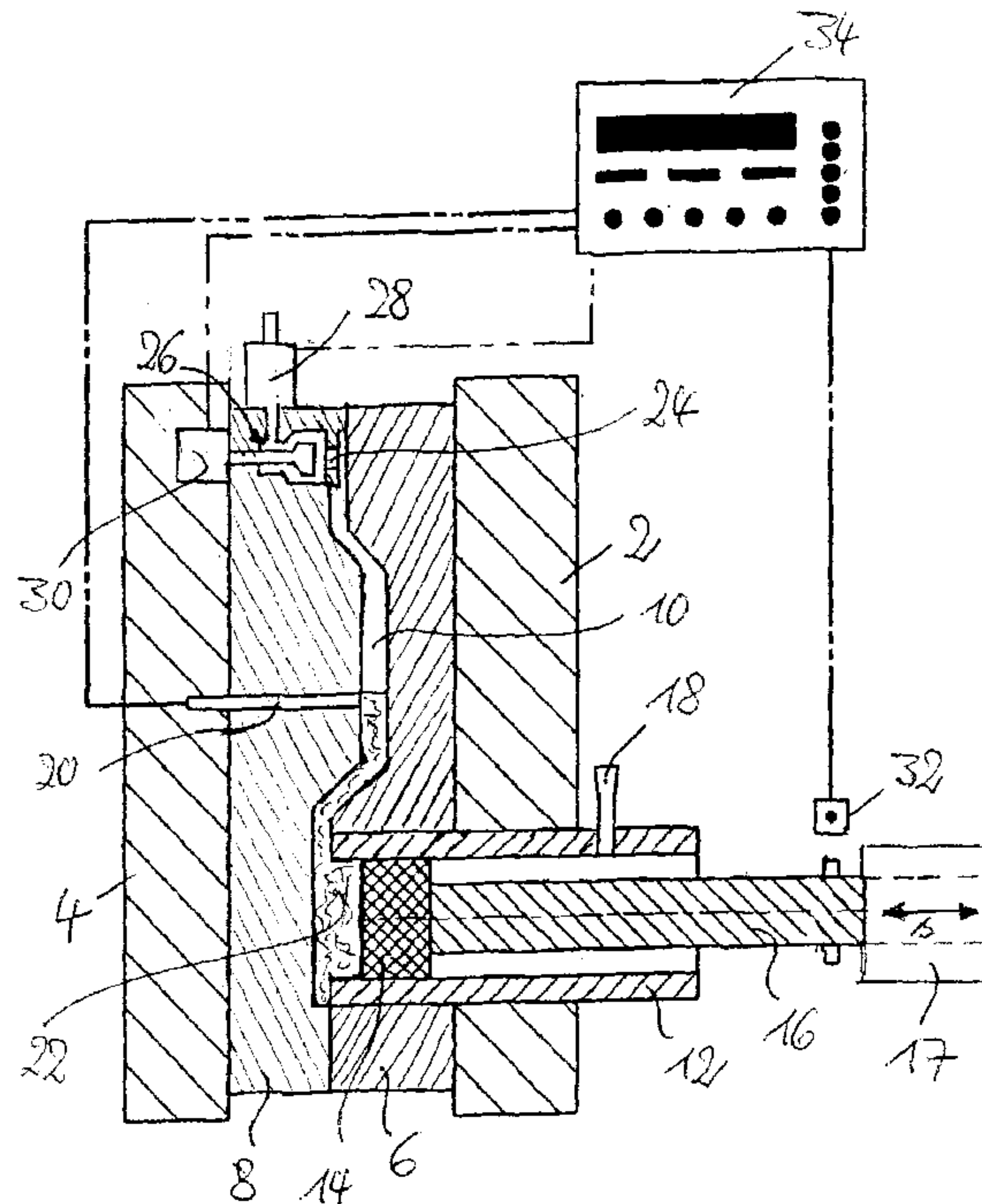




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(54) Titre : PROCEDE DE COMMANDE D'UNE SOUPEPE A VIDE D'UN DISPOSITIF DE MOULAGE SOUS VIDE ET
DISPOSITIF DE MOULAGE SOUS VIDE
 (54) Title: METHOD FOR CONTROLLING A VACUUM VALVE OF A VACUUM DIECASTING DEVICE AND VACUUM
DIECASTING DEVICE



