system for the pieces to be pressed, when in its rest position. This unit is shown, by way of a non restrictive example, as being mechanically connected with the stationary upper cross-member 11 through a support means 43 that is provided, for example, with prismatic guides on which a carriage 45 can run or be positioned by means of a screw spindle 44, the carriage 45 being equipped with an appropriate threaded ring (not shown) cooperating with the screw spindle 44.

Screw means 46 and associated lock nuts 47 permit the carriage 45 to be rigidly held in the position shown. When changes occur in the type of product to be pressed, then the entire batching and preforming unit that is rigidly connected through the cylinder body 5 to the carriage 45 by means of screws 48 and cotter 49, can be made to occupy different positions, if this is

necessary to suit different depths of new products.

In effect, the unit shown in figures 2 and 3 allows for considerable ease of independent manoeuvring and adjusting operations, as will explained further in the following.

Introduction of this further positioning ability as achieved by the press elements 43, 44, 45, etc., permits production of salad plates, tureens or other pieces considerably great in depth, of course, by also substituting the elements 7, 8, 9, 27, 29 etc..

In prior art, vertical-type presses for the production of plates,this positioning ability is excluded due to their substantial limitations as described herein above; on the other hand, in known horizontal types of presses, said special plates are produced on machines having provisions for strokes of increased length with respect to the same type of presses producing plates of usual shapes. As a result, difficulties and additional costs are encountered by both the manufacturer and the user.

In order to accommodate this vertical axis-type of press to the production of pieces of considerable depth having peripheral walls tending to be more vertical, or, in any case, more or less tapered or bulging-out in shape, the invention provides an electric valve having a movable nozzle 56, figure 1, which can admit compressed, properly calibrated air via a conical aperture 50 and associated passages 51.

Said calibrated air blowing may be used under specific circum-

stances to cause slight inflation or swelling of the elastic membrane or skull-cover 52 (which is only peripherally bonded to the metal punch 7) in conjunction with the preforming and precompressing action exerted through the counterpunch 27 corresponding to the concerned piece.

This condition results in a gentle counter-pressure being created inside the conical or nearly vertical-walled piece, which substantially reduces precompressing work exerted on the external walls of the piece to be helpful in strengthening it with no difficulty arising for any further operations involved.

The punch 7 is centered on the revolving table by a pierced bushing 53; it is rigidly positioned by means of a conical pin 54 and rigidly fastened to the table by the aid of screws 55.

Figure 3 shows, in vertical sectional view, the batching and preforming unit with the housing 8 having been lowered onto the punch 7; the assembly being in the position that permits filling of the lower chamber and subsequent preforming and precompressing operation.

Said figure 3 illustrates a modification in construction and operation of the movable punch 7' and certain auxiliary parts thereof.

More specifically, said punch 7' comprises a metal base-plate having a rigid, skull-like covering 52' molded thereon, which is obtained from a high strength resin-bonded metal powder based material. This punch 7' is particularly useful when production

involves use to be made of ceramic powders containing about 1.5 % of H_2O with chemical bonding agents added thereto.

The difference resides in that said punch 7' is connected resiliently with the rotary table 6 through one or more assemblies 58 which comprise, as viewed in figure 3, a distance member attached to the punch 7', an antagonistic (or return) spring, and a screw means fitted to the punch 7' which permits the assembly, except for the spring, to be firmly secured to said punch.

The punch 7' is centered on the revolving table by a taper pin 53'.

A further pair of cylindrical pins 57 secured to the punch 7' are arranged to be vertically slidable in a free manner in corresponding recesses provided in the rotary table 6. A bellows means 59 is provided to prevent any foreign matter from having access to between the working surfaces of punch 7' and revolving table 6.

The above-described arrangement permits use to be made of a mini-vibrator (not illustrated) which, by acting through the pins 57 at the time when the lower cavity is being filled, will assist in obtaining homogeneous distribution of the powder, thereby to achieve a still more improved quality of the product, if necessary.

All of the above will not involve any change in the operation of the batching and preforming unit, so that the modified

punch 7' may very well be substituted for the punch 7 of figure 2.

Figure 3 shows a pneumatic, diaphragm actuator 60 which under action of air pressure conveniently supplied to it through a passage 61, will cause movement of a hollow pin or spindle 62. This hollow pin 62 is attached to the actuator diaphragm and has a tie rod 63 passed therethrough which is, in turn, attached to the obturator 31 through a pin 64. Thus, said actuator will cause, at the proper time, displacment of obturator 31 since it overrides the spring 35 and the associated tie members 36 that are themselves attached to obturator 31.

As a result of said displacement operated by actuator 60, the holes 28 in the obturator are communicated with the holes in the support 29 and the counter-punch 27.

At this time, powder contained in the upper chamber of housing 8 commences to run through said holes and into the lower chamber that has formed between the convex surface of the underlying punch 7, or 7', and the counter-punch 27.

The filling depth of the soft matter, which is the same as the preset distance between the opposing faces of punch 7, or 7', and counter-punch 27, is dictated by the shaping piston 65 in cooperation with the annular piston 66.

Said charging depth of the soft matter will dictate the final thickness of a pressed plate.

Said position is, in fact, controlled by the down stroke that

the double acting piston 65 is caused to perform through the piston rod 34 attached to the flange 39 which is, in turn, connected with the housing 8.

As is known, during production on an industrial scale, a powder to be pressed is liable to undergo variations in humidity content, particle size, etc..

Under these circumstances, such variations will automatically affect the final thickness of a pressed piece since, with both the charging depth and the specific pressure of the press remaining unchanged, the soft product will practically be of higher or lower density thereby giving rise to the above-mentioned variations in thickness.

In order to obviate this drawback related to the variation in thickness, the invention has provided the annular piston 66. This annular piston 66 has an adjusting ring 67 mounted on the lower threaded end thereof, which adjusting ring 67 is, in turn, provided all around its circumference, with spherical recesses into which a stop or locking pin 68 is caused to fit each time, this locking pin 68 being permanently urged against the adjusting ring 67 by a spring 69. Thus, the maximum stroke of the annular piston 66 is bound, upwardly, by a bearing surface formed in cylinder 5, and, downwardly, by the bearing surface that is afforded by a guide means 70 attached to cylinder 5 through screw means 71.

Therefore, it is apparent that, as viewed in figures 2 and 3, the end of the down-stroke of said annular piston 66 is

fixed, while the up-stroke of piston 66 is bound to the position of the threaded ring 67 which, in going up, will bear against the base of guide 70.

Thus, when the actuator is at rest, as shown figure 2, the chamber A of cylinder 5 is discharging, while the chambers B and C are under pressure. Thus, the piston 65 will be at its highest point, the annular piston 66 will bear against the guide 70 and this due to the differences in section to the advantage of chamber B.

In order to cause lowering of the housing 8, chamber A is put under pressure while chamber B is simultaneously discharged. This causes instantaneous up-motion of the annular piston 66 which stops when the threaded ring 67 is striking against said guide.

Descent of piston 65 will be stopped when it comes into contact with the top of the annular piston 66 that is held in this position by the pressurized chamber C. This condition will be maintained throughout the time the lower cavity is being filled, since chamber C is larger in section than chamber A.

It is to be intended that pressure is the same for all of the concerned chambers. Thus, if necessary, correction of the filling depth of soft product discharged into the lower chamber, is obtained by adjustment, even during automatic operation of the press, of thethreaded ring 67. This ring is indented all around its periphery, since correction of the depth and the soft product could also be performed automatically as, for example, in the field of ceramic tiles.

