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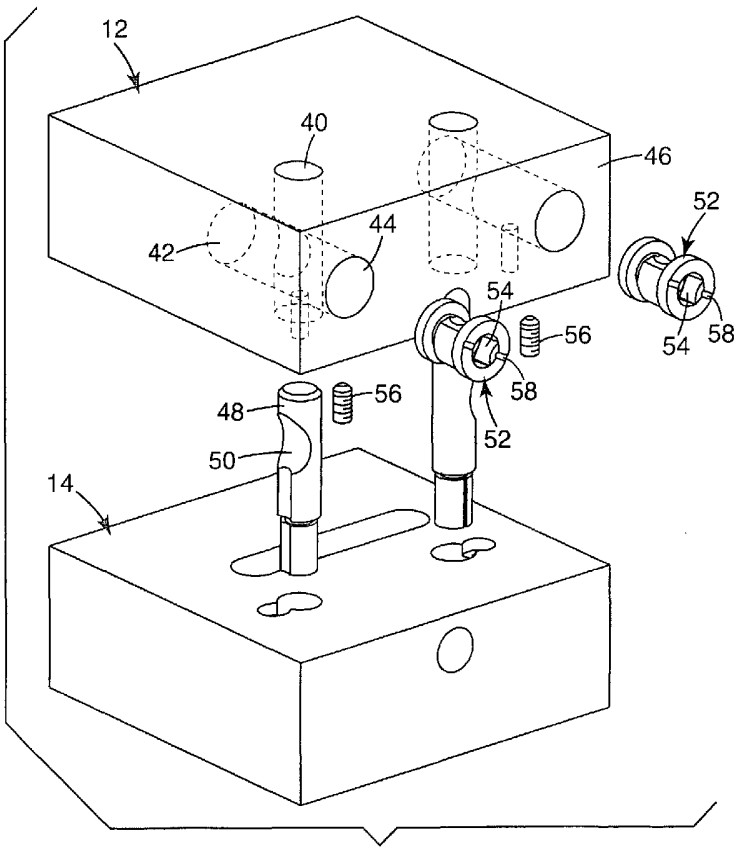
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(54) Title: COATING DIE HAVING QUICK ASSEMBLY FEATURES



(57) Abstract: A slot coating die (10) having at least a first (12) and a second portion (14) together defining a cavity in fluid communication with a first applicator slot, and at least one quick release fastener (48, 52) disposed so as to clamp the first portion against the second portion. The invention particularly lends itself to the preparation of multilayer coating dies that include a third portion with the second portion and the third portion together defining a second cavity in fluid communication with a second applicator slot. The preferred rear operating quick release clamps obviate the need to tear down the entire die to access one of the interior portions in order to replace a shim or clean a slot.

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COATING DIE HAVING QUICK ASSEMBLY FEATURES

TECHNICAL FIELD

The invention relates generally to the construction of dies for the application of coating material to e.g. a web of indefinite length material, and more particularly to a coater having features facilitating rapid assembly and disassembly.

BACKGROUND

Coating a fluid onto a web of material is well known. Such coating can often be conveniently done using a coating die having a cavity communicating with an applicator slot. Liquid under pressure is introduced into the cavity, and is then extruded out of the applicator slot onto a desired substrate such as, e.g. a web of indefinite length material or individual articles.

In die coating it is very desirable to exercise precise control of the die geometry so as to achieve a die assembly with a uniform slot height. The uniformity of the slot height is a function of the flatness, rigidity and joining method for the two portions that comprise the die. A shim may be (and often is) employed between the die portions, and its dimensional uniformity is also a factor. This hopefully uniform slot is in fluid communication with the cavity inside the die in a way that a uniform flow is maintained across the width of the die when the fluid to be coated is pumped under pressure into the cavity.

More sophisticated multilayer dies having more than one applicator slot are known and used to evenly spread two of more liquid layers simultaneously to coat a web of indefinite length material or individual articles. Precise control of die geometry becomes more difficult as the number of layers increases and cascading errors arise during assembly. Typically the manifold and the metering slot for a layer in a multilayer die are formed by joining two precisely machined metal portions using standard fasteners such as bolts that are threaded down through the top of one portion into the next, clamping the portions together. This creates several problems for multilayer dies, such as having to tear

down the entire die to access one of the interior layers in order to replace a shim or clean a slot. Often this is the case because the upper portion for the next layer covers over the fasteners joining the underlying section to the next section below.

