United States Patent [19]

Paterson et al.

[11] **3,734,673**

[45] **May 22, 1973**

[54] DIE CASTING AND LIKE APPARATUS

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[22] Filed: **Mar. 30, 1971**

[21] Appl. No.: **129,397**

[30] **Foreign Application Priority Data**

Apr. 4, 1970 Great Britain.....16,052/70

[52] **U.S. Cl.**.....**425/450,** 164/303

[51] **Int. Cl.**.....**B22d 17/10**

[58] **Field of Search**.....164/303, 306, 314, 164/315, 321, 323, 120, 292, 309, 312, 316, 343, 304, 305, 307, 308, 313; 425/150, 243, 248, 249, 450, 149, 1, 190, 251, 412, 441; 60/54

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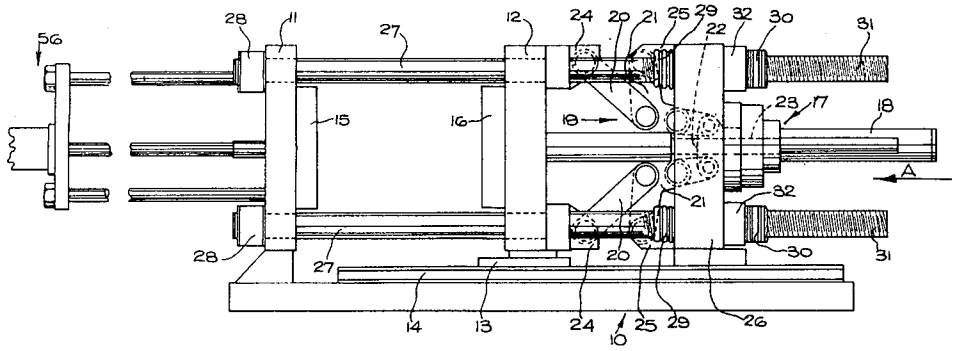
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Primary Examiner—J. Spencer Overholser
Assistant Examiner—John S. Brown
Attorney—Merriam, Marshall, Shapiro & Klose

[57] **ABSTRACT**

In die casting, injection moulding or like apparatus having tie bars which are subjected to tensile stress when die carrying members are moved to a die-closed position, a respective liquid-filled chamber is interposed in the stress path through each tie bar. The chambers have movable wall parts so arranged that the pressure of fluid in the chamber varies as the tension in the associated tie bar, and the chambers are interconnected to equalize pressures therein and therefore to equalize tensions in the tie bars. The chambers may also communicate with pressure relief means such as a pressure relief valve, a reservoir pressurized by a gas, or a solid state resilient element which can yield to provide a local increase in the space available for accommodation of the liquid.