In order to prevent any axial rotation of housing 8 during lowering thereof, a pivot 72 is provided. This pivot 72 is attached to the flange 39 and can slide in a bushing 73 that is, in turn, attached to a protruding portion of guide 70. A magnetic sensor 74 is mounted on an associated adjustable support 75 and is designed to check, at each cycle, a constant position attained by the pivot 72 secured to flange 39.

Whenever the repeatability of this position did not occur, the press would be stopped by failure of the system.

On the other hand, when all the things are proceeding in a regular manner, then, as soon as the time (as set by a timer) for performing the step of filling the lower chamber is elapsed, the step of preforming and precompressing the product in the chamber formed by punch 7, or 7', and counter-punch 27, is started.

For this operation to occur, the chamber C is caused to discharge; thus, the annular piston 66 will no longer counteract descent of piston 65 which is still urged downwardly by pressure in chamber A.

Then, a further down movement of housing 8 will take place under pushing action of piston 65. The material to be pressed will take on, by compaction, the same shape as that of the profiles in intimate contact with which it is confined inside the lower chamber. There will occur, at this stage, a slight swelling up of the protruding peripheral portion 27' of counter-punch which, during the preceding step of filling up the lower

chamber, has provided the peripheral seal between the counter-punch and the underlying punch.

It is to be noted that throughout the time during which the powder is preformed and precompressed, the actuator 60 and, thus, the obturator 31, are in the position shown in figure 3, in which the upper chamber and the lower chamber are kept communicating with one another through the holes 28.

This particular condition results in a very little tendency of the powder to flow back towards the upper chamber during pre-compression thereof.

Anyhow, this very slight backflow of the powder does not alter in any way the result aimed at in the lower chamber and ensures that the holes 28 should not be obstructed during precompressing of the underlying powder.

At the end of the time, as preset by a proper timer, allowed for the preforming and precompressing operation to take place, the diaphragm actuator 60 is caused to discharge through discharging passage 61 thereby to permit the spring 35 to move the obturator 31 back to its rest position as shown in figure 2.

The time allowed for carrying out preforming and precompressing of the powder is, in the actual practice, in excess of that required, since it is desired to make sure that the powder shall be precompressed with the same specific pressure, at each cycle.

In order to ensure obtention of a more qualified production,

a further electronic control is provided which is controlled by a magnetic sensor 76, adjacent to the sensor 74, to read the position of the pivot 72 when in its lowermost position as reached during the precompressing stage. This position must, in the first place, be iterative during the various consecutive cycles, and whenever this should not happen, then the sensor 76 will give warning of it by stopping the press.

In any case, this sensor will stop the automatic cycle whenever the rod 72, connected with the housing 8, would move beyond the programmed lowermost position of the system as a whole. This would mean a not sufficient volume of powder having entered the lower chamber in spite of consent from all of the preceding electronic controls. It could also denote a partial obstruction of holes 28 or a loss of powder peripherally occurring at the protruding area 27' which does not provide for a thorough sealing there. Thus, this checking allows for determining in advance whether a preformed and precompressed part will be suitable for final pressing operation, thereby to avoid such damages to the upper and lower pressing punches as are experienced on known presses of the vertical or horizontal axis type.

In fact, in these prior known presses, the above-mentioned checking only takes place at the final pressing stage of said punches, because of said presses not utilizing the preshaping and precompressing stage according to this invention.

At any rate, in this case, stopping of the press sometimes occurs when it is to late so that the dies are damaged even if

to a very small extent, which obviously requires stopping the production to replace the dies with all the troubles that are likely to be involved under such circumstances.

On the other hand, when all of the work is taking place according to the program as established by the automatic cycle of the press, then, at the end of the time alloved for completing the preshaping and precompressing operation, chamber A of cylinder 5 is put to discharge while at the same time chambers B and C are pressurized and cause the pistons and, thus, the parts connected therewith, to m o v e to the starting position for a next cycle.

Thus, it can be appreciated from the above description that all of the previously mentioned limitations experienced with the prior art presses, of the vertical axis type, for the production of plates, have been removed by the present invention. In fact, the shaping scraper is entirely dispensed with, as well ase are the disadvantages involved in the use of this device.

The combination of the counterpunch 27 and the feeding system utilizing the holes 28 to supply the powder therethrough according to this invention, permits use to be made of dies of any shape, profile and size, obviously subject to the maximum tonnage of the vertical axis press used.

The fact of applying a precompression following to the charging of powder and, therefore, the preforming of a soft product, as disclosed by this invention,allows for the pieces to be given

a sufficient consistency prior to their final pressing, thereby to avoid the powder 'fall-back' phenomenon that is experienced when using a shaping scraper.

The above and further advantages are attained by the automatic mode of operation of the invention, which is thoroughly controlled in every individual detail by means of electronic static devices that are essential to the obtention of first quality products.

Figure 4 shows, on a true scale, in sectional view, a part of the housing 8, the counter-punch 27, the protrusion 27' when in its swollen condition due to the pushing action exerted during precompression, and the lower punch 7 with its covering 52.

Also shown in figure 4 are, in particular, the thickness of the support 29 and the associated obturator 31 (both of stainless steel), and the holes 28 provided therein.

The chamber formed by the punch 7 and the counter-punch 27 is shown to contain a plate 77 at the time when preshaping and precompressing have taken place and, thus, before the housing 8 is raised, the holes 28 being already obturated.

It is to be noted that the not precompressed powder remaining inside the holes 28 of the counter-punch 27 and the support 29 will then form very minute, individual heaps on the middle part of plate 77. On the foot side of this latter said residual powder will practically be inexistent. At any rate, these

very minute heaps will be uniformly absorbed and incorporated without any alteration in profile and density; there will be, at the zones corresponding to said minute heaps, a very slight difference in precompression at the surface of the precompressed piece. It has been envisaged to provide, as an alternative to the obturator 31, a sort of stake-holder that is arranged in the upper chamber in housing 8 in such a manner that, when actuated by suitable means, it closes and opens the holes 28, the stakes of the stake-holder being able to penetrate said holes to a point where they extend slightly into the lower chamber with the purpose of eliminating formation of said minute heaps. However, in view of the insignificant influence these latter are likely to have on quality of the finished product, this modification is only theoretically incorporated in this invention, at this stage.

By comparing the thicknesses of the preformed and precompressed plate 77, figure 4, and the pressed plate 19, figure 5, both of these plates being shown on 1:1 scale, it will be seen that the thickness ratio is about 1/1.4 while, in general, the soft to pressed ratio of the powdery atomized products ranges from 1/1.8 to 1/2.2.

As the prior art presses with either vertical or horizontal axis, for the production of plates, are not provided with the piece preshaping and precompressing unit of this invention, they obviously operate with the above-mentioned compression ratios, and, in fact, their pressing punches are directly in contact with the soft product.

The difference in these compression ratios, namely 1/1.4 in

the present case to about 1/2 in the cases known, corresponds to a greater air content of the powder in the latter case with respect to the former.

In fact, in the prior art, vertical or horizontal presses, the automatic pressing cycle comprises at least one first low pressure, slow pressing step for deaerating the powder contained in a soft state in their dies, and at least one further high pressure, rapid pressing step for final sintering of the piece.

