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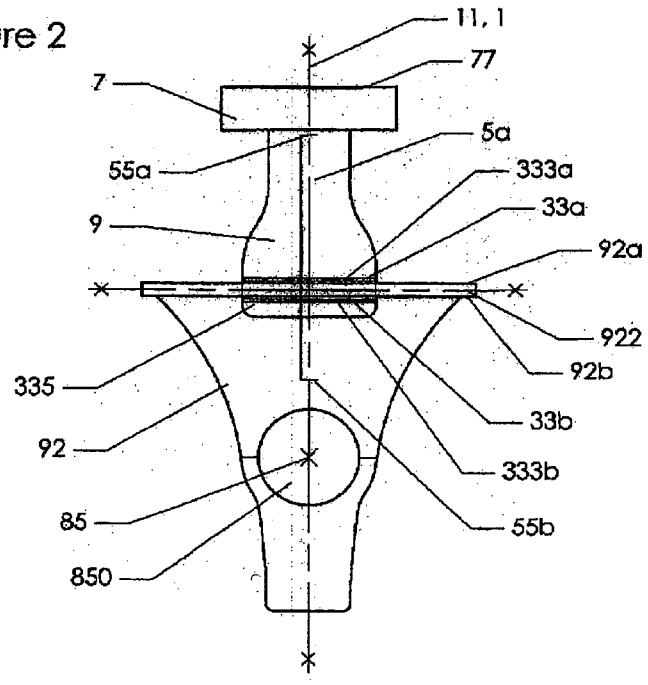
[Continued on next page]

(54) Title: IMPROVED SCOTCH YOKE ENGINE OR PUMP

Figure 2



(57) Abstract: A linear bearing system for the guide bearings of the scotch yoke engine which has been formed from at least one layer of white metal bearing material, the white metal being bonded to the guide bearing housing by means of a solder or flash tinning process.

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Improved Scotch Yoke Engine or Pump

Field of Invention

This disclosure relates to scotch yoke engines and pumps. More particularly this disclosure relates to improvements to the linear bearing structures of these devices, the linear bearings being those structures which guide the slider mechanism which orbits the main axis and also those (excluding the piston skirt) which guide the yoke and its piston assembly in its reciprocation along the cylinder axis.

The Prior Art

It is customary for the linear bearing surfaces of the yoke structure and other components of the scotch yoke engine or pump to be formed from the material of which the yoke or component is made from or to use a separate bearing structure and then screw clamp it to the yoke structure or component. These prior art attempts at providing linear bearing surfaces are not as practicable as they may at first seem. A significant drawback of these prior art approaches is the restriction they pose to the manufacturer as there is in incumbent need to provide access to the space adjacent to the surface to be created or attached to by screw means such that a machining tool can have ease of access to prepare the surface whether that be the finished bearing surface made of the yoke or a surface of the yoke to which the bearing structure is to be screwed to. This is especially the case with regards to a special form of scotch yoke engine or pump, hereinafter called "the slider engine" or "Raffaele slider engine", can be found in PCT/AU/2000/00281 and wherein the opposed linear bearing surfaces which form the first guide means are closer together than the diameter of the big end journal and are located to only that side of the big end bearing pin axis the piston itself is located on. The slider engine includes second guide means having a first end and a second end and the second guide means engages third guide means within a projection of the piston circumference, the projection of the circumference being in the direction of the crankshaft, the second guide means engaging third guide means such that the piston assembly is prevented from rotating around an axis extending generally parallel to the main axis of the crankshaft, the first end of the second guide means being located closer to the crown of the piston than is the first guide means and the second end of the second guide means located further away from the crown of the piston than is the first guide means, the second guide means moving into and then wholly out of the volume swept by the big end bearing journal of the crankshaft during a rotation of the crankshaft around the main axis. The beauty of the slider engine being the small distance between the opposed linear

bearing surfaces of the first guide means, the small distance between the opposed bearing surfaces forming the second guide means, and the small distance between the opposed bearing surfaces forming the third guide means in comparison to those generally seen in the older form of donkey cross head type of scotch yoke engine or pump. The invention makes it far easier to form linear bearings in these small spaces between the surfaces forming each group of opposed bearing surfaces of the slider type engine.

