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SEMI-AUTOMATIC MACHINES FOR CHILL CASTING
HOLLOW PARTS SUCH AS PISTONS
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Fig-1

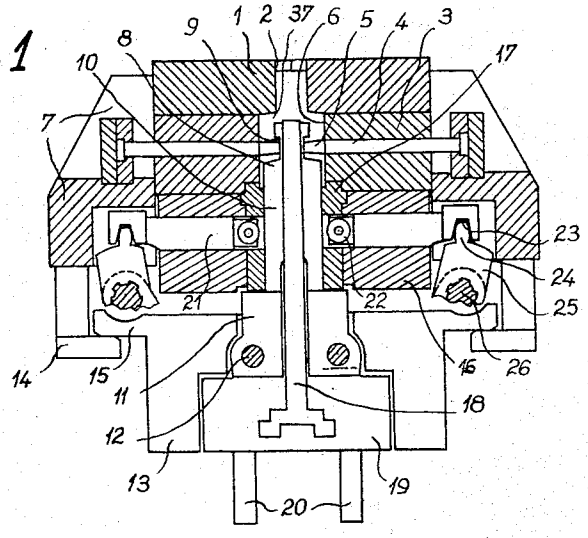
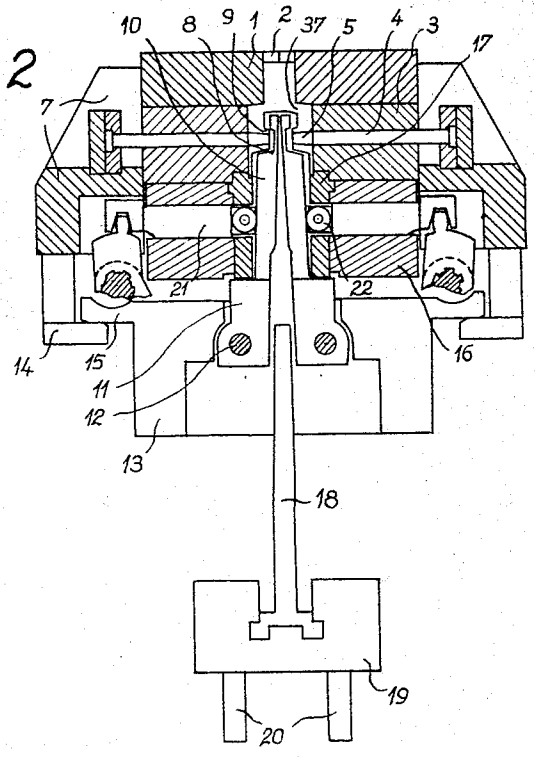


Fig-2



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Fig-3

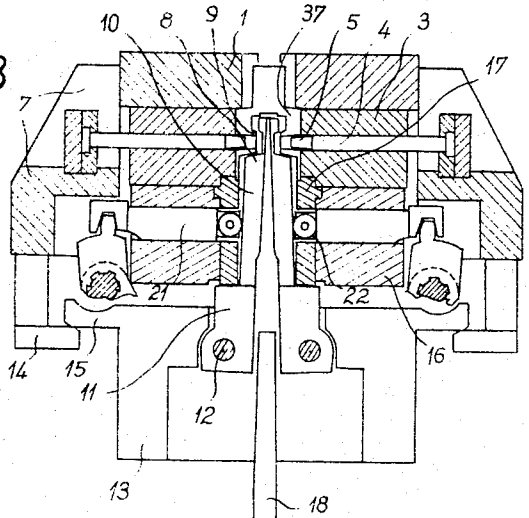
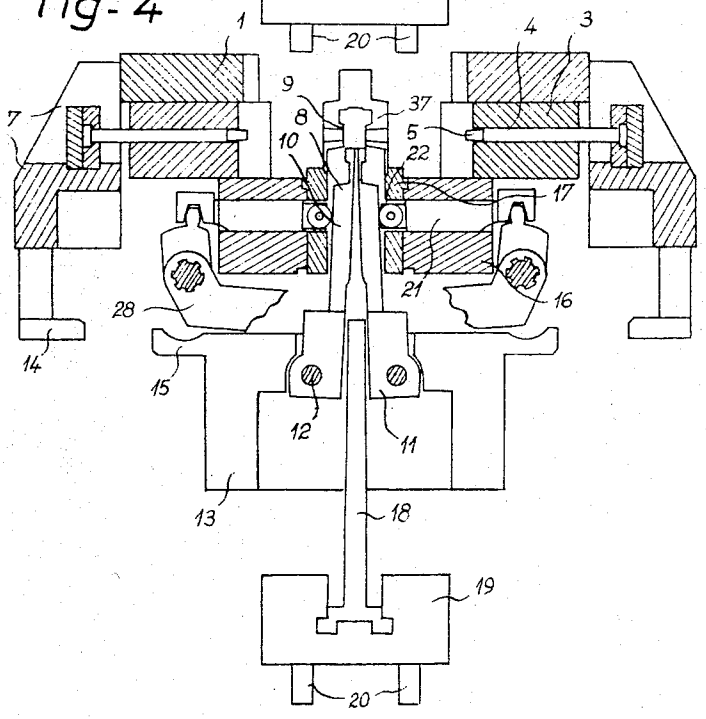


Fig-4



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HOLLOW PARTS SUCH AS PISTONS
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Fig. 5