Said first pressing step for deaerating the powder, which is essential in conventional presses, requires that, in the isostatic or not isostatic dies, considerable clearances be provided between the moving parts in order to allow air escaping. The clearances significantly increase with the time due to the fact that escaping of air contained in the powder tends to draw along dust, often very abrasive in nature, which wears away the edges of the generally hardened punches and the rings of the dies in which the punches slide.

In addition to this phenomenon, there is to be considered an increased wear of the above-mentioned elements due to frequent mismatching of the moving parts.

All of the above will practically result in the formation of peripheral burrs or fins which impair the edges of the pressed pieces.

The burrs are to be removed on automatic machines that are very complicated and expensive since they have to operate on

crude and, thus, delicate pieces.

This disadvantage is still more significant in horizontal presses which, due in particular to the principle of construction of their dies, whether isostatic or not, are not able to perform pressing in the punch-to-punch or punch-to-die mode, or in the so-called'mirror'mode, as used in the tile art, which enables to reduce, at least on one face, formation of burr to be removed.

The cost of deburring the pressed pieces is, indeed, very high, since a permanent control must be done on both the finished piece and the trimming tools, which latter, however adequate they may be, undergo very rapid wear and necessitate continuous adjustment and periodical replacement.

By this invention, all of the above drawbacks are substantially eliminated since deaeration is almost entirely achieved during the time the powder is precompressed between the lower movable punch 7 and the counter-punch 27. At that stage, air contained in the powder in the lower chamber is blown out through the holes 28 in counterpunch 27.

By summing up the sections of holes 28, it appears that a substantially large section is available for the air to escape therethrough in spite of the fact that it has to get its way through the soft powder contained in holes 28. This confirms and explains the described slight flow-back of powder and air from the lower chamber in housing 8 toward the upper chamber, and this while powder is being precompressed.

Because of this almost complete elimination of air in the

precompressed piece 77, clearances provided for in the dies utilized by conventional vertical presses for producing plates or the like, are entirely dispensed with, since unnecessary, by the use of this invention.

More specifically, reference is made to figure 5 which is a 1:1 scale, partial sectional view, showing a pair of punches during final pressing of plate 19.

The upper punch 9, of the isostatic type, is attached to the piston rod of the pressing piston 10, figure 1.

Said punch includes a prefabricated, high pressure diaphragm or membrane 78 whose peripheral sealing is ensured by a ring 79 and the provision of close-set screw means 80 which fasten said ring to the upper punch 9 by firmly pressing the membrane edge in between.

More precisely, as viewed in figure 5, the oil-tight seal for the high pressure oil introduced, at the time of the final pressing step, through the passages 81, 82, 83, 84 provided in the upper punch 9, is ensured by the particular peripheral profile 85. The threaded connection 86 ensures sealing of the end of the flexible pipe that is connected to said isostatic punch. Oil at high pressure is supplied, at the required time, from a suitable motor pump unit or a pressure booster. Also shown in figure 5 is the chamber 87 that, during the pressing step shown, is filled up with high pressure oil.

The lower movable punch 7, that is adequately provided with

a non-sticking, self-cleaning, skull-like elastic covering 52, reproduces the visible face of a plate, while the membrane 78 reproduces the rear part, i.e. the foot side thereof.

This precise allocation of functions to both the covering 52 and the membrane 78, is of basic importance from a practical point of view. In fact, the visible side of a plate must be free from any technical defects or blemishes, and the semi-rigid surface of the skull-like covering 52 is especially adapted to answer this requirement. On the other hand, the membrane 78 has the particular function of applying a specific, isostatically distributed pressure everywhere on the surface of plate 19 including the plate foot. Thus, in respect of this element, very slight imperfections may be allowed for, since these are less apparent on the rear of a plate.

As shown in figure 5, the skull-like covering 52 and the membrane 78 have, at their respective peripheral zones, a radially extended end-portion corresponding to the edge of a pressed plate. During final pressing step, said two radially extended end-portions, the peripheral inclined plane of punch 7 and the opposing part of membrane 78, will be in contact with, and firmly compressed against one another, under high pressure exerted on the membrane, so that this latter is deformed on all points of its surface, including the above-mentioned portion. As no interspace exists between said two surfaces it is ensured that no burr in any form whatsoever is produced, according to the invention. Thus, this invention has suppressed all of the scraping, finish or trimming operations that are to be carried out when plates are produced on presses

of the prior art. Only a final wet moping, or sponging operation will be required and is a simple operation useful in smoothing the edge of any type of plate, a part from the type of press or production involved.

In use, the upper punch 9 is moved down to a point above the precompressed piece 77 so as to encompass it without being in contact therewith. The membrane 78, wheil still adhering to the steel of the punch 9, since still in a discharging stage at this time, is positioned by the pressing piston 10 (figure 1) at a few 10th distance to the piece 77 (foot side) to be pressed.

The same distance as above is also maintained between the inclined peripheral plane of punch 7 and the opposite surface of membrane 78. The upper chamber of piston 10 is, at this time, hermetically closed to prevent any oil escaping, due to said thus locked piston also having the function of resisting upward movement of the isostatic upper punch 9, at the time when the membrane 78 is being pressurized. Then, low pressure oil supplied by the centralized system 17, is admitted to the isostatic punch 9 through passage 81,82,83,84 for precharging or filling the chamber 87. This causes the membrane 78 to be displaced so that, by its coming into contact with the preshaped and precompressed plate 77, it will apply a first compression thereon.

Said compression permits any residual air contained in the precompressed piece 77 to escape through the gap between the inclined peripheral plane of punch 7 and the facing surface

of membrane 78. Thereafter, high pressure oil provided in the mean time by the pressure booster 16 (figure 1), is immediately admitted upon the low pressure oil acting on the membrane, and final pressing of the plate 19 is caused to occur instantaneously. Admission of high pressure produces further substantial deformation of membrane 78 and, thus, instantaneous suppression of the above-mentioned gap, which prevents any possible formation of burr.

An electronic manometer causes the final pressing of the plate to come to an end as soon as a preset pressure is reached. The piston 10 and the upper punch 9 attached thereto are moved back to their starting position thereby to release the plate 19 and the corresponding lower movable punch 7, these latter being then moved to a position beneath the revolving suction-cup arm which will bring the plate 19 to a trimming machine 21 (figure 1).

This mechanical transfer of the pressed piece from the movable punch 7 to the turnplate 20 of finishing machine 21 (figure 1) is carried out in the same manner as in conventional vertical presses for producing plates, that is to say in a manner that ensures protection of the pressed piece against such shocks and malfunctioning as are experienced on the discharging systems associated with the prior art horizontal presses, this being achieved, by the present press, without any limitations as to the shape, profile or weight of the product obtained according to the invention.

Moreover, the invention ensures still more protection, since,

as already described, the pressed pieces 19 are conveyed to the finishing machine 21 substantially turned upside down, i.e. such as they are pressed: a condition permitting them to be easy received on the respective turnplates 20, which latter have profiles and utilize mechanical arrangements equivalent to those of the movable punches 7 of the press according to the invention.

As already said, the arrangement of the individual punches is of primary and decisive importance for permitting extension of all of the above-described peculiarities and advantages of the invention from the range of the pressed plates to any of other alternative and complementary ranges of products without any restrictions as to the shape, profile and size of such products. Moreover, the invention offers the significant exclusive advantage that said alternative products are obtainable on one and the same vertical press, by the use of either single or multiple dies, with the only provision that the external sizes of said dies be such as to enable them to be introduced into the press.