8 Claims, 4 Drawing Figures



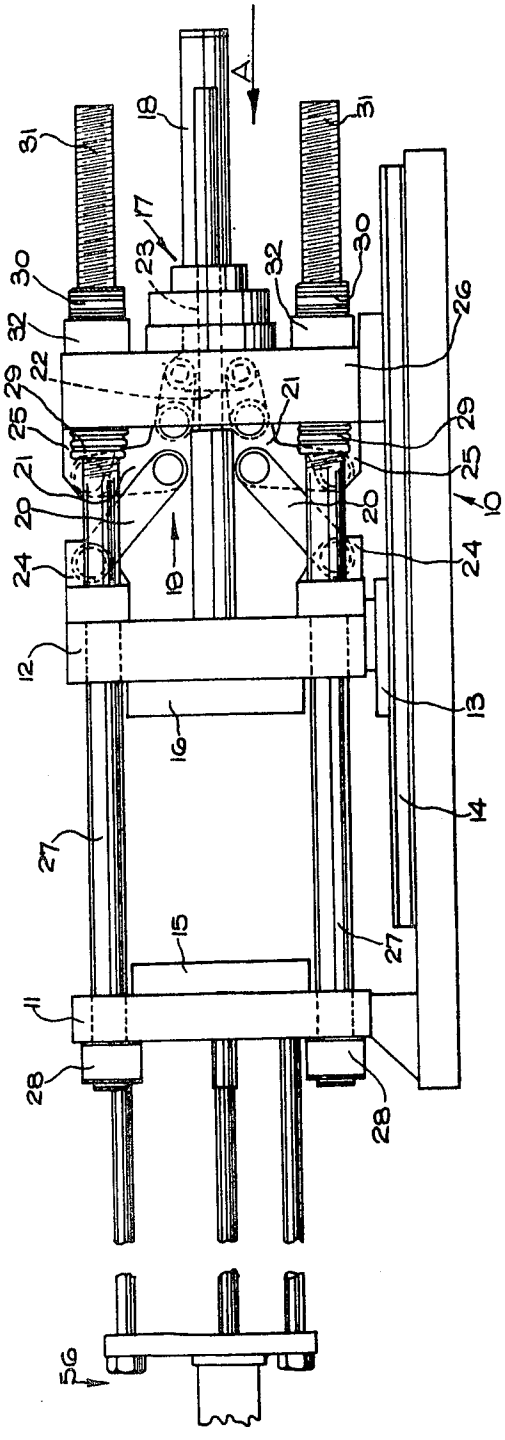


Fig. 1

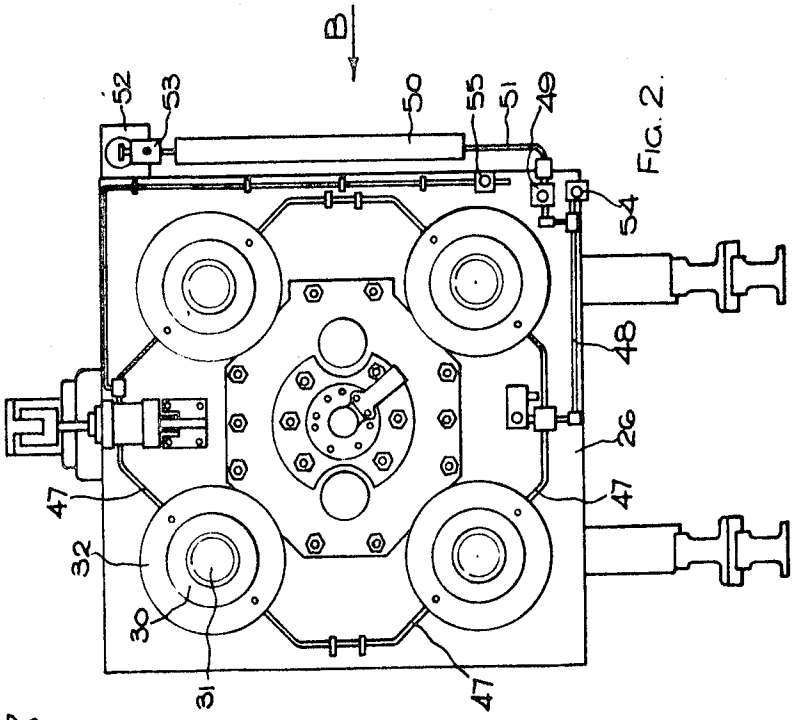

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FIG. 2

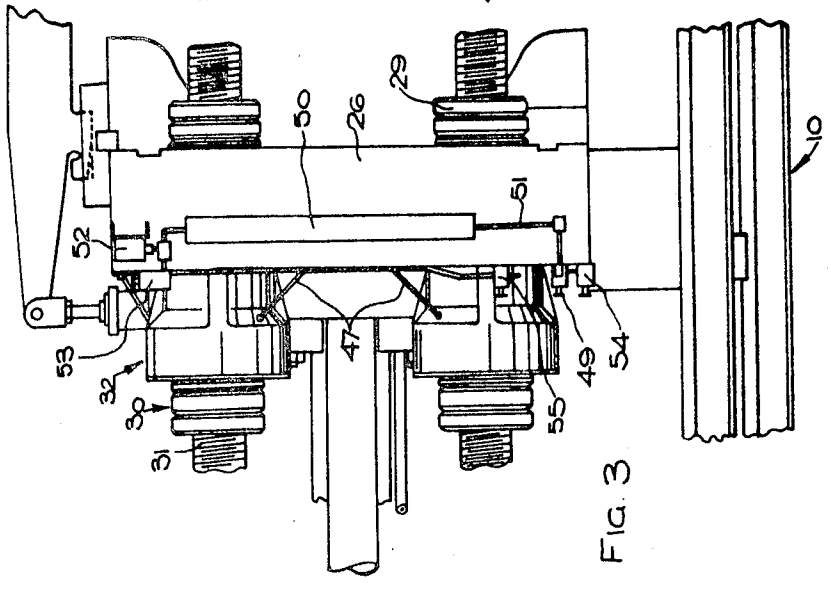

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FIG. 3

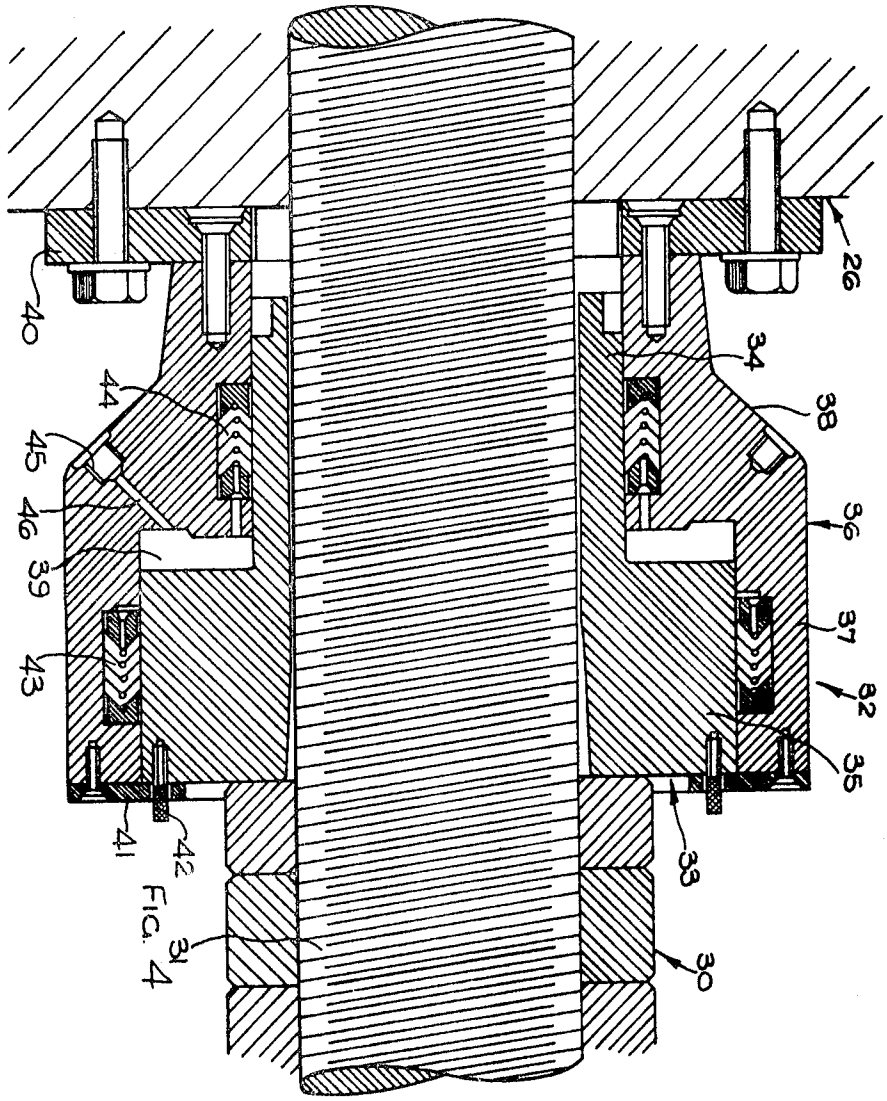


FIG. 4

DIE CASTING AND LIKE APPARATUS

BACKGROUND TO THE INVENTION

This invention relates to die casting, injection moulding or like apparatus comprising a body, first and second members mounted on the body and which, when the apparatus is in use, are moved relative to each other between first and second positions, in the former of which positions the members or respective parts carried thereby are closed to one another and in the latter of which positions the members or the parts carried thereby are spaced apart, actuating means for effecting such relative movement and for establishing a contact pressure between the members or parts carried thereby when in said first position, and a plurality of elongate tie elements which extend parallel to the direction of said relative movement and which are arranged to bear collectively the stress produced upon operation of the actuating means to establish said contact pressure, the tie elements then being subjected to a tensile stress.