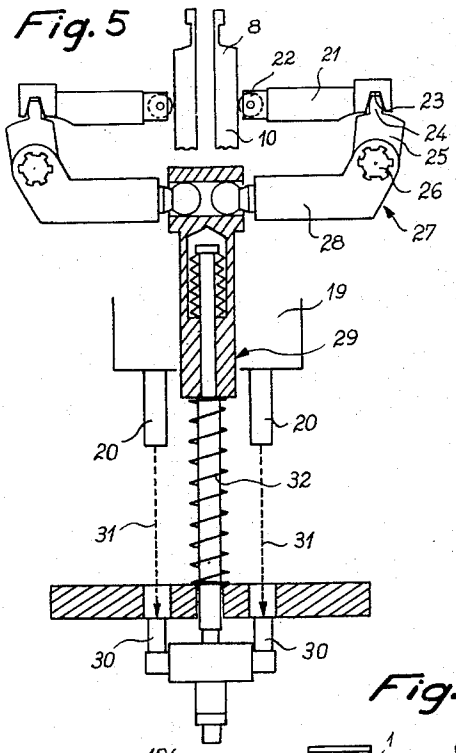


Fig. 6

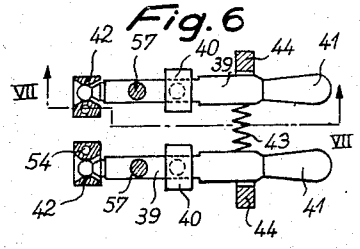


Fig. 7

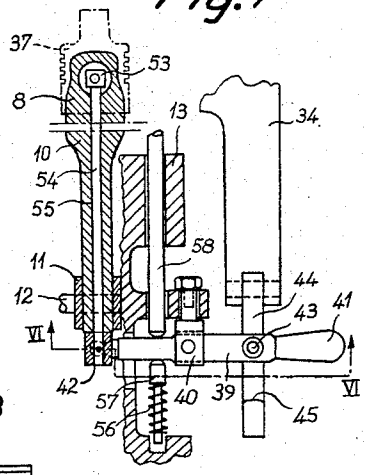
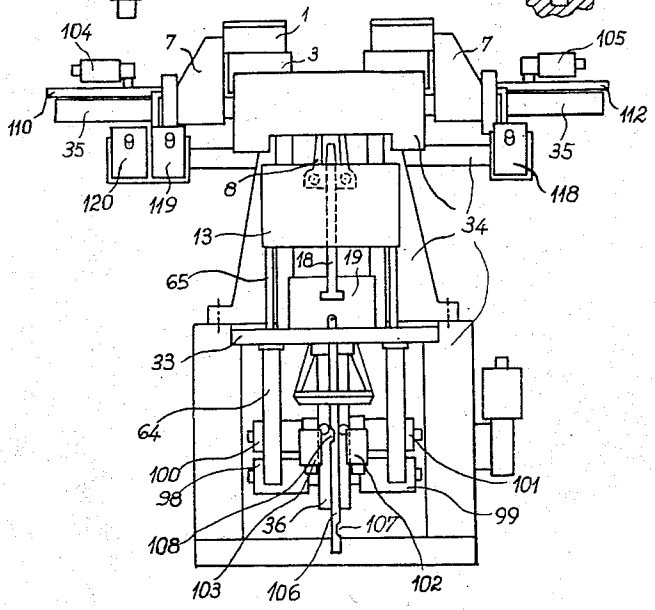