As a non restrictive example of what has been said herein above, figure 6 is a vertical sectional view showing a housing 8', a counterpunch 27", a support 29' and associated obturator 31' together with various complementary parts, a respective isostatic upper punch 9' and the corresponding movable semi-rigid lower punch 7', all of which are provided in relation to an octagon-shaped vessel designated by numeral 77' and shown at the time when it has been preshaped and precompressed by the combined action of counterpunch 27" and skull-like

covering 52', under action of air pressure supplied via the passages 51' that are in turn fed through the movable nozzle of the electric valve 56. Pressurization of the membrane 52' balances, in the case of hollow, very deep bodies, the action of the counter-punch 27' to ensure adequate consistency of the preshaped piece 77' before its final transformation into piece 19' under combined action of the isostatic punch 9' and the movable lower punch 7', right side. As shown in figure 6, said two punches differ only in shape and size from the corresponding punches for producing plates, cups, small cups, pans and other like or complementary pieces.

Figure 6 also shows the differences in internal and external profiles of the preshaped piece 77' with respect to the finished piece 19'.

This flexibility, that is only achieved by the present invention, permits preliminary correction of a preformed piece independently of the finished pieces required. In fact, as described herein before, by easy intervention on, for example, the counter-punch 27', it is possible to make appropriate modifications or adaptations of the profile of preformed piece 77' in order to achieve a perfect and homogeneous final pressed shape 19' : a feature of primary importance in view of a proper and competitive industrial-scale production.

The operation of the press and the associated dies, according to this invention, is described below in relation to figures 7 to 12.

Figure 7 shows the just pressed plate 19 when it has been

picked or sucked-up by the suction-cup arm 18.

Said plate will then be deposited on a turnplate 20 of the finishing machine 21 to be subjected to a wet sponging or moping operation, carried out by moping or sponging units 22.

Picking-up of the plate 19 is performed by a suction cup 88 which also can be lowered and raised through the pipe 24 connected with a vacuum pump, not shown here.

During said picking-up of plate 19 both the punch 7 and the revolving table 6 are held locked in position by a proper locking system such, for example, as a cam system or of the Maltese cross type.

Figure 8 shows a subsequent stage where the punch 7 is positioned beneath the piece charging and preshaping unit. Said unit is, obviously, at rest in order to permit the lower movable punch 7 to be put in position.

Said rest position is achieved by the piston 65 whose upper chamber A is in a discharging condition while the lower chamber B+ of same piston 65 is under pressure.

Figure 8 also shows the annular piston 66 in its at-rest position in which it does not counteract the piston 65. This condition is achieved by the existence of fluid pressure in chamber B+ and the absence of pressure exerted by the counter-face of said chamber C. Powder contained in housing 8 cannot pass through the holes 28 because of the obturator

31 obturing said passages under traction exerted on it by spring 35. This condition is ensured by the fact that the diaphragm actuator 60 is at rest since not being urged by fluid pressure via the passage 61. Once positioning of punch 7 is obtained, the batching and pre-shaping unit is permitted to move down, as shown in figure 9. In fact, in this figure, the upper chamber A+ of piston 65 is shown to be under pressure, while the intermediate chamber is discharging via B.

The piston 65 is, therefore, in a low position, and this position is controlled by counter-action of the annular piston 66 which is urged by fluid pressure at inlet C+.

Said annular piston 66 is in turn controlled, in its upward stroke, by the adjusting, threaded ring 67 which is bearing against the bottom side of guide 70. As described previously, this position sets a limit to the downwardly adjustable stroke of piston 65 and, thus, of the housing 8 and the counterpunch 27 connected thereto.

When this down movement has taken place, the counterpunch 27 is at a predetermined distance to the movable lower punch. This corresponds to the volumetric filling depth of a powder to be preshaped and precompressed in the chamber that is defined by the counterpunch 27 and the lower punch 7.

When both the housing 8 and the counterpunch 27 are correctly positioned (as controlled and confirmed by appropriate sensor means), the diaphragm actuator 60 is operated through passage D+ and causes, against action of spring 35, displacement of

the obturator 31 to bring the holes 28 in said obturator 31 to a position in which they are registering with the holes 28 in support plate 29 and with those in the counter-punch 27.

Then, powder commences to run from the upper chamber in housing 8 to the lower chamber formed, as already said, by the counter-punch 27 and the lower punch 7. Upon distribution and pre-shaped filling step being accomplished (in a correct manner, as checked and confirmed by proper sensor means), the precompressing step shown in figure 10 is started.

As is apparent from figures 8, 9, 10, the revolving table 6 and the movable lower punch 7 are held locked in this position until said steps of lowering the pre-shaping and precompressing unit, and causing preshaped filling and precompressing of the piece, are completed as viewed in figure 10.

In fact, in said figure 10, the piston 65 is shown as being acted upon by fluid pressure in the upper chamber, through A+. In the mean time, the lower chambers -that were counteracting, in cooperation with the annular piston 66, the further down-movement of piston 65- are caused to discharge via the passages B- and C-.

The actuator 60 is kept positive through the fluid pressure-f e d passage 61 in order that registration of the holes 28, which communicate the lower and upper chambers of housing 8 with one another, be ensured also during the pre-compression of piece 77.

Thus, said pre-compression is performed by the piston 65

during its further down movement that is only counteracted, in this case, by the progressive increase in compaction of the powder enclosed in between the counterpunch 27 and the movable punch 7.

The amount of compaction is usually bound to the effect of the maximum (pre-regulated) fluid pressure working, at each cycle, on piston 65 in opposition to the counter-acting powder that is being precompressed.

The above features,as a whole, along with the particle size curve and the humidity content of the powder, will dimensionally and physically dictate the iterative characteristics of the precompressed piece 77.

During precompression of the powder, air contained in the material is almost entirely discharged through the holes 28.

Said deaeration is considerably facilitated by the great number of holes 28 that are provided, and this is an additional advantage offered by the present invention.

Once the pre-shaping and pre-compressing operation is completed (as checked and confirmed by a suitable sensor), the diaphragm actuator is d.e energized whereupon the spring 35 causes the obturator 31 to move back to its rest position. When this position is attained, the obturator shuts off communication of holes 28 thus preventing the powder and air from flowing further to or from one chamber or the other respectively.

Resetting of the fluid pressure conditions at points A, B, C

as shown in fig. 8, causes the counter-punch 27 and the associated housing 8, to move back to the same high position as occupied at the start of the preceding cycle.

Upon releasing of the punch 7 and the corresponding precompressed plate 77, the revolving table is actuated to bring said lower movable punch and the piece resting thereon, to a position beneath the isostatic pressing punch 9 that is firmly retained in a self-aligned manner, by a magnetic surface 89 (figure 11), against the piston rod of piston 10.

Upon said punch 7 being axially aligned with the upper punch 9 and associated piston 10, the lower chamber in cylinder 90 is caused to discharge through passage E- which was, up to that time, in a positive state. At the same time, the valve 91 for fast pre-charging is opened and permits filling of the upper chamber of piston 10 until this latter is stopped at its lowermost preset point. Then, the pre-charging valve 91 is closed to permit fluid at the working pressure to be admitted through passage F and check valve 92 in order to apply a first compression on piece 77, through the piston 10 and the upper punch 9.

