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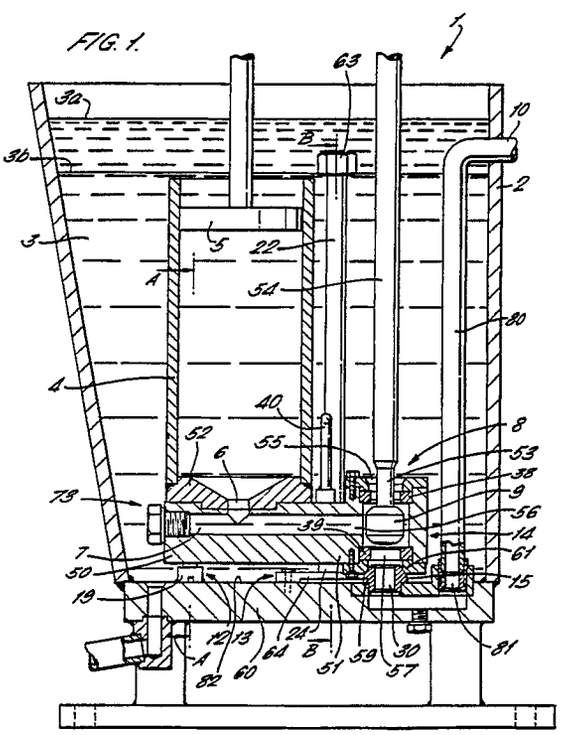
(54) Casting apparatus.

(57) A casting apparatus (1) comprises a tank (2) receiving molten metal (3) in use, a housing (73) comprising a dispensing cylinder (4) and a valve means (8) in communication with the cylinder, locating means (12,14) for removably locating the housing in the tank, a dispensing port (10), connection means (80) defining a passageway (30,81) between the valve means and the dispensing port, the connection means including a releasable coupling (59,61) through which the passageway normally extends and having first and second parts (59,61) which are separable to facilitate removal of the housing, the first and second parts being connected to the dispensing port and the valve means respectively and being relatively swivelable to allow adjustment of the housing relative to the tank. The first part (59) of the coupling is mounted on an internal surface (82) of the tank beneath the normal level (3a) of molten metal in the tank and the housing is held in position by a compliant mounting (43,71). The apparatus is suitable for casting low melting point alloys to be used as cores in plastic mouldings.



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CASTING APPARATUS

The invention relates to a casting apparatus and in particular to a way of mounting parts of the casting apparatus together.

The casting of low melting point alloys is of increasing importance. Such alloys are often cast to form complex metal cores for use in moulding plastics material; the plastics material being moulded about the metal core and the core subsequently removed by melting the metal alloy.

In our copending European Patent Application No. 90301038 we describe casting apparatus for supplying molten metal to a die which comprises a cylinder with a piston mounted therein for reciprocating movement to fill and deliver molten metal from the cylinder, connection means for connecting the cylinder to a supply of molten metal and to a die the connection means being provided with valve means to open and close the connection means between the cylinder and the supply and between the cylinder and die. In a preferred embodiment the valve means is a ball valve having a first port for communication with the supply of molten alloy, a second port for communication with the cylinder, and a third port for communication with the die. In this way the valve may be operated to open the connection between the supply and the cylinder to fill the cylinder with metal on retraction of the piston while maintaining the connection between the cylinder and the die closed and then adjusted to close the connection between the supply and the cylinder and open that between the cylinder and the die to permit metal to be dispensed into the die on the forward stroke of the piston.

The whole arrangement of cylinder, piston, connection means and valve means is usually mounted submerged within a tank of the molten metal. This not only provides molten metal at the supply port of the valve but also ensures that all of the apparatus is surrounded by molten metal and is thereby maintained at an even temperature; this reduces the likelihood of local solidification of metal or variations in alloy composition.

However, the need to surround the apparatus with molten metal leads to difficulties in maintaining the apparatus. Normally the cylinder and valve are bolted on a side wall of the tank. The cylinder must be positioned very accurately to align with the cooperating piston ald its operating means which is mounted overhead on the machine frame. The cylinder is fixed at its lower end onto a block which is bolted rigidly to the valve body. The valve body is attached to the tank wall by bolts passing through holes in the tank wall from the outside into receiving threaded holes in the valve body which bolts are then tightened or released from outside. Often further pieces of apparatus are bolted on to the outside wall of the tank over the heads of the bolts for the cylinder or valve mountings.

While such an arrangement keeps the bolts out of the tank of molten metal and can locate the cylinder and valve firmly and accurately it has several drawbacks.

It is necessary to be able to remove the cylinder and valve for maintenance and repair purposes. With the conventional arrangement the tank must be drained so that the cylinder and valve can be removed from their mountings and lifted out of the tank and this involves considerable downtime. There are also many bolts to be undone in diverse places and often other components must be removed to gain access to those bolts. This all means that removal of the cylinder and valve for routine maintenance or repair is time consuming and costly.

It is also known from GB-2063127 to provide casting apparatus comprising a tank receiving molten metal in use, a housing comprising a dispensing cylinder and a valve means in communication with the cylinder, locating means for removably locating the housing in the tank, a dispensing port, connection means defining a passageway between the valve means and the dispensing port, the connection means including a releasable coupling through which the passageway normally extends ard having first and second parts which are separable to facilitate removal of the housing, the first and second parts being connected to the dispensing port and the valve means respectively and being relatively swivelable to allow adjustment of the housing relative to the tank.

A disadvantage of this arrangement is that air may enter the connection means when the coupling is released to allow removal of the housing.

