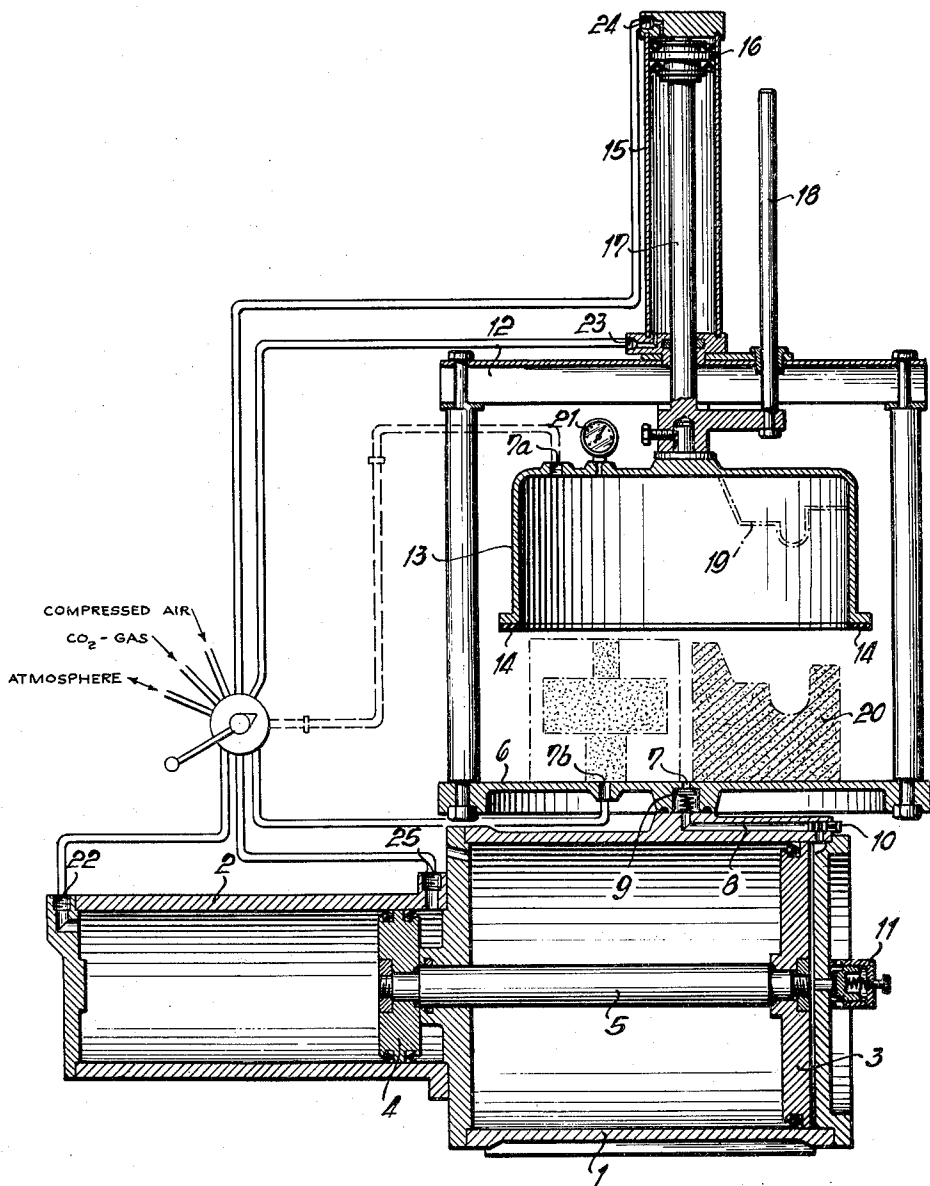


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 DEVICE FOR HARDENING FOUNDRY CORES AND FOUNDRY
 MOULDS BY MEANS OF GASEOUS OR ATOMIZED
 REAGENTS, PARTICULARLY CO₂ GAS
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ATTORNEYS

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DEVICE FOR HARDENING FOUNDRY CORES AND FOUNDRY MOULDS BY MEANS OF GASEOUS OR ATOMIZED REAGENTS, PARTICULARLY CO₂ GAS

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This invention relates to a device for hardening setting sands or the like in producing foundry cores and foundry moulds by means of gaseous or atomized chemical reagents, in particular by means of CO₂ gas.