This operation allow for the air still remaining in the precompressed piece 77 to be entirely blown out through the peripheral gap that is purposely formed between the two punches, thus giving said piece a higher amount of compaction preparatory to the final pressing stage. This final pressing stage may occur either through the piston 10 in cooperation with the pressure booster 16 and a semi-rigid upper punch,

or, as an alternative, by means of the isostatic pressing punch 9, as shown in figure 12, in cooperation with both the piston 10 and the pressure booster 16 which generates the high pressure for said isostatic punch 9, this latter being fed, at the preset time, through passage G.

Once the final pressing is accomplished on the piece 77 such that this latter is transformed to plate 19, the valve 91 is opened again while pressure fluid causes the piston 10, via the passage E and the lower chamber of said piston 10, to move back to its raised starting position.

As a matter of fact, said piston 10 will cause -through the magnetic surface 89- the pressing punch 9 to move up again, thereby to release both the plate 19 and the lower punch 7. Then, the revolving table will bring again the punch 7 along with the plate 19, to a position below the suction-cup 88, shown in figure 7, preparatory to the start of a next cycle.

As already explained herein above, the automatic cycle of this rotary table press 6 comprises, for each upper pressing punch, at least two or three movable lower punches 7 which, depending on their respective positions, ensure execution of the different steps of the above-mentioned cycle in a simultaneous manner, so as to reduce the times of execution while speeding up production of this press to a maximum.

Other modes of operation are conceivable for accomodation to an unrestricted range of products that this invention enables to obtain in a thoroughly satisfactory manner

by making, each time, proper provision for each individual piece concerned.

CLAIMS

1. A press having a vertical or inclined axis, for the production by a dry process using suitable flowing powders, of parts or pieces of any shape, profile, depth, thickness and size requiring for the industrial processing thereof a pre-shaping step with moderate expenditure of force, an intermediate pressure and a final high pressure compaction as used in making plates, cups, vases, ordinary tiles and special tiles having irregular opposing faces, shaped metal or light-alloy small parts and the like, wherein use is made of at least one combination device which provides, inter alia, for supplying a flowing powder to be pressed, through a movable, horizontal obturator plate having holes properly provided at different points on the surface thereof, in cooperation with an underlying stationary, horizontal support plate attached to at least one counter-punch reproducing the profile of a side of a piece to be pressed, the two latter elements being both provided with vertical, axially registering holes corresponding with the holes in said movable perforated obturator the position of which is properly controlled, each time, by suitable opposed actuators that cause the upper holes to be brought into, or out of register with the underlying holes to allow or shut off passage of a powder caused to vertically run, by gravity or under high vacuum, from at least one upper chamber of said combination device into a lower corresponding chamber that is formed by said counter-punch, on the one hand, and, on the other hand, by a respective underlying movable punch, in such a manner that, upon filling of said lower chamber, this arrangement give rise to a pre-shaping of the still soft piece to be pressed, whereupon the pre-shaped piece is, still by means of said combination device,

under action of suitable hydropneumatic actuators mechanically connected to said counter-punch, through said counter-punch and against opposition of said underlying lower movable punch, subjected to such a pressure as to permit, in combination, a deaeration of the powder together with a precompaction or precompression thereof so as to give the piece a compactness and toughness allowing for it, once having been released, at the top, from the combination powder-supplying and precompressing device, to be transferred without undergoing damage or change, by means of said lower movable punch on which the piece is resting, to a position beneath an overlying isostatic or semi-rigid type of pressing punch, said pressing punch being suitably operated by hydromechanical means to which it is connected and which also ensures, in cooperation with the tough structure of the press, a counter-reaction at the time when the piece undergoes final pressing; said final pressing being effected by said upper punch in cooperation with said lower movable punch which, upon this operation being completed, is conveyed, with the pressed piece carried thereon, to a station where picking-up, discharging and finishing of the piece take place, at any rate, to a position corresponding to a starting position for a next cycle.

2. The press according to claim 1, wherein it includes a base-plate supporting a revolving table which is actuated intermittently by means of a conventional type of cam device and which has at least three movable lower punches arranged in equally spaced apart relationship thereon, said movable lower punches being able, at each operation of the revolving table, to be simultaneously moved such that a first one of them is positioned beneath the combination preforming and precompressing device; a second one

beneath the upper pressing punch that is of the isostatic type or, as an alternative, of the rigid type provided with an elastic skull-like, self-cleaning covering; and a third one beneath a suction-cup arm designed to carry a pressed piece away and anchored to the baseplate of the press, said base-plate having at least two side-column or-uprights extending upwardly therefrom, which columns or uprights serve as supports to a stationary upper cross member which carries the hydromechanical means provided for operation in cooperation with the upper pressing punch of the isostatic type or, as an alternative, of the rigid type provided with said covering.

3. The press according to the preceding claims, wherein, as an alternative to the rotary table of low productivity, said press includes a roundabout of lower movable punches which, as designed for sets of three or four pieces differing in shape and size from one another, and connected by proper mechanical linkages, are in turn conveyed, through belt and roll means, to beneath the corresponding combination preshaping and precompressing devices; wherein, upon said pre-shaping and precompressing operation being completed, said set of punches is, again by belt and roll means, aligned with, and suitably positioned in front of, an electro-hydraulic ram that will cause said set of punch to be placed, in a self-aligned manner, below a cross-slide supporting the upper pressing punches, which upper pressing punches differ from each other but are made to matchingly fit, individually, the lower, underlying punches; and wherein, when pressing operation has been performed, said movable lower punches are pushed forwardly, together with their pressed pieces, by the same action of

the electrohydraulic ram as that corresponding to the setting in place of a next set of movable lower punches carrying the respective pre-shaped and precompressed pieces to be pressed, while the already pressed pieces resting on the lower movable punches having just been removed from beneath the cross-slide, are picked-up by a corresponding number of suction-cups to be moved to a finishing machine arranged alongside the press, and the individual lower movable punches, now free from pieces are again conveyed, by belt and roll means, to a position beneath the combination pre-shaping and precompressing devices to repeat an automatic production cycle in the same manner as described above.

4. The press according to the preceding claims, wherein each combination powder pre-shaping and precompressing device individually includes a positioning system attached to the press structure and vertically adjustable by screw, nut and guide means, for individually positioning each said device so that it is placed at a proper distance with respect to a movable lower punch which may differ in shape, depth and size each time.

5. The press according to the preceding claims, wherein each said individual combination preshaping and precompressing device attached to said vertically adjustable positioning system, includes at least one hydropneumatic cylinder within which a double acting, adjustable stroke, annular piston can slide to control the down stroke of a second double acting piston whose piston rod, that passes through said annular piston, is attached to at least one housing to which a powder

to be pressed is admitted, which powder is in turn caused to run, through said purposely provided holes, into said lower chamber that is formed by said counterpunch in cooperation with a corresponding lower movable punch, said combination of the adjustable stroke annular piston and the double acting piston permitting this latter to perform a precise repeating down stroke corresponding each time to a desired thickness of the soft material concerned and, thus, to the thickness of a finished piece, said thickness of the soft material being able to be changed, in accordance with changes in the type of product to be obtained, by adjusting, each time, said adjustable stroke of said annular piston.

6. The press according to the preceding claims, wherein the lower movable punch, preferably made of steel, is provided with a skull-like semirigid and shaped covering snughly fitting thereto, whose periphery is bonded to, or, at any rate, firmly retained against the underlying steel punch which has holes provided therein, which holes open beneath the skull-like covering to permit this latter to blow-out or swell by air pressure that will exert, at a given time, a counter-pressure on the powder to be pressed such that pre-compaction of said powder, under cooperating action of the matching counter-punch, is facilitated.