Fig. 8



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Fig. 9

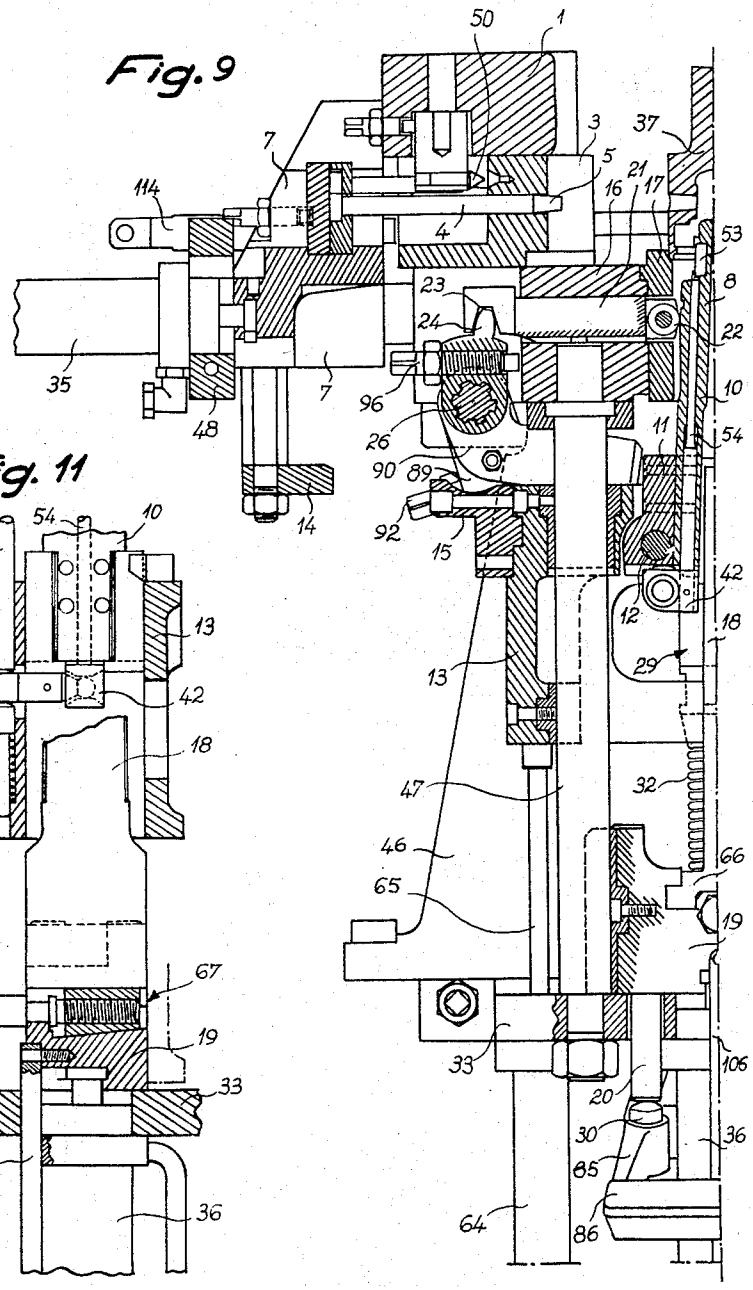


Fig. 11

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Fig. 10

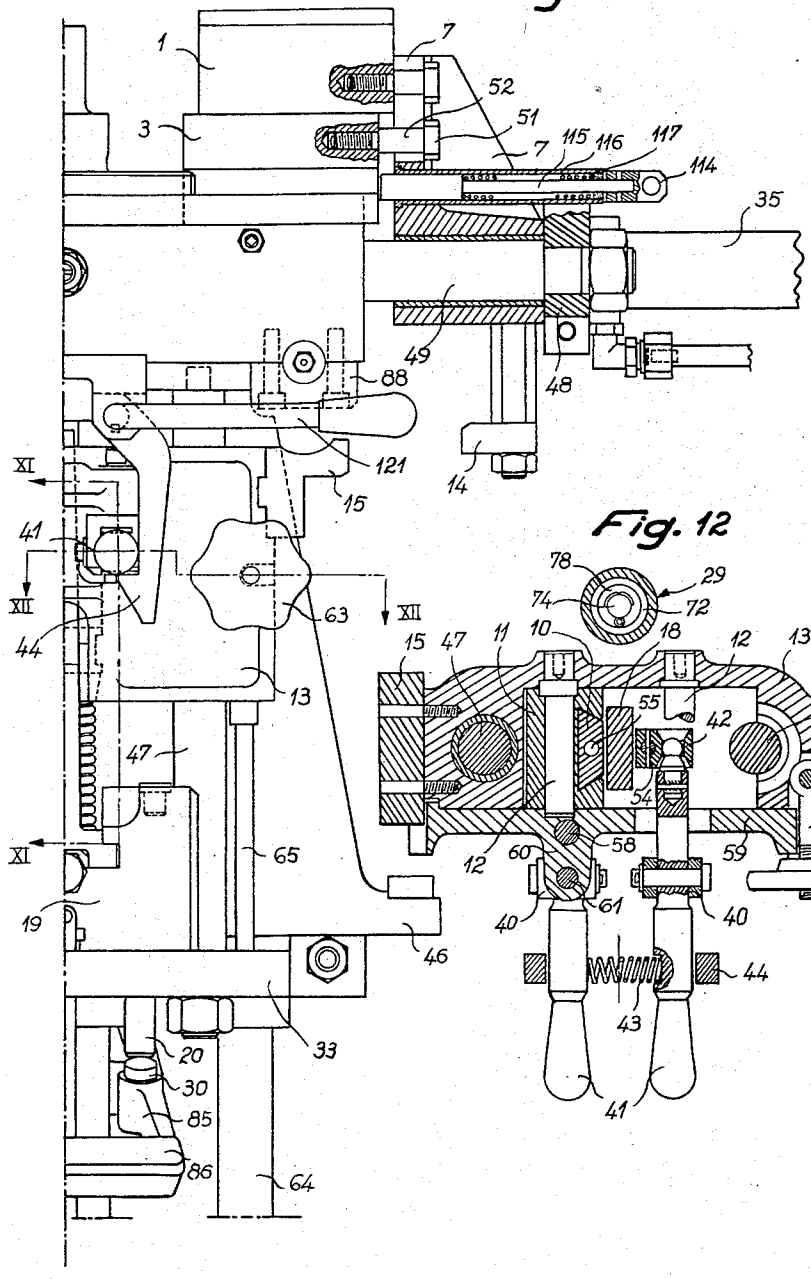
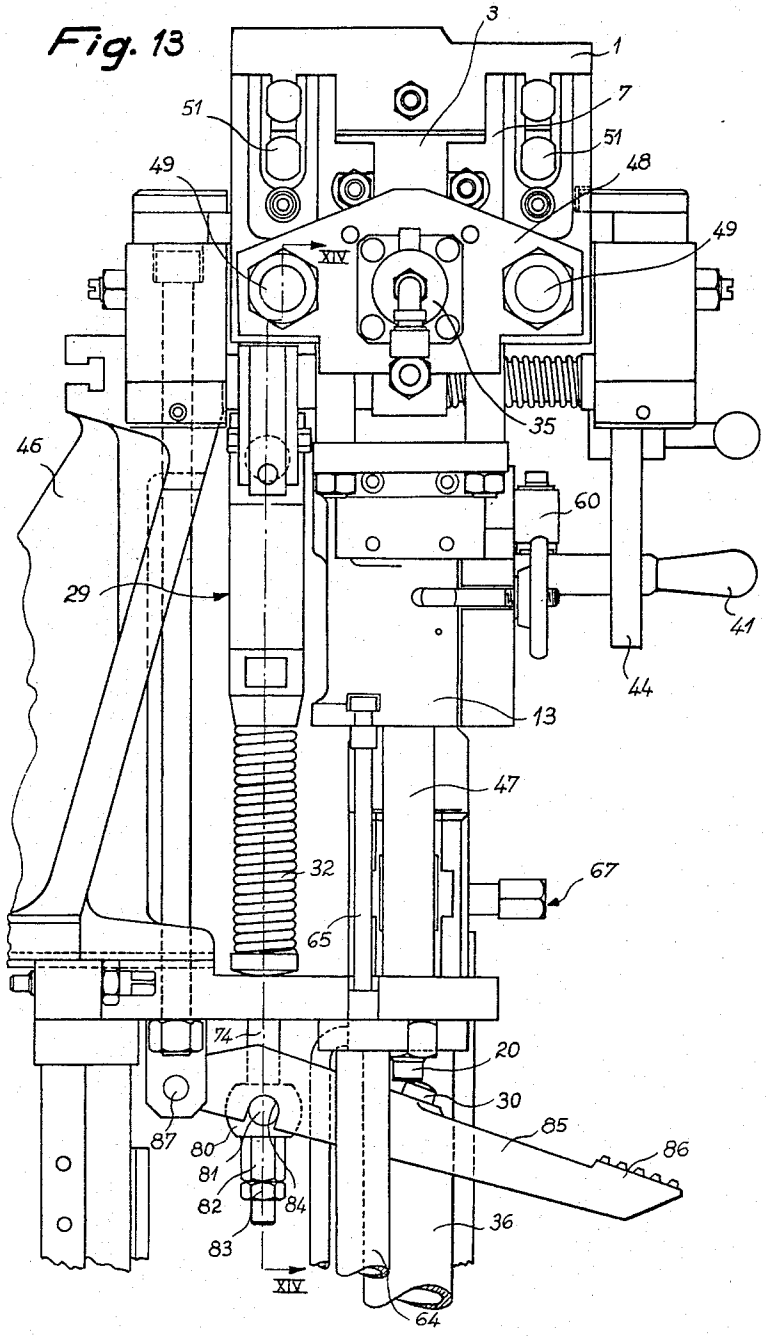