The invention has been developed primarily in relation to die casting apparatus in which the particular problems which it is the object of the invention to overcome or reduce are hereinafter more fully explained. It will however, be understood that the invention may be applied to other forms of apparatus, of which an injection moulding apparatus is one example, and a power press is another example, in which similar or analogous problems arise.

In die casting apparatus it is common practice to provide two die supporting members (the first and second members hereinbefore referred to) one of these being stationarily mounted on the body of the machine and the other being movably mounted and moved by the actuating means towards and away from the fixed member. When the movable member is moved towards the fixed member the die parts carried by the two members respectively come into abutting relation at the parting or separating surfaces of the die parts and are held by the actuating means in a closed position defining the die cavity. The actuating means usually comprises a form of mechanism which provides an extremely high closure force, holding the die parts in contact with each other, such as a toggle mechanism in which the toggle arms are in a straight or nearly straight position when the die supporting members are in the first position hereinbefore mentioned.

To ensure that the abutting surfaces of the die parts remain accurately parallel to each other, it is common practice to provide a plurality of tie elements, conveniently in the form of rods, which are connected to the fixed die supporting member at positions spaced apart around the periphery thereof and are also connected to a support for supporting the actuating means or part thereof.

Ideally, these tie rods are stressed equally, and when the die supporting members are moved to their first position the stress has a predetermined value which is sufficient to prevent escape of metal from the die cavity between the surfaces of the die parts abutting each other on the parting plane, but is below a valve which would cause excessive wear or damage to the actuating means or other parts of the apparatus.

After a period of operation the temperature of the die parts rises and the dimension which collectively they present between the movable and fixed die supporting members increases due to thermal expansion exceeding that of the tie rods.

In consequence of this contact pressure between the abutting faces of the die parts may rise above the proper value. Furthermore, the stress borne by the tie rods may become unequal as between one tie rod and another due to differential heating or other causes.

Considerable time and skill has hitherto been consumed in adjusting tensioning nuts on the tie rods to ensure that so far as possible each will be stressed equally.

SUMMARY OF THE INVENTION

It is an object of the invention to provide die casting or like apparatus of the kind referred to wherein unequal tensioning of the tie rods is avoided.

According to the invention there is provided in die casting or like apparatus of the kind referred to a plurality of chambers which, when the apparatus is in use, are filled with fluid, each chanber being interposed in the stress path to or through a respective one of the tie elements and comprising relatively movable wall portions for transmitting said stress through said fluid, and duct means for interconnecting all of said chambers whereby the respective fluid pressures in the latter are equalised.

With this construction a predetermined relationship is maintained between the stress in each of the tie elements. For example, if the tie elements are in the form of rods having the same cross-section as one another, and the respective chambers associated with the tie rods are all of the same construction, equal stress will be maintained in all of the tie elements.

Preferably, the chambers all communicate with pressure relief means.

The pressure relief means is operative to prevent an excessive contact pressure between the first and second members or parts carried thereby, and to prevent the tie elements and components of the actuating means from being stressed excessively.

The pressure relief means may operate either to prevent stress in the tie elements exceeding a predetermined maximum value, or to reduce the mangitude of an increase of the stress in the tie elements, as compared with the increase which would occur in the absence of the pressure relief means. Thus, the pressure relief means may comprise a pressure relief valve for limiting the pressure which can exist in said chambers. Additionally, or alternatively, the pressure relief means may comprise a reservoir, at least an upper part of which contains a gaseous fluid under pressure, the chambers being filled with liquid and the arrangement being such that liquid can be expelled from said chambers into a lower part of the reservoir.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic representation of a die casting apparatus in accordance with the invention, the die supporting members being shown in the second position and the duct means being omitted,

FIG. 2 is an end view of a die casting apparatus corresponding to a view on the arrow A of FIG. 1 and on an enlarged scale as compared with FIG. 1,

FIG. 3 is a fragmentary view on the arrow B of FIG. 2, and

FIG. 4 is a fragmentary view on a further enlarged scale showing in diametral cross-section one of the

chambers of FIGS. 2 and 3, together with a tie element associated with the chamber.

DETAILED DESCRIPTION

The apparatus of FIG. 1 comprises a body indicated generally by the reference 10 on which is mounted an upstanding die supporting member in the form of a plate 11 which is fixed with respect to the body. A further die supporting member, also in the form of a plate 12, is mounted on the body for sliding movement towards and away from the plate 11, the plate 12 being provided for this purpose with a slide portion 13 operating in a guideway 14 on the body 10.