7. The press according to the preceding claims, wherein the lower movable punches may, during filling step, through appropriate semi-rigid connecting means, be subjected to an axially directed vibration from a conventional type of vibrating means (not shown) so as to improve filling of the powder to be pre-compressed.

8. The press according to the preceding claims, wherein both the pressing punch and the lower movable punch are peripherally greater in size than the individual pieces to be produced to allow for the protruding opposed surfaces of said elements to be directly in contact with one another under maximum urging effect exerted thereon at the time of pressing, thus preventing undesirable formation of peripheral burrs.

9. The press according to the preceding claims, wherein said press enables to simultaneously produce one or more pieces having shapes, surfaces and sizes that differ from one another to a given extent, while ensuring that a specific, precise and uniform pressure is applied on the entire surface of each piece through each individual upper isostatic pressing punch.

10. The press according to the preceding claims, wherein, by one and the same combination preshaping and precompressing device, said press enables to produce flat, shallow pieces as well as cylindrical or truncated-cone-shaped pieces having substantially upright sides perpendicular to a bottom thereof, by merely substituting the housing inside which the obturator, the support plate and the corresponding counter-punch of self-cleaning material are located, the assembly being properly provided with perforations to suit to requirements for each individual piece concerned.

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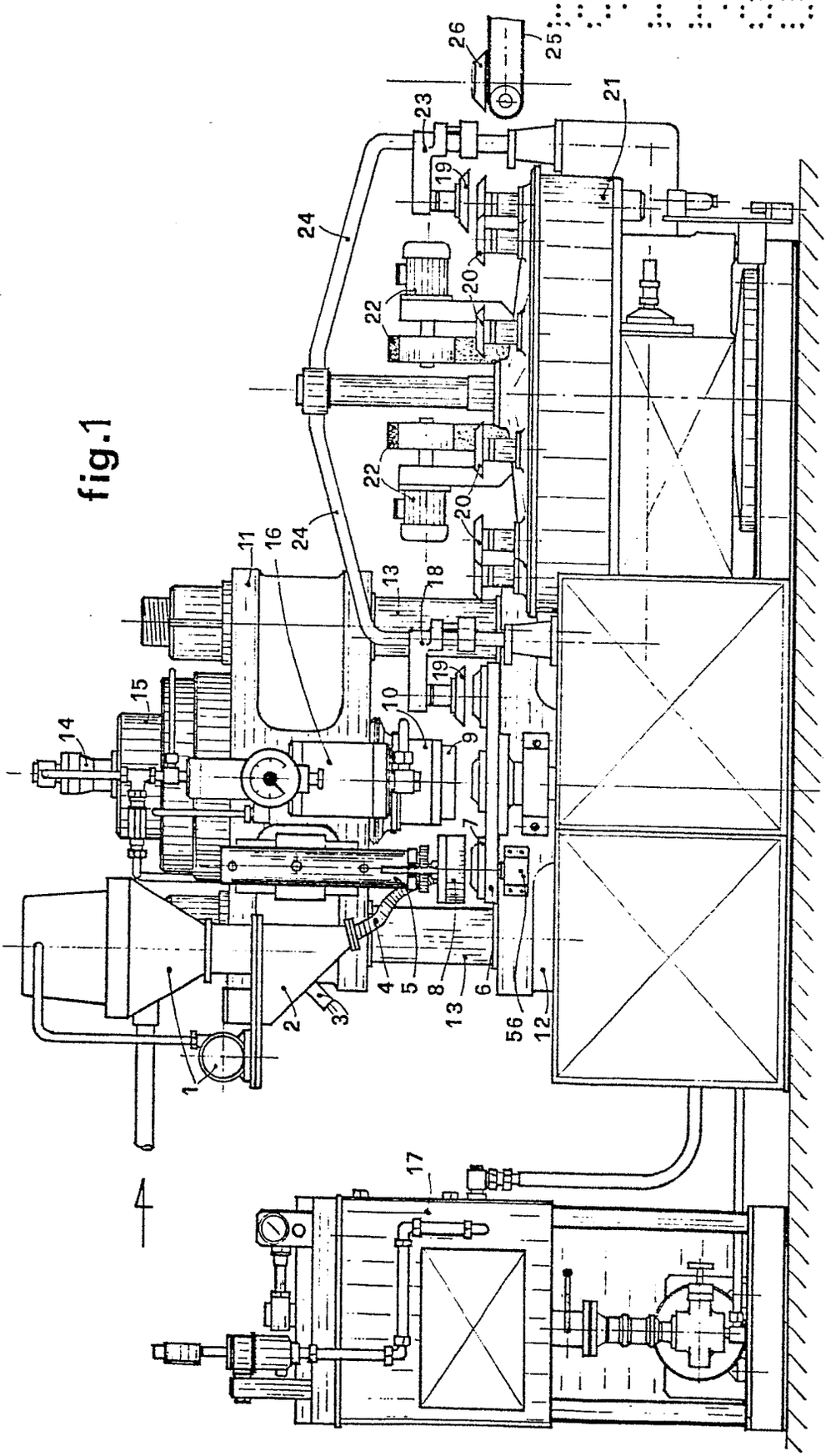

fig.1

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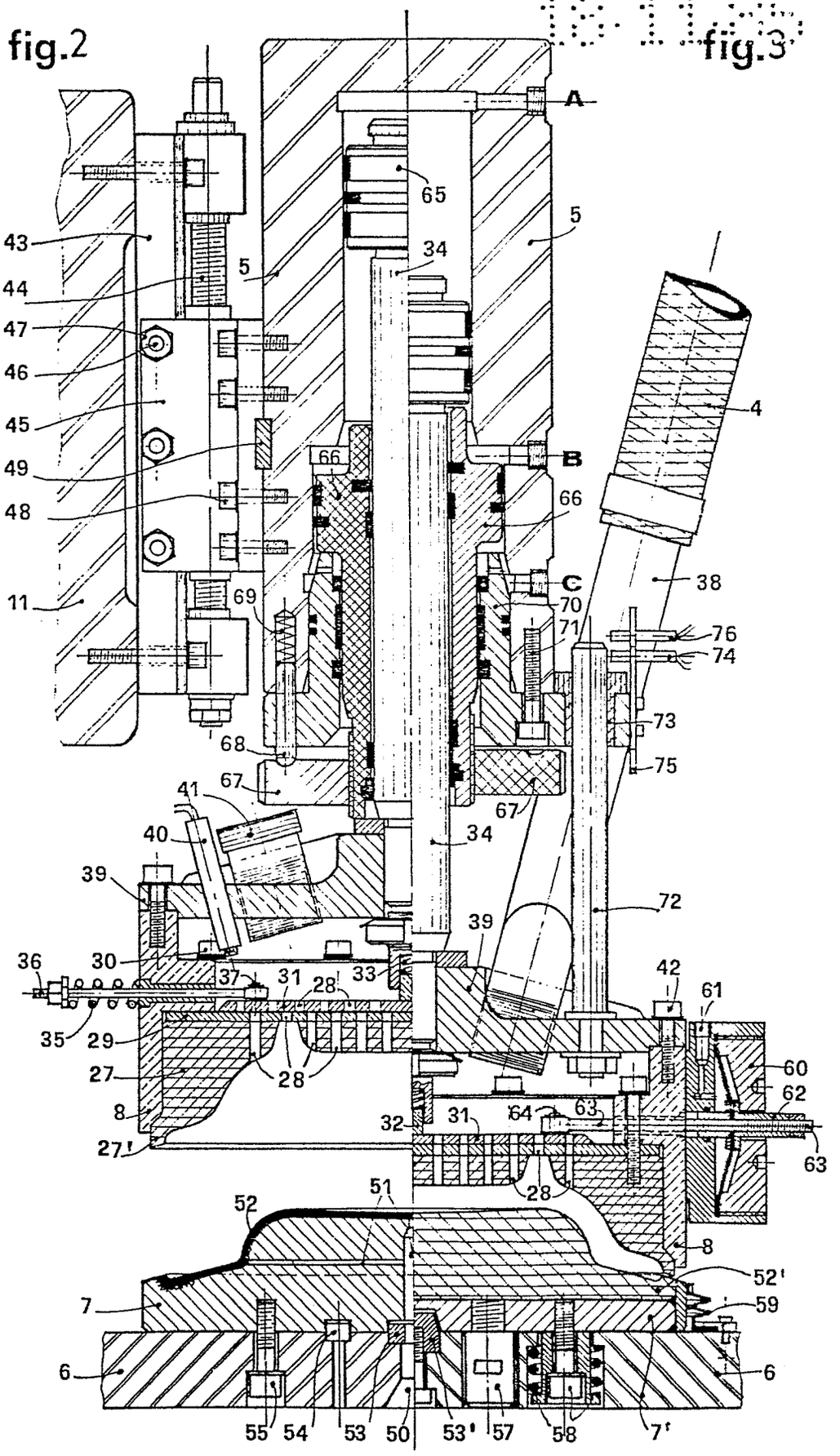
fig.2