(57) Abrégé/Abstract:

The invention relates to a vacuum diecasting device that comprises a casting cavity (10) which can be evacuated via a vacuum valve (26) and into which a liquid casting material can be pressed by a piston (14) that is actuated by an actuator (17). The device further comprises a level sensor (20) for detecting a level of the casting material in the casting cavity, a control device (34), linked with the level sensor, for controlling the vacuum valve, and a position sensor (32), linked with the control device (34), for detecting the movement of the piston (14). The control device produces a close signal for the vacuum valve (26) when the piston, once position (s_1) is reached, at which the level sensor (20) indicates a predetermined level of the casting material in the casting cavity (10), has been displaced in a predetermined manner.

Abstract

A vacuum die casting apparatus includes a casting cavity (10), which is evacuable via a vacuum valve (26), and into which a liquid casting material is pressable
5 by means of a piston (14) actuated by an actuator (17), a filling level sensor (20) for detecting a filling level of the casting material in the casting cavity, a control device (34) connected to the filling level sensor for controlling the vacuum valve, and a position
10 sensor (32) connected to the control device (34) for detecting the movement of the piston (14), wherein the control device produces a closing signal for the vacuum valve (26) when the piston, after reaching the position (s_1) at which the filling level sensor (20) indicates a predetermined filling level of the casting cavity (10) with casting material, is displaced in a predetermined manner.

(Figure 1)

METHOD FOR CONTROLLING A VACUUM VALVE OF A VACUUM DIE
CASTING APPRATUS AND A VACUUM DIE CASTING APPARATUS

The invention concerns a method for controlling a vacuum valve of a vacuum die
5 casting apparatus as set forth in the preamble of claim 1. The invention further concerns a
vacuum die casting apparatus as set forth in the preamble of claim 2.

A vacuum die casting apparatus according to the preamble is known from DE 200
16 166 U1, in which the filling level of liquid metal injected into the casting cavity is
detected by a metal contact sensor; upon coming into contact with the liquid metal, the
10 sensor outputs a signal and a closing piston of the vacuum valve, which is driven by a
linear motor, is moved in response to the signal so that the vacuum valve is entirely closed
at the time of corresponding filling of the metal. In a further teaching, the known vacuum
die casting apparatus utilizes a meandering vacuum and venting passage, in which a
plurality of metal contact sensors are disposed and are connected to a computer; the
15 computer controls the linear motor of the closing piston in accordance with the signals
from the sensors.

If there is only one metal contact sensor, it is not possible to compensate for
fluctuations in the speed at which the molten metal is injected during the manufacture of
the castings; therefore, if the vacuum valve is not timely closed at high filling speeds, the
20 evacuation will be prematurely ended, thereby possibly detrimentally influencing the
quality of the casting. The use of a plurality of metal contact sensors is comparatively
complicated and expensive.

The object of the invention is to provide a method and an apparatus that can
manufacture castings of improved quality.

25 A first solution of that object is the method according to claim 1.

According to this method of the invention, the position of the piston, which presses
or injects the liquid casting material into the mold cavity, is detected, and the vacuum
valve is closed in dependence on the piston position; as a result, it is possible for the
vacuum valve to be reliably closed just before the casting material, preferably liquid metal,
30 reaches the vacuum valve. In that way, the casting mold or the casting cavity can be
connected to a vacuum source for as long as possible; thus, polluting gases, i.e., gases

originating from lubricants and separating substances and the like, are suctioned away and a casting is produced that is substantially free of pores or inclusions.

The quality of the manufactured vacuum castings is further improved with the features of claim 2.