The slider engine preferably includes a female first guide means formed in the shape of a T-shaped channel which is adapted to engage a male generally similarly shaped sliding connecting means. The sliding connecting means being adapted to be rotatably mounted on the big end bearing journal of a crankshaft. The slider portion of the connecting means preferably being a T-shaped male device and the first guide means being preferably a female T-shaped device, however, it is possible and often better to have the channel portion included in the slider portion and the male T-shaped portion the first guide means. In most of the drawings herein however it will be presented the other way around. Similarly with respect to the second and third guide means in that we present herein the second guide means in the form of a rail and the third guide means in the form of a channel – this may easily be reversed so that the second guide means are in the shape of a channel and the third guide means in the form of a rail.

The invention we teach in this disclosure shows a new way to form the linear bearing surfaces of the yoke, whether that be for the slider engine or the older donkey cross head type form, which overcomes the disadvantages of the prior art by providing the means by which a suitable linear bearing structure can be produced despite the constraints imposed by the lack of otherwise suitable space.

Disclosure of the Invention

We have discovered how to make linear bearings for the scotch yoke engine or pump by the use of soft metal or metal alloy material of a kind with the various forms of white metal. The metal or alloy may be used to form the bearing surface or be used to bond a suitable bearing structure to the yoke or component used to guide the yoke or its piston assembly along the cylinder axis. Non-limiting examples of the invention are described and depicted in drawings throughout this overall disclosure. It is usual to use white metal bearings in engine and pumps of conventional design, that is, the design of engine or pump commonly used in power applications throughout the world but these common white metal bearings are rotary bearings. It is known that stop start movements of rotational type white bearing can cause the

bearings to deteriorate but we have discovered that in the scotch yoke engine the usual fatigue from stop start motion can be avoided because in the scotch yoke engine there are no point loads as there are in rotational bearings. This is a truly significant discovery because it means that we have discovered a way or set of ways by which a cheap and easily manufactured linear bearing system suitable for the scotch yoke engine can be manufactured.

The linear bearing structures of the scotch yoke engine or pump are in the form of rail like members and channel or slot like members, the rail like members being constrained to reciprocate within the channels or slots. The slots or channels are preferably kept to the narrowest they may practicably be due to the need to keep thermal distortions and growth to an absolute minimum. The problem being though that in having narrow slots one is presented with having to use narrow tooling to produce the surfaces of the slots or channels. Narrow tooling and confined spaces heighten the risk of tool flexure and so the slot or channel is hard to produce of a consistent set of dimensions. Another factor is that the prior art inventors have used the body material the channel or slot is formed from to create the running surfaces. The body material is often of a necessity very rigid and difficult to machine and so the problems associated with narrow tooling become compounded. With our invention we largely overcome these limitations because we have found a way to create a bearing structure wherein the material used to produce the bearing surface is considerably softer and easier to machine that is the body material used by those expressing the views found in the prior art.

We speak of the body material in this application as being of metal but it is envisaged that carbon fibre or fibre composite materials can often be used to form the body material and even with this more exotic material our invention still functions and can provide an excellent bearing structure for the purposes disclosed herein. With fibre or fibre composite materials we prefer that the first surface of the bearing structure be a electrodeposited layer and then over laying that either a white metal or white metal like layer is directly cast or even a solder layer and then a white metal layer or even a construction layer and the a white metal layer or solder layer and then a white metal layer. Truth to tell it is practicable in some circumstances and needs that a bearing structure including a multiplicity of layers is formed to carry out the invention. What is more it may be required in some situations that a further layer or group of layers is overlaid on the white metal bearing surface, these overlays or overlay of material can be regarded as protective layers and are meant to be somewhat sacrificial in that they provide the initial bearing layer when the bearing system is being broken in when the engine first starts after manufacture and that period shortly thereafter.

We also envisage a hybrid form of our invention wherein prefabricated white metal bearing shell are formed and then bonded to the body material by means of a solder. The prefabricated bearing "shell" being a straight shell and not curved as is the case in rotational white metal bearings and just as is the case with rotational forms of white metal bearings these new straight shells may be bi-metal, tri-metal or any other further number of layers bearings. The straight shells may in fact be surfaced with material or formed of material which is not white metal and as such be an alloy of a metal or metals including but not limited to the following such as copper, aluminum, lead, phosphorous, lead, tin, zinc, bismuth, antimony, or even compounds elements of carbon or silica. With regards to the straight shells of the invention they may include solder material on their back face/s so that they truly are a prefabricated bearing in many senses and they can then be heated or the body material heated to melt the solder and as the body and shell are forced together effect the bonding required. It is also the case that components can be chilled to rapidly set of harden a material involved in the construction of the bearing. In an alternative arrangement the shell may be held a small distance from the body material and a solder or any other useful bonding agent flowed into the space laying in between so as to fill the space and form a bridge between the shell back and the body, the bridge then hardening to effect the bond required. It is also conceivable that the shell may be back filled between the body and the shell so as to push the shell upper surface against a last which is held at a set distance from the body. We have also envisaged and show that the shell material maybe in the form of a roll or sheet which may be advanced over the body material to be bonded to and cut or docked to size in situ. The roll or sheet material may be tensioned or held in tension as the space behind the shell between the body material and the shell back is filled with a bonding agent.