According to the present invention the casting apparatus is characterised in that the first part of the coupling is mounted on an internal surface of the tank beneath the normal level of molten metal in the tank.

Preferably the first part of the coupling comprises a domed projection which projects upwardly from a bottom surface of the tank and the second part of the coupling comprises an annular seat through which the passageway communicates with the valve means. The coupling is therefore in effect a ball and socket coupling allowing three-axis adjustment of the housing position relative to the tank. An advantage of such an arrangement is that the domed projection also assists in locating the housing relative to the tank during reassembly.

Preferably the apparatus includes clamping means operable to clamp the housing in position relative to the tank, which clamping means includes a compliant mounting facilitating limited movement of the housing.

An advantage of such an arrangement is that the compliant mounting functions to relieve stress resulting from expansion or contraction of metal in the tank in the event of solidification occuring.

Preferably the clamping means comprises spring means operable to bias the housing in a downward direction towards the bottom surface of the tank. Such spring bias is needed to counter the upward pull created by suction in the cylinder when the piston is raised to recharge the cylinder. The spring bias is also necessary to counter the tendency for the casting apparatus to float when immersed in molten metal of greater density than the components of the apparatus. The spring bias also ensures complete sealing between the domed projection and the seat which together comprise the coupling.

Preferably the clamping means comprises at least one rod connected to the housing and extending upwardly so as to project above the normal level of molten metal in the tank and a frame fixed to the tank and overlying the housing, the spring means being operable between the frame and the rod so as to downwardly bias the rod. An advantage of such an arrangement is that the clamping means can be actuated and adjusted externally of the molten metal within the tank.

Conveniently the locating means comprises a plurality of pegs projecting downwardly from the housing to an adjustable extent and engaging cooperating holes provided in bosses projecting upwardly of a bottom surface of the tank. The attitude of the housing relative to the tank can be adjusted by adjusting the extent to which the pegs project. It is important to ensure correct alignment of the piston and cylinder when the piston is actuated from an actuating mechanism mounted on a frame overlying the tank.

Advantageously the conrecting means comprises an outlet pipe extending between the first part of the coupling and the dispensirg port and wherein the outlet pipe passes through the tank such that the passageway defined therein is located beneath the normal level of molten metal within the tank. This arrangement ensures that the cutlet pipe is maintained at the temperature of molten metal within the tank and also ensures that positive liquid pressure exists within the passageway so that the likelihood of air being drawn into the passageway is reduced.

Preferably the housing comprises a mounting block extending horizontally in use, the dispensing cylinder being connected to one end of the mounting block so as to extend vertically upwards therefrom and the valve means being connected to the other end of the mounting block, the mounting block being provided with a horizontally extending conduit communicating between the cylinder and the valve means.

Preferably the valve means has a first port for communication with molten metal in the tank, a second port for communication with tha cylinder via the connecting means and a third port for communication with the dispensing port. For example, a 3-way ball valve such as that described in our copending European Patent Application No 90301038 may be employed or a 3-way plug valve may be employed such as that described in United States pending patent application No. 268492 filed 8th November 1988.

The invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a sectional view through casting apparatus according to the invention;

Figure 2 is a staggered cross-sectional view through the apparatus with the left hand side taken on direction A-A of Figure 1 and the right hand side taken through line B-B of Figure 1. For clarity many details have been omitted from this drawing;

Figure 3 is a plan view of the mounting block of the apparatus of the invention. Again many details have been omitted for clarity;

Figure 4 is a cross-section through the compliant mounting means for the clamping means along line C-C′ in Figure 3; and

Figure 5 is an end elevation of an alternative casting apparatus having a modified clamping means.

Referring to Figures 1 to 4, the casting apparatus indicated generally by 1 is suitable for casting metal alloys having low melting temperatures for example having solidus temperatures in the range of 35 to 300 °C. The apparatus 1 has a tank 2 to hold molten alloy 3 with its normal level shown as 3a. The tank 2 is insulated so that the alloy 3 may be maintained in its molten state. Within the tank 2 and immersed in the molten alloy 3 is a cylinder 4 and cooperating piston 5. The piston 5 may be hydraulically, pneumatically or otherwise operated. The cylinder 4 is mounted so as to extend upwardly from a rear end 50 of a horizontally extending mounting block 11. A valve indicated generally by 8 is mounted within a front end 51 of the mounting block 11. The cylinder 4, mounting block 11 and valve 8 are normally bolted together as a single unit or housing 73.

The cylinder 4 has a lower end plate 52 in which is formed an opening 6 which opens into a conduit 7 which communicates with the valve 8. The conduit 7 extends horizontally through mount-

ing block 11. The opening 6 acts as both the inlet and the outlet of the cylinder 4 and is situated so that it is below the piston 5 at all times during operation.

The illustrated valve B is a 3-port ball valve which may be hydraulically, pneumatically or otherwise operated. The 3-port ball valve 8 has a ball 9 mounted on a lower end 53 of a vertically extending stem 54 and located between seats 38 and 39. The valve 8 is provided with an upwardly directed first port 55 which is open to the molten alloy 3 within the tank 2, a laterally located second port 56 which opens to the connecting means 7 and so is in communication with cylinder 4 and a downwardly directed third port 57 which is in communication with the dispensing port 10 via a releasable coupling 59, 61 (described below) and a pipe 80 defining a passageway 81. Normally the dispensing port 10 will be connected to a die (not shown) via a flow valve (not shown) which may be operated by a rotary actuator. The dispensing port 10 is positioned just below the normal level 3a of the molten metal 3. This is to ensure that positive pressure always exists in the passageway 81 so that air bubbles are not drawn back into the apparatus during operation by the presence of any leakage.