5 Claim 3 characterizes the basic structure of a vacuum die casting apparatus for solving the corresponding object of the invention.

Claims 4 through 10 are directed to advantageous embodiments of the die casting apparatus according to the invention.

10 The vacuum valve used in accordance with claim 4 advantageously operates with a time delay that is as short as possible so that the closing signal can be generated as late as possible; as a result, the closing time is as late as possible, and is substantially independent of fluctuations that occur during the operation of the casting apparatus.

A particularly simple control system for the generation of the closing signal is possible with the features of claim 5.

15 In accordance with claim 6, the time point at which the closing signal must be generated can be calculated from the piston speed almost in real-time.

Claims 7 through 9 are directed to advantageous characteristic curves that are stored in the control device, while the operating condition of the die casting apparatus can be monitored according to the features of claim 9.

20 Using the features of claim 10, operating fluctuations of the casting apparatus are taken into account when generating the closing signal.

The invention is described in further detail hereinbelow by way of example and with reference to schematic drawings, in which:

Figure 1 shows a schematic view of a vacuum die casting apparatus, and

25 Figures 2 and 3 show curves to illustrate the operational mode of the apparatus according to the invention.

30 As shown in Figure 1, a vacuum die casting apparatus includes at least two main bodies 2 and 4 that are movable towards and away from each other by means of a drive device (not shown) in a known manner. An associated mold portion 6 and 8 is respectively fixed to each main body, wherein mutually facing surfaces of the mold portions 6 and 8 have a configuration such that a casting cavity 10 is formed when the tool is closed or when the main bodies are moved towards each other.

A cylinder 12, which opens towards the casting cavity 10 and which contains a movable piston 14, serves to introduce casting material, preferably liquid metal, into the casting cavity 10; the piston 14 is connected via a shaft 16 to an actuator 17 for driving the piston 14. A filling conduit 18 passes through the wall of the cylinder 12 for introducing
5 the liquid casting material.

A filling level sensor 20 is disposed adjoining the casting cavity 10, which filling level sensor 20 generates a signal upon contacting the casting material 22 that rises in the casting cavity 10. A vacuum opening 24 adjoins the upper end region of the casting cavity 10 and the vacuum opening 24 is connected via a vacuum valve 26 to a vacuum pump 28.
10 The vacuum valve 26 is configured such that, in response to a closing signal, the valve member of the vacuum valve moves with the shortest possible delay into the closed position, at which the vacuum valve 26 is closed. Actuation of the valve member is effected for example by means of an actuator, for example a solenoid 30. The actuation can also be suitably effected hydraulically or by other means.

15 The position of the piston 14 or the shaft 16 is detected by a motion sensor 32 along the stroke of the piston 14. The motion sensor 32 can be, for example, a linear sensor or an incremental rotational motion sensor when the linear movement of the piston is converted into a rotational movement by a suitable mechanism.

The motion sensor 32, the filling level sensor 20 and the solenoid of the vacuum
20 valve 26 are connected to a control device 34 that includes a microprocessor with associated storage devices, a display unit, for example in the form of a display, and operating elements.

The structure and function of the described components are known. The co-operation of the components is described in the following:

25 It will be assumed that the piston 14 is moved towards the right in Figure 1 beyond the outlet port of the filling conduit 18. Then, liquid metal can be introduced into the evacuated casting cavity 10 via the conduit 18, wherein the space within the cylinder 12 to the left of the piston 14 is filled, for example, to between 20% and 60% with liquid casting material, depending on the volume relationships. The piston 14 is then moved towards the
30 left beyond the outlet port of the filling conduit 18. The vacuum valve 26 is open. The vacuum pump 28 is running so that the casting cavity 10 is subjected to a vacuum. The

casting material 22 is pressed into the casting cavity 10 and reaches the filling level sensor 20.

