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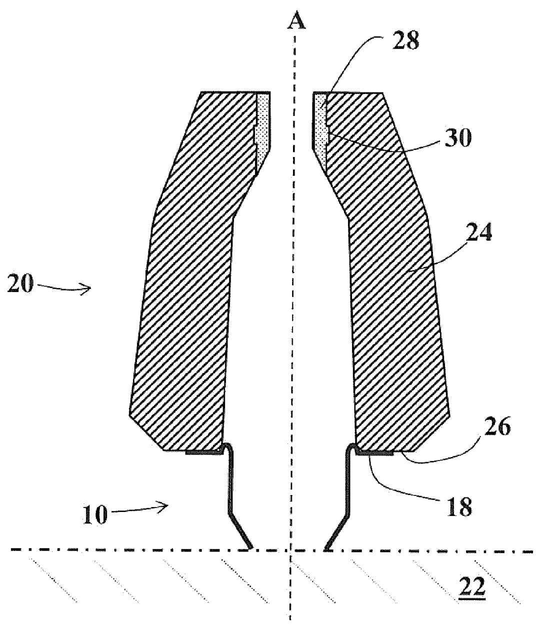
(54) **Feeder element**

(57) Aspects of the invention relate to a feeder element for use in metal casting; a feeder system comprising the feeder element and a feeder sleeve secured thereto; and a method for preparing a mould employing the feeder system.

The feeder element is of unitary construction and may be manufactured from metal. The feeder element comprises a generally tubular body defining a bore therethrough and having mutually spaced apart first and second end regions. The second end region flares outwardly and towards the first end region to form a flange around the body from which extends a mounting plate for a feeder sleeve.

The method for the preparation of a mould comprises placing the feeder system on a pattern and surrounding the pattern with a mould material such as sand. The mould material is then compacted and the pattern is removed therefrom to form the mould. Compacting the mould material comprises applying pressure to the feeder system such that the height of the feeder element is reduced.

Figure 2



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Description

[0001] The present invention relates to a feeder element for use in metal casting operations utilising casting moulds, a feeder system comprising the feeder element and a method for the preparation of a mould employing the feeder system.

[0002] In a typical casting process, molten metal is poured into a pre-formed mould cavity which defines the shape of the casting. However, as the metal solidifies it shrinks, resulting in shrinkage cavities which in turn result in unacceptable imperfections in the final casting. This is a well known problem in the casting industry and is addressed by the use of feeder sleeves or risers which are integrated into the mould, either during mould formation by applying them to a pattern plate, or later by inserting a sleeve into a cavity in the formed mould. Each feeder sleeve provides an additional (usually enclosed) volume or cavity which is in communication with the mould cavity, so that molten metal also enters into the feeder sleeve. During solidification, molten metal within the feeder sleeve flows back into the mould cavity to compensate for the shrinkage of the casting.

[0003] After solidification and removal of the mould material, unwanted residual metal from within the feeder sleeve cavity remains attached to the casting and must be removed. In order to facilitate removal of the residual metal, the feeder sleeve cavity may be tapered towards its base (i.e. the end of the feeder sleeve which will be closest to the mould cavity) in a design commonly referred to as a neck down sleeve. When a sharp blow is applied to the residual metal it separates at the weakest point which will be near to the mould (the process commonly known as "knock off"). A small footprint on the casting is also desirable to allow the positioning of feeder sleeves in areas of the casting where access may be restricted by adjacent features.

[0004] Although feeder sleeves may be applied directly onto the surface of the casting mould cavity, they are often used in conjunction with a feeder element (also known as a breaker core). A breaker core is simply a disc of refractory material (typically a resin bonded sand core or a ceramic core or a core of feeder sleeve material) with a hole usually in its centre which sits between the mould cavity and the feeder sleeve. The diameter of the hole through the breaker core is designed to be smaller than the diameter of the interior cavity of the feeder sleeve (which need not necessarily be tapered) so that knock off occurs at the breaker core close to the casting surface.

[0005] Moulding sand can be classified into two main categories. Chemical bonded (based on either organic or inorganic binders) or clay-bonded. Chemically bonded moulding binders are typically self-hardening systems where a binder and a chemical hardener are mixed with the sand and the binder and hardener start to react immediately, but sufficiently slowly enough to allow the sand to be shaped around the pattern plate and then allowed to harden enough for removal and casting.

[0006] Clay-bonded moulding uses clay and water as the binder and can be used in the "green" or undried state and is commonly referred to as greensand. Greensand mixtures do not flow readily or move easily under compression forces alone and therefore to compact the greensand around the pattern and give the mould sufficient strength properties as detailed previously, a variety of combinations of jolting, vibrating, squeezing and ramming are applied to produce uniform strength moulds at high productivity. The sand is typically compressed (compacted) at high pressure, usually using one or more hydraulic rams.

[0007] To apply sleeves in such high pressure moulding processes, pins are usually provided on the moulding pattern plate (which defines the mould cavity) at predetermined locations as mounting points for the feeder sleeves. Once the required sleeves are placed on the pins (such that the base of the feeder is either on or raised above the pattern plate), the mould is formed by pouring moulding sand onto the pattern plate and around the feeder sleeves until the feeder sleeves are covered and the mould box is filled. The application of the moulding sand and subsequent high pressures may cause damage and breakage of the feeder sleeve, especially if the feeder sleeve is in direct contact with the pattern plate prior to ram up, and with increasing casting complexity and productivity requirements, there is a need for more dimensionally stable moulds and consequently, a tendency towards higher ramming pressures and resulting sleeve breakages.