The hardening of setting sands by the introduction of CO₂ is based on the chemical reaction of a bonding agent consisting mostly of water glass, Na₂SiO₃·xH₂O, with carbon dioxide. For this purpose cold dried quartz sand is used with which 4–5% of a bonding agent is mixed. After filling the core box the core is "set" by introducing CO₂. The period for which the introduction of CO₂ is continued depends on the size and shape of the core. After the hardening process the core is taken out of the core box. It can then be immediately used for casting thus avoiding any drying process. A further advantage is that the finished core and sand mixture, because of the fluidity of the bonding agent, has very good flow properties, so that intricate cores can be produced by machine methods, in particular by shooting. The core is accurately dimensioned, while with intricate cores drying pans are not required as the drying of the core is dispensed with and core irons are not used.

However the drawback of the CO₂ process is its high cost. This is mainly due to the heavy consumption of CO₂ and also the laborious and time-consuming process of carrying out the hardening, due to the manual labour involved.

Originally, in carrying out the CO₂ process the method was that a sprinkler, simply connected to a CO₂ cylinder by means of a long flexible pipe, was merely held over the sand feed aperture from box to box, and the operator then waited until the CO₂ gas penetrated the sand in the box. With such a mode of operation naturally a large quantity of CO₂ is lost, particularly in the spraying process. These losses are especially high in proportion to the size of the core when it is a matter of hardening small cores.

To cut down the loss of CO₂ gas and to accelerate the hardening process automatic hardening devices are known which work with a time switch mechanism and introduce the CO₂ gas into the core boxes under pressure. But here again with these automatic hardening devices the consumption of gaseous reagents and the hardening time are still too great, since it is always necessary to operate with an excess of, for instance, CO₂ gas, in order to ensure that the reagent does actually penetrate and harden the whole of the core or mould to be hardened.

Operators have therefore been led to carry out the hardening of the cores or moulds in a vacuum chamber, in which the core or mould to be hardened is first subjected to an underpressure and then to the action of the hardening agent. The creation of a considerable underpressure results in the air enclosed in the porous cores or moulds being thoroughly removed, so that after this the CO₂ gas acting at an overpressure of about 1.2 atmospheres gauge pressure is better able to penetrate the setting sand and fully harden the core or mould.

Hardening devices of this type, working on the vacuum principle, have a treatment chamber, which, for each cycle of the process has to be fully packed on each occasion with the setting sand cores or moulds or the like to be

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hardened. In this connection it is known to construct the treatment chamber with a side opening, the cover of which can be swung up and a stack of the cores or moulds to be hardened inserted in the chamber from the side, and then withdrawn in the same manner when the hardening process is finished. It is also known to form the treatment chamber as a trough-shaped vessel provided with a trough lid which can be removed vertically, on whose underside is suspended a perforated box type frame, in which the cores or moulds to be hardened are stacked and then by lowering the trough lid lowered into the treatment trough for carrying out the hardening process. The treatment chamber, more or less completely packed with the cores or moulds is next evacuated by means of a conventional small vacuum pump and then subjected to an overpressure of CO₂ gas, which can be repeated several times. In order to accelerate the evacuation and to reduce the consumption of CO₂ gas it is usual to fill up the dead spaces remaining when the treatment chamber is being fully packed, by suitable wooden blocks. This is particularly necessary when the cores or moulds cannot be stacked, for example because of their intricate structure, and have to be treated individually.

Such a method of handling is however too laborious and time-consuming and hence unsuitable for mass production.

The present invention has for its object to obviate as far as possible these drawbacks and to offer a device which not only possesses special advantages in handling, and because of the very restricted consumption of CO₂ made possible with the device according to the invention renders possible for the first time an economic CO₂/vacuum process.

It is a further object of the invention to provide a method of hardening setting sand by means of gaseous or atomized liquid reagents in mass production.

The device, according to the invention, for hardening foundry cores and foundry moulds by means of gaseous or atomized reagents, in particular CO₂ gas, which in known manner has a vacuum chamber, in which the cores or moulds to be hardened are first subjected to an underpressure and then to the action of the hardening agent, is characterized in that it possesses for the purpose of producing the vacuum a suction cylinder with a large suction volume, in which is displaceable a suction piston with a large surface area. This makes it possible to evacuate the chamber-like vacuum space abruptly, which, by comparison with the known treatment chambers fitted with the normal vacuum pumps results in a considerable saving of time, considerably simplifying the construction of the hardening device and rendering it suitable for the rougher classes of foundrywork. The hardening device preferably includes, for the production of the vacuum, two cylinders with a double piston which can move therein, preferably on a horizontal axis, one cylinder of which acts as a suction cylinder and the other cylinder as a working cylinder. The working piston and the working cylinder, which may work without difficulty pneumatically with the compressed air available in any foundry of not more than 6 atmospheres gauge pressure, are preferably smaller in diameter than the suction piston and the suction cylinder with the object of minimizing the consumption of compressed air.