As soon as the casting material 22 reaches the filling level sensor 20, the filling level sensor 20 sends a trigger signal to the control device 34; at the time the trigger signal is sent, the piston position is detected by the motion sensor 32 and the detected position is marked in the control device 34. Advantageously, the actuator 17, e.g. a hydraulic actuator, is switched to a higher speed by the trigger signal so that the casting material is injected at high speed and under high pressure into the remainder of the mold cavity.

Figure 2 clarifies these relationships. The speed of the piston 14 is illustrated as being dependent upon the distance s that the piston has been displaced. As can be clearly seen, the piston movement begins at low speed until the position s_1 , at which position the casting material 22 reaches the filling level sensor 20. The associated position s_1 is stored in the control device 34. At the same time, the force or, if provided, the speed, with which the actuator 17 drives the piston 14, is switched to a high value. It will be assumed that the position s_2 of the piston corresponds to the position at which the casting material reaches the vacuum opening 24 of the vacuum valve 26; in other words, it is the piston position at which the vacuum valve 26 must be closed in order to avoid being damaged by the casting material. It will further be assumed that the piston moves by the distance Δs within the predetermined time delay period Δt that is required to close the vacuum valve 26 in response to a closing signal. Therefore, as can be readily seen from Figure 2, the closing signal for the vacuum valve 26 must be generated at the time when the piston is at the position s_3 . Because the position s_1 of the piston is marked in the control device 17, the distance $s_3 - s_2$ or the position s_3 of the piston can be accurately detected by the motion sensor 32, and the closing signal for the vacuum valve 26 can be generated at that time.

Figure 3 provides a characteristic curve indicating the change of the piston position over time. Figure 3 additionally shows the time delay Δt of the vacuum valve 26.

It will be appreciated that the characteristic curve of Figure 2 can be generated by differentiation of the characteristic curve of Figure 3. Depending on the particular design configuration of the motion sensor 32, the characteristic curve of Figure 2 or Figure 3 can be recorded directly; the characteristic curve of Figure 3 can be generated by integration of the characteristic curve of Figure 2; or, the characteristic curve of Figure 2 can be generated by differentiation of the characteristic curve of Figure 3.

Depending upon the construction of the vacuum valve and the arrangement thereof in the casting cavity, it is possible to completely fill the casting cavity when the piston reaches the position s_2 (casting material reaches the vacuum opening 24); or, as illustrated in the Figures, the casting cavity can be only substantially filled, so that the piston is still
5 displaced a short additional distance. It will be appreciated that the piston can also be controlled in such a way that the piston is braked at the position s_2 .

It is advantageous for the characteristic curve of Figure 2 to be stored as a desired or reference characteristic curve that corresponds to a functionally acceptable condition of the casting apparatus. That reference characteristic curve can then serve to determine the
10 piston position s_3 for generating the closing signal for the vacuum valve.

The reference characteristic curve can be continuously displayed together with an actual characteristic curve, for example on a display screen, so that operating changes in the die casting apparatus are directly visible and any faults can be recognised at an early stage. In addition, in the series production of castings, the characteristic curve, which
15 curve is used to ascertain the position s_3 , can be continuously updated by a procedure, for example, a procedure in which the actual characteristic curve of an immediately preceding casting operation is used as the characteristic curve for ascertaining s_3 , or a characteristic curve is used that is ascertained from a plurality of preceding casting operations.

Overall, the invention provides that the casting cavity is subjected to the effect of a
20 vacuum as long as possible during the casting operation so that high quality vacuum die castings are produced. The elimination of pores in the die castings is further improved due to the fact that the final phase of the casting procedure is performed under a high casting pressure provided by the higher piston force; any pores remaining in the die casting, due to the gas being contained therein, that are not suctioned away by the vacuum are reduced in
25 volume.

The apparatus according to the invention can be developed and modified in many different ways.