Generally speaking when discussing in broad forms of the invention the yoke is formed having a T-shaped channel which has first been coated by a flash tinning process or solder or solder like material and then at least one other material is cast or formed onto the solder or solder like material such that it is bonded to the solder or solder like material. The at least one other material being a bearing material. Preferably the channel surface onto which the flash tinning or solder or solder like material is coated onto has been cleaned of impurities. This may be especially important if the yoke and its channel have been produced using a casting process, and, there are various methods which may be used to do this cleaning process including abrasion, ablation, machine cutting, alkali and/or acid washes. In fact a combination of any of the following methods may be used but what is important is

that cleaning or clearing away of impurities may be necessary to ensure a proper bonding of the flash tin, solder or solder like material to the channel surface.

When we speak of casting of the bearing material we include but don't intend that the invention be limited to the following techniques: molding and injecting techniques, painting, flowing over or flow casting, die casting, gravity casting, extruding, sintering, electroplating, electrodeposition. In fact instead of having a first layer of solder, solder like material or flash tin an electroplating or electrodeposition technique can be used to create a suitable layer onto which a bearing material or construction layer can be cast. The bearing material is preferably a liquid or a suspension and may be structurally reinforced with fibre, wire, or aggregate material, silica, metal oxides. The reinforcing material may be added to the material before, during or after casting but before solidification. Even Kevlar type fibre or tape or filaments may be added to the material to aid stiffness or other performance enhancing attributes and the reinforcing may be organized so that it is uniform or in a certain orientation or even somewhat chaotic depending on need and objective. It is envisaged that with certain techniques that the casting result the material being formed net size or shape but this need not be so as one may wish to cut or further work the surface to end up with the correct sizing or shape.

Certain other preliminary step/s may need to be enacted before the flash tinning or soldering or solder like coating or casting of the bearing material is performed which might include for example the heating up or cooling down of the component to be treated, the component being the yoke structure or guide means whether that be a first guide means, second guide means or even a third guide means or the slider portion of the connecting means.

The bearing material is preferably formed by a casting process subsequent to the formation of the yoke or guide means. The bearing material may be of any useful metal or alloy including but not limited to the following list of materials: Britannia metal, white metal, babbitt metal, pewter, fuseable alloy, and the alloyed metals can be chosen from the following list of materials but are not limited to the following list: silver, aluminum, cadmium, copper, lead, bronze, tin, bismuth, brass, zinc, antimony, gold, also it is anticipated that carbon materials be included in the metal or alloy chosen and accordingly we include metal or alloys containing carbon material, Kevlar or like substance or any other suitable organic or inorganic material.

To reduce the wordiness of this disclosure we hereinafter will refer to flash tin, solder like material or solder or electrodeposited material or electroplated material or fuseable alloy as solder and the processes by which any of these are performed as

soldering. When forming the bearing of the invention it is preferable that the surface to be bonded to by a bearing material is first coated with a solder by a soldering process.

In some embodiments of the invention a number of layers of material may be used to build up the bearing structure whereas in certain embodiments of the invention the bearing material may be directly cast onto the channel or rail.

In some embodiments of the invention a solder may be used as the first layer in a stack of layers forming the bearing, a second layer or number of layers of material may then be subsequently applied before the actual bearing material is finally added. These we hereinafter generally call construction or intermediate layers of the bearing. Solder may be used between each construction layer or it may not be needed depending on the materials used. Generally speaking an initial layer of solder is applied to the base material – by base material we mean the raw channel or rail onto which the bearing is to be bonded.