The use of bolts to assemble coating dies causes a second problem to occur in dies that do not have e.g. fixed pins between the layers to guarantee a particular alignment. Such alignment pins are often foregone when it is desirable that the two layers that together define a manifold cavity and its associated applicator slot be repositionable during assembly to vary the overbite between the edges at the exit end of the slot. Reaction torque from the first bolt to be tightened tends to twist the top portion relative to the bottom portion and often mars the setup if the part is not rigidly restrained from rotating prior to snugging down the bolts.

SUMMARY OF THE INVENTION

The present invention provides a multilayer slot coating die adapted for precisely joining the major die portions together in a way that allows the user to independently assemble, reposition or disassemble individual layers without disturbing the other already assembled layers. This is conveniently accomplished by a series of quick release fasteners that are preferably installed in specially designed recesses within the die body. It is particularly convenient for these quick release fasteners to be cams that are rotated along axes that are parallel to the parting plane of the die. Such fasteners allow the user assembling the die to have unrestricted access to the fasteners through the exposed rear of the die at any point during the assembly process, even after multiple layers have been assembled one on top of another.

More particularly, the invention can be thought of as an apparatus including a die having at least a first and a second portion together defining a die cavity in fluid communication with a first applicator slot, and at least one quick release fastener disposed so as to clamp the first portion against the second portion. More commonly, there will be at least a second quick release fastener disposed so as to clamp the first portion against the second portion, the better to resist any forces tending to twist the die portions relative to one another. Indeed, a very wide die may need a number of quick release fasteners to provide sufficient stability and clamping force.

In preferred embodiments, the quick release fastener is of a type such that the first portion of the die can be clamped against the second portion by the quick release fastener over a range of positions relative to each other, the range being oriented in a direction perpendicular to the first applicator slot. This allows the operator to assemble the die so as to provide the right amount of offset where one edge of the applicator slot is advanced compared to the other edge relative to the substrate being coated. The offset is sometimes called "overbite" in the art when the downweb edge of the slot is advanced towards the roll compared to the upweb edge, and "underbite" if the reverse is true. More information about the use of offset die edges in die coating is disclosed in U.S. Patent 5,759,274 to Maier et al, which is incorporated herein by reference. It is particularly convenient if the quick release fastener is operable from the rear of the die compared to the applicator slot.

The invention particularly lends itself to the preparation of multilayer coating dies that include a third portion with the second portion and the third portion together defining a second cavity in fluid communication with a second applicator slot. The preferred rear operating quick release fasteners obviate the need to tear down the entire die to access one of the interior portions in order to replace a shim or clean a slot.

One particularly convenient quick release fastener that can be used in connection with the present invention includes a stud attached to one of the first portion or the second portion and adapted to extend into a recess in the other portion. The other portion has a rotatable cam positioned so as to exert a variable force against the stud when rotated.

Even in conditions when it is desirable to provide non-quick release fasteners such as bolts to handle the expected forces tending to separate die portions, quick release fasteners of the type just described can expedite the assembly of the die. More specifically, such cam lock fasteners hold without exerting a twisting force around an axis perpendicular to the separation plane of the die portions the way bolts do when they are torqued up. So if such cam lock fasteners are provided and used to lock the die portions together before the bolts are employed, their clamping force will be available to resist any tendency the bolts have to twist the die portions out of alignment.

With this in mind, the invention can also be thought of as a method of assembling a coating die, comprising at least a first and a second die portion that together define a cavity in fluid communication with a first applicator slot, providing at least one quick release

fastener disposed so as to clamp the first portion against the second portion, and actuating the quick release fastener. In many preferred embodiments of the method, the quick release fastener is of a type such that the first portion can be clamped against the second portion by the quick release fastener over a range of positions relative to each other, the range being oriented in a direction perpendicular to the first applicator slot. In these embodiments, the method can further include positioning the first portion relative to the second portion within that range of positions so as to achieve a predetermined offset between the first portion and the second portion at the application slot.

In some preferred variations of the method, the quick release fasteners are adapted to hold without exerting a twisting force around an axis perpendicular to the separation plane of the die portions. In these variations, the method most easily accommodates an additional step of clamping the first portion to the second portion with at least one non-quick release fastener.