The movements of piston 5 and valve stem 54 are controlled, for example by electrical control means, so that they cooperate together to dispense molten metal from the tank through the dispensing port 10. The piston 5 and stem 54 are detachable from their respective operating means so that the dispensing cylinder, ball valve and mounting block can be removed from the tank.

During assembly of the casting apparatus 1, both the cylinder 4 and the valve 8 are secured to the mounting block 11 with the cylinder 4 being mounted so as to extend upwardly from the block and the valve 8 forming a horizontal extension of the mounting block. The mounting block 11 is then located on the base plate 60 of the tank 2 via rear and front location means 12, 14 respectively and secured by clamping means 13. The location means consist of rear, and front means indicated generally by 12 and 14 respectively. The clamping means are indicated generally by 13. The location means 12 and clamping means 13 are more clearly illustrated in Figures 2 and 3.

From Figure 3 it can be seen that there are two rear location means 12 one on either side of the mounting block 11 and similarly two clamping means 13 one on either side of the mounting block. There is only one front location means 14. Figure 2 is a staggered cross-section which on the left hand side cuts through rear left location means 12 and on the right hand side cuts through right clamping means 13. The corresponding left clamping means 13 which should appear in the left hand side of Figure 2 has been omitted for clarity.

Rear location means 12 consists of support 16 protruding laterally from the rear end 50 of the mounting block 11 and is provided with a threaded vertical bore 5s through which passes a cooperating threaded screw 17. A smooth peg 18 forms a downward projection of the screw 17 which is of narrower cross-section than the rest of the screw. The peg 18 is normally received within a cooperating hole 20 in a boss 19 which is fixed to and projects upwardly from a horizontal base plate 60 of the tank. The rear of the mounting block 11 is thus located both vertically and laterally by the rear location means 12.

The front location means 14 consists of a domed projection 59 having a generally spherical domed surface 15. The projection 59 projects upwardly from a bottom surface 82 of the tank 2 defined by the base plate 60 and is provided with a vertically extending passage 30 therethrough. The passage 30 is aligned with port 57 of the ball valve 8 to provide communication between the value and the dispensing port 10. The ball valve 8 is provided with an annular seat 61 which sits on the top of the domed projection 59 and seals therewith.

The projection 59 and the annular seat 61 are relatively swivelable whilst continuing to provide communication between the passage 30 and the port 57 so that the orientation of the housing 73 relative to the tank 2 is possible. The projection 59 and annular seat 61 are separated when the housing is removed from the tank 2 and thereby constitute a releasable coupling 59, 61.

The clamping means 13 consists of a support 21 which projects horizontally on each side from the middle of the mounting block 11 and which is provided with a smooth vertical bore 62 through which passes a vertical clamping rod 22. The clamping rod 22 has a threaded lower end 23 which cooperates with a threaded boss 24 which is mounted through a compliant mounting means 43 to the base plate 60 of the tank 2. The clamping rod 22 is also provided with a collar 25 which is wider than the bore 62 in the support 21 so that it limits downward movement of the rod 20. A second collar 41 on the clamping rod is spaced beneath the support 21 and limits upward movement of the rod 22 relative to the support. The upper end of the rod 22 is provided with a hexagonal head 63 to facilitate turning of the rod 22 to screw or unscrew the rod 22 in the boss 24.

The compliant mounting means 43 accomodates local strains caused by solidification or melting of alloy 3 beneath the mounting block 11. Some alloys, for example bismuth alloys expand on solidification and this can produce local strains underneath the mounting block 11. Alloys which contract on solidification can also cause strain on

remelting. The compliant mounting means 43 permits the mounting block 11 to rise or fall slightly in relation to the base plate 60 of the tank 2. Thus the boss 24 into which the clamping rod 22 is screwed is welded to the centre of a rectangular horizontal metal plate 64 provided at each end with a downward extension 44 through which a smooth bore 46 has been drilled. The plate 64 is then fixed to the base plate 60 of the tank 2 by two screws 45 which pass through the smooth bore and then screw into the tank base. The plate 64 and extensions 44 constitute the compliant mounting means 43. The metal plate 64 has some inherent flexibility enabling boss 24 to move up and down relative to the tank base plate 60.

A loop 40 is connected in an upwardly extending position to the mounting block 11 so that a long rod (not shown) with a hook on the end may be hooked through the loop to lift the mounting block from the tank.

At start up, before the tank 2 is filled with molten alloy 3, the mounting block ww complete with dispensing cylinder 4 and ball valve 8 secured thereto is lowered into the tank so that the two pegs 18 rest in the holes 20 of the two bosses 19 and the annular seat 61 of of the ball valve 8 around the port 57 rests on the domed surface 15 of projection 59. The screws 17 may then be screwed up and down and the mounting block 11 tilted on the domed surface 15 until the dispensing cylinder 4 and piston 5 are correctly aligned to connect the operating means. The presence of both the screws 17 and the domed surface 15 provides great flexibility in the positioning of the mounting block 11 and facilitates very accurate positioning. Once the screws 17 have been adjusted to the correct position they need not again be altered and may be fixed in position by means of lock nuts 42 The mounting block 11 can then be removed from the tank 2 and returned without need for further adjustment of screws 17.

Once the positioning of the mounting block 11 has been correctly aligned it can be clamped in position by means of the clamping means 13. The two rods 22 are screwed into the corresponding bosses 24 with the aid of a hexagonal socket and extension bar (not shown) inserted from above. The mounting block 11, dispensing cylinder 4 and ball valve 8 are then all held firmly in position.

Piston 5 and valve stem 9c are then connected to their respective operating means (not shown).