In the invention a construction layer may be deposited in a variety of ways including those listed above for the bearing material. Castrusion is a semi-cast semi extrusion process we have invented which is performed by extruding against a die that does not entirely border the boundary of the material extruded, at least part of the boundary of the material being forced into contact with and engagement with a layers or layers of the bearing structure. Layers in the bearing whether they be solder layers, construction layers or even the bearing layers itself may be overlaid with plated material. The overlay can be absolute or patchy if required. The overlay may be in the form of a pattern, the overlay adhering to the underlying layer. An overlay may be deposited by way of galvanization, electroplating, wet or dry. The overlay may be deposited by way of gas borne deposition. The overlay may be an oxide of the underlying surface material, it may be grown on and of the underlying surface of the material. An overlay once laid may be machined chemically, mechanically, electrically, optically, lasered, ablated, and during subsequent steps any of the following: cleaned, fluxed, pickled, hardened, work hardened, flame hardened, induction hardened, etched. It is envisaged that at least one layer of a multi layered form of the invention be glued or cemented or otherwise bonded to at least one other layer in the stack of layers forming the multilayered bearing.

In some embodiments of the invention a prefabricated bearing shell may be formed which is then bonded or otherwise fused to the underling base material or construction layer. In some arrangements it may be practicable to tension or otherwise hold the prefabricated bearing at a distance from the underlying body

otherwise to be known as base material and then introduce a bonding agent in between the back face of the shell and the base materials.

A great advantage of the invention, in almost all its guises, is the fact that it can be used to produce a suitable bearing surface even over a rough body. By using a fuseable alloy or solder/glue/rose metal as the means to combine a bearing of the invention with a body for example a rail or slot the need to have a completely smooth surface on the body to bond to is largely obviated as the bonding agent, whatever one chooses to use within the limits of the invention, acts as a filling agent so that it fills up the irregularities in surface contour which may exist. It is also disclosed that bearing material be cast directly onto a body without the need for a solder or bonding layer to be used, certainly this can be accomplished with some of the family of Babbitt metal or white metals and even with certain copper and tin alloys.

There are a number of other novel aspects in our disclosure herein and we would speak of these now. The white metal or soft metal bearing of the invention may be adapted to have a pin cushion like nosing so that and hard matters is prevented from entering the bearing space proper. Another aspect is the provision of wells which are pressure oil filled so as to act as cleaning ponds. Yet another aspect is the inclusion of magnetic elements adjacent the long end of the bearing of the invention. The magnet serving to pluck magnetically sensitive material from the surface of that component of the linear bearing system which is the moving component.

Another inventive aspect of the invention is the provision of one way oil valve means in the oil gallery provisioning the oil supply to the bearing interface, whether that be between the big end journal and the slider portion of the connecting means or whether that be between the first guide means and the piston underside. By having a one way valve situated in these locations it is possible to ensure that gravity does not have the wherewithal to drain the oil from the bearing interface.

Many perhaps are the small variations which may be performed by those skilled in the art to make small changes to that which we have disclosed herein but these would only be small shop floor scale improvements which should in no way be seen to limit the scope of the invention in all or any of its various aspects or detract from its overall and specific inventive qualities. It is obvious that we teach that various inventive aspects from any particular embodiment of the invention may be swapped or otherwise used wherever possible with those features from any other embodiment of the invention. The reader is encouraged to let their mind run with the palette of solutions we have served up herein , this invention is sweeping in its breadth afterall.

Brief Description of the Drawings

Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

Figure 6

Figure 7

Figure 8

Figure 9

Detailed Description of the Drawings

Figure 1 shows an isometric view of a first embodiment of the invention 10. The invention is shown in this drawing in relation to a generalized form of yoke/piston assembly of the slider engine which includes a yoke 2 having a longitudinal axis 1 which extends substantially parallel to the cylinder axis 11. The yoke 9 has a T-shaped first guide means 3 which extends along an axis 4 substantially perpendicular to the cylinder axis 11. The yoke includes second guide means 5a located on a first side of the first guide means and another second guide means 6a located on the other side of the first guide means. Adjacent the top end 22 of the yoke is located a piston 7 having a crown top surface 77 and an underside surface 78. The second guide means 5a has a first end 55a and a second end 55b, the first end is located closer to the piston crown than is the first guide means and the second end 55b of the second guide means 5a is located further away from the piston crown top surface than is the first guide means, similarly the first end 66a of the other second guide means 6a is located closer to the piston crown top surface than is the first guide means and the second end 66b is further away from the piston crown top surface than is the first guide means. As can be seen the second guide means 5a and 6a extend within a projection 777 of the piston crown outer circumference, the projection being away from the crown top surface in the direction of the first guide means.