[0008] The Applicant has developed a range of collapsible feeder elements for use in combination with feeder sleeves, which are described in WO2005/051568, WO2007141446 and WO2012110753. The feeder elements compress when subjected to pressure during moulding, thereby protecting the feeder sleeve from damage.

[0009] The present invention provides a feeder system comprising an improved feeder element for use in metal casting.

[0010] According to a first aspect of the present invention there is provided a feeder element of unitary construction comprising a generally tubular body defining a bore therethrough and having mutually spaced apart first and second end regions, wherein the second end region flares outwardly and towards the first end region to form a flange around the body from which extends a mounting plate for a feeder sleeve.

[0011] In use the feeder element is mounted on a mould pattern such that the first end region is next to the mould and a feeder sleeve is mounted on the mounting plate at a distance from the mould. The bore defined by the tubular body provides a passage from the feeder sleeve to the mould cavity to feed the casting. During moulding and subsequent ram-up, the feeder element will experience a force applied to the mounting plate in the direction of the longitudinal axis of the tubular body (the bore axis) towards the first end region. This force causes the mounting plate to move in the direction of the first end region and pulls the adjacent part of the tubular body such that it deforms. Without being bound by theory, the inventors propose that such deformation helps to protect the associated feeder sleeve in use.

[0012] US2008/0223543 describes a feeder for casting metal comprising a tube-like body (2) having an abutment (9). The abutment (9) extends outwardly from the tube-like body (2) perpendicular to the axis of the tube-like body. US'543 provides an alternative solution to the difficulties of sleeve breakage during ram-up. The tube-like body (2) is located within the feeder head (2) in a mobile manner so that it can telescope when force is applied. The abutment (9) is located within the cavity of the feeder head (1) to prevent the tube-like body from falling out of the feeder head (2). When this feeder is used for casting, it is placed on a fixed or spring pin on a mould pattern, such that the feeder connected to the tube-like body is held by the pin, and the tube-like body can be pulled out of the feeder head until the end of the tube-like body facing the cast part sits on the mould pattern surface or base of the pin. During moulding and ram up, the pressure forces the feeder head down towards the mould pattern surface relative to the tube like body. The tube-like body remains fixed in the original position and the surface furthermost from the mould pattern telescopes into the cavity of the feeder head, and retains its overall shape and integrity. The US'543 tubular body cannot compress in the manner described above.

[0013] The feeder element has a height (h, measured along the bore axis), and a diameter (measured in a plane orthogonal to the bore axis). The feeder element is compressible in use whereby to reduce its height (measured along the bore axis).

[0014] The mounting plate supports a feeder sleeve in use. In one embodiment the mounting plate is perpendicular to the bore axis. The maximum diameter of the feeder element generally corresponds to the maximum diameter of the mounting plate. In other embodiments, the mounting plate is inclined away from the first end region (upwards in use) such that the angle between the plate and the bore axis is less than 90°.

[0015] The mounting plate has an inner diameter and an outer diameter. In some embodiments, the distance between the inner and outer diameters of the mounting plate (also known as the width of the mounting plate) is from 4 to 20mm or from 6 to 16mm. In one embodiment the mounting plate is generally annular i.e. ring shaped.

[0016] In one embodiment the second end region of the tubular body flares radially outwards and away from the first end region and then curves towards the first end region. In use this means that the tubular body curves upwards toward the feeder sleeve and then turns downwards toward the mould pattern or casting surface. This shape is considered to provide an even (symmetrical) smooth compression of the feeder element. Such a flange can be considered to have an arched or a U-shaped cross-section, the open ends of which project towards the first end region. Hence the flange can be considered to have a curved cross-section; the curve can be part-circular or part-elliptical.

[0017] The flange has an inner diameter and an outer diameter (measured in a plane orthogonal to the bore axis) and a width which is the difference between the inner and outer diameters (measured in a plane orthogonal to the bore axis). In some embodiments, the width of the flange is from 2 to 15mm, from 3 to 10mm or from 4 to 7mm.

[0018] The width of the flange can be compared to the maximum diameter of the feeder element. In one series of embodiments, the width of the flange is at least 3, 5, 7 or 10% of the maximum diameter of the feeder element. In one series of embodiments, the width of the flange is less than 20, 15 or 10% of the maximum diameter of the feeder element.

[0019] The flange has a height (h', measured in the direction of the bore axis). In one series of embodiments the flange has a height (before compression of the feeder element) of at least 1, 3, 5 or 10mm. In one series of embodiments the flange has a height of less than 20, 15, 10 or 5mm. The height of the flange increases when the mounting plate is pushed towards the pattern during moulding.

[0020] The height of the flange may be compared to the total height of the feeder element. In one series of embodiments the height of the flange (before compression of the feeder element) is at least 3, 5, 8, 10, 15 or 20% of the total height of the feeder element. In one series of embodiments the height of the flange (before compression of the feeder element) is less than 30, 25, 20, 15, 10 or 7% of the total height of the feeder element.

[0021] As discussed above, the height of the feeder element (h) is reduced when sand is compacted around it to form a mould. Although the total height of the feeder element (h) decreases when the mounting plate is pushed towards the pattern, the height of the flange (h') increases. Hence, the ratio h'/h increases during moulding.

[0022] In one series of embodiments, the ratio h'/h after moulding is at least 0.5, 0.6, 0.7, 0.8 or 0.9. In one series of embodiments, the ratio h'/h after moulding is less than 1, 0.9, 0.8, 0.7 or 0.6. In a particular embodiment, the ratio h'/h is from 0.5 to 0.6 after moulding.

[0023] In one series of embodiments a particular ratio h'/h is obtained when a force of at least 2, 2.5, 3, 3.5, 4 or 4.5kN is applied to the mounting plate. In a particular embodiment a ratio h'/h of from 0.5 to 0.6 is obtained when a force of from 3 to 3.5kN is applied to the mounting plate.

