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(54) Abstract Title
A method of casting

(57) A method of casting a metal part in a vertically parted foundry mould 17 comprises inserting into a sleeve receiving cavity 15 of the mould 17 a feeder sleeve 1 of refractory and/or exothermic material, the sleeve 1 having an outwardly projecting flange 11 which is received in a correspondingly shaped, sized and positioned portion (19 of the sleeve receiving cavity 15. In this way the sleeve is securely retained in the cavity 15 until a second vertically-parted sand mould part is brought together with part 17 to form an enclosed mould cavity. At least one projection may extend outwardly beyond the external peripheral surface of the sleeve in every 180° of arc centred at the longitudinal axis of the sleeve. Preferably the projection extends beyond the peripheral surface of the sleeve by a distance of 10-50% of the radius of the sleeve. The method may be at least partly automated.

FIG 2

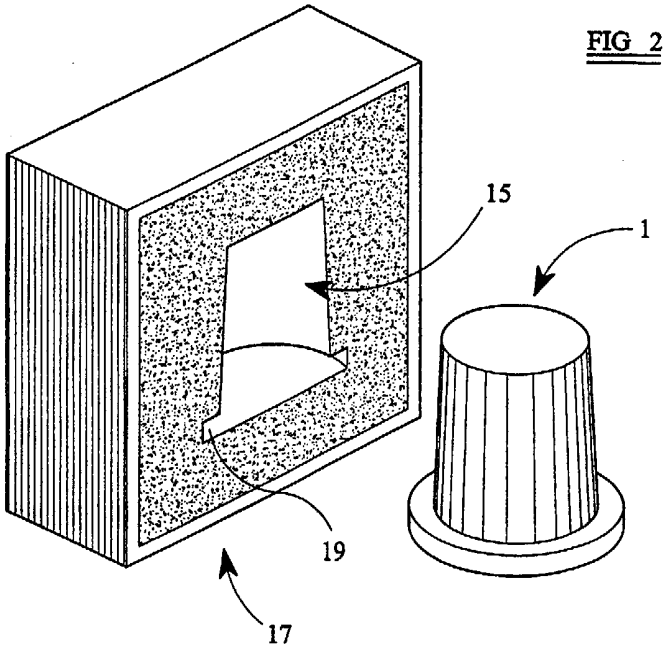

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FIG 1

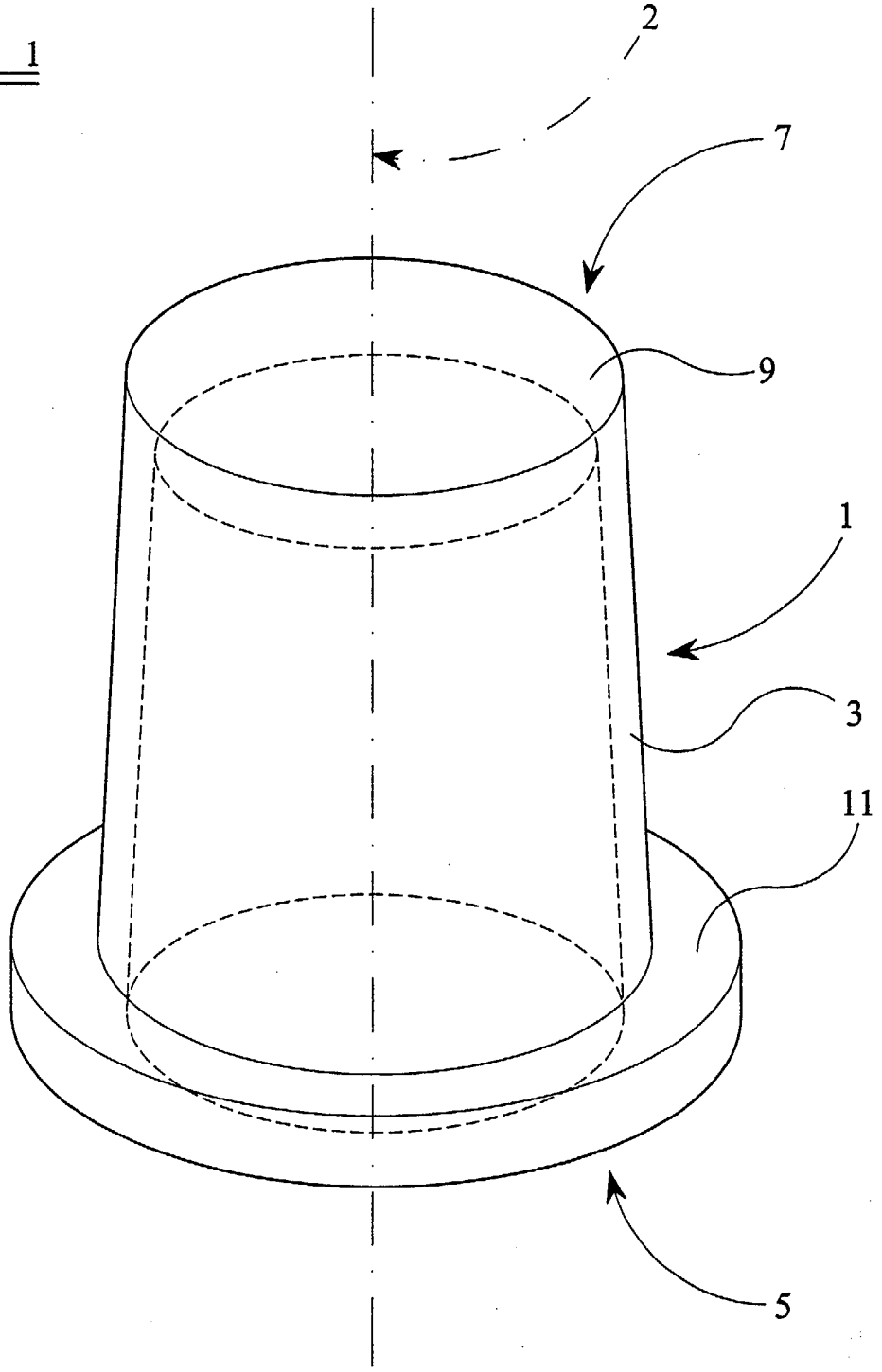


FIG 2

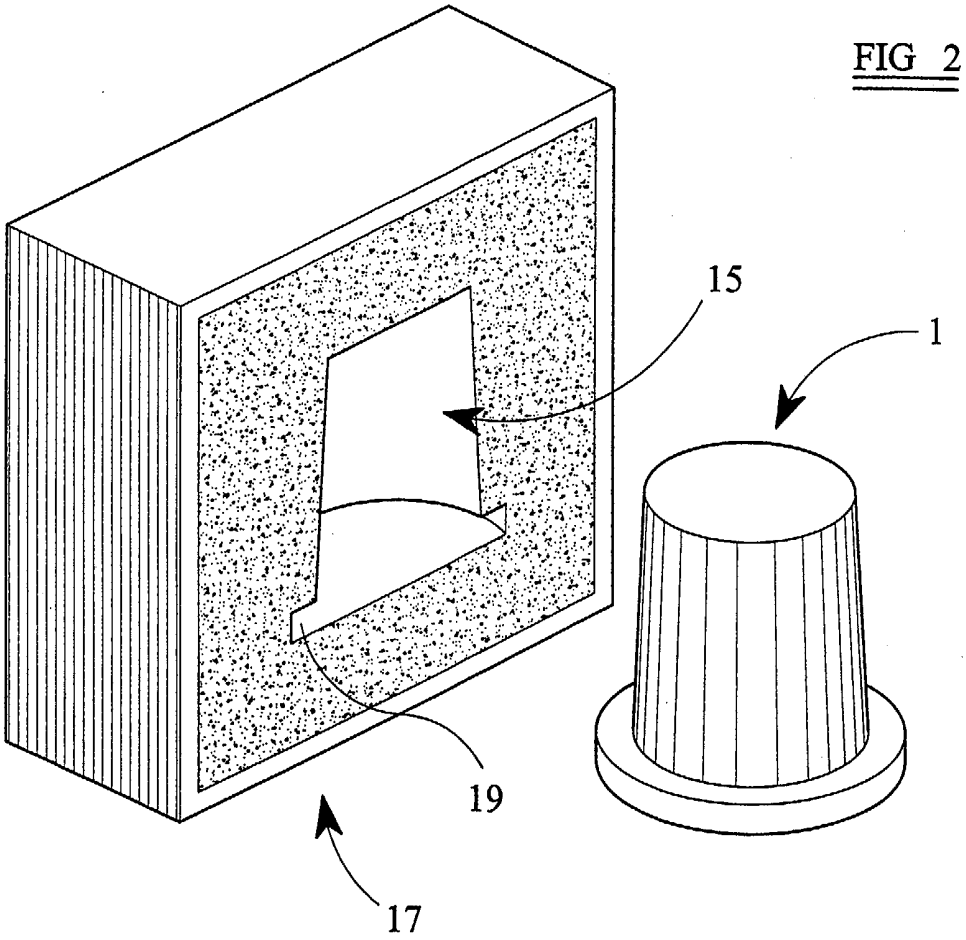
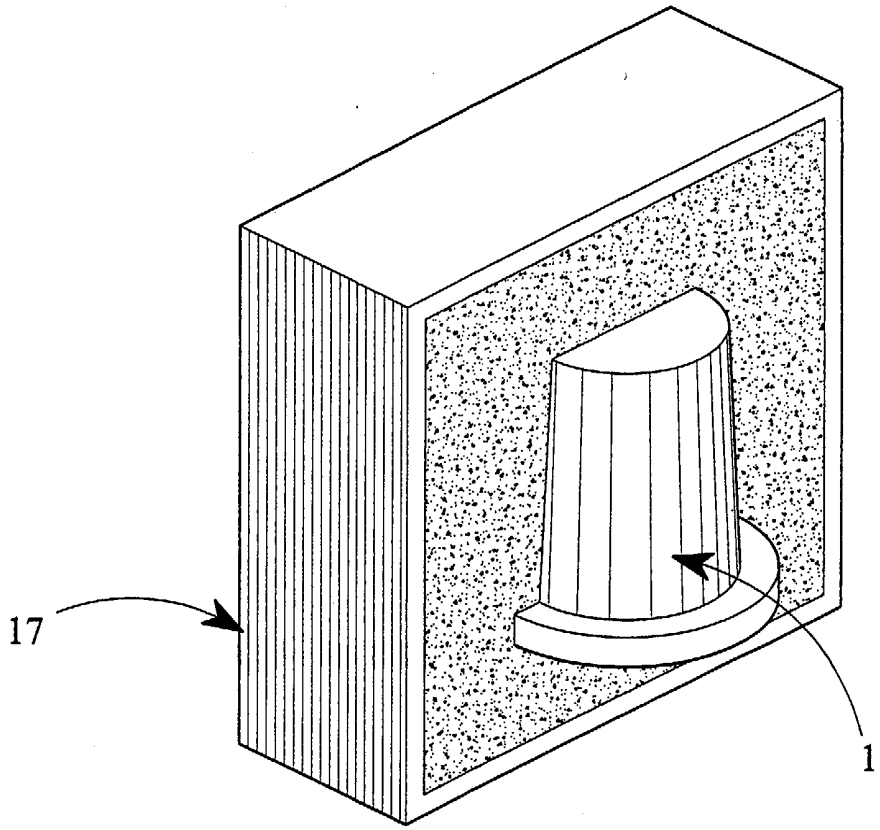


FIG 3



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A Method of Casting

The present invention relates to processes for the casting of metals in moulds. In particular, the invention relates to vertically-parted foundry moulds, and especially to automated systems of producing and using vertically-parted moulds.

When molten metal is poured into a foundry mould and allowed to cool and solidify to form a cast metal part, the metal shrinks in volume. In order to prevent the formation of voids and other defects in the casting, so-called "feeders" or "risers" are used. Feeders and risers (which terms are synonymous) are vessels located above or adjacent to the mould cavity (which forms the casting) which contain a quantity of molten metal that remains molten for longer than the molten metal in the mould cavity, and which function as a supply of molten metal to the mould cavity to prevent the formation of voids and other defects as the metal in the mould cavity solidifies. Feeders and risers are commonly in the form of sleeves of insulating refractory and/or exothermic material. Insulating feeder sleeves function by retarding the heat loss from the molten metal contained in the sleeve more effectively than does the mould cavity. Exothermic feeder sleeves function by undergoing an exothermic (i.e. heat-generating) chemical reaction initiated by the heat of the molten metal. Exothermic sleeves may also have insulating characteristics.