Fig. 12

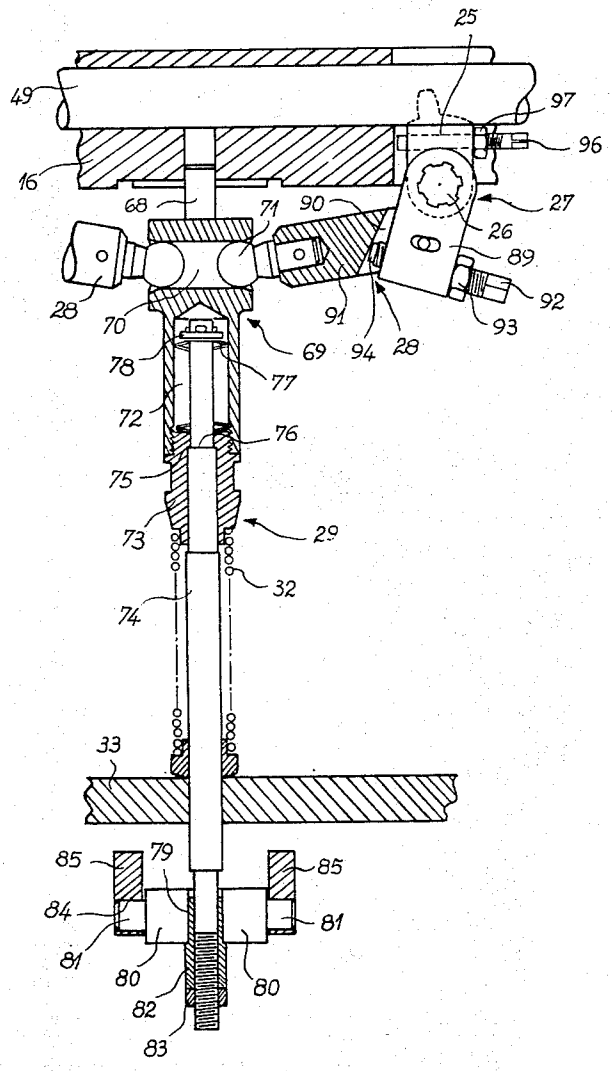
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Fig. 13



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Fig. 14



United States Patent Office 3,283,374 Patented Nov. 8, 1966

3,283,374

SEMI-AUTOMATIC MACHINES FOR CHILL CASTING HOLLOW PARTS SUCH AS PISTONS

Lucien Péras, Billancourt, France, assignor to Regie Nationale des Usines Renault, Billancourt, France, a French works

Filed Mar. 30, 1964, Ser. No. 355,729
Claims priority, application France, Apr. 5, 1963, 930,654
8 Claims. (Cl. 22—93)

This invention relates to semi-automatic machines for chill casting parts comprising a cavity which embodies a narrowed portion requiring the use of a core consisting of a plurality of movable core elements. The latter are held close together whereby to have a minimum cross-section during the stripping operation, and a mutually spaced position during the casting operation. For performing the latter operation a retractable key is inserted between the core elements and contributes therewith to the formation of a core whose outer shape matches that of the cavity it is desired to form within the casting. In such well known machines, closure and opening of the die, engagement and withdrawal of the key, spreading and contracting of the core elements, moving said elements into their operative position and completely or partially withdrawing the same, are all accomplished by means of as many reciprocating motion engendering power devices as there are components to be actuated.

Automatic or semi-automatic operation of the machine is obtained through the agency of actuating means triggered by synchronising or time-delaying devices.

Since the power devices are usually pneumatic actuators, consecutive operation thereof is controlled by electromagnetic valves of any convenient type controlled by limit or cam-operated microswitches.

These devices, however, have the disadvantage of requiring scrupulously correct adjustments which are difficult to make, of being fragile, of being prone to go out of adjustment to a considerable extent and of permitting only a comparatively slow production rate due to the multiplicity of actuators, electromagnetic valves and contacts, not to mention the added delay resulting from the time-lags involved in actuator and valve response.

The present invention considerably mitigates these drawbacks by enabling the number of power devices and control means thereof to be reduced. A machine according to this invention permits of operating the key, spreading, contracting, and inserting and withdrawing said care elements into and from the die, by means of a single actuator only, all the operations referred to precedingly being performed by purely mechanical direct-acting transmission means.

A semi-automatic machine according to this invention comprises movable core elements whose ends remote from the die are extended by an actuating heel. These elements are kept spread apart during the moulding operation and contracted toegther during the stripping operation. Mounted on a sliding key support is an extended retractable key adapted to be translated longitudinally of itself between a position wherein it is positively engaged between the core elements during casting and a position wherein it is retracted therefrom during stripping. A reciprocating actuator is fixed to the machine in such manner that its moving member be capable of operating on the key through the medium of the key support and of pushing it from its retracted position into its operatively engaged position. Essentially, such a machine is characterized by the fact that provision is made thereon for a device which, during operation of the machine, continuously urges said core elements towards their spread-open position. To each such element is assigned a bell-crank lever which is fulcrumed on the machine in such manner as to enable one of its arms to exert pressure on the actuating heel of the core element whereby to urge the same into the core contracting position when, on reaching the end of its retraction stroke, the key support exerts a force on the other lever arm through the medium of a draw-link common to all the bell-crank levers.

These and other features of the invention will become apparent from the description which follows, with reference to the accompanying non-limitative exemplary drawings, of a machine according to the invention adapted to the manufacture of internal combustion engine pistons.

Referring to the drawings filed herewith:

FIGURES 1 through 4 are schematic sectional illustrations of the die and the core with its key, in their respective consecutive positions during operation of the machine;

FIGURE 5 schematically illustrates the manner of operation of the mechanism for controlling the mutual contraction of the core elements;

FIGURES 6 and 7 schematically illustrates the device for spreading open the core elements;

FIGURE 8 is a front elevation view of the machine;

FIGURE 9 is a sectional side elevation view of the left half of the machine;

FIGURE 10 is a front elevation view of the right half of the machine;

FIGURE 11 shows in section through the line XI—XI of FIGURE 10 the core element spreading device and the key support;

FIGURE 12 shows in section through the line XII—XII of FIGURES 9 and 10 a core-bearing device;

FIGURE 13 is a sectional view of the left side of the machine; and

FIGURE 14 is a section taken through the line XIV—XIV of FIGURE 13, showing the mechanism for controlling contraction of the core elements.