[0024] The tubular body has an inner diameter and an outer diameter and a thickness which is the difference between the inner and outer diameters. The thickness of the tubular body is a factor in how it deforms under pressure and the ideal thickness will vary from body to body and be influenced by the material of the feeder element. In some embodiments the thickness of the tubular body is from 0.1 to 1.5 mm, from 0.2 to 1.2 mm, from 0.3 to 0.9 mm or from 0.4 to 0.6 mm.

[0025] In one embodiment the tubular body has a circular cross-section. However, the cross-section could be non-circular e.g. oval, obround or elliptical. In one preferred embodiment the tubular body narrows (tapers) towards the first end region. A narrow portion adjacent the casting is known as a feeder neck and provides better "knock off" of the feeder. In one series of embodiments, the angle of the tapered neck relative to the bore axis shall be less than 45°.

[0026] It will be understood that the amount of compression and the force required to induce compression will be influenced by a number of factors including the material of manufacture of the feeder element and the shape and thickness of the tubular body. It will be equally understood that individual feeder elements will be designed according to the intended application, the anticipated pressures involved and the feeder size requirements.

[0027] The initial crush strength (i.e. the force required to initiate compression and irreversibly deform the feeder element over and above the natural flexibility that it has in its unused and uncrushed state) may be no more than 7000N, 5000N, or 3000N. If the initial crush strength is too high, then moulding pressure may cause the feeder element to fail before compression is initiated. The initial crush strength may be at least 250N, 500N, 750N, or 1000N. If the crush strength is too low, then compression of the element may be initiated accidentally, for example if a plurality of elements are stacked for storage or during transport. The initial crush strength is illustrated in figure 4 as point X.

[0028] The roll back strength (i.e. the force required to irreversibly and fully roll back the tubular body on itself once the initial crush strength has been applied and the feeder element has been deformed and begun to roll back) may be no more than 9000N, 7000N, 5000N, or 4000N. If the roll back strength is too high, then moulding pressure may cause the feeder sleeve to fail before full compression and deformation of the feeder element has occurred. The roll back strength may be at least 750N, 1000N, 1500N, or 2000N. The roll back strength is illustrated in figure 4 as point Q.

[0029] The feeder element can be manufactured from a variety of suitable materials including metal (e.g. steel, iron, aluminium, aluminium alloys, brass, copper etc.) or plastic. In a particular embodiment, the feeder element is a metal feeder element.

[0030] In certain embodiments where the feeder element is formed from metal, it may be press-formed from a single metal piece of constant thickness. In one embodiment the feeder element is manufactured via a drawing process, whereby a metal sheet blank is radially drawn into a forming die by the mechanical action of a punch. The process is considered deep drawing when the depth of the drawn part exceeds its diameter and is achieved by redrawing the part through a series of dies. In another embodiment, the feeder element is manufactured via a metal spinning or spin forming process, whereby a blank disc or tube of metal is first mounted on a spinning lathe and rotated at high speed. Localised pressure is then applied in a series of roller or tool passes that causes the metal to flow down onto and around a mandrel that has the internal dimensional profile of the required finished part.

[0031] To be suitable for press-forming or spin-forming, the metal should be sufficiently malleable to prevent tearing or cracking during the forming process. In certain embodiments the feeder element is manufactured from cold-rolled steels, with typical carbon contents ranging from a minimum of 0.02% (Grade DC06, European Standard EN10130 - 1999) to a maximum of 0.12% (Grade DC01, European Standard EN10130 - 1999).

[0032] The size and mass of the feeder element will depend on the application. It is generally preferable to reduce the mass of the feeder element when possible. This reduces material costs and can also be beneficial during casting, e.g. by reducing the heat capacity of the feeder element. In one embodiment the feeder element has a mass of less than 50, 40, 30, 20 or 10g.

[0033] It will be understood from the foregoing discussion that the feeder element is intended to be used in conjunction with a feeder sleeve. Thus, the invention provides in a second aspect a feeder system for metal casting comprising a feeder element in accordance with the first aspect and a feeder sleeve secured thereto.

[0034] The feeder sleeve typically comprises a continuous sidewall which defines a cavity. In one embodiment the base of the continuous sidewall mates with the mounting plate on the feeder element such that the flange extends into the feeder sleeve cavity.

[0035] The nature of the feeder sleeve is not particularly limited and it may be for example insulating, exothermic or a combination of both. Neither is its mode of manufacture particularly limited, it may be manufactured for example using either the vacuum-forming process or core-shot method. Typically a feeder sleeve is made from a mixture of low and high density refractory fillers (e.g. silica sand, olivine, alumino-silicate hollow microspheres and fibres, chamotte, alumina, pumice, perlite, vermiculite) and binders. An exothermic sleeve further requires a fuel (usually aluminium or aluminium alloy), an oxidant (typically iron oxide, manganese dioxide, or potassium nitrate) and usually initiators/sensitisers (typically cryolite).

[0036] In one series of embodiments the feeder sleeve has a strength (crush strength) of at least 5kN, 8kN, 12kN, 15kN, 20kN or 25kN. In one series of embodiments, the sleeve strength is less than 25kN, 20kN, 18kN, 15kN, 10kN or 8kN. For ease of comparison the strength of a feeder sleeve is defined as the compressive strength of a 50x50mm cylindrical test body made from the feeder sleeve material. A 201/70 EM compressive testing machine (Form & Test Seidner, Germany) is used and operated in accordance with the manufacturer's instructions. The test body is placed centrally on the lower of the steel plates and loaded to destruction as the lower plate is moved towards the upper plate at a rate of 20mm/minute. The effective strength of the feeder sleeve will not only be dependent upon the exact composition, binder used and manufacturing method, but also on the size and design of the sleeve, which is illustrated by the fact that the strength of a test body is usually higher than that measured for a standard flat topped sleeve.