For example, a plurality of connections extending from a casting cavity 10 to vacuum valves, and a plurality of filling level sensors, can be provided in the die casting
30 apparatus; in this case, the use of the method according to the invention assumes that no changes occur in the relationships of the degrees of filling of the individual passages, which are between the filling level sensors and the vacuum valves. As is immediately

apparent, visualization of the characteristic curve of Figure 2 is advantageous due to the good resolution thereof; however, it is also possible to display other characteristic curves. It is further possible for the closing signal not to be generated based upon the piston reaching the predetermined position (s_3) in Figure 2, but rather by the piston moving at a
5 predetermined speed, and the like.

Reference Number List

	2	main body
	4	main body
10	6	mold portion
	8	— mold portion
	10	casting cavity
	12	cylinder
	14	piston
15	16	shaft
	17	actuator
	18	filling conduit
	20	filling level sensor
	22	casting material
20	24	vacuum opening
	26	vacuum valve
	28	vacuum pump
	30	solenoid
	32	motion sensor
25	34	control device

CLAIMS:

1. A method for controlling a vacuum valve of a vacuum die casting apparatus, in which

liquid casting material (22) is pressed by a piston (14) into an evacuated casting cavity (10),

a predetermined filling level of the casting material in the casting cavity is detected, and

the vacuum valve (26) is disposed in a connection between a vacuum source (28) and the casting cavity (10) and the vacuum valve is actuated so that the vacuum valve is closed when the casting material reaches a connection of the vacuum valve to the casting cavity,

characterised in that

the movement of the piston (14) is continuously detected,

the position (s_1) at which the piston is disposed when the casting material reaches the predetermined filling level is marked, and

the vacuum valve (26) is closed when the piston has moved further by a predetermined distance ($s_3 - s_1$) from the marked position (s_1)

2. A method as set forth in claim 1, characterised in that the predetermined distance ($s_3 - s_1$) is the difference between the distance ($s_2 - s_1$) by which the piston further moves, starting from the marked position (s_1), until the casting material reaches the connection of the vacuum valve (26), and a distance ($s_2 - s_3$) by which the piston moves during a predetermined time delay period, wherein the vacuum valve switches into its closed position after the time delay in response to a closing signal.

3. A method as set forth in claim 1 characterised in that the speed at which the piston (14) is displaced is increased when the predetermined filling level is reached.

4. A method as set forth in one of claims 1 to 3, characterised in that the position of the piston (14), which is detected by a motion sensor (32), is differentiated with respect to time, and the time point at which the closing signal for the vacuum valve (26) is generated is determined based upon the speed of the piston and the instantaneous position of the piston.

5. A method as set forth in one of claims 1 to 3, characterised in that a characteristic curve is used to determine the timing of the closing signal, which curve indicates the piston position in dependence on time or the piston speed in dependence on the piston position.

6. A method as set forth in claim 5, characterised in that the characteristic curve used to determine the timing of the closing signal is stored as a reference characteristic curve.

7. A method as set forth in claim 6, characterised in that deviations between the reference characteristic curve and an actual characteristic curve are displayed.

8. A method as set forth in one of claims 5 to 7, characterised in that the characteristic curve used for determining the timing of the closing signal is continuously updated.

9. A vacuum die casting apparatus including
a casting cavity (10), which is evacuable by way of a vacuum valve (26), and into which a liquid casting material can be pressed by means of a piston (14) actuated by an actuator (17),
a filling level sensor (20) for detecting a filling level of the casting material in the casting cavity,
a position sensor (32) for detecting at least one predetermined position of the piston (14), and

a control device (34) connected to the filling level sensor for controlling the vacuum valve,