In what follows, whenever reference is had to machine components comprising two parts which, though not identical, are similar and symmetrically disposed to either side of the symmetry plane of the machine, these two parts will invariably be designated by the same reference numeral.

Reference will first be had to FIGURES 1 through 8 for a description of the general principle underlying the machine according to the present invention.

FIGURE 1 shows the die without its actuators and control members, the core and the core-bearing device, the key and its sliding key support, and the upper portion of the mechanism for controlling contraction of the core elements.

The die is made up of two separable halves comprising, from top to bottom, a pouring cap **1** with its pouring hole **2** and a casting block **3**. Through each half of the casting block is slidable a rod **4** whose extremity **5** extends into a chamber **6** whose shape matches that of the piston to be cast. These rod extremities are designed to form the gudgeon pin bearings in the piston.

Cap **1** and block **3** are horizontally slidable along the base structure of the machine (not shown), which structure supports two double-acting actuators for controlling movement of each half-die and thereby enabling the die to be opened and closed. Each half of the pouring cap **1** is rigidly connected to a movable reinforcement **7** to which are likewise secured the rod **4** and the outer extremity of the corresponding actuator plunger rod. These parts are adapted to translate with respect to, and in the same direction as, the corresponding half of the casting block, such translation being limited in each direction by stop means (not shown).

The core is composed of two identical core elements **8**, each comprising a cavity **9** matching the shape of the gudgeon pin bosses. Each core element is extended downwardly by an actuating heel **10** which invariably remains outside the die. The lower portion of the actuating heel is secured to a part **11** through the agency of which it is pivotally connected, about a shaft **12**, to a core-bearing device **13**, thereby enabling the core elements to swing away or towards each other in the plane containing the axes of rods **4**. A spreader spring (not shown) continuously urges the core elements **8** away from each other.

When the die is in the closed position, locking toes **14** engage on each side of the machine beneath flanges **15** on the core-bearing device **13**.

Beneath the casting blocks a plate **16** rigid with the machine base structure embodies a central passage lined with a locating bush **17** which also performs the function of a sealing member during the casting operation and through which extend the actuating heels **10**.

A long vertical central key **18** has one of its ends fixedly secured to a key support **19** which is vertically slidable through the base structure. Said key support **19** is movable in both directions by a double-acting hydraulic or pneumatic vertical actuator (not shown) and raises the key **18** into an operatively engaged position between core elements **8** (which are spread open prior to pouring) and lowers it into the retracted position for the stripping operation. In its operatively engaged position, the upper end of key **18** and the two core elements **8** jointly provide the shape of the interior piston cavity.

Projecting from its lower face, the key support **19** has two vertical pegs **20** whose function will be described hereinafter.

Opening out laterally opposite each actuating heel **10** is a horizontal passage extending through plate **16** and locating bush **17**, parallel with the axis of rods **4**, and serving as guide means of a pushrod **21**. One end of pushrod **21** terminates in a roller **22** rotatable on a horizontal pin parallel with the symmetry plane of the machine and against which the corresponding actuating heel **10** is applied in pressure contact by the spreaded spring referred to precedingly. Engaging into a recess **23** provided on the lower face of the other end of pushrod **21** is a cog **24** provided on the tip of the upwardly directed upper arm **25** of a bell-crank lever fulcrumed on a splined shaft **26** rotatably mounted in the base structure.

The pushrods **21** and bell-crank levers hereinbefore referred to form part of the mechanism for moving the core elements **8** towards each other, which mechanism is schematically illustrated in FIGURE 5.

Reference to FIGURE 5 clearly shows the core elements **8** and their actuating heels **10** maintained in pressure contact against the rollers **22** of pushrods **21** by a suitable spring (not shown). Two bell-cranks **27** are angularly rigid with splined shafts **26** pivotally supported in convenient base structure bearings. Each bell-crank has an upwardly directed upper arm **25** terminating in said cog **24** engaging into recess **23** of pushrod **21**, and a substantially horizontal arm which, for greater clarity, will hereinafter be referred to as horizontal arm **28**.

Horizontal arms **28** are convergent and their ends are slidably pivoted on the upper end of a vertical draw-link **29** disposed in the plane of symmetry of the machine.

Draw-link **29** is guided in the base structure and has its lower extremity connected to abutment pieces **30** positioned along the path **31** of the pegs **20** of key support **19**. A spring **32**, whose lower extremity bears against a horizontal bed plate **33** through which extends draw-link **29** and whose upper extremity thrusts against a shoulder portion of draw-link **29**, continuously urges the latter upwardly, whereby pushrods **21** tend to recede from each other.

The general arrangement of the subject machine of the invention, as adapted for the manufacture of pistons, will be clearly apparent from the schematic illustration of FIGURE 8 in which may be recognized the main component parts referred to hereinabove.

Referring now to FIGURE 8, the base structure **34** is seen to support the various component parts and to have fixed thereto two double-acting horizontal actuators **35** controlling opening and closure of the die, and a double-acting central actuator **36** which alone controls both raising and lowering of the key support **19** with its key **18** and the mechanism controlling the mutual closing motion of core elements **8**.

FIGURE 8 also shows such control members as the electromagnetic valves and limit switches ensuring automatic sequence operation, the precise functions of which members will be described hereinafter.

The manner of operation of a machine according to the invention will be manifest from FIGURES 1 through 4, which show the consecutive functional configurations.

In the position shown in FIGURE 1, pouring has just taken place and the metal of piston **37** fills the chamber **6** bounded by casting block **3** and pouring cap **1**. The ends **5** of rods **4** are engaged into the internal piston bosses occupying the core cavities **9**. The rollers **22** on the ends of pushrods **21** are kept spaced from actuating heels **10** by the influence of spring **32** on draw-link **29** and bell-cranks **27** (see FIGURE 5). Key support **19** and key **18** are in their uppermost position and the locking toes **14** rigid with movable reinforcement **7** restrain the core-bearing device and the core in the upper-most position.