[0037] Feeder sleeves are available in a number of shapes including cylinders, ovals and domes. The sleeve body may be flat topped, domed, flat topped dome, or any other suitable shape. The roof of the sleeve may be closed so that the feeder sleeve cavity is enclosed, and it may also contain a recess or blind bore extending partially through the top section of the feeder to assist in mounting the feeder system on a moulding pin attached to the mould pattern. Alternatively, the feeder sleeve may have an aperture or bore that extends through the whole of the feeder roof so that the feeder cavity is open. The feeder sleeve may be conveniently secured to the feeder element by adhesive but may also be push fit or have the sleeve moulded around part of the feeder element. Preferably the feeder sleeve is adhered to the feeder element.

[0038] In use, the feeder system is typically placed on a support pin to hold the feeder system in the required position on the mould pattern plate prior to the sand being compressed and rammed up. On ram up, the sleeve moves towards the mould pattern surface and the pin, if fixed, may puncture the roof of the feeder sleeve, or it simply may traverse through the aperture or bore as the sleeve moves downwards. This movement and contact of the sleeve with the pin may cause small fragments of sleeve to break off and fall into the casting cavity, resulting in poor casting surface finish or localised contamination of the casting surface. This may be overcome by lining the aperture or bore with a hollow insert or internal collar, which may be manufactured from a variety of suitable materials including metal, plastic or ceramic. Thus, in one embodiment, the feeder sleeve may be modified to include an internal collar lining the aperture or bore in the roof of the feeder. This collar may be inserted into the aperture in the sleeve roof after the sleeve has been produced, or alternatively, is incorporated during manufacture of the sleeve, whereby sleeve material is coreshot or moulded around the collar, after which the sleeve is cured and holds the collar in place. Such a collar protects the sleeve from any damage that might be caused by the support pin during moulding and ram up.

[0039] According to a third aspect of the present invention there is provided a method for the preparation of a mould comprising

placing the feeder system of the second aspect on a pattern; the feeder system comprising the feeder element of the first aspect having a feeder sleeve secured thereto;
surrounding the pattern with a mould material,
compacting the mould material, and
removing the pattern from the compacted mould material to form the mould,
wherein compacting the mould material comprises applying pressure to the feeder system such that the height of the feeder element is reduced.

[0040] In one series of embodiments the height of the feeder element is reduced by at least 20, 30, or 40% (as compared to the height before pressure is applied). In one series of embodiments the height of the feeder element is reduced by no more than 50, 45 or 40%.

[0041] The height of the feeder element is reduced by the pressure applied to the system. The mounting plate is pushed in the direction of the first end region and pulls the adjacent part of the tubular body towards the first end region. This action causes the tubular body to roll back on itself, thereby increasing the height of the flange. In one embodiment compacting the mould material comprises applying pressure to the feeder system such that the height of the flange is increased (as compared the height before pressure is applied) by a factor of at least 2, 3, 4, 5, 7 or 10.

[0042] The ratio of the height of the flange (h') to the height of the feeder element (h) will increase as the moulding pressure is applied. In one series of embodiments the height of the flange (after compression) is at least 30, 40, 50, 60, 70, or 80% of the height of the feeder element (after compression) i.e. after compression h'/h is at least 0.3, 0.4, 0.5, 0.6, 0.7 or 0.8. In one series of embodiments the height of the flange (after compression) is less than 90, 80, 70, 60, 50 or 40% of the height of the feeder element (after compression) i.e, after compression h'/h is less than 0.9, 0.8, 0.7, 0.6, 0.5 or 0.4.

[0043] In one series of embodiments compacting the mould material comprises applying a ram up pressure (as measured at the pattern plate) of at least 30, 60, 90, 120 or 150 N/cm^2.

[0044] In one embodiment the mould material is clay bonded sand (usually referred to as greensand), which typically comprises a mixture of clay such as sodium or calcium bentonite, water and other additives such as coal dust and cereal binder.

[0045] In one embodiment the mould material is mould sand containing a binder.

[0046] Embodiments of the invention will now be described by way of example only with reference to the accompanying drawings in which:-

Figure 1 shows a feeder element in accordance with an embodiment of the invention.
Figure 2 shows a feeder system in accordance with an embodiment of the invention.
Figure 3 is a schematic diagram showing compression of the feeder element in use.
Figure 4 is a plot of force against displacement for the feeder system shown in Figure 2.

[0047] Figure 1 shows a cross-section of a feeder element 10. The feeder element 10 was made by a spin-forming process from a flat steel disc on a lathe machine using rollers mounted on the end of levers to form the metal down to the mandrel, and is therefore of unitary construction. The feeder element 10 comprises a generally tubular body 12 having a bore therethrough. The tubular body 12 has a first end region 14 which is frustoconical and a second end region 16 which is a flange that surrounds the body. The flange 16 first extends way from the first end region 14 and then curves back towards the first end region 14. An annular mounting plate 18 extends radially outwards from the flange 16 and holds a feeder sleeve in use.

[0048] The height h of the feeder element is measured along the bore axis A. The diameter of the feeder element is measured in a plane orthogonal to the bore axis A and generally increases from the first end region 14 to the second end region 16. The maximum diameter of the feeder element 10 corresponds to the outer diameter of the mounting plate 18.