The tank 2 is then filled with molten alloy to its normal level 3a and the metal dispensed by operation of the piston 5. Initially the piston 5 is in its up position and the cylinder 4 is full of molten alloy 3. In operation the control system actuates the piston 5 so that it begins to move down. The speed of the piston is controlled by the control system. As the piston 5 starts to move down the control system also actuates the 3-port ball valve 8 so that the second and third ports 56 and 57 are open and in communication with one another. The first port 55 is closed, closing the supply of molten alloy 3 from the tank 2 to the cylinder 4. As the piston 5 continues to move down molten alloy 3 is forced from the cylinder 4 along the connecting means 7 through the second port 56 and out through the third port 57 to the dispensing port 10 from which it is dispensed to a die. Once this dispensing stroke of the piston 5 is complete, the control system operates the ball valve 8 so that the third port 57 is closed and first and second ports 55 and 56 are open and then retracts the piston 5 so that the molten alloy 3 is drawn from the tank 2 through ports 55 and 56 along the connecting means 7 and into the cylinder. The ball valve 8 is then again actuated to close port 55 and open ports 56 and 57 so that molten alloy can once again be dispersed.

After many cycles it will be necessary to remove the ball valve 8 for maintenance or repair. With the casting apparatus 1 of the present invention this is a very simple procedure and there is no need to drain the tank 2 fully. The level 3a of metal alloy 3 is allowed to drop below the dispensing port 10 to level 3b so that, when the dispensing cylinder 4 and valve 8 are disconnected metal alloy can not syphon out through the dispensing port 10. Then one simply unscrews the rods 22 with the aid of a hexagonal socket so as to unclamp the mounting block 11. One also uncouples the piston 5 and stem 54 from their respective operating means. A long rod with a hook on the end is then lowered into the molten metal and hooked beneath loop 40. Then when the rod is pulled vertically upwards the mounting block together with the attached dispensing cylinder 4 and ball valve 8 is removed in one piece from the tank. The mounting block 11, dispensing cylinder 4 and ball valve 8 can then be cleaned and examined for maintenance and repair purposes. When it is desired to return the mounting block 11 to the tank 2 it is simply necessary to lower the mounting block back into the tank using the rod hooked around the loop 40. The mounting block must le carefully positioned so that the pegs 18 on the bottom of screws 17 drop into the holes provided for them in the bosses 19 mounted on the base plate 60 of the tank 2. The other end 51 of the mounting block 11 will then sit on the domed surface 15 of projection 59. It then remains only to lower the clamping rods 22 onto the bosses 24 and then to screw them up so that the threaded ends 23 bite on the threads provided in the bosses 24 mounted on the base plate 60 of the tank 2.

It will be appreciated that this provides a very quick and simple way of removing both the cylinder 4 and the valve 8 from the tank 2.

A further advantage of the apparatus of the present invention is that it enables one easily to substitute a dispensing cylinder of one diameter for a dispensing cylinder of greater or lesser diameter. One normally chooses the diameter of the cylinder 4 and the cooperating piston 5 according to the quantity of the metal alloy 3 which one wants to dispense. Because with the prior art mounting arrangements it was so cumbersome to remove a dispensing cylinder from a tank, changing to a dispensing cylinder of a different size has previously involved a large amount of downtime and loss of production. With the casting apparatus 1 of the present invention it is much more simple to remove the dispensing cylinder 4 and this can easily be substituted for one of a different size. The different cylinder could be mounted to the same mounting block 11 in place of the original cylinder 4 or a separate mounting block assembly and cylinder could be substituted for the original mounting block assembly and cylinder.

If desired, one may even use an alternative mounting block (not shown) which has two dispensing cylinders mounted on it for operation by two separate operating means and which both dispense into the connecting passage 7.

Additional compliance of the compliant mounting means 43 may be provided by placing a coil spring or stack of disc springs between the head of each screw 45 and the metal plate 64 thus enabling the metal plate to move upwardly when subjected to a force sufficient to compress the springs.

An alternative casting apparatus 70 is shown in Figure 5 and will now be described using corresponding reference numerals to those of preceding Figures for corresponding elements where appropriate.

The alternative casting apparatus 70 differs from the casting apparatus 1 of Figures 1 to 4 in that it includes a modified clamping means 71. The clamping means 71 includes a frame 72 rigidly connected to the tank 2 and extending above the normal level 3a of alloy 3 so as to overlay the housing 73.

Horizontally extending supports 21 project from opposite sides of the mounting block 11 of the housing 73 and each support is bored vertically to receive a vertically extending clamping rod 22. Each clamping rod 22 has a tubular upper end portion 74 to which is welded a lower boss 75. A screw-threaded bolt 76 projects downwardly through the frame 72 to an extent which is adjustable by screw action and has a downward projecting spigot 77 of smaller diameter received as a loose fit within the tubular upper end 74.

An upper boss 78 is a sliding fit on the spigot 77 and a coiled compression spring 79 is located between the upper and lower bosses 75 and 78. Since the frame 72 is fixed the rods 22 are biassed downwardly by the compression springs 79 and this bias is communicated through the supports 21 to downwardly bias the housing 73. This bias ensures sealing engagement between the domed surface 15 and the annular seat 61 of the valve 8. Adjustment of the orientation of the housing. 73 relative to the tank 2 is possible by adjusting the rear locating means such that the annular seat 61 swivels relative to the domed projection 59 with corresponding tilting of the housing 73. The rods 22 are received as a loose fit within the supports 21 such that tilting of the housing 73 during adjustment results in minimal lateral movement of the upper ends 74. The loose fit of the spigots 77 within the upper ends 74 accommodates sufficient tilting of the rods 21 during such alignment.