The die parts carried respectively by the die supporting plates 11 and 12 are shown in outline at 15 and 16.

At the side of the movable die supporting plate 12 remote from the fixed die supporting plate 11 is provided an actuating means indicated generally at 17. This includes a pressure fluid ram 18 adapted to be energised hydraulically or pneumatically and a toggle mechanism 19 operatively connecting the piston rod of the ram to the movable die supporting plate 12.

For this purpose the toggle mechanism comprises upper and lower pairs of toggle arms 20 and 21 shown diagrammatically, the joint between each pair of toggle arms being connected by an equalising link 22 which in turn is connected to the piston rod 23 of the ram 18.

The toggle links 20 and 21 are pivotally connected to bearing blocks 24 and 25 respectively on the movable die supporting plate 12 and on a support, also in the form of a plate 26, slidably mounted on the body 10 and apertured for the passage of the piston rod 23 of the ram therethrough.

The support 26 is connected to the fixed die supporting plate 11 by a plurality of tie elements in the form of rods 27 which extend through openings in the movable die supporting plate 12 and have a secondary function in guiding same and assisting the maintenance of parallelism between the die supporting plates 11 and 12.

The tie rods 27 terminate at their left-hand ends, as seen in FIG. 1, in screw threaded spigots passing through openings, in the fixed die supporting plate 11, these spigots carrying securing nuts 28 which are tightened to cause the plate 11 to abut the shoulder at the junction of the spigot and the main part of the tie rod in each case.

At the other end each tie rod 27 is formed with a screw-threaded portion 31 onto which is threaded an abutment nut 29 bearing against the left-hand face of the support 26. A further abutment nut 30 is provided on the screw-threaded portion of each tie rod to the right-hand side of the support 26. Between each of the abutment nuts 30 and right-hand face of the support 26 is disposed a unit 32 which affords an annular chamber having wall parts which are movable relative to each other in such a manner as to vary the volume of the chamber.

One of the units 32 is illustrated in detail in FIG. 4 from which it will be seen that the unit comprises an inner component 33 having a sleeve-like portion 34 fitting closely about the screw-threaded portion 31 of the associated tie rod, and an integral radially extending and generally cylindrical flange 35. The unit 32 further comprises an outer component 36 having a sleeve-like portion 37 which fits closely over the peripheral face of the flange 35, and a radially inwardly extending flange portion 38 which fits closely about the sleeve-like portion 34.

An annular chamber 39 is defined by the inner and outer components 33 and 36 respectively, one axial wall and the radially inner boundry of the chamber being constituted by face portions of the inner component, and the other axial wall and the radially outer boundary being constituted by face portions of the outer component. The inner and outer components can slide relative to one another in an axial direction, thus varying the volume of the chamber 39.

The outer component 36 is attached by screws to a ring 40 which in turn is attached to the support 26. As will be made clear hereinafter, when the apparatus is in use the ring 40 is loaded compressively and therefore the screws securing the ring to the support 26 and outer component 36 do not have to withstand the force which is transmitted along the tie element 27.

A locating ring 41 is screwed to the end face of the outer component 36 which is remote from the support 26. This locating ring overlies a radially outer part of the adjacent end face of the inner component 33. Pins 42 secured in the inner component extend in an axial direction through apertures formed in the locating ring with a sliding fit so that relative rotation of the inner and outer components is prevented whilst relative sliding movement in an axial direction is permitted.

The radially inwardly presented faces of both the sleeve-like portion 37 and the flange portion 38 of the outer component are formed with annular recesses within which are disposed respective sealing rings 43 and 44. These sealing rings establish a fluidtight seal between the inner and outer components at either end of the chamber 39 whilst permitting relative sliding movement of the inner and outer components.

Two sockets 45, each formed with a female screw thread, are provided in the outer component 36 and respective ducts 46 extend from these sockets to the chamber 39.

As shown in FIGS. 2 and 3, duct means is provided for connecting the units 32 with one another and with pressure relief means. The duct means comprises pipes 47 provided with end fittings (not shown) which engage screw-threadedly in the sockets 45. Thus, all of the chambers 39 communicate one with another, either directly through one of the pipes 47 or indirectly through one of the pipes 47, a further one of the chambers 39 and a further one of the pipes.