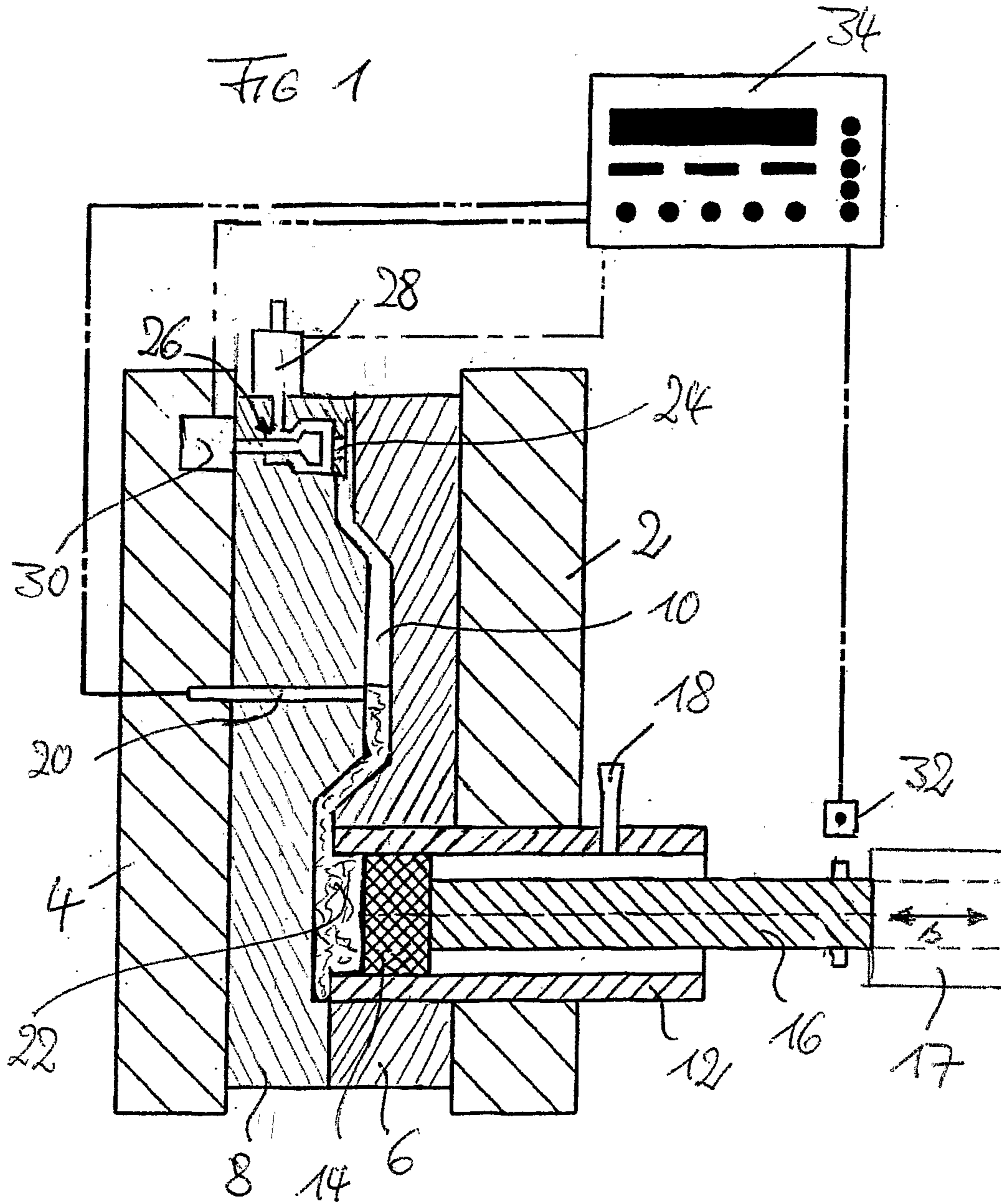
characterised in that

the position sensor (32) is designed so that it continuously detects the movement of the piston (14), and

the control device (34) is designed so that it generates a closing signal for the vacuum valve (26) when the piston, after reaching a position s_1 at which the filling level sensor (20) detects the casting material (10), is displaced by a predetermined distance ($s_3 - s_1$).

10. A vacuum die casting apparatus as set forth in claim 9 characterised in that the control unit (34) includes a storage device for storing a characteristic curve that indicates the piston position in dependence on time or the piston speed in dependence on the piston position.

11. A vacuum die casting apparatus as set forth in claim 9 or 19 characterised by a display device for displaying deviations between a stored reference characteristic curve and a recorded actual characteristic curve.