The frame 72 is rigidly bolted to the tank 2. When it is required to remove the mounting block 11 from the tank together with the valve 8 and cylinder 4 then the bolts 76 are unscrewed to lift the spigots 77 clear of the springs 79 to uncouple the rods 22. The mounting block 11 together with the cylinder 4 and valve 8 float to the surface of the alloy 3 and can be easily removed.

As the mounting block 11 is lifted clear of the domed projection 59 the passage 30 in the projection communicates directly with the molten metal 3 in the tank 2 so that no air is admitted to the pipe 80. The housing 73 can subsequently be replaced or an alternative housing located in the tank without there being any risk of introducing air into the pipe 80.

During insertion of the housing 73 into the tank 2 the domed projection 59 facilitates location of the housing as well as the left and right rear locating means 12.

The springs 79 and upper and lower bosses 78 and 75 respectively provide compliant mounting means for the housing 73 such that the housing can be lifted away from the bottom surface 82 if sufficient pressure is applied for example by virtue of metal between the bottom surface and the housing solidifying and expanding. Such compliant mounting means 75, 78, 79 thereby prevent damage from resulting which might otherwise occur if for example the housing were bolted rigidly to the tank 2. The pressure exerted by the springs 79 is however adjusted such that sufficient downward force is applied not only to prevent flotation of the housing 73 but also to resist lifting of the housing due to upward movement of the piston 5 which creates suction within the cylinder 4 in order to recharge the cylinder with molten metal.

The alternative casting apparatus 70 also includes rear locating means 12 as described with reference to the apparatus 1 and as shown in the

left half of Figure 2. Details of the rear locating means 12 are omitted from Figure 5 for clarity.

The coupling may alternatively comprise a domed projection extending downwardly from the housing and locatable in an annular seat formed in the tank.

Claims

1. Casting apparatus (1) comprising a tank (2) receiving molten metal (3) in use, a housing (73) comprising a dispensing cylinder (4) and a valve means (8) in communication with the cylinder, locating means (12,14) for removably locating the housing in the tank, a dispensing port (10), connection means (80) defining a passageway (30,81) between the valve means and the dispensing port, the connection means including a releasable coupling (59,61) through which the passageway normally extends and having first and second parts (59,61) which are separable to facilitate removal of the housing, the first and second parts being connected to the dispensing port and the valve means respectively and being relatively swivelable to allow adjustment of the housing relative to the tank, characterised in that the first part (59) of the coupling is mounted on an internal surface (82) of the tank beneath the normal level (3a) of molten metal in the tank.

2. Casting apparatus as claimed in claim 1 wherein the first part (59) of the coupling comprises a domed projection (59) which projects upwardly from a bottom surface (82) of the tank and the second part (61) of the coupling comprises an annular seat (61) through which the passageway (30) communicates with the valve means.

3. Casting apparatus as claimed in any preceding claim including clamping means (13) operable to clamp the housing in position relative to the tank, which clamping means includes a compliant mounting (43, 71) facilitating limited movement of the housing.

4. Casting apparatus as claimed in claim 3 wherein the clamping means (71) comprises spring means (79) operable to bias the housing (73) in a downward direction towards the bottom surface (82) of the tank (2).

5. Casting apparatus as claimed in claim 4 wherein the clamping means (71) comprises at least one rod (22) connected to the housing and extending upwardly so as to project above the normal level (3a) of molten metal (3) in the tank (2) and a frame (72) fixed to the tank and overlying the housing, the spring means being operable between the frame and the rod so as to downwardly bias the rod.

6. Casting apparatus as claimed in any preceding claim wherein the locating means (12, 14) comprises a plurality of pegs (18) projecting downwardly from the housing to an adjustable extent and engaging cooperating holes (20) provided in bosses (19) projecting upwardly of the bottom surface (82) of the tank.

7. Casting apparatus as claimed in any preceding claim wherein the connecting means comprises an outlet pipe (80) extending between the first part (59) of the coupling and the dispensing port (10) and wherein the outlet pipe passes through the tank (2) such that the passageway (81) defined therein is located beneath the normal level (3a) of molten metal (3) within the tank.

8. Casting apparatus as claimed in any preceding claim wherein the housing (73) comprises a mounting block (11) extending horizontally in use, the dispensing cylinder (4) being connected to one end (50) of the mounting block so as to extend vertically upwards therefrom and the valve means (8) being connected to the other end (51) of the mounting block, the mounting block being provided with a conduit (7) communicating between the cylinder and the valve means.

9. Casting apparatus as claimed in any preceding claim wherein the valve means comprises a 3-way ball valve (8) actuable between a first position in which the cylinder (4) is placed in communication with the second part (61) of the coupling for dispensing molten metal to the dispensing port (10) and a second position in which the cylinder is placed in communication with the molten metal (3) in the tank (2) for recharging the cylinder.

FIG. 1.