Vertically-parted moulds are moulds in which two (or more) parts are brought together in a vertical plane (rather than in a horizontal plane) to form an enclosed mould cavity. When a feeder sleeve is used in such mould, the (or each) sleeve needs to be located in position in one of the mould parts prior to the mould parts being brought together. However, there is a problem inherent in such systems, in that it is often easy for the sleeve to fall out of the mould part in which it is positioned, or at least for the sleeve to become displaced from its precisely correct position, before the two mould parts can be properly brought together. This problem is particularly acute with automated moulding systems, especially those wherein a "stack" or "string" of moulds is formed in an automated casting process. A well-known process of this type is the commercially available "DISAMATIC" (trade mark)

automated moulding machine (supplied by Georg Fischer Disa A/S of Denmark). In these types of processes the accidental displacement of a feeder sleeve will cause a defective casting and/or disrupt the casting process. Automatic moulding processes are described for example in US-A-3008199 and US-A-5836383.

The present invention seeks to provide an effective solution to the above problem.

The present invention provides a method of casting a metal part in a vertically parted foundry mould, the method comprising the step of inserting a feeder sleeve into a sleeve-receiving cavity in one of two or more vertically parted mould parts, the feeder sleeve being formed from insulating refractory and/or exothermic material and having a longitudinal axis and including at least one projection extending outwardly beyond an external peripheral surface thereof, the sleeve receiving cavity including at least one portion shaped, sized and positioned to receive as a snug-fit engagement a corresponding said projection extending outwardly beyond an external peripheral surface of the sleeve. The present invention preferably employs a method of casting that is at least party automated. Preferably the step of inserting the feeder sleeve into the sleeve-receiving cavity is automated. Most preferably the casting comprises using an automated string moulding plant.

Thus, for example, a preferred plant for use in the method of the present invention comprises a string moulding plant including a pouring zone comprising a pouring device for sequentially pouring metal into an individual mould assembly of a plurality of mould assemblies as said mould assemblies are advanced in sequence past the pouring device, and a cooling zone downstream of the pouring zone at which the mould assemblies are cooled, each of said mould assemblies comprising first and second mutually abutting moulds of green sand, a space between each of said first and second mutually abutting moulds defining at least one mould cavity there-between. For further details of a string moulding process of this type reference may be had to US-A-5836373 and US-A-3008199 the whole contents of which are hereby incorporated into the present specification.

As stated above, the feeder sleeve, which is formed from insulating refractory and/or exothermic material, has a longitudinal axis and including at least one projection extending outwardly beyond an external peripheral surface thereof.

The sleeve used in the method of the present invention has the advantage that because it includes at least one projection extending outwardly beyond an external peripheral surface of the sleeve, the projection can serve to retain the sleeve in its correct position in a mould part of a vertically parted mould before the two (or more) mould parts are brought together. The mould part in which the sleeve is initially positioned includes a sleeve-receiving cavity which is profiled to match the external profile of part, preferably half, of the sleeve, including the (or each) projection of the sleeve. The (or each) sleeve projection preferably forms a snug-fit engagement with its corresponding portion of the sleeve-receiving cavity. The engagement between the sleeve projection and its corresponding sleeve cavity portion therefore serves to prevent, or at least to hinder, accidental displacement of the sleeve from its correct position, by friction between the sleeve projection and its sleeve cavity portion and/or by the prevention of rotation of the sleeve out of the cavity, for example.

Advantageously, the moulding method may be generally as described in US Patent No. 3,008,199, the entire disclosure of which is incorporated herein by reference.

In preferred embodiments of the invention, the sleeve has a generally cylindrical shape, the external peripheral surface of the sleeve having a substantially circular cross-section centred on the longitudinal axis of the sleeve and thus comprising an external circumferential surface. The cross-section of the external peripheral surface of the sleeve may vary along the longitudinal axis of the sleeve (for example the sleeve may be substantially frusto-conical); alternatively the sleeve may have a substantially constant external peripheral surface cross-section.

As indicated above, in some embodiments of the invention there may be more than one projection on the external peripheral surface of the sleeve. In such embodiments, it is generally preferred for there to be at least one projection extending outwardly beyond the external peripheral surface of the sleeve in every 180° of arc centred at the longitudinal axis of the sleeve. This has the advantage that in most orientations of the sleeve about its longitudinal axis, one of the projections will project towards the sleeve-receiving cavity in the mould part in which it is initially positioned, thereby lessening the possibility that none of the projections projects into the sleeve receiving cavity due to incorrect orientation of the sleeve. Clearly, for embodiments in which there is a plurality of projections arrayed around the periphery of the sleeve, the more projections in each sector of arc, the better, in this respect. Therefore, in such embodiments, preferably there is at least one projection extending outwardly beyond the external peripheral surface of the sleeve in every 120° of arc, more preferably every 90° of arc, centred at the longitudinal axis of the sleeve.