fig.3



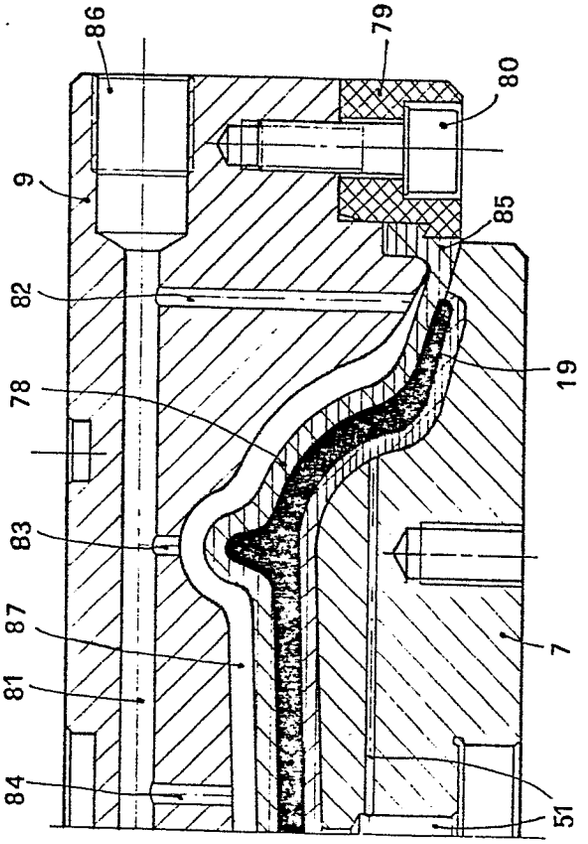


fig.5

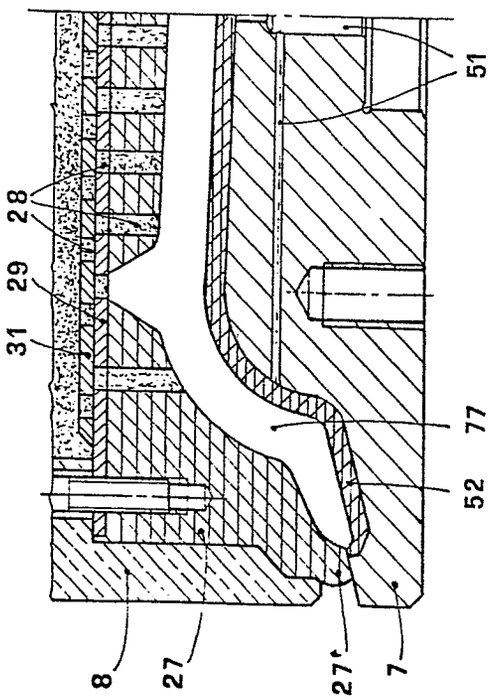


fig.4

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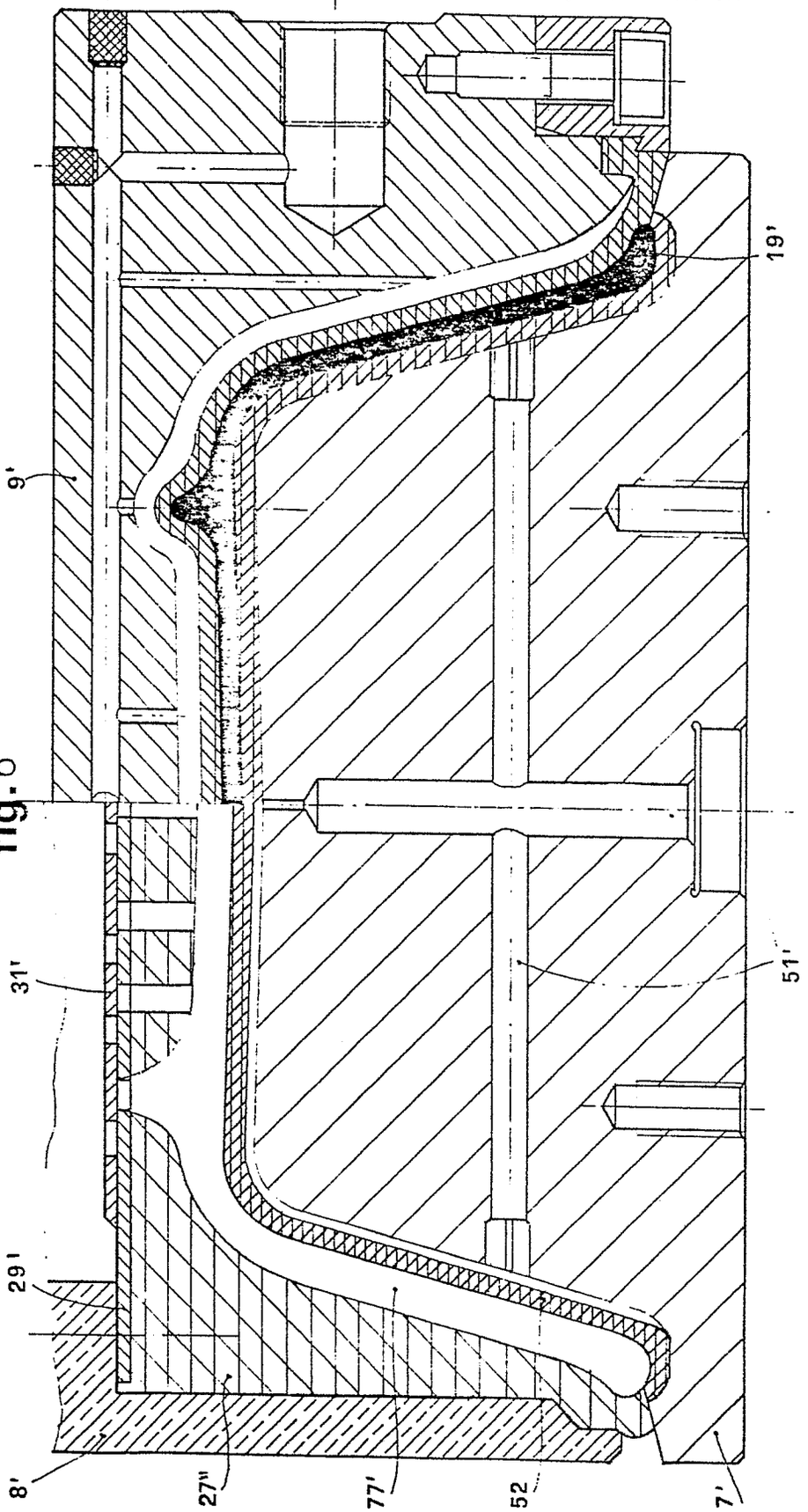