BRIEF DESCRIPTION OF THE DRAWING

In the several figures of the attached drawing, like parts bear like reference numerals.

FIG. 1 is a perspective view of an illustrative coating die according to the present invention.

FIG. 2 is an exploded perspective detail view highlighting a preferred type of quick release fasteners.

It is to be understood that the above description is intended to be illustrative, and not restrictive. Various modifications and alterations of this invention will become apparent to those skilled in the art from the foregoing description without departing from the scope of this invention, and it should be understood that this invention is not to be limited to the illustrative embodiments set forth herein.

DEFINITIONS

The distribution chambers of most coating dies have a common general shape. They include a cavity (also sometimes referred to in the art as a distribution chamber or channel) that is oriented substantially in the cross-web direction and which is connected to

an applicator slot (also sometimes referred to in the art as a slit or land). As used herein, the term "manifold" means the cavity as defined above and any other passageways between the cavity and the applicator slot and includes the applicator slot.

As used herein, the term "clamp" means to use a mechanism to apply a force tending to fix two objects in a positional relationship to one another. It does not imply that the two objects are in actual contact. (In connection with the present invention, die portions are often slightly separated by noncompliant shims. They are nonetheless clamped if a mechanism is used to fix their relative position.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS OF THE INVENTION

Referring now to FIG. 1, a front perspective view of an exemplary coating die 10 is illustrated. The coating die 10 includes first die portion 12, second die portion 14, and a third die portion 16. In many convenient embodiments, the portions are separated by shims as illustrated here as shims 18 and 20. This allows the height of the applicator slot to be conveniently adjusted. A first applicator slot 22 and the second applicator slot 24 are conveniently defined by shim 18 and shim 20 respectively. The applicator slots 22 and 24 are in fluid communication with fluid distribution cavities defined by first die portion 12 and second die portion 14, and second die portion 14 and third die portion 16, respectively, although these cavities are hidden from view in this illustration of the assembled coating die 10.

In the present invention, there will be at least one quick release fastener employed to clamp the first portion 12 against the second portion 14. A quick release fastener is operable without repetitive motion, and diverse mechanical expedients will be apparent to the ordinary artisan. Rotatable and linear cam arrangements, taper connections, and overcenter toggles are non-limiting examples of quick release fasteners. In connection with the present invention, expedients where the quick release fastener is of a type such that the first portion can be clamped against the second portion by the quick release fastener over a range of positions relative to each other, the range being oriented in a direction perpendicular to the first applicator slot, are much preferred. Additionally, mechanized devices may be utilized for engaging or disengaging the quick release fasteners.

A quick release fastener capable of providing this advantage is illustrated in FIG. 2, which is an exploded perspective detail view focusing on the quick release fasteners. An isolated portion of first die portion 12 is shown separated from second die portion 14 at their natural parting line. First die portion 12 has been provided with a recess 40 extending in a direction perpendicular to the parting line. The recess 40 is intersected by a transverse bore 42 that extends to the opening 44 in the rear face 46 of first die portion 12. The recess 40 is sized to receive stud 48, which is mounted in die portion 14. The stud 48 has a bearing surface 50, conveniently shaped to interact with rotatable cam 52. The stud 48 is mounted so that the bearing surface 50 can be fixed in any one of a plurality of positions in a direction perpendicular to the separation plane of the die portions 12,14. Rotatable cam 52 is shaped so as to be able to exert a variable force tending to draw first die portion 12 towards second die portion 14 depending on its rotational position against bearing surface 50. Rotatable cam 52 is conveniently provided with a tool feature 54 so they can be manipulated within transverse bore 42 with a tool such as a screwdriver, square drive wrench or an Allen wrench depending upon the detail of the feature. A locking set screw 56 is provided to retain the rotatable cam 52 that is spring loaded against it within transverse bore 42 after assembly. The rotatable cam 52 preferably has a notch 58 on the exposed face to provide tactile feedback to the user, clicking into the correct rotational position for release and die disassembly whenever the notch 58 is rotated to within close proximity of the tip of the set screw 56. The rotatable cam 52 is also inscribed with a mark on the exposed face to indicate the correct rotational position for release. The set screw 56 also provides a means of adjusting the axial location of the rotatable cam 52 by means of a beveled tip that the spring loaded cam 52 rides against. Screwing the set screw 56 further into the die forces the rotatable cam further back into the recess that houses the rotatable cam 52.