[0049] The flange 16 has a cross-section that can be considered to be arched or U-shaped. The open ends of the arch/U-shape project towards the first end region 14. The height h' of the flange is the maximum height of the arch measured from the mounting plate 18 in the direction of the bore axis. The height of the flange h' is approximately 8% of the total height of the feeder element h i.e. h'/h = 0.08. The width w of the flange measured in a plane orthogonal to the bore axis is approximately 7% of the total diameter of the feeder element.

[0050] Figure 2 shows the feeder element 10 having a feeder sleeve 20 secured thereto and placed on a pattern 22. The feeder sleeve 20 is an exothermic feeder sleeve sold under the trade name FEEDEX (Foseco International Limited).

[0051] The feeder sleeve 20 has a generally cylindrical sidewall 24 which defines a cavity. The bore axis A passes through the feeder sleeve cavity as well as the tubular body 12. In use, the cavity serves as a reservoir for molten metal in order to feed the casting via the tubular body 12. The sidewall 24 has an annular base 26 which mates with the mounting plate 18. The annular base 26 is wider than the mounting plate 18. This decreases the mass of the feeder element 10 and thereby reduces the risk of premature freezing of the metal in the neck of the riser, thus allowing sufficient feeding of the casting and avoidance of any shrinkage defects in the casting. If desired, the mounting plate 18 could be larger such that more of the annular base 26 is supported. The upper part of the continuous sidewall 24 forms a roof having an aperture or bore therein. A plastic tube (collar) 28 is located in the aperture and thereby protects the feeder sleeve 20 against scratching and subsequent damage in use. The plastic collar 28 has a raised area or annulus 30 on its surface to hold the collar in place within the sleeve, the internal collar being incorporated during manufacture of the sleeve via a coreshot process.

[0052] In use the feeder sleeve 20 and the feeder element 10 are placed on a pattern in a moulding box, which is then filled with moulding sand. The sand is then compacted around them (known as "ramming up"). This leads to a pressure (P) being exerted on the mounting plate 18 in the direction of the bore axis A toward the pattern 22. Figures 3a to 3c show the effect of the pressure on the feeder element 10 in use. The base of the feeder element remains stationary and the feeder sleeve moves towards the pattern.

[0053] Figure 3a shows the feeder element 10 mounted on a pattern before any pressure is applied. The height of the feeder element 10 is shown as h and the height of the flange 16 is shown as h'. The ratio h'/h is approximately 8%.

[0054] In figure 3b some pressure (P) has been applied pushing the mounting plate 18 downward (toward the pattern and the first end region of the feeder element). The mounting plate 18 pulls the adjacent flange 16 downward as well and this in turn causes part of the tubular body 12 to be rolled over and drawn into the feeder sleeve cavity increasing the height of the flange h'. It can be seen that the ratio of the height of the flange to the height of the feeder element (h'/h) increases as the pressure is applied.

[0055] In figure 3c further pressure has been exerted on the mounting plate 18 to push it towards the pattern and draw more of the tubular body into the feeder sleeve cavity. Hence it can be seen that the height of the annular flange h' increases and the total height of the feeder element h decreases as pressure is exerted. The height of feeder element is reduced by approximately 40% as a result of the pressure that is applied. The height of the flange after compression is at least 4 times greater than the height of the flange before compression. The ratio h'/h is approximately 55%.

Test Examples

Example 1 - investigation of crush strength

[0056] Samples of feeder systems were tested by placing them between two parallel plates of a Hounsfield compression strength tester. The bottom plate was fixed. Whereas the top plate traversed downwards via a mechanical screw thread mechanism at a constant rate of 30 mm per minute and graphs of force against plate displacement were plotted.

[0057] The feeder system tested had the basic configuration shown in Figure 2 with a feeder element 10 (manufactured via spin-forming from 0.5mm thick low carbon steel plate, having a height h of 33mm, a mounting plate diameter of 63mm, and a tubular body (12) diameter of 36mm) and a FEEDEX HD feeder sleeve (fast-igniting, highly exothermic, high density, high strength spot feeder sold by Foseco). Two identical samples were tested.

[0058] Referring to Figure 4, force is plotted against plate displacement and it will be noted that as force is increased, there is minimal compression (associated with the natural flexibility in its unused and uncrushed state) of the feeder element until a critical force is applied (point X), referred to herein as the initial crush strength, after which compression and roll back proceeds under a slightly lower loading, with point Y marking the minimum force measurement after the initial crush strength occurs. Further compression and roll back of the element occurs with increasing force being required. A second maximum (point Z) occurs as the tubular body continues to roll back on itself in a number of stages, the force increasing steadily and displacement becoming smoother (smaller maximum and minimum step points) until the force levels off at ca 3200N (line Q), representing the maximum force required for the tubular body to fully roll back on itseif i.e. the roll back strength.

Example 2 Moulding and Casting Trials

[0059] Testing was conducted on a commercial Heinrich Wagner Sinto high-pressure moulding line ZFA-SD-5,5 with moulding box dimensions 900mm x 1100mm x 350/350mm. The moulding medium was a clay-bonded greensand system. The casting weighing approximately 25 Kg was a suspension bracket casting in ductile iron (spheroidal graphite iron) for automotive use.

[0060] The moulding pressures in use on this machine at this particularly foundry are very high, and due to the orientation of some of the pins used on the mould patterns for certain castings, some of the feeder systems are not applied fully vertically. As a consequence of this, when certain commercial feeder systems such as those described in WO2005/051568 are utilised, the metal breaker core collapses too severely or unsymmetrically, which in some cases causes some minor damage to the feeder sleeve.