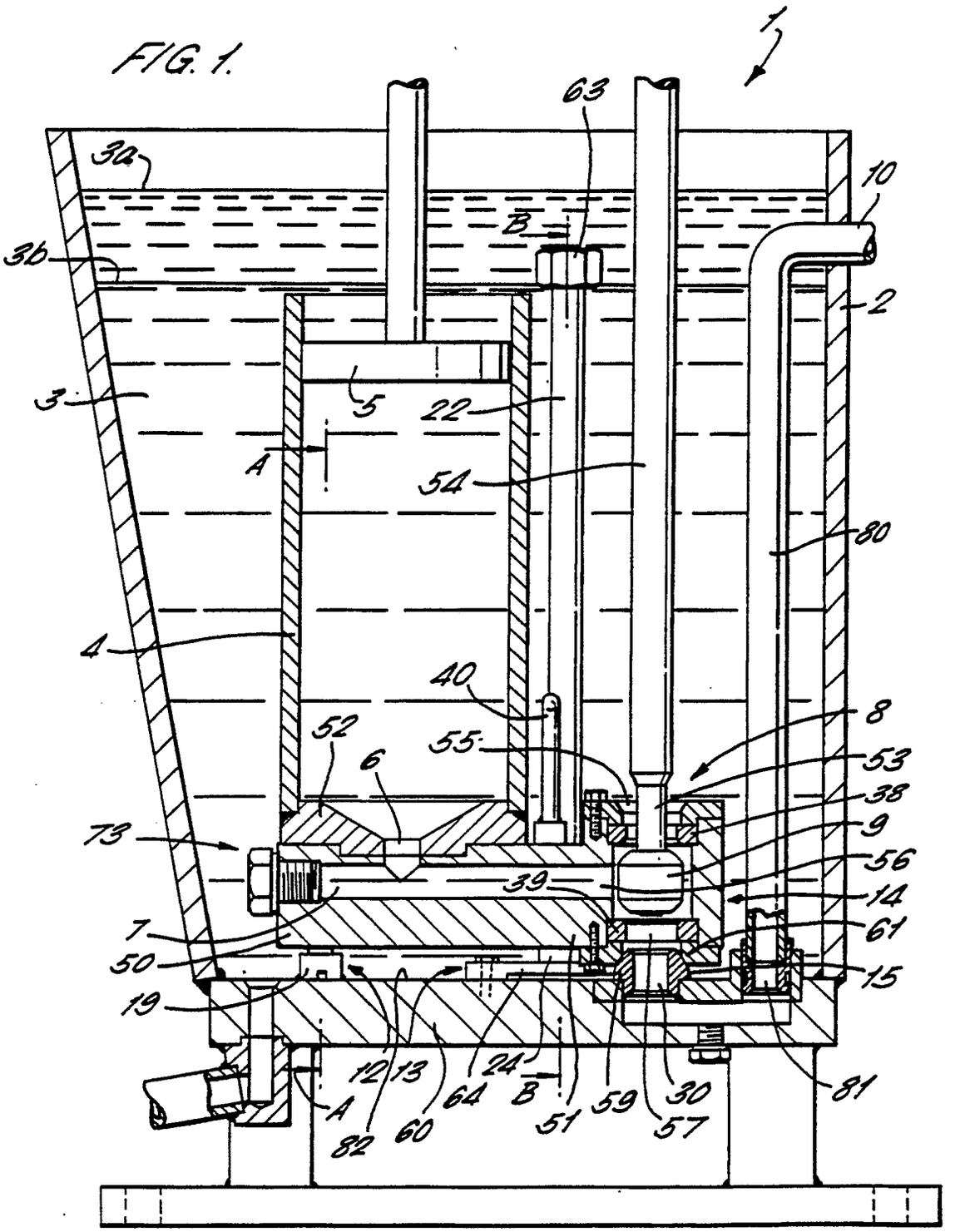
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FIG. 2.

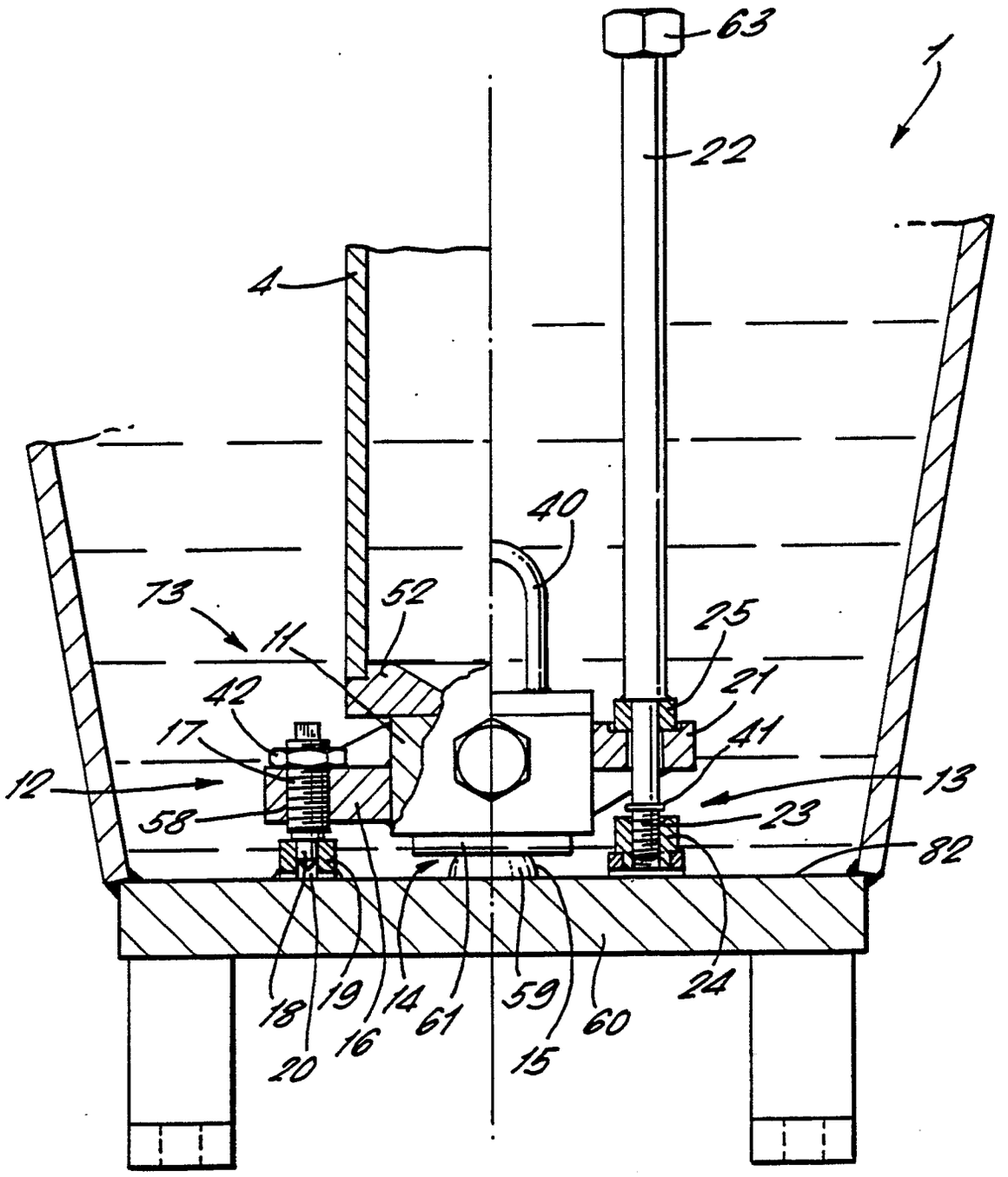
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FIG. 3.