Example 1

A coating die having two applicator slots each 25 cm wide and being generally as depicted in Fig. 1 was prepared from stainless steel, and provided with six quick release fasteners generally as depicted in Fig. 2. More specifically, these quick release fasteners included studs appropriate for a D1-2" camlock spindle nose. The stud had a diameter of

7/16" (11 mm), and its bearing surface was inclined 40° from vertical. The stud was provided with a 3/8-24UNF thread so that the height of the stud can be adjusted in 41 mil (1 mm) increments during initial assembly. The linear cam was a nominal 5/8" (15.8 mm) in diameter, with a 210° profile that was 0.063" to 0.004" (1.6 to 0.1 mm) less than the outer circumference, having a rise of approximately 60 mils (1.5 mm). The eccentricity of the stud follower to the cam was .358" (9.1 mm).

The described coating die was tested at pressure to compare the performance of the camlock fasteners to that of conventional capscrews that are typically used to join the die portions together. A 3.7-mil (0.09 mm) layer of 3M 5490 extruded PTFE (3M Company, St. Paul, Minnesota) tape was applied to the parting face of the upper block, which was then stacked on top of the lower block. A fitting was threaded into a feed port in the bottom block so as to connect it by piping to a Rosemount 3051C pressure transmitter (Emerson Process Management, Rosemount Division, Chanhassen, Minnesota) and an air pressure regulator.

A Mitutoyo Digimatic digital indicator (Mitutoyo/MTI Corporation, Aurora, Illinois) was mounted to the bottom block using a magnetic stand such that the axis of the indicator was normal to the parting plane and directly over the upper block located on the line of symmetry for the assembly near the exit end of the slot. The indicator was then zeroed against the upper face of the upper block that was parallel to the parting plane.

The block was then joined together by hand tightening the cams clockwise with a ¼" square end driver. When the block was pressurized to 60 psig and the indicator reading increased 3 mils (0.076 mm). Air jetted out of the die along the edge of the parting plane that is opposite the feed port side. The air pressure was then vented and the cams were then torqued to approximately 60 in-lbs. The block was pressurized and this time the indicator reading did not change nor were there any audible sounds of leaking. When the air supply was turned off, the pressure within the block slowly bled down to zero over a period of three minutes.

Comparative Example

For comparison, a coating die was prepared generally similar to the coating die of example 1, except that the quick release fasteners were replaced by conventional 3/8-24

socket head cap screws that fully penetrated the upper block. These were torqued to 60 in-lbs, 1/6th the maximum torque for this fastener. The block was then taped and pressurized as described above in Example 1. The result was similar to the test in which the quick release fasteners were also torqued to 60 in-lbs. Increasing the torque on the cap screws to 480 in-lbs yielded the same result. Reducing the torque on the cap screws to 30 in-lbs resulted in the lip deflecting 0.3 mil (0.0076 mm). This demonstrates that the convenience of the quick release fasteners can be accomplished without a loss of sealing force.

CLAIMS:

1. An apparatus, comprising:

a die having at least a first and a second portion together defining a manifold in fluid communication with a first applicator slot; and

at least one quick release fastener disposed so as to clamp the first portion against the second portion.

2. The apparatus according to claim 1 further comprising at least a second quick release fastener disposed so as to clamp the first portion against the second portion.

3. The apparatus according to claim 1 wherein the quick release fastener is of a type such that the first portion can be clamped against the second portion by the quick release fastener over a range of positions relative to each other, the range being oriented in a direction perpendicular to the first applicator slot.

4. The apparatus according to claim 1 wherein the quick release fastener is operable from the rear of the die compared to the applicator slot.

5. The apparatus according to claim 1 wherein the coating die is a multilayer die further comprising at least a third portion with the second portion and the third portion together defining a second manifold in fluid communication with a second applicator slot.

6. The apparatus according to claim 5 at least one quick release fastener disposed so as to clamp the second portion against the third portion.

7. The apparatus according to claim 1 wherein the quick release fastener comprises

a stud attached to one of the first portion or the second portion and adapted to extend into a recess in the other portion, and

a rotatable cam positioned so as to exert a force against the stud when rotated.