The duct means comprises a further pipe 48 and an isolating valve 49 through which the chambers 39 communicate with the pressure relief means. The latter comprises a reservoir 50 formed as a cylinder which is arranged vertically and is mounted on a side face of the support 26. A duct 51 connects the lower end of the reservoir with the isolating valve 49 and at its upper end the reservoir is connected with a pressure gauge 52 and a pressure relief valve 53.

When the apparatus is in use the chambers 39, pipes 47 and 48, and a lower part of the reservoir 50 are filled with an hydraulic fluid such as the type of oil customarily employed in hydraulic machinery. An upper part of the reservoir is filled with an inert gas which is maintained under a pressure indicated by the gauge 52. The inert gas can be supplied to the reservoir through the pressure relief valve 53 from any suitable pressurised source, and if the pressure within the reservoir 50 reaches a predetermined maximum value, the valve 53

will open to release some inert gas, thus preventing the pressure within the reservoir from exceeding the predetermined maximum value. Hydraulic fluid can be introduced into the apparatus through an inlet valve **54** connected with the pipe **48.**

A bleed valve **55** is suitably connected with one of the pipes **47** for exhausting air from the chambers **39** and pipes **47** when these are first filled with hydraulic fluid, and for any subsequent bleeding operations which are necessary during the working life of the apparatus.

In operation of the apparatus closure of the die parts **15** and **16** by the actuating means **17** results in the establishment of a predetermined pressure between the abutting faces of the die parts at the parting plane. Concurrently each of the tie rods **27** is stressed in tension since the force exerted upon the die part **15** by the die part **16** is transmitted to the toggle mechanism **19** along a stress path which includes the fixed die supporting plate **11,** the nuts **28,** and tie rods **27,** the nuts **30,** assemblies **32** and support plate **26.** The units **32,** support **26** and arms **20** and **21** of the toggle mechanism will each be subjected to compressive stress.

Collapse of each of the chambers **39** when the units **32** are subjected to compressive stress is prevented by the pressure exerted by liquid within the chamber **39** on the exial walls thereof. The tension in each of the tie rods **27** is therefore determined by the pressure of fluid within the associated one of the chambers **39.**

Since the chambers **39** communicate one with another through the pipes **47,** the respective pressures in the chambers will be equal. Furthermore, the units **32** are of identical construction and the tie rods **27** are also of identical construction, so that the tie rods will be stressed equally.

It will also be apparent that the tension in each tie rod is limited by virtue of the fact that the pressure in the associated chamber **39** cannot rise above a predetermined maximum value which corresponds to the opening pressure of the pressure relief valve **53.**

The valve **53** may be provided with means for adjusting the pressure at which the valve opens to release gas from the reservoir **50** so that an operator can select the maximum tension to which the tie rods **27** can be subjected.

During a period of operation of the apparatus molten metal will be injected by means indicated diagrammatically at **56** in FIG. **1** through a duct which extends through the fixed die supporting plate **11** into the die cavity defined by the die parts **15** and **16** when in a closed position. Accordingly, the die parts **15** and **16,** and to some extent the plates **11** and **12** will become heated and will expand. Although the tie rods **27** may become heated also to some extent, they do in general rise much less in temperature than do the die parts. Accordingly, the dimension which the die parts collectively present between the fixed and movable plates **11** and **12** will increase relative to the lengths of the tie rods.

The excessive increase in contact pressure between the die parts **15** and **16** which would otherwise result from this expansion of the die parts relative to the tie members is avoided by the units **32.** As the tension in each of the tie rods **27** increases, the inner component of the associated unit **32** slides in an axial direction relative to the outer component so as to reduce the overall length of the unit **32.** Accordingly, some hydraulic fluid is expelled from the chamber **39** along the pipes **47** and **48** to the reservoir **50.** Such movement of hydraulic fluid into the reservoir will produce some compression of the inert gas in the upper part thereof and a corresponding increase in the pressure of both the gas and liquid. However, during normal operation the volume of fluid expelled from the chambers **39** is relatively small and the increase in pressure will not be such as to cause damage to, or a significantly increased rate of wear of, components of the apparatus.