[0061] The mould contained patterns for two castings, and three feeder systems with the basic configuration shown in Figure 2 with a feeder element 10 (manufactured via spin-forming from 0.5mm thick low carbon steel plate, having a height h of 33mm, a mounting plate diameter of 63mm, and a tubular body (12) diameter of 36mm) and a FEEDEX HD feeder sleeve (fast-igniting, highly exothermic, high density, high strength spot feeder sold by Foseco) were used for each casting. Each feeder system was placed on a fixed pin and after moulding and ram up, each feeder element collapsed and rolled back evenly, and it was observed that there was excellent sand compaction of the mould in the area directly below the feeder element and base of the feeder sleeve. There was no visible damage to the feeder and no particles of sleeve seen in the mould cavity.

[0062] After casting, the knock off point of the metal feeders was excellent, being reproducible and close to the casting surface, and there were no surface defects on the casting surface. X-Ray analysis of the metal casting showed no evidence of any shrinkage occurring underneath the metal feeders.

Claims

1. A feeder element of unitary construction comprising a generally tubular body defining a bore therethrough and having mutually spaced apart first and second end regions, wherein the second end region flares outwardly and towards the first end region to form a flange around the body from which extends a mounting plate for a feeder sleeve.

2. A feeder element according to claim 1, wherein the mounting plate is perpendicular to the bore axis or is inclined away from the first end region such that the angle between the mounting plate and the bore axis is less than 90°.

3. A feeder element according to claim 1 or 2, wherein the second end region of the tubular body flares radially outwards and away from the first end region and then curves towards the first end region to form the flange with an arched cross-section, the open ends of which project towards the first end region.

4. A feeder element according to any one of the preceding claims, wherein the flange has a width of from 2 to 15mm and/or a width which is at least 3% of the maximum diameter of the feeder element.

5. A feeder element according to any one of the preceding claims, wherein the flange has a width which is less than 20% of the maximum diameter of the feeder element.

6. A feeder element according to any one of the preceding claims, wherein the flange has a height of at least 1 mm and/or a height which is at least 3% of the total height of the feeder element and/or a height which is less than 30% of the total height of the feeder element.

7. A feeder element according to any one of the preceding claims, wherein the tubular body has a circular, oval, obround or elliptical cross-section, and optionally tapers towards the first end region.

8. A feeder element according to any one of the preceding claims, having (i) an initial crush strength of no more than 7000N and/or (ii) an initial crush strength of at least 250N.

9. A feeder element according to any one of the preceding claims, having a maximum roll back strength of (i) no more than 9000N and/or (ii) at least 500N.

10. A feeder element according to any one of the preceding claims manufactured from metal, preferably steel.

11. A feeder system for metal casting comprising a feeder element in accordance with any one of the preceding claims and a feeder sleeve secured to the mounting plate thereof, such that the flange extends into the feeder sleeve cavity.

12. A feeder system according to claim 11, wherein the feeder sleeve crush strength is less than 25kN.

13. A feeder system according to claim 11 or 12, wherein the feeder sleeve is secured to the feeder element by adhesive, by means of it being a push fit with the feeder element or by means of the sleeve being moulded around part of the feeder element.

14. A feeder system according to any one of claims 11 to 13, wherein the feeder sleeve is provided with an internal collar lining an aperture or bore in the roof of the feeder.

15. A method for the preparation of a mould comprising placing the first end region of a feeder element forming part of a feeder system of any one of claims 11 to 14 on a pattern;
surrounding the pattern with a mould material,
compacting the mould material, and
removing the pattern from the compacted mould material to form the mould,
wherein compacting the mould material comprises applying pressure to the feeder system such that the height of the feeder element is reduced.

16. The method of claim 15 wherein the height of the feeder element is reduced by the compaction by at least 20% and/or the height of the flange is increased by the compaction by a factor of at least 2 and/or the height of the flange after compaction is at least 30% of the height of the feeder element after compaction.

17. The method of any one of claims 15 or 16, wherein compacting the mould material comprises applying a ram up pressure of at least 30N/cm^2.