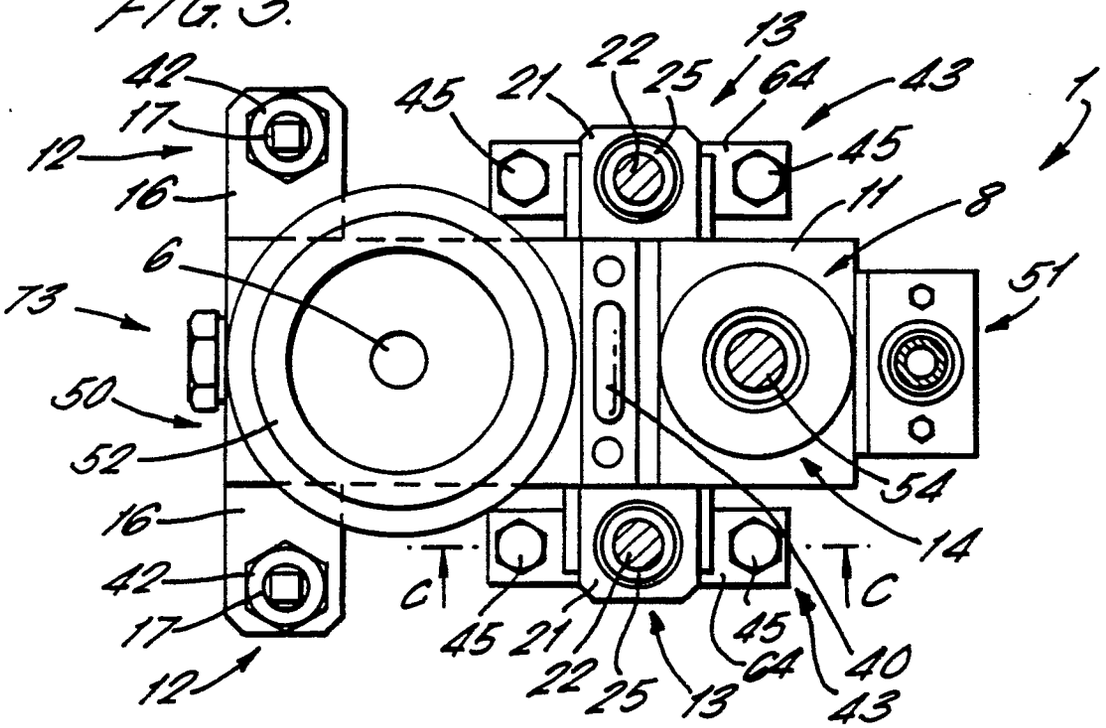
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FIG. 4.