8. The apparatus according to claim 7 wherein the force against the stud is variable depending on the degree of rotation of the rotatable cam relative to the stud.

9. The apparatus according to claim 7 wherein the rotatable cam can be accessed from the rear of the die compared to the applicator slot.

10. The apparatus according to claim 9 such that the first portion can be clamped against the second portion by the quick release fastener over a range of positions relative to each other, the range being oriented in a direction perpendicular from the axis of the applicator slot.

11. A method of assembling a coating die, comprising:

providing at least a first and a second die portion that together define a manifold in fluid communication with a first applicator slot,

providing at least one quick release fastener disposed so as to clamp the first portion against the second portion, and

actuating the quick release fastener.

12. The method according to claim 11 further comprising

providing at a second quick release fastener disposed so as to clamp the first portion against the second portion, and

actuating the second quick release fastener.

13. The method according to claim 11 wherein the quick release fastener is of a type such that the first portion can be clamped against the second portion by the quick release fastener over a range of positions relative to each other, the range being oriented in a direction perpendicular to the first applicator slot, and where in the method further comprises

positioning the first portion relative to the second portion within the range of positions so as to achieve a predetermined offset between the first portion and the second portion at the applicator slot.

14. The method according to claim 11 wherein the quick release fastener is operable from the rear of the die compared to the applicator slot.

15. The method according to claim 11 wherein the coating die is a multilayer die, and the method further comprises providing at least a third portion with the second portion and the third portion together defining a second manifold in fluid communication with a second applicator slot.

16. The method according to claim 11 wherein the quick release fastener comprises

a stud attached to one of the first portion or the second portion and adapted to extend into a recess in the other portion, and

a rotatable cam positioned so as to exert a force against the stud when rotated.

17. The method according to claim 16 wherein the force against the stud is variable depending on the degree of rotation of the rotatable cam relative to the stud.

18. The method according to claim 17 further comprising positioning a shim having a thickness selected from a range of thicknesses between the first portion and the second portion, wherein

rotation of the rotatable cam will exert a variable force against the stud when any of the possible shims has been so positioned.

19. The method according to claim 12 wherein the quick release fasteners are adapted to hold without exerting a twisting force around an axis perpendicular to the separation plane of the die portions.