It will be evident that when the die parts **15** and **16** are opened during operation of the apparatus, the tension in the tie rods **27** will decrease somewhat and accordingly each of the chambers **39** may expand, drawing hydraulic fluid from the reservoir **50.**

A visual indication of the relative positions of the inner and outer components **33** and **36** of each of the units **32** is given by the length of the pins **42** which extend beyond the locating ring **41.** The relative positions of the inner and outer components shown in FIG. **4** corresponds to minimum tension in the screw-threaded portion **31** of the associated tie rod. Such minimum tension is established by adjustment of nuts **29** relative to the nuts **30.** Preferably these nuts are so adjusted relative to one another that the tension in the screw-threaded portion of the tie rod is equal to the maximum tension established in the tie rod during an initial working cycle of the apparatus, i.e. before the die parts have ecome heated. If the apparatus is set up in this manner, the pressure within each of the chambers **39** will not vary during the initial working cycle of the apparatus, but during later working cycles will increase somewhat when the die parts **15** and **16** are brought into pressure contact.

Although in the preferred embodiment illustrated in the accompanying drawings, the chambers are filled with hydraulic fluid, it would be possible for these chambers to be filled with a gaseous fluid under pressure, in which case the reservoir may be omitted. Since a gaseous fluid is compressible, it would inherently provide a degree of pressure relief and a pressure relief valve would be provided to limit the maximum pressure which can exist in the chambers.

In a further alternative arrangement the chambers would contain an hydraulic fluid and the pressure relief means would comprise a solid state resilient element which can yield to provide a local increase in the space available for accommodation of the liquid. Preferably, such resilient element would be disposed in a reservoir communicating with the chambers, but it will be evident that the resilient element could be disposed within, or form a wall of, one of the chambers itself. Equal tension would be maintained in the tie rods since the chambers would communicate one with another.

It will be apparent that if the units **32** were interconnected one with another, but not connected with a pressure relief means, the apparatus would nevertheless possess the advantage over conventional die casting or like apparatus of the kind referred to that the tie elements would be stressed equally. Equal tensioning of the tie rods ensures equal, or substantially equal, straightening of the two pairs of toggle arms **20** and **21,** and also avoids departure from a truly parallel relation between the die parts **15** and **16** which may result from unequal tensioning of the tie rods.

We claim:

1. In apparatus of the kind used for die casting, injection moulding and the like and which comprises:

a. a body,

b. first and second members mounted on the body for relative movement towards and away from each other,

c. a plurality of elongate tie elements, each connected at one of its ends with said first member, and

d. actuating means connected with the other end of each of said tie elements and connected also with said second member for urging one of said members towards the other, the arrangement being such that when the first and second members are subjected to compressive stress by operation of the actuating means, the tie elements are subjected to tensile stress, the improvement wherein:

e. at least one of said first and second members is slidably mounted on said tie elements and is guided thereby,

f. there is provided in association with each of said tie elements a respective chamber which, when the apparatus is in use, is filled with fluid, each of said chambers being interposed in the stress path to or through a respective one of said tie elements and comprising relatively movable wall portions for transmitting said stress through said fluid, and

g. duct means interconnecting all of said chambers whereby the respective fluid pressures in the latter are equalised.

2. The improvement according to claim 1 further comprising pressure relief means communicating with said chambers.

3. The improvement according to claim 2 wherein:

a. said chambers are filled with liquid, and

b. said pressure relief means comprises a reservoir, at least an upper part of which contains a gaseous fluid under pressure, and a lower part of which is connected by said duct means with said chambers, the upper and lower parts of the reservoir communicating one with the other.

4. The improvement according to claim 3 wherein said pressure relief means further comprises a pressure relief valve for limiting the pressure which can exist in said chambers.

5. The improvement according to claim 4 wherein said pressure relief valve is adjustable to vary the maximum pressure which can exist in said chambers.

6. The improvement according to claim 1 wherein:

a. said actuating means comprises a support through which said tie elements extend, and a toggle mechanism connected between said support and said second member, and

b. said chambers are interposed between said support and respective abutment members on the tie elements.

7. The improvement according to claim 2 wherein:

a. said chambers are filled with liquid, and

b. said pressure relief means comprises a solid state resilient element which can provide a local increase in the space available for accommodation of said liquid.

8. The improvement according to claim 2 wherein said pressure relief means comprises a pressure relief valve for limiting the pressure which can exist in said chambers.

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