Figure 2

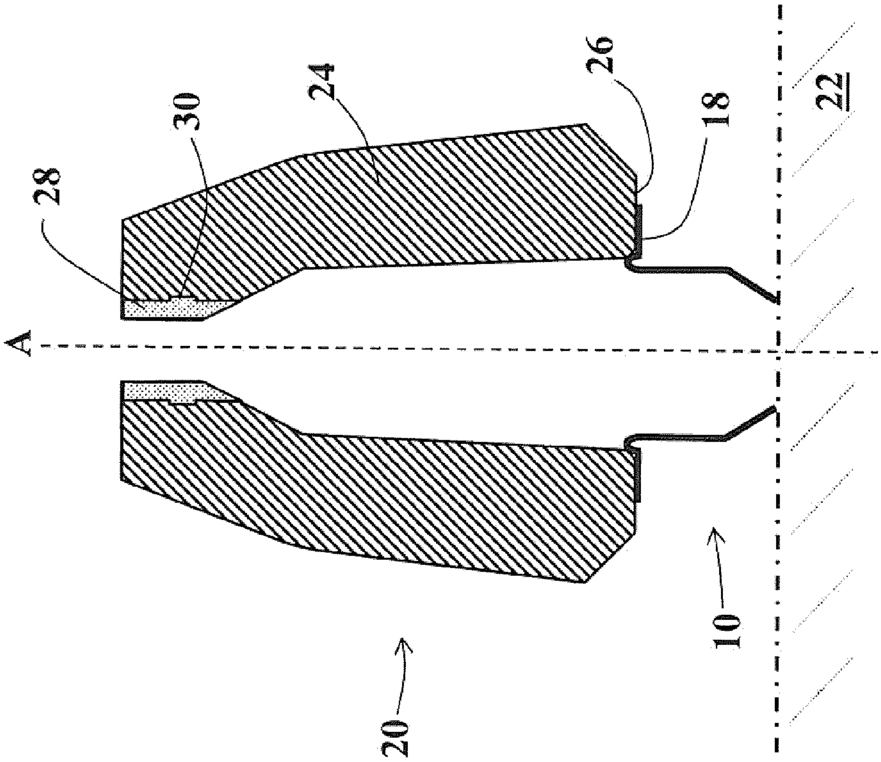
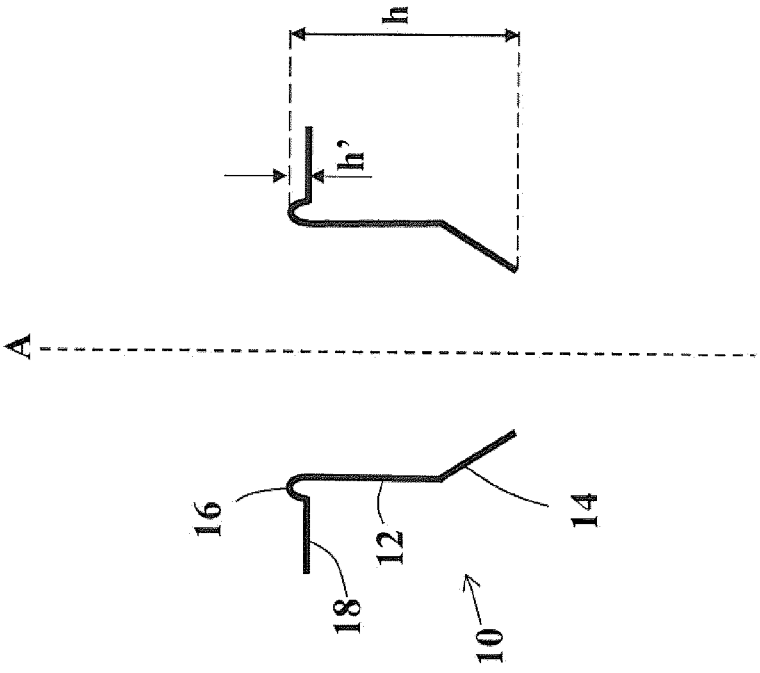