fig. 6

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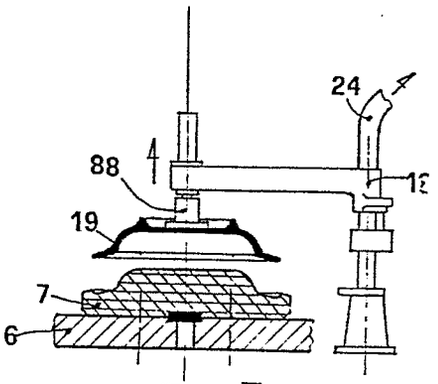

FIG 7

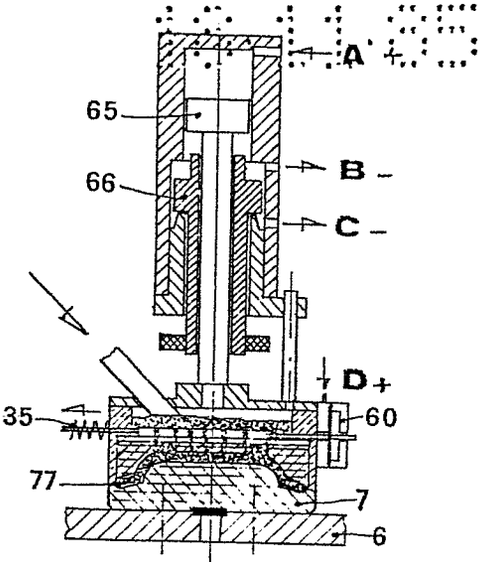

FIG 10

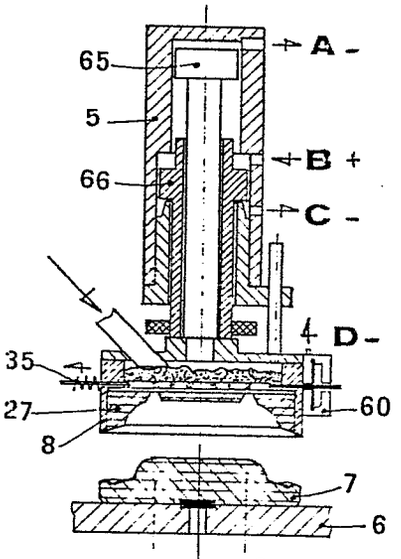

FIG 8

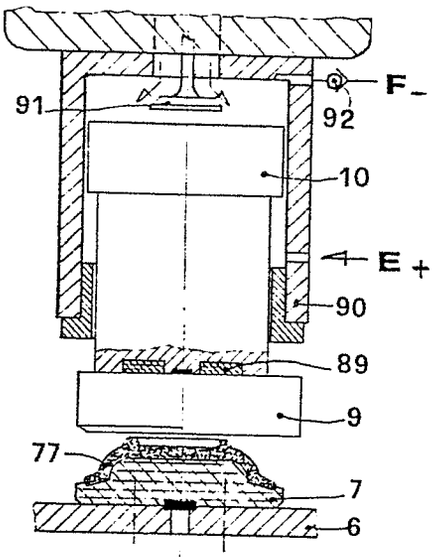

FIG 11

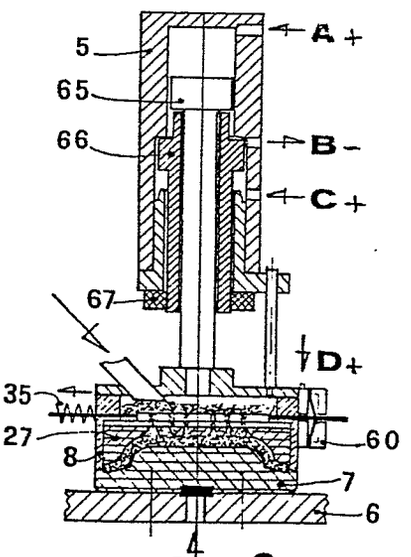

FIG 9

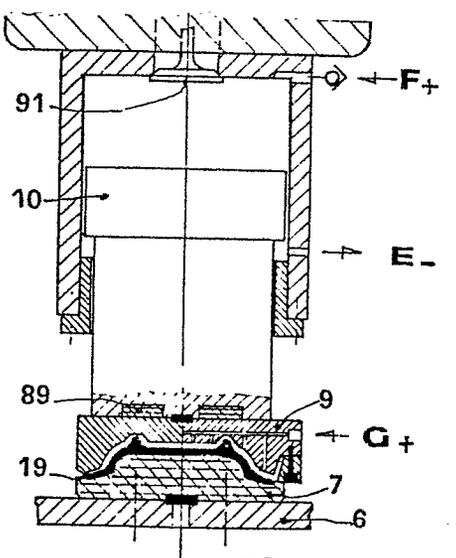

FIG 12

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Application number

EP 85 83 0252

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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl 4)
Y	FR-E- 63 296 (R. DUFRENNE) * Whole document *	1,2,7	B 30 B 11/00 B 30 B 11/10 B 28 B 5/08 B 28 B 5/04
Y	DE-C- 126 374 (BERLINER SPECIALMASCHINEN-FABRIK ALTMANN & WAGNER) * Page 1, lines 54-67; page 2, lines 38-55; figures 1-4 *	1,2,7	
A	FR-A-2 475 971 (VE WISSENSCHAFTLICH-TECHNISCHER BETRIEB KERAMIK) * Whole document *	1,2,5, 10	
A	DE-C- 194 739 (W. SURMANN) * Whole document *	1,2	
A	DE-C- 441 515 (P. WERNICKE) * Whole document *	1	TECHNICAL FIELDS SEARCHED (Int. Cl 4) B 22 F B 28 B B 30 B
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A	DE-A-1 604 492 (DORST-KERAMIKMASCHINENBAU) * Whole document *	1,6,10	

-/-

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	12-06-1986	GOURIER P.A.

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A	US-A-2 409 221 (W.J. MILLER) * Whole document * ---	1,3,4, 9,10	
A	GB-A-2 064 417 (LAEIS-WERKE AG) * Page 1, lines 1-115; page 2, lines 26-59; figures 1-4 * -----	6,8	

TECHNICAL FIELDS SEARCHED (Int Cl 4)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	12-06-1986	GOURIER P.A.

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