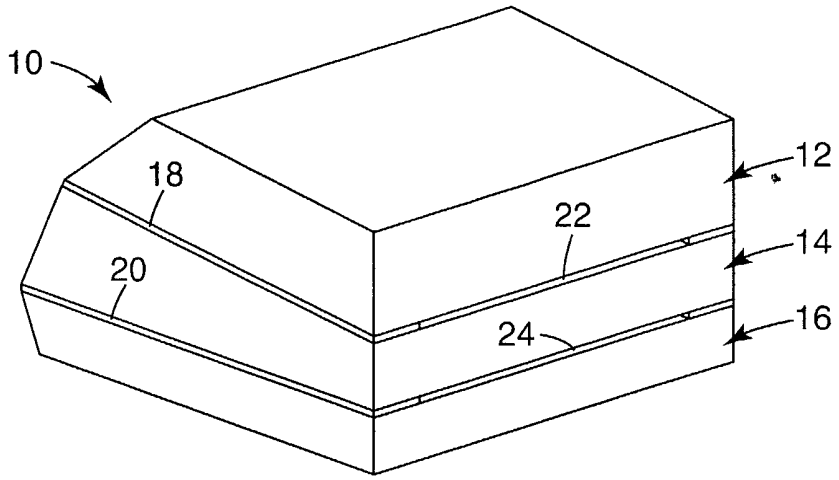


Fig. 1

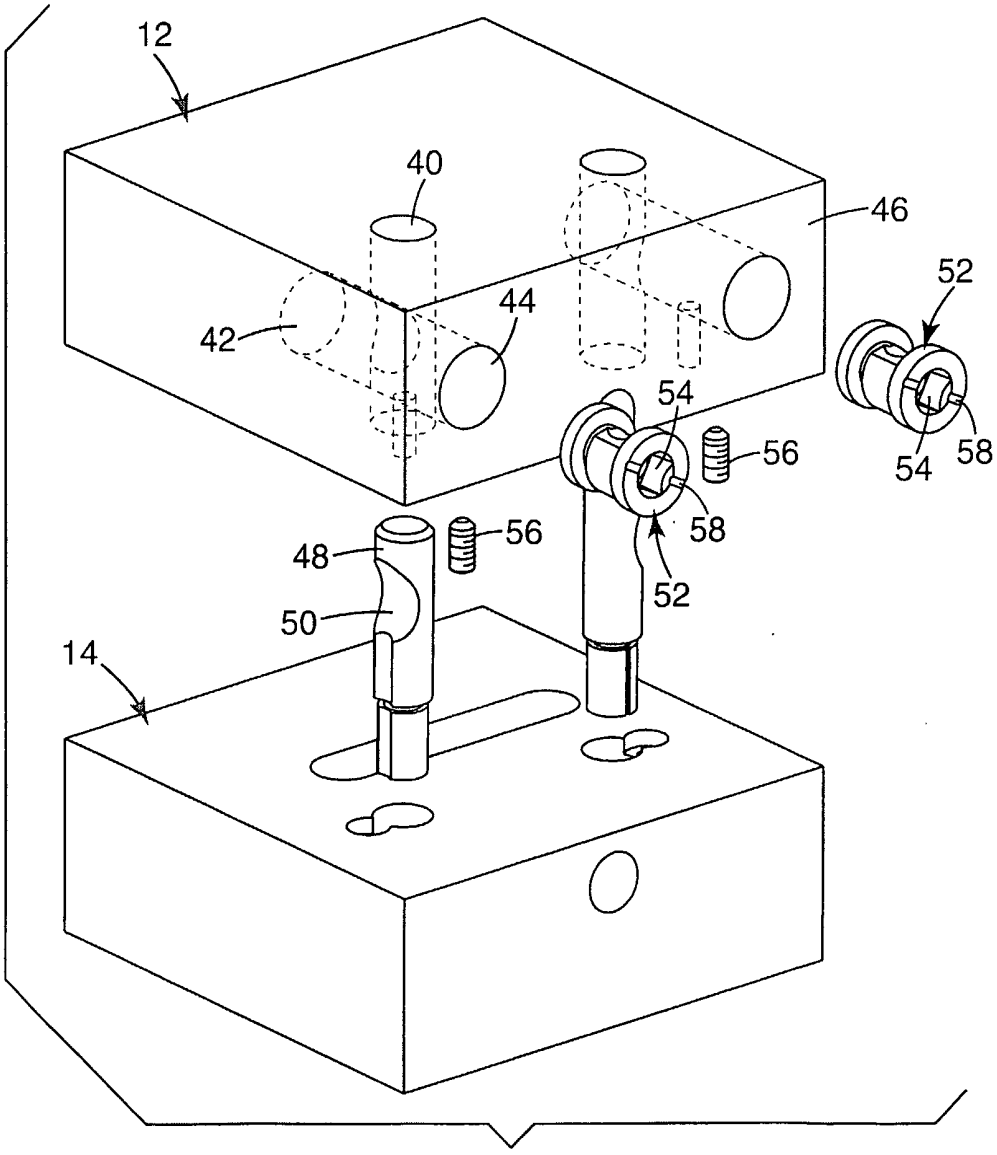


Fig. 2

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US2005/031395

A. CLASSIFICATION OF SUBJECT MATTER
B29C47/08 B29C47/14 B05C5/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B29C B05C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	GB 1 282 876 A (GUTHRIE INDUSTRIES LIMITED) 26 July 1972 (1972-07-26) page 5, line 37 - line 70 figures	1-3,7,8, 11-13, 16,17,19
X	EP 0 679 496 A (OFFICINE FRATELLI CARRARO S.N.C., DI CARRARO GINO, ANGELO E C) 2 November 1995 (1995-11-02) column 3, line 37 - line 43 column 6, line 4 - line 14 figures	1-19

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search	Date of mailing of the international search report
4 January 2006	12/01/2006

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Barré, V

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US2005/031395

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 577 136 A (FRIZ MASCHINENBAU GMBH) 5 January 1994 (1994-01-05) column 6, line 24 - line 31 column 8, line 12 - line 19 claim 1 figures	1-3, 11-13,19
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Form PCT/ISA/210 (continuation of second sheet) (January 2004)

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