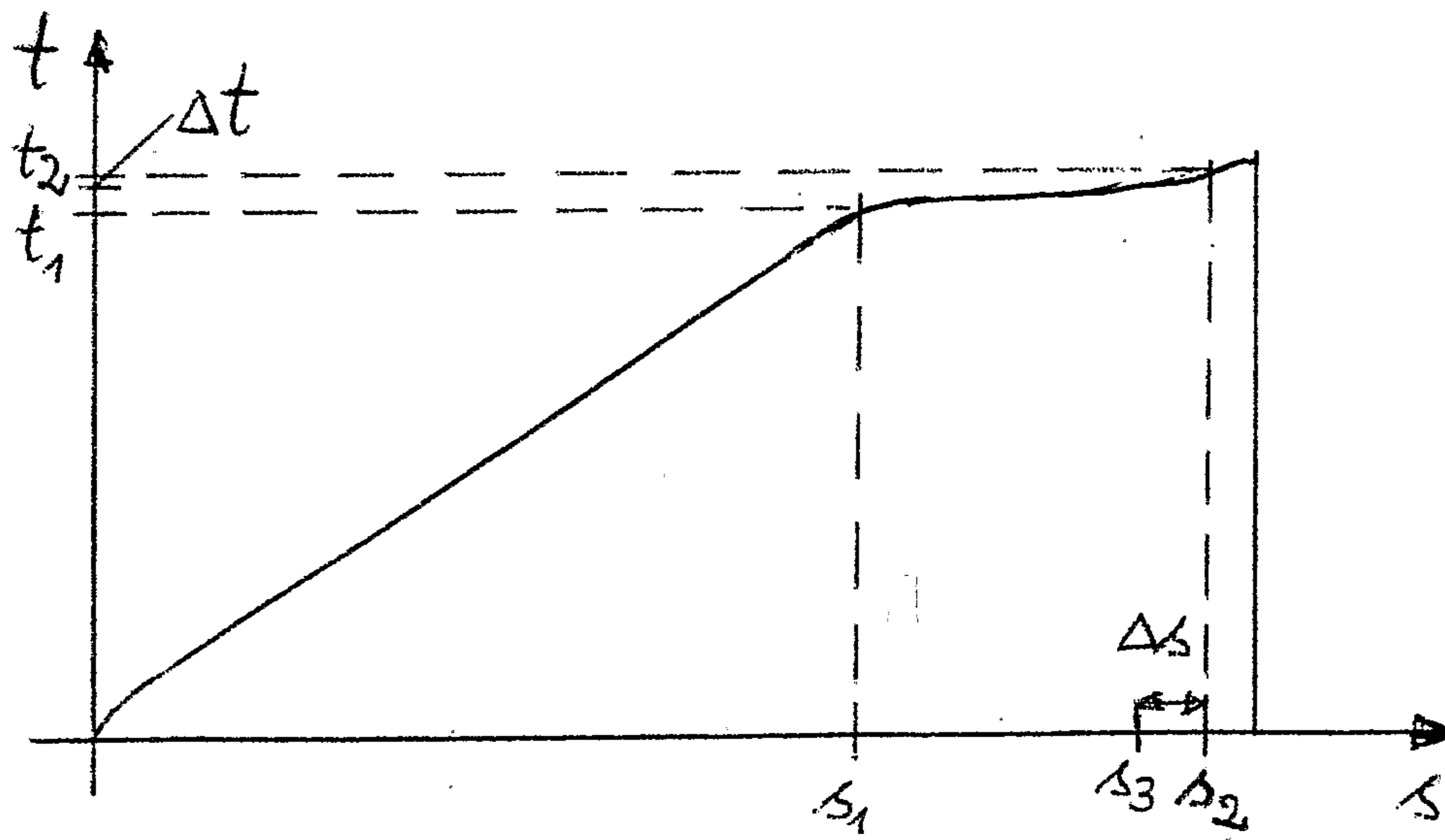