The bearing material comprising the first guide means is formed as a group of opposed parallel linear (planar) bearing surfaces, a first surface 33a closest to the piston crown top surface, and, surfaces 33b and 33c less close to the piston crown top

surface than is surface 33a, these surfaces and 33a are parallel to axis 4. The surfaces 33a, 33b, 33c are not formed of the yoke material but are rather formed by a casting process subsequent to the formation of the yoke. They are cast in metal or alloy bearing material. The metal or alloy material selected for this can be any form of metal or alloy including but not limited to the following list of materials: Britannia metal, white metal, Babbitt metal, Heusby metal, rose metal silver, aluminum, cadmium, copper, lead, bronze, tin, bismuth, brass, antimony, gold, also it is anticipated that carbon materials be included in the metal or alloy chosen and accordingly we include metal or alloys containing carbon material, Kevlar or any other suitable organic or inorganic material.

In this embodiment it is shown that a yoke for the slider engine has been created which includes a first guide means which has bearing surfaces formed by the addition of a bearing material subsequent to the production of the basic yoke structure but as you will see in further drawing following this figure 1 the second guide means and even the third guide means and slider component of the connecting means may have bearing structures which has been added to them after their basic production.

Figure 2 shows the invention 10 in relation to a generalized form of yoke/piston assembly and sliding connecting means of the slider engine. It can be seen the yoke 9 includes a group of cast on bearings 33a and 33b, furthermore it is shown that the bearings are fixed to the yoke structure 9 by solder layer 333a which is itself in bond with the underlying base material 335 of which the yoke 9 is formed. It can also be seen the sliding connecting means 92 in relation to the yoke and its group of bearings 33a and 33b (33c not shown). The slider portion 922 of the connecting means including its own group of opposed parallel linear bearings 92a and 92b. The connecting means adapted to be rotatably mounted on a big end journal 850 of a crankshaft (not shown). The big end journal having a big end axis 85. Figure 2 is a sectional schematic end view of the invention looking along the big end axis. The slider portion being in the form of a T.

Figure 3a shows an embodiment of the invention 10 wherein it is included as a portion of the sliding connecting means 92. The view is a sectional schematic along the big end journal axis. As can be seen the slider portion 922 of the connecting means 92 includes the invention 10. The slider portion including its own group of parallel opposed linear bearings 92a and 92b, these bearings have been bonded to the basic slider portion by way of solder layers 922a and 922b respectively.

Figure 3b shows a sectional schematic side view of the embodiment of the invention depicted in Figure 3 and it can be seen that the slider portion is in the form of a cross

bar of a T. The T being male and obviously in this case for the slider to engage with a suitable first guide means the first guide means will of necessity be able to receive within it the slider portion thus-wise conferring female status on the first guide means, but of course if the situation were reversed with the first guide means being a male T then the slider would be a female for receiving it.

Figure 4 shows an embodiment of the invention 10 in sectional schematic side view. As can be seen a generic to the invention basic component 205 is shown including a first layer of bonding material, glue, cement 255 which is adhered to the basic component and atop it is bonded a metal layer 256 and atop it is cast a solder layer 258. The basic component may be formed of metal or non-metal. The metal layer 256, that is the second layer is bonded to the base component 205 by way of a bonding agent 255 which may be a glue or cement. The third layer 257 being a solder layer then bonds the bearing layer 258 to itself. The bearing layer being a white metal linear bearing whose surface may be dressed by machining means if required. Base could be metal or carbon, organic or inorganic. Glue, Cement, Bridging Bonding Material which is of course solid in use.

Figure 5 shows an embodiment of the invention which includes a basic component 205 onto which is bonded a white metal bearing material 258 by means of an intermediate layer 257 being a solder layer. Base, Steel, Aluminiumalloy, Copper alloy, titanium alloy, metal or metalized surface.

Figure 6 shows an embodiment of the invention which includes a basic component 205, which has bonded to it a steel layer 259 by way of a solder layer 257 and a white metal layer 258 is self bonded to the steel layer.

On this page we show layer were build up of linear bearing for yoke slideway or guide ways or piston to yoke joint, whether angled for variable compression ratio or flat joint. However when we say white metal we include flat bearing material whether metal or carbon based, organic or inorganic, also when we say solder we include all fusable metals, glues, cements.