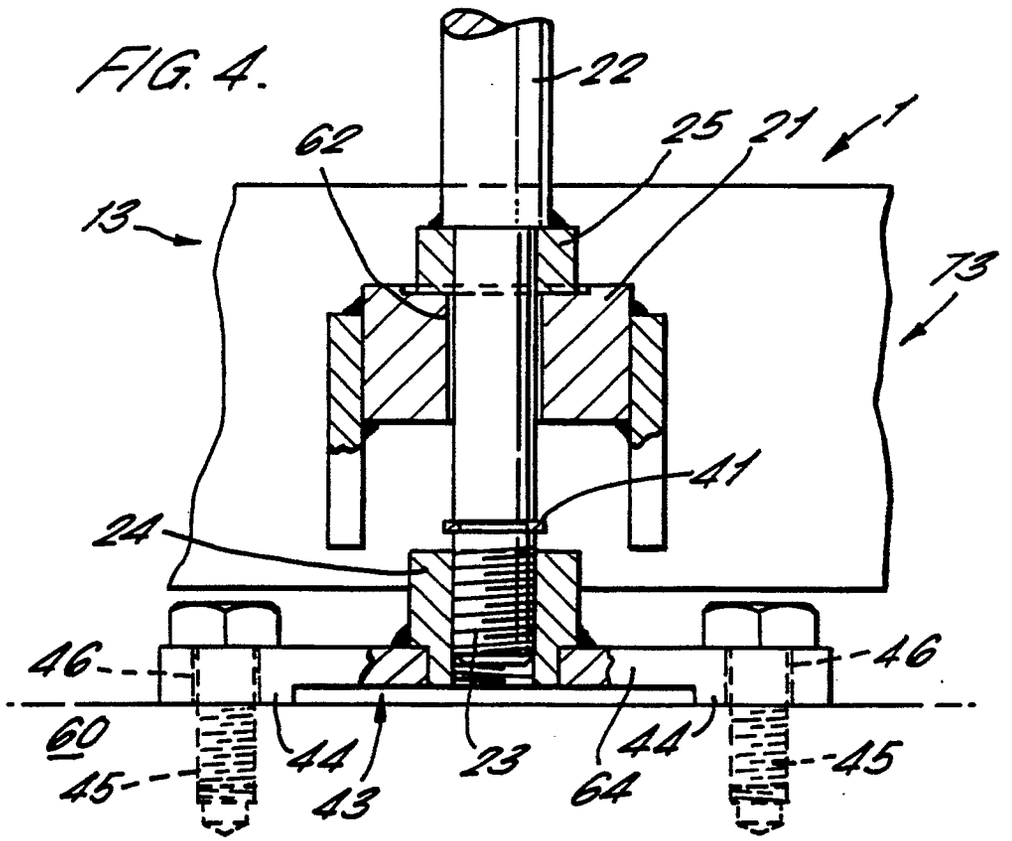
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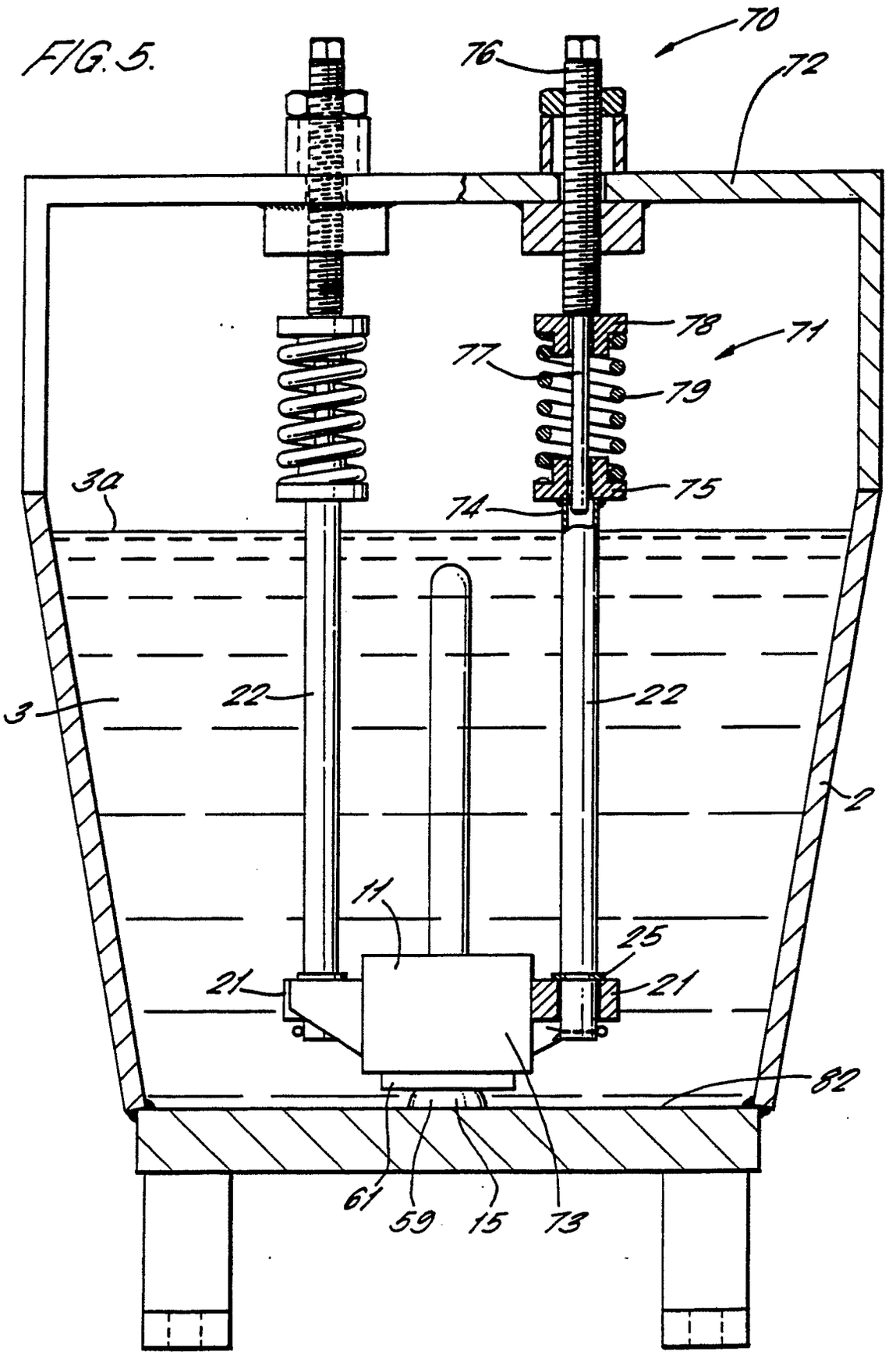
FIG. 5.



European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 90 30 6052

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.5)
A	GB-A- 624 584 (H.G.V. BULLOCK) * Whole document *	1,3,5	B 22 D 17/04
A	US-A-1 947 876 (J.E. RHOADS et al.) * Figure 1; page 2, lines 1-20 *	1	
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TECHNICAL FIELDS SEARCHED (Int. Cl.5)

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	27-07-1990	MAILLIARD A.M.

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