According to another embodiment of the invention the suction cylinder or the two cylinders are enclosed in the machine frame of the hardening device or form the machine frame substantially in the form of a base frame or a machine base. In this way the suction cylinder or the two cylinders can form a support table, when it is a case of the hardening device having one of these with a vacuum dome, which is inverted over the cores or moulds

to be hardened and is fitted at its application edge with a sealing joint. In this case the support table may have one or more connecting bores for the suction and/or readmission of air and/or for the feed of the hardening agent into the dome.

It is preferable to make the suction cylinder and the suction piston of a material resistant to the hardening agent, particularly of hard rubber, synthetic plastic material or ceramic material. This is easily possible as the suction cylinder only has to withstand a pressure of about 1 atmosphere gauge pressure.

According to a further embodiment of the invention the suction cylinder has a spring-loaded discharge valve, the closure force of whose closing spring is adjustable. This has the advantage that after the ejection of the original atmosphere air sucked out of the vacuum chamber a given residual pressure can be maintained in the dead space of the suction cylinder, which prevents the in-flow of the CO₂ gas or the like fed into the treatment chamber into the suction cylinder. With the same object in view a spring-loaded non-return valve can be arranged in the suction pipe (in which an air filter is preferably provided) leading from the vacuum chamber to the suction cylinder. In this connection it is arranged to make the closure force of the closing springs of the discharge valve and of the non-return valve added together greater than the overpressure of the hardening agent prevailing in the vacuum chamber during the hardening of the cores or moulds.

The accompanying drawing shows diagrammatically a specific example of an embodiment of the hardening device in accordance with the invention.

Referring to the drawing, the base frame or machine base consists of two cylinders 1 and 2, in which a twin piston consisting of two pistons 3 and 4 is horizontally displaceable. The larger cylinder 1 is a suction cylinder with a large suction volume and large-surface suction piston 3, while the smaller piston cylinder 2 is a working cylinder with a working piston 4 of smaller cross-sectional area. The two pistons 3 and 4 are connected by a piston rod 5. The suction cylinder 1 supports a support table 6, in which is arranged a suction nozzle 7, which is connected with the suction side of the suction cylinder 1 by means of a suction pipe 8. In the suction pipe 8 is arranged a non-return valve 9 and also an air filter 10. At the head end of the suction cylinder 1 is provided an ejection valve 11, the closure pressure of whose closing spring is adjustable.

Above the support table 6 is located a vacuum dome 13 on a holding frame 12, which dome has a sealing member 14 at its lower application edge. The vacuum dome is held by a lifting device, consisting of a lifting cylinder 15 with a lifting piston 16 vertically movable therein, to whose piston rod 17 the vacuum dome 13 is interchangeably fixed. A guide rod 18 prevents any twisting of the vacuum dome 13 during its descent and ascent. On the right of the drawing is indicated in chain line how the inner wall 19 of the vacuum dome 13 can be adapted to the surface contours of the core or mould 20 to be hardened. Here the vacuum dome 13 has a measuring appliance 21 for indicating the underpressure or overpressure prevailing in it after it is lowered. There is also provided in the vacuum dome 13 a connecting bore 7a for the introduction of CO₂ gas and the subsequent readmission of atmospheric air, although instead of this there may be provided an equivalent connecting bore 7b in the support table 6.

The hardening device is operated as follows: Through a central control valve (not shown) compressed air is fed, at a pressure of 6 atmospheres gauge pressure, for example, to the connecting bore 22 of the working cylinder 2, which moves the working piston 4 and hence the suction piston 3 to the right and thus presses the air present in the suction cylinder 1 through the adjustable ejection valve 11 into the free air. Simultaneously com-