FIGURE 2 shows the next phase. The die is still closed and central actuator **36** (FIGURE 8) has moved key support **19** downwardly, thereby withdrawing key **18** from the space between core elements **8** while the latter remain in mutually spaced relation under the urge of the spreader spring (not shown). On reaching the end of its stroke, key support **19** exerts pressure through its vertical pegs **20** on the abutments **30** of draw-link **29**, against the countering force of spring **32** (FIGURE 5). This causes the draw-link to be moved downwardly and to thereby pivot levers **27** (see FIGURE 5), which overcome the force of the spreader spring and apply the core elements **8** against each other through the medium of pushrods **21**. In moving towards each other thus, the core elements release the bosses of piston **37** from the matching cavities **9**.

Reference to FIGURE 3 shows that the horizontal actuators **35** (see FIGURE 8) have operated to firstly spread open the two halves of pouring cap **1** and the two rods **4**, while the remaining machine components are in the position shown in FIGURE 2.

As they complete their retracting motion, movable reinforcements **7**, after covering the first part of their stroke, displace the two halves of casting block **3** through an equal distance, thereby causing the locking toes **14** rigid with said reinforcements to release the flanges **15** of core-bearing device **13**. The latter then descends by gravity until it butts against stop means (not shown) and pulls with it the core elements **8**, if not clear of piston **37** in any event sufficiently downwardly for the core to be fully withdrawn from the space between the internal bosses of piston **37**.

Fully released thus, piston **37** can then be withdrawn from the machine in order to cut off the gate **58**.

Subsequent to withdrawal of piston **37**, horizontal actuators **35** and central actuator **36** operate anew to return the various moving parts of the machine into the position shown in FIGURE 1, whereby to cast the next piston.

FIGURES 6 and 7 show the spreader device which continuously urges the core elements **8** into their mutually spaced position.

Two substantially horizontal spreader beam-levers **39** are each fulcrumed on the core-bearing device **13** through the agency of a rotating yoke **40** enabling the lever to be oriented into either of two mutually perpendicular planes. Disposed substantially in parallelism with the plane of symmetry of the machine, each lever end emerging from the machine is equipped with an operating grip **41**. The other end of each lever is slidably pivoted at **42** onto the lower extremity of the corresponding pivotal member **11**, each of which members has fixed thereto the actuating heel **10** of a core element **8**.

The spreader spring **43** is anchored between the lever arms bearing the grips **41** and tends to move the same away from each other and hence to move the sliding pivots **42** and the lower extremities of pivotal members **11** towards each other. Since FIGURES 1 through 4 show the actuating heels **10** to be pivotally connected to shafts **12**, it follows that the core elements **8** will be continuously urged into mutually spaced relationship by spreader spring **43**.

Where necessary, operating grips **41** permit of moving the core elements **8** towards each other manually.

Two vertical hooks **44** pivotally connected to base structure **34** each comprise a horizontal stop **45** positioned vertically beneath a lever arm bearing an operating grip **41**, which stops limit downward travel of core-bearing device **13**.

FIGURES 6 and 7 additionally comprise, illustrated in diagrammatic fashion, a number of features which will be described in greater detail hereinbelow with reference to FIGURES 9 through 14. These figures clearly reveal certain constructional details of the automatic machine for casting internal combustion engine pistons, which machine is described by way of example only and not of limitation, it being clearly understood that the present invention likewise encompasses such constructional details.

As may be clearly seen from FIGURES 9, 10 and 13, the base structure **34** (FIGURE 8) comprises a rear support **46** fixed to a convenient stand (not shown). Mounted on the lower part of rear support **46** is horizontal plate **33** and, on its upper part, plate **16**. Two guide columns **47** acting as spacers between plate **16** and horizontal plate **33** serve to reinforce the base structure and to guide the core-bearing device **13** and the key support **19** in their vertical movements. On either side of the machine, parallel with its plane of symmetry, two cheeks **48** are mounted on the extremities of two horizontal bars **49** supported by plate **16**. The horizontal actuators **35** are secured to said cheeks **48**, while central actuator **36** is mounted on horizontal plate **33**.

The movable reinforcements **7** connected to the pouring cap **1** and the casting blocks **3** slide along said horizontal bars **49**. Pouring cap **1** is fixedly mounted on the movable reinforcements **7**, while casting block **3** is displaceable with a degree of endwise play in the same direction as pouring cap **1** and reinforcement **7**. This play is limited in one direction by two adjustable stops **50** provided on pouring cap **1** and which, during closing movement of the die, cooperate with bearing surfaces provided on the outer surfaces of the casting block (see FIGURE 9). In the die opening sense, it is the heads **51** of screws **52** screwed into the casting blocks **3** and sliding in passageways embodied in the movable reinforcements **7** which bear against the edge of said passageways and are thereby pulled along by the reinforcements (see FIGURES 10 and 13).

The core-bearing device **13** slidably mounted on the guide columns **47** includes all the parts precedingly referred to in the description of the underlying principle of the machine described herein by way of example.

Said device may be equipped in addition with a mechanism for positioning distance pieces **53** inserted into the piston bosses, said distance pieces embodying a hole for the gudgeon pin and being made of a metal different from that poured into the die.

This positioning mechanism is shown in side elevation

and in section in FIGURES 9 and 11, in horizontal section in FIGURE 12 and in diagrammatic fashion in FIGURES 6 and 7. It comprises two locking rods **54** each extending through the full length of a passageway **55** provided in the lower parts of core elements **8** and in their actuating heels **10**. These rods have their lower ends secured to the sliding pivots **42**, while their other ends are so devised that they project into the cavity **9** of each core element **8** and hold a distance piece **53** clamped between the latter-mentioned rod end and the upper wall of cavity **9**. Each of two springs **56** accordingly thrusts a pushrod **57** upwardly against the inner arms of spacer beam-levers **39** and thereby exerts a likewise upwardly directed pressure against said rods.