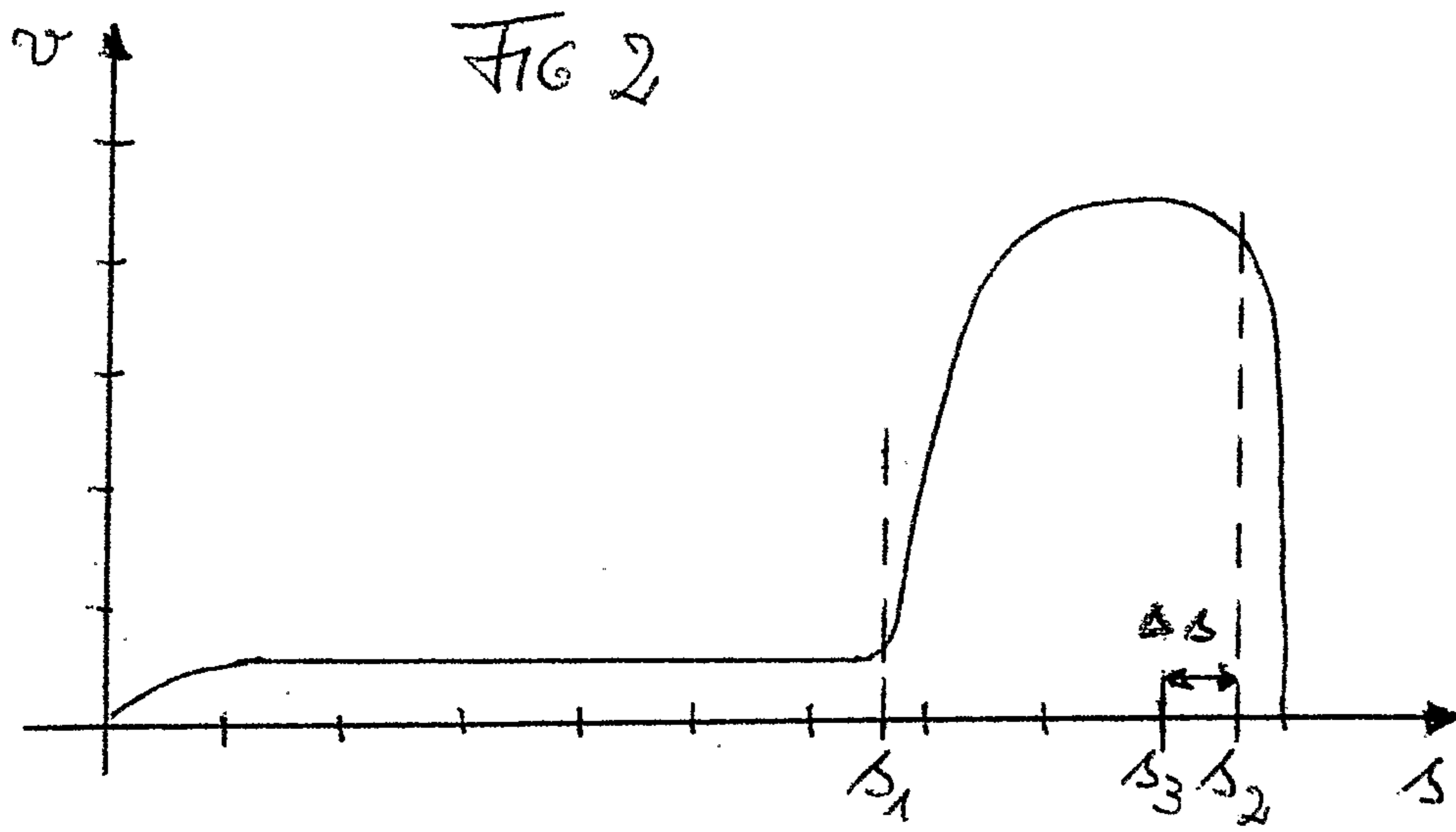


FIG 3