Figure 7 shows in cross sectional view an embodiment of the invention 10 which is made of a multiplicity of layers. The base component 205 can be made of steel or iron or any other useful metal or alloy including but not limited to copper, brass, bronze, silver, magnesium, titanium, aluminum. The base component material is shown presenting a non-smooth surface 206 although given the qualities of the invention this is not the worry it might first appear as it may be smoothed or etched by particle bombardment or even hardened. The base component surface is first

covered with a flashing of solder or solder like material 207. The solder like material may be a Britannia metal or a pewter metal or a Huesby metal or a rose metal or any other useful fuseable alloy and it may be deposited in any useful way including but not limited to the following methods: troweled on, mechanically and actively smoothed on, cast on, semi-cast and semi-extruded on. With respect to this latter process we have called it castrusion, "to castrude", "to have formed a castrusion". Castrusion is performed by extruding against a die that does not entirely border the boundary of the mass extruded such that at least part of the boundary of the mass extruded is in contact with and in electro-mechanical engagement with a layer of layers of metal substrate matter, said matter being layer like and a member of a bearing stack, the stack being preferably crowned by a white bearing metal layer or babbitt metal or a plated overlay or any other useful bearing layer of metal. A white metal bearing material 258 is then bonded to the flashing layer 207. May have solder layer. Brittania Metal, Fuseable Metal Solder, Pewter, Huesby Metal.

Base Surface/s may be smooth or rough or etched or treated or particle bombarded or hardened.

The base may be steel or iron or any other useful metal, copper, brass, bronze, silver, magnesium alloy.

A construction, filler layer may be used, this layer may be deposited in an number of ways, it may be troweled on, it may be thereby cast and mechanically actively smoothed and or surfaced. Semicast and semi-extruded at the same time. This is a process we call castruding, to castrude, to have formed a castrusion. Castrusion is performed by extruding only against a die that does not entirely border the boundary of the mass extruded, at least part of the boundry of the mass extruded being in contact with and engagement with a layer or layers of metal substrate matter, said matter being layer-like and a member of a bearing stack, the stack being preferably crowned by a white metal bearing material layer or babbet metal or a plated on overlay or any other useful bearing lays of metal.

Figure 8 shows a cross sectional view of an embodiment of the invention 10 wherein the base component 205 surface 206 is rough and has been flashed with a solder layer 207. Atop the solder layer has been cast a layer of filler material 211. The filler material being a white metal, rose metal, fuseable material which has been blended with fibre and or aggregate, or even with wire such that the layer is a reinforced white metal filler layer and atop this layer is fused a white metal bearing material 258 for the production of a bearing surface. In the reinforcing layer there may be added metal rods, mesh, weaves, cable which may be tensionable as concrete can be post-

tensioned. Fibre and or aggregate reinforced white metal layer covers over relatively rough or unmachined surface of base material. White metal layer is cast onto the reinforced white metal or there is an intermediate layer.

Figure 8a a casting could have its surface cleaned by acid for example and the resulting surface may be too crude for being a running surface. The object of this invention is to use a novel form of white metal bearing construction material. It is novel because it is bearing material of a blended nature, white metal alloys and fibre, carbon, kevlar, to name but two. The bearing being formed of at least one tinning layer in adherance to a base, the tinning having bonded to its other face a layer of white metal infused or mixed with fibre, this is a construction layer, capping this layer is another layer of white metal, the bearing surface layer. Reinforcing mesh or fibre orientation can be metal mesh. Can be free strands, rods, wire, fibres, mesh, welded mesh, chain, woven, can be tensionable, post or pretensioned. Solder layer is an intermediate layer

Figure 9 shows a cross sectional isometric view of a prefabricated straight bearing shell 100 for use within the invention. The prefabricated shell being a bi-metal bearing of similar properties to those found in the rotational bearings of conventional engines and pumps. The first layer 101 being made of steel and the second layer 102 including copper or a bronze alloy, preferably. The view is looking at the back 103 of the bearing shell. It can be seen that an oil hole 104 passes through the metal layers enabling oil to pass through the bearing shell walls to a component further along if needs be. The shell being elongate along an axis 109.

Figure 10 shows an cross sectional isometric view of the upper or front face 110 of the prefabricated straight bearing shell of Figure 9. The front face being the bearing face of the shell. It can be seen that the second layer 102 includes an oil groove 108 in communication with the oil through hole 104.