In order to position the distance pieces **53**, operating grips **41** are raised whereby to lower the upper ends of locking rods **54**; the distance pieces are then located between said upper end and the upper edge of the cavities **9**, after which the grips are lowered once more, whereupon the distance pieces are correctly positioned for the casting operation.

A second pushrod **58** acting in the opposite sense to the first pushrod **57** and actuated by a mechanical, electromagnetic, hydraulic or pneumatic control system (not shown), may be provided for retracting the upper ends of locking rods **54** from the cavities **9** or the piston bosses without the need to use the operating grips **41**.

As is clearly apparent from the sectional view of FIGURE 12, the front face of core-bearing device **13** comprises a cover **59** having thereon two lugs **60** in which rotate the vertical pins **61** of yokes **40**.

As the core-bearing device **13** moves downwardly under gravity as soon as the locking toes **14** fixed to movable reinforcement **7** release the flanges **15** of said core-bearing device, its downward motion is damped by two hydraulic or pneumatic dampers **64**. The latter are fixed to the horizontal plate **33**, and their plunger rods **65**, which extend therethrough, have their extremities fixed to the core-bearing device. Since the other component parts of the core-bearing device designated by their several reference numerals in FIGURES 9 through 13 have been adequately described with respect to their shapes and functions, with reference to the diagrammatic illustrations of FIGURES 1 through 7, any further description thereof is thought to be redundant.

The key support **19** likewise slides along guide columns **47**. The lower end of key **18** forms a heel **66** which is engaged into an inverted T-slot and clamped against the projecting edges of said slot by means of a screw-and-wedge device **67** (see FIGURES 9 and 11).

One possible form of embodiment of the mechanism for moving the core elements **8** towards each other is shown in detail in FIGURES 9, 13 and 14.

The draw-link **29** is guided at the bottom by the horizontal plate **33**, being slidable through a hole therein. The upper portion of said link is guided by engagement of an axial peg **68** in a recess provided in the plate **16** supporting the horizontal bars **49**. The upper end of the draw-link comprises a pivot member **69** having therein a horizontal bore **70** into which engage the ball-ends **71** fitted to the extremities of the horizontal arms **28** of bell-cranks **27**. The pivot member **69** further embodies a vertical cylindrical housing **72** into the lower end of which is screwed a socket **73**. A tensile rod **74** is inserted through an axial bore in socket **73**, the degree of penetration of tensile rod **74** into the cylindrical housing **72** being limited by an abutment **75** provided in the axial bore of socket **73** and against which butts a corresponding shoulder **76** on tensile rod **74**. Spring means consisting of cup washers **77** inserted intermediate the socket **73** and a washer **78** retained by a linchpin on the end of tensile rod **74** maintain abutments **75** and **76** in mutual pressure contact. The spring **32** is fitted under

compression between the socket **73** and the horizontal plate **33**.

The lower threaded end of tensile rod **74** engages into a central hole **79** provided in a small horizontal strip **80** terminating at each end in a journal **81**. A distance piece **82** is positioned between said strip and a nut **83** which is screwed onto the threaded end of the tensile rod and enables the position of said horizontal strip to be adjusted on the tensile rod.

The lower end of tensile rod **74** can be pivoted through cooperation of the journals **81** with notches **84** located at the load-absorbing intermediate point of an end-fulcrumed lever **85** whose other end bears the abutment pieces **30** placed in the path of the pegs **20** of key support **19** and a pedal **86** for applying a downward effort on said lever. Lever **85** is fulcrumed about a pin **87** on horizontal plate **33**.

Bell-cranks **27** are formed of a plurality of elements by reason of the fact that the opposing loads are exerted in a vertical plane which is perpendicular to the plane of symmetry of the machine and passes through the axis of the die and the key **18**, whereas the effort is exerted along the axis of the vertical draw-link **29**, which axis is compulsorily located rearwardly of said vertical plane.

The upper arms **25** of bell-cranks **27** are consequently mounted individually on a splined shaft **26** rotating in bearings **88** provided on plate **16**.

The horizontal arms **28** are mounted on the same splined shafts **26**, but at a distance equal to that between the axis of draw-link **29** and said vertical plane.

In addition, each of said horizontal arms has a straight section **89** thereof mounted angularly rigid with splined shaft **26**, and the bent prongs **90** of a fork **91** are so mounted on said straight section **89** as to enable said fork to rotate about the axis of splined shaft **26**. An adjustment screw **92** fitted with a locknut **93** is screwed into the straight section **89** in such manner that the end of adjustment screw **92** forms a stop **94** for cooperation with an abutment surface **95** provided between the two bent prongs, on the bridge-piece of fork **91**. This system permits of permanently adjusting the angle subtended by the arms of bell-crank lever **27**.

Likewise provided is a second adjustment screw **96** with locknut **97**, screwed into each upper arm **25** of bell-cranks **27**, and the tip of this adjustment screw **96** serves as a stop for cooperating with a vertical abutment face provided on the right and left sides of plate **16** and permits of adjusting the minimum spacing between the core elements **8**. The resilient system formed by the cup washers **77** of tensile rod **74** acts as a tensile force limiter capable of offsetting possible inaccuracies in the adjustment made with the screw **96** with respect to that made with the nut **83** on tensile rod **74**.

Semi-automatic operation of the machine hereinbefore described by way of example is obtained in the manner well known per se in the field of industrial automation. As FIGURE 8 clearly shows, it is obtained by means of electromagnetic slide-valves or the like connected into the hydraulic or pneumatic fluid passages of the actuators. The electric power supply circuits for energizing the coils of such electromagnetic valve means comprise suitable switches, pushbutton-operated timers and selector switches, and limit switches. The rollers on the pivotal operating levers of the latter are placed in the path of cam-rods rigid with the members displaced by the actuators.

A control slide-valve of the casting block and the pouring cap is equipped with a coil **98** whose energization causes the actuators **35** to be supplied on the sides thereof whereby said casting block and pouring cap are opened, and with a coil **99** whose energization causes said actuators to be supplied on the sides thereof whereby said casting block and pouring cap are closed.