It is generally preferred, however, for there to be at least one projection extending outwardly beyond the external peripheral surface of the sleeve around substantially the entire periphery of the sleeve. The, or each, such projection preferably comprises a substantially continuous ridge extending around substantially the entire periphery of the sleeve. The projection may be located at or near a longitudinal extremity of the sleeve, and consequently the projection may comprise a flange or outwardly projecting rim of the sleeve.

The, or each, projection extends beyond the peripheral surface of the sleeve preferably by a distance of between 10% and 50%, more preferably between 20% and 40%, of the radius (perpendicular to the longitudinal axis) of the sleeve measured from the longitudinal axis to the external peripheral surface of the sleeve immediately adjacent to the projection.

The feeder sleeve employed in the method of the present invention may be formed from any refractory insulating and/or exothermic material from which known

feeder sleeves may be formed; the skilled person will be able to select the appropriate materials for each particular requirement. Examples of suitable materials include ceramic materials, metals, bonded particulate refractory materials, etc. Additionally, the feeder sleeve employed in the process of the present invention may be formed in any of the known methods of forming feeder sleeves, for example by vacuum forming a slurry of the sleeve material around a former and inside an outer mould, followed by heating of the sleeve to remove the water and to harden or cure the material. Alternatively, the sleeve may be formed by ramming or blowing the material in a core box.

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

Figure 1 shows, schematically, a feeder sleeve suitable for use in the method of the present invention;

Figure 2 shows, schematically, a sleeve receiving cavity of a vertically-parted foundry mould, shaped and sized to receive the feeder sleeve of Figure 1 (also shown here); and

Figure 3 shows, schematically, the feeder sleeve shown in figures 1 and 2 received in the sleeve-receiving cavity shown in Figure 2.

Figure 1 shows a feeder sleeve 1 for use in the method of the present invention, having a longitudinal axis indicated by reference numeral 2. The sleeve 1 is generally frusto-conical in shape, a sidewall 3 of the sleeve having a circular cross-section reducing from a relatively wide lower longitudinal extremity 5 to a relatively narrow upper longitudinal extremity 7 of the sleeve. The upper extremity 7 of the sleeve is capped by a circular upper wall 9. The lower extremity 5 has a projection 11 extending outwardly beyond an external peripheral surface 13 of the sleeve, the projection 11 being in the form of an outwardly extending rim, or flange of the sleeve. The projection 11 extends beyond the peripheral surface of the sleeve by a distance of approximately 30% of the radius (perpendicular to the longitudinal

axis) of the sleeve measured from the longitudinal axis to the external peripheral surface of the sleeve immediately adjacent to the projection.

Figure 2 shows, schematically, the sleeve 1 shown in Figure 1, and a sleeve receiving cavity 15 provided in a vertically-parted foundry sand mould part 17. The cavity 15 is shaped and sized to receive the sleeve 1 as a snug-fit engagement, such that half of the sleeve is received in the cavity in a vertical orientation. The cavity 15 includes a semi-annular portion 19 shaped, sized and positioned to receive the projection 11 of the sleeve as a snug-fit engagement. In this way, the sleeve is securely retained in the cavity 15 until a second vertically-parted sand mould part (not shown) is brought together with the part 17 to form an enclosed mould cavity (not shown). The second mould part will also include a corresponding cavity 15, to accommodate the sleeve 1.

It will be appreciated that, since Figure 2 is merely a schematic representation of a sleeve-receiving cavity, there is no sprue shown extending into the cavity. In practice, the sleeve receiving cavity will include a sprue communicating between the cavity and the mould cavity, to allow the feeding of molten metal from the feeder sleeve to the mould cavity to compensate for the shrinkage of the metal in the mould cavity as it solidifies.

Figure 3 shows the feeder sleeve 1 shown in figures 1 and 2 received in the sleeve-receiving cavity shown in Figure 2.

Claims

1. A method of casting a metal part in a vertically parted foundry mould, the method comprising the step of inserting a feeder sleeve into a sleeve-receiving cavity in one of two or more vertically parted mould parts, the feeder sleeve being formed from insulating refractory and/or exothermic material and having a longitudinal axis and including at least one projection extending outwardly beyond an external peripheral surface thereof, the sleeve receiving cavity including at least one portion shaped, sized and positioned to receive as a snug-fit engagement a corresponding said projection extending outwardly beyond an external peripheral surface of the sleeve.