Figure 1



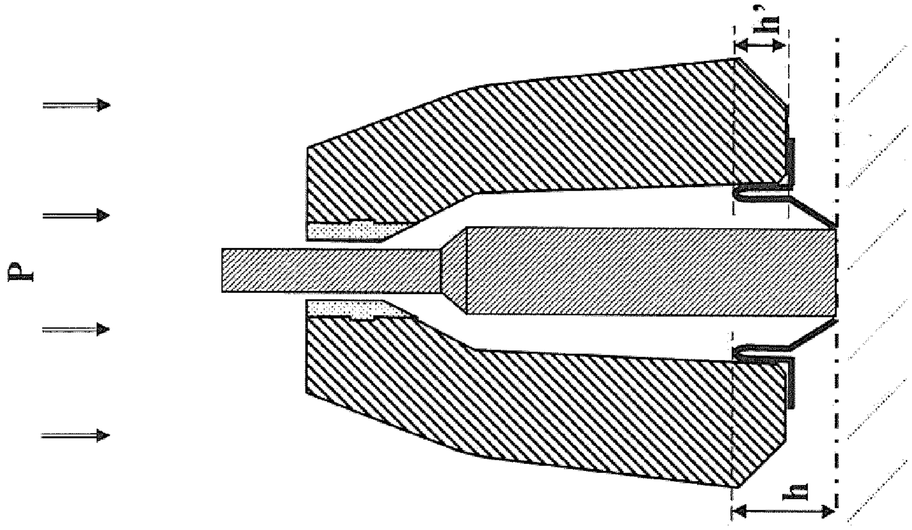


Figure 3c

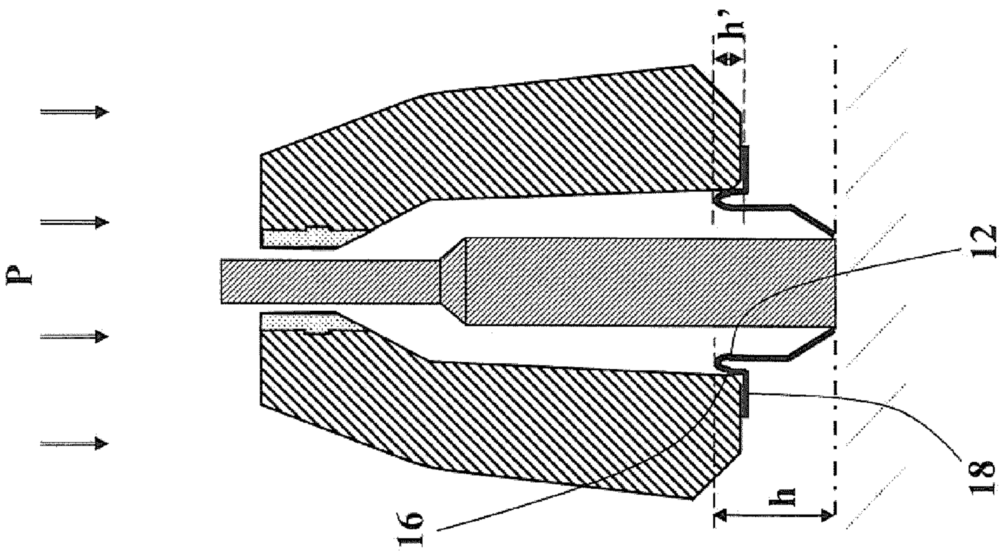


Figure 3b

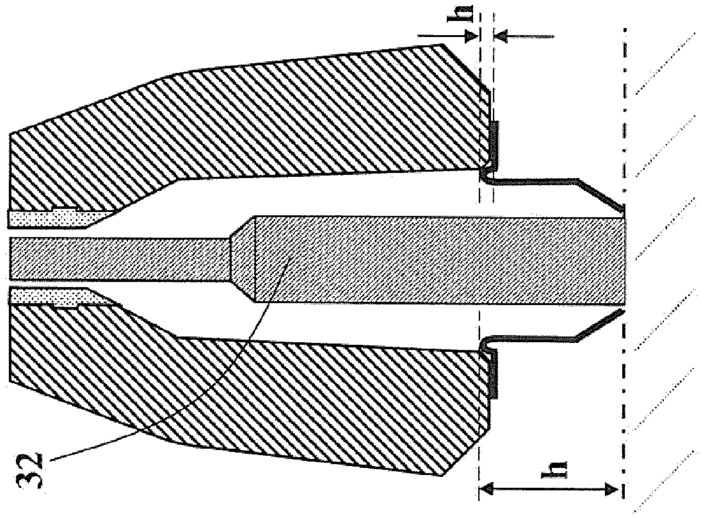
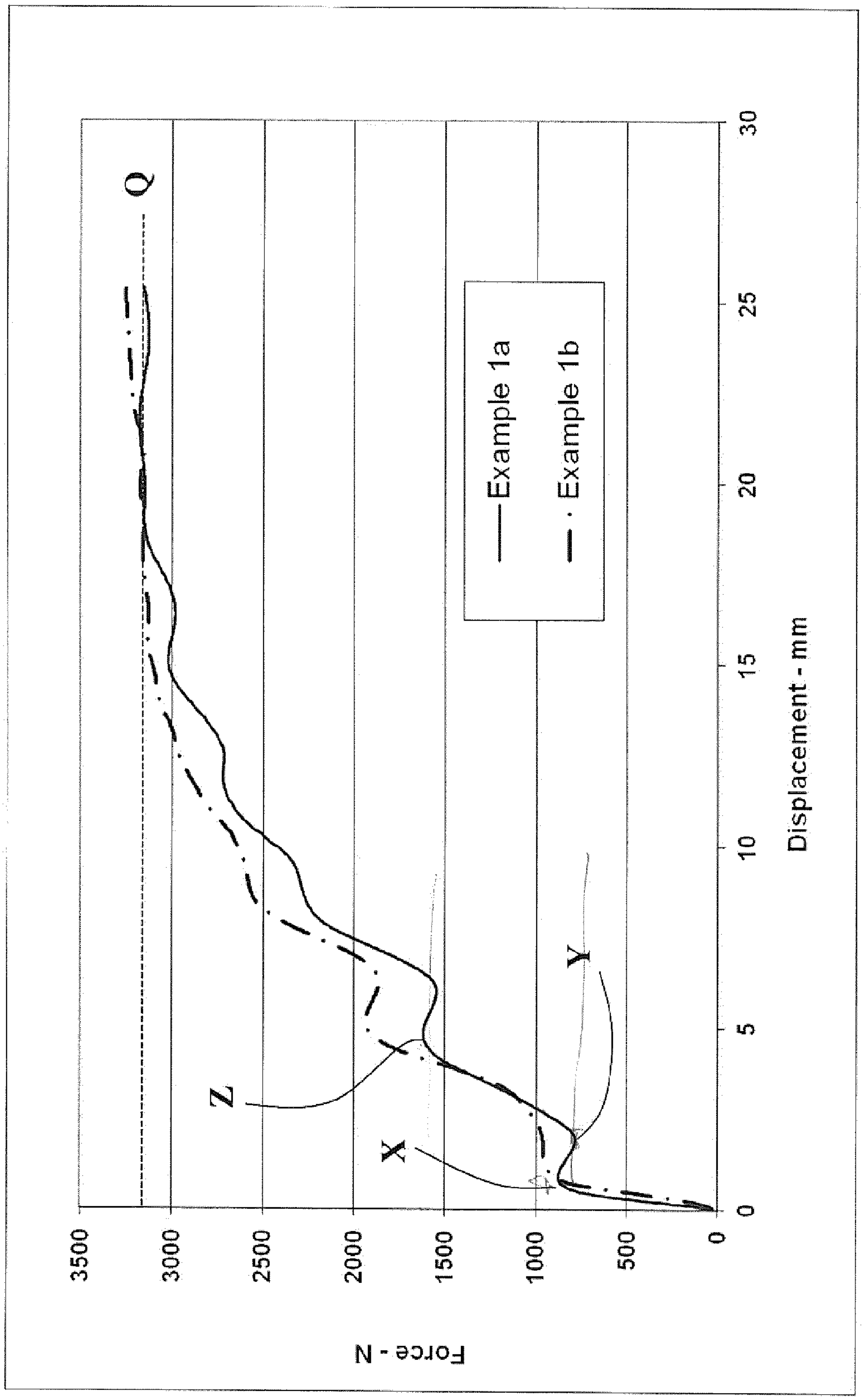


Figure 3a

Figure 4


Force - N
3500
3000
2500
2000
1500
1000
500
0
0
5
10
15
20
25
30
Displacement - mm
Example 1a
Example 1b
Q
Z
X
Y

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EUROPEAN SEARCH REPORT

Application Number
EP 13 16 3954

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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
Munich	11 October 2013	Gavriliu, Alexandru

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EUROPEAN SEARCH REPORT

Application Number
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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
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