A control slide-valve of the key is equipped with a coil **100** whose energization causes the vertical actuator **36** to be supplied on the side thereof whereby the key support **19** is lowered, and with a coil **101** whose energization causes said vertical actuator **36** to be supplied on the side thereof whereby said key support is raised.

Limit switches **102**, **103**, **104** and **105** ensure the correct sequence of movements of the casting block, the pouring cap and the key and obviate determimental interference with the various operations. A vertical cam-rod **106** is accordingly fixed to the key support **19** (FIGURES 8, 9 and 11) and embodies, on one side, a notch **107** which operates a limit switch **102** at the end of the downward stroke and, on the other side, a notch **108** which operates the limit switch **103** at the end of the upward stroke.

Likewise, a horizontal cam-rod is mounted on each of the movable reinforcements **7**. Thus, the cam-rod **110** operates the limit switch **104** when the casting blocks have opened fully, while the cam-rod **112** operates the limit switch **105** when said casting blocks have closed fully.

Said horizontal cam-rods **110** and **112** are slidably mounted on the base structure and secured to the end **114** of a pushrod **115** (see FIGURES 9 and 10). Pushrod **115** slides in a cylinder **116** fixed to the movable reinforcement **7** and is maintained in pressure contact against the casting block **3** by a spring **117** fitted under compression between an abutment face on said pushrod and an annular plug which closes the end of the cylinder. These pushrods **115** not only permit of actuating said horizontal cam-rods but also of opening the pouring cap **1** before the casting block **3**.

Various pushbutton boxes enable the various operations to be initiated.

Pushbutton **118** controls the ascent of key **18**, while simultaneous operation of pushbutton **118** and a pushbutton **119** initiates closure of the casting block and the pouring cap.

Pushbutton **120** sets off a timer which determines the cooling time of the metal in the die. After the preset time-delay has elapsed, this timer energizes the coil **100** controlling descent of key support **19**. When the downward stroke is completed, the notch **108** of cam-rod **106** operates the limit switch **103** which energizes coil **98**, thereby causing the casting block and the pouring cap to open.

Obviously, the piston casting machine hereinbefore described cooperates with plant for supplying molten metal, which is not covered by the scope of the present invention. The subject machine of the invention enables a high production output of fifty castings per hour to be achieved.

It is additionally feasible to mount a multiplicity of such machines on a turret base and to have recourse to an appropriate automatic plant of known type for pouring the molten metal. The casting operation can then be slaved to the functional characteristics of the machine and be triggered, say, by the casting block and pouring cap closing limit switch **113**.

Further, the machine for casting pistons according to the invention is so devised as to enable essential parts prone to wear to be rapidly disassembled and replaced. By way of example, the hooks **44** (FIGURES 7 and 10) acting as limit stops for the core-bearing device **13** are pivotally connected to the base structure and can be tilted laterally by means of levers **121**. The abutment **45** then retracts and the core-bearing device **13** descends sufficiently low to permit easy dismantling and removal of the core.

While there has been shown and described, the presently preferred embodiment of the machine for chill casting hollow parts of this invention, it will be well understood by those skilled in the art that various changes and modifications may be made in this embodiment. Of course, it will be understood that, in its broader aspect, the basic object of this invention, to wit, causing the motion towards each other of the core elements to be me-

chanically slaved to motion of the key as it reaches the end of its retracting stroke, may lkewise be applied to machines which not only operate in positions other than that of the vertical piston casting machine herein described but which are generally adapted to casting or moulding hollow parts from other materials, including plastics.

I claim:

1. A semi-automatic machine for chill casting parts comprising a cavity which has a narrowed portion requiring the use of a core formed of a plurality of movable core elements severally extended by an actuating heel and maintained spaced from one another during casting and close to one another during stripping, an extendable retractable key adapted to translate longitudinally of itself between an operatively engaged position between the mutually spaced core elements during the casting operation and an inoperative position of retraction therefrom during the stripping operation being mounted on a slidable key support through the agency of which the movable part of reciprocating translational motion engendering drive means is adapted to push said key from its retracted position to its engaged position, said machine being characterized in that spreader means are provided for biasing during machine operation said core elements towards their mutually spaced position and in that in respect to each of said elements there is provided a bell-crank lever fulcrumed intermediate its ends on the machine in such manner that one of its arms exerts pressure against said actuating heel of the corresponding core element in the sense of moving the same towards the other core elements when on reaching the end of the retracting stroke said key support exerts a force on the other bell-crank arm through the medium of a draw-link common to all the bell-crank levers.

2. A machine as claimed in claim 1 having two core elements and vertical core and key axes, wherein said core element actuating heels are pivotally connected to the machine.

3. A machine as claimed in claim 1 having two core elements and vertical key axes, wherein said core element actuating heels are pivotally connected to the machine to form intermediately fulcrumed levers whose upper ends terminate in core elements, said actuating heels having their other ends urged towards each other by spring means.

4. A machine as claimed in claim 1, wherein said reciprocating translational motion generating drive means is a double-acting actuator whose plunger rod is rigidly united in translation with said slidable key support.

5. A machine as claimed in claim 1, wherein spring means continuously bias said vertical draw-link in the opposite direction to the force exerted by said key support for moving said core elements towards each other.

6. A machine as claimed in claim 1, wherein said bell-crank levers act upon said core element actuating heels through the medium of slidable pushrods.

7. A machine as claimed in claim 1, wherein said core element actuating heels are pivotally connected to a core-bearer sliding vertically in the machine and whose upward stroke is limited by an upper abutment and downward stroke by a lower abutment, said core-bearer being so disposed in the path of said slidable key support as to cause the latter to raise said core-bearer during the ultimate portion of its ascending motion in the course of which said key is pushed into its positively engaged position, and being provided with locking means which so cooperate with control means of opening and closure of the die that when the latter opens said core-bearer be released and descend under gravity until it encounters said lower abutment.

8. A machine as claimed in claim 1, wherein the upper end of said vertical draw-link is connected to one of the lever arms of said bell-crank levers through a slidable ball-joint and the lower end pivoted about the intermediate load-absorbing point of an end-fulcrumed lever whose free end which is located in the path of a vertical peg provided on the underside of said slidable key support and which is equipped with a thrust surface or grip whereby said draw-link may be lowered by foot or by hand.

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