2. A method as claimed in Claim 1 wherein the method is at least partly automated.

3. A method as claimed Claim 1 or 2 wherein the step of inserting the feeder sleeve into the sleeve-receiving cavity is automated.

4. A method as claimed in any one of the preceding claims wherein the moulding comprises using an automated string moulding plant.

5. A method as claimed in any one of the preceding claims wherein the sleeve has a generally cylindrical shape, the external peripheral surface having a substantially circular cross-section centred on the longitudinal axis of the sleeve and thus comprising an external circumferential surface.

6. A method as claimed in any one of the preceding claims wherein the cross-section of the external peripheral surface of the sleeve varies along the longitudinal axis of the sleeve.

7. A method as claimed in any one of the preceding claims wherein there is at least one projection extending outwardly beyond the external peripheral surface of the sleeve in every 180° of arc centred at the longitudinal axis of the sleeve.

8. A method as claimed in Claim 7 wherein there is at least one projection extending outwardly beyond the external peripheral surface of the sleeve in every 90° of arc centred at the longitudinal axis of the sleeve.

9. A method as claimed in any one of the preceding Claims wherein there is at least one projection extending outwardly beyond the external peripheral surface of the sleeve around substantially the entire periphery of the sleeve.

10. A method as claimed in any one of the preceding Claims wherein at least one projection is located at or near a longitudinal extremity of the sleeve.

11. A method as claimed in Claim 11 wherein said at least one projection comprises a flange or outwardly projecting rim of the sleeve.

12. A method as claimed in any one of the preceding Claims wherein at least one projection extends beyond the peripheral surface of the sleeve by a distance of between 10% and 50% of the radius (perpendicular to the longitudinal axis) of the sleeve measured from the longitudinal axis to the external peripheral surface of the sleeve immediately adjacent to the projection.

13. A method as claimed in Claim 12 wherein said distance of projection is between 20% and 40% of said radius.

Application No: GB 0130078.9 **Examiner:** Pete Beddoe
Claims searched: 1-13 **Date of search:** 11 June 2002

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): B3F (FCXA, FDJA, FDP, FFD, FFE, FGF)

Int Cl (Ed.7): B22C (9/00, 9/08); B22D (7/10, 15/00, 17/00)

Other: Online: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X,Y	GB 2260285 A	(MASAMITSU) see esp p6 lines 5-25 & fig 1	X,Y=1,6 at least
X,Y	GB 2257646 A	(FOSECO) see esp p5 line 22-33, p7 lines 14-20, figs 1,8	X,Y=1,6 at least
X,Y	GB 2141649 A	(STEETLEY) see esp p1 lines 116-122 & fig V	X,Y=1,6 at least
X,Y	EP 0906802 A1	(MASAMITSU) see esp col4 lines 1-31 & figs 1,3	X,Y=1,6 at least
X,Y	EP 0206507 A2	(FOSECO) see esp col3 lines 38-48 & fig 2	X,Y=1,6 at least
X,Y	WO 98/00255 A1	(FOSECO) see esp p5 line 15 - p7 line 5 & figs 1,5	X,Y=1,6 at least
Y	US 4719958	(FOSECO) see esp col6 line 8 - col8 line 27	1,6 at least
X,Y	US 4665966	(FOSECO) see esp col4 lines 49-54 & fig 10	X,Y=1,6 at least
X,Y	US 4582112	(UNITED STATES) see esp col2 line 66 - col3 line 4 & fig 4	X,Y=1,6 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Application No: GB 0130078.9 **Examiner:** Pete Beddoe
Claims searched: 1-13 **Date of search:** 11 June 2002

Category	Identity of document and relevant passage		Relevant to claims
X,Y	US 4352482	(FOSECO) see esp col3 lines 1-34 & figs 2,4,5	X,Y=1,6 at least
X,Y	US 3467173	(SUSQUEHANA) see esp col1 line 66 - col2 line 25 & figs	X,Y=1,6 at least
X,Y	JP 62-040953 A & Japio abstract of JP 62-040953 A (ASAHI) see esp figs & English abstract		X,Y=1,6 at least
X,Y	JP 62-040952 A & Japio abstract of JP 62-040952 A (ASAHI) see esp figs & English abstract		X,Y=1,6 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.