pressed air is fed from the central control valve to the lifting cylinder 15 through the feed channel 23, and moves the lifting piston 16 and hence the vacuum dome 13 fixed to its piston rod 17 upwards. The hardening device is thus made ready for the first working cycle. The cores or moulds of setting sand to be hardened are now either placed in the core box, as shown on the left in chain line, or laid freely, as shown in chain line on the right, on the support table 6. By further actuation of the central control valve (not shown), air is vented from the pipe 23 of the lifting cylinder 15, so that the vacuum dome is lowered and inverted over the core or mould to be hardened. As soon as the vacuum dome 13 comes to rest with its sealing member 14 provided at its lower edge, which member may consist for instance of rubber or any other suitable material, on the support table 6, the central control valve is adjusted to feed compressed air to the lifting cylinder 15 through the upper connecting channel 24, in which connection the lifting piston 16 now acts as a pressure piston and presses the vacuum dome 13 firmly so as to be fluidtight on the support table 6. The dome 13 then forms together with the plane surface of the support table 6 an airtight and gastight treatment chamber, in which are located the cores or moulds to be hardened.

By further actuation of the central control valve, which may also work automatically by means, for example, of a time switch mechanism, compressed air is now fed to the other air connection 25 of the working cylinder 2 and simultaneously its connecting pipe 22 is vented. The compressed air, for instance under an overpressure of 6 atmospheres gauge pressure, then drives the working piston 4 abruptly into its left dead centre position. Because of the construction as a twin piston the suction piston 3 is thereby also moved abruptly towards the left. The underpressure thereby rapidly arising in the suction cylinder 1 causes a speedy evacuation of the interior 13 of the dome, the atmospheric air located therein flowing off through the non-return valve 9 and an air filter 10 provided in the suction pipe 8 into the suction cylinder 1, which has for this purpose a large suction capacity, which is here a multiple of the dome capacity. The result of the vacuum forming in the dome is that the atmospheric air adhering in the pores of the core or mould is sucked out and sucked off with the other air into the suction cylinder 1.

By further actuation of the central control valve the connection 25 of the working cylinder 2 is now vented and compressed air admitted through the connection 22, which drives the twin pistons 4—5—3 to the right and presses the sucked-off air present in the suction cylinder 1 now that the non-return valve 9 is closed, over the adjustable closure spring pressure of the discharge valve 11 into the free air. The residual pressure remaining in the dead space of the suction cylinder 1 and in the suction pipe 8 assist the closure force of the non-return valve 9, while simultaneously the vacuum dome 13 is supplied interiorly with CO₂ gas at an overpressure of, for example, 0.8 atmospheres gauge pressure. The CO₂ gas thereby penetrates the pores (evacuated of atmospheric air) of the core or mould, and hardens the core or mould completely in a few seconds.

When the requisite hardening time has expired the feed of CO₂ gas is cut-off the connecting pipe 24 of the lifting cylinder 15 is vented and the lifting piston acted on with compressed air through the feedpipe 23, whereby the vacuum dome 13 is lifted from the support table 6. The finished hardened cores or moulds can then be removed from the support table 6, after which the hardening device is then ready for the next working cycle.

I claim:

1. In an apparatus for hardening molded foundry cores and molds by first evacuating the molds and cores in a vacuum chamber to liberate air inclusions in said cores and molds, then subjecting the evacuated cores and molds

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in said chamber to the action of a gaseous hardening agent, vacuum pump means including cylinders disposed in tandem, a twin piston displaceable in said cylinders, one of said cylinders being a suction cylinder with a large suction capacity in response to a short piston stroke and means coacting with the other cylinder for selectively reciprocating the pistons therein, a wall of one of said cylinders constituting a support frame, a support table for said cores and molds having an opening therein mounted on said wall, a bell chamber movably mounted on said table and facing said table with its open side, a sealing means at the rim of said bell chamber engageable with said table in sealing arrangement, conduit means including valve means connecting the suction side of said suction cylinder to the bell chamber through said opening, said valve means being responsive to pressure in said cylinder for controlling the periods said cylinder is open to said bell chamber, venting valve means, including spring means for biasing said valve means in a closed position, secured to another wall of said suction cylinder and responsive to the direction in which said pistons are displaced for ejecting air from said cylinder, and drive means for moving said bell chamber up and down in reference to the table.

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2. An apparatus according to claim 1 wherein said support table is mounted on said suction cylinder.

3. An apparatus according to claim 2 wherein said table is supported in a horizontal position on said wall of the suction cylinder.

4. An apparatus according to claim 1 wherein said cylinders are horizontally disposed, and said table is mounted on one of said walls of one of said cylinders.

5. An apparatus according to claim 1 wherein the air capacity of the suction cylinder is larger than that of the bell chamber and the diameter of the suction cylinder is approximately equal to the stroke length of the piston therein.

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