Figure 11 shows a cross sectional schematic side view of an embodiment of the invention 10 and it can be seen that a prefabricated straight bi-metal bearing shell 100 of the invention is located in a position adjacent a base component 205 (in this case a portion of a yoke structure) and that there are two holes 115a and 115b passing through the body of the base component 205 through which has been fed a suitable fuseable alloy like a rose metal or other useful or like white metal to backfill the space laying between the shell back face 103 and that surface 207 of the base component to which the shell is bonded.

Figure 12 shows a cross sectional schematic side view of the invention 10 depicted in Figures 9 thru 11. It can be seen that the base component 205 has a predrilled oil galley 213 adapted and positioned for communication (that is of course, fluid communication) with the oil through hole 104 of the shell 100, what is more, because the back of the shell 104 is a distance away from the to be bonded to surface 216 of the base component a spacer means in the form of a flexible gasket 117 has been included around the through hole back opening and the predrilled oil gallery opening in the base component surface so that when the fuseable alloy 207 is introduced in the intervening space between the shell back and the surface to be bonded with of the base component the fuseable alloy is prevented from making its way into the oil galley or the through hole. The spacer means is preferably of toroidal shape but can be of any useful shape to form the barrier required. It can also be seen that the bearing shell 100 has wrap around ends 219a and 219b so that the bearing material 258 extends not just along the axis 4 but also away from it as well.

Figure 13 shows a sectional schematic end view of an embodiment of the invention 10 and it can be seen that a prefabricated straight bearing shell 231 has been configured to be a type of piston which is adapted to be disposed within a basin like cylinder 232 formed in a base component 205 (though the cylinder and the piston need not be round as it may be rectangular or any other useful shape). The basin is a walled depression in a base component which has a fluid supply gallery 237 passing through it so that the volume trapped between the shell back 104 and the basin floor 233 can be filled with a bonding agent 241 which is preferably a suitable fuseable alloy. The shell back is in the form of a dish or pan and there may be if desired a seal 243 placed between the side 244 of the piston like shell 231 and the wall 245 or walls of the basin of the base component to aid in sealing the piston in the cylinder/basin. The idea being that the base component is held a distance away from a laste (not shown) and the piston is able to be hydraulically motivated by the supply of fill material in the form of a liquid fuseable alloy into registration against the laste (mandrel)

Figure 14 shows a isometric view of the basin 232 in the base component shown in Figure 13.

Figure 15 shows a isometric view of the piston like shell 231 of Figure 13.

Figure 16 shows a sectional schematic side view of a bearing shell 231 similar to that in Figure 13 which has been fitted into a basin like depression or hole/cylinder 232 in a base component 207. The shell 231 has been bonded into the cavity 232 by a fuseable alloy 257.

Figure 17a shows a sectional schematic side view of a bearing shell 231 fitted into a hole 232 in a base component 207. the underside surface 103 of the shell 231 has a discontinuous crenellated shape so as to increase its purchase on the solder layer 292 which bonds it to the case component.

Figure 17b shows a bearing arrangement of the invention 10. It can be seen that there are two white metal bearings 258a and 258b which have been bonded to the base component 207 by solder means 292 and that the solder means parts the two bearing along a midpoint between them extending along its longitudinal axis.

Figures 18a through to 18c shows a stepwise process for the manufacture of an embodiment of the invention. Figure 18 is a cross sectional side view of a prefabricated strip of bearing material 26 . The strip has lug means 266 and 267 adjacent its ends. The strip has a upper face 182 being the bearing face and an underside face 183 being that face of the strip to be bonded to a base component 205. The strip has a through hole 104 for fluid passage. The strip may be of any number of layers but in this instance we show it having only one layer. The lugs are shown proud of the bearing surface and underside surface but in reality what we mean to convey is that at least the strip ends are adapted to be engaged by some kind of grip or engagement means so the strip may be tensioned between the engagement means.

Figure 18b is a top plan view of the strip 26 shown in figure 18a and it can be seen the fluid through hole 104 and the lugs 267a and 267b at or adjacent the ends of the strip. The strip is long and narrow and it is meant to be tensioned by engagement and tensioning means so that it is as straight as practicable when it is bonded to the base component. The base component as we have made you aware throughout may be a yoke, a second guide means, a third guide means or a slider portion of a connecting means or even a surface onto which or into which a piston base is mounted to a yoke top end portion.

Figure 18c is sectional schematic side view of the strip 26 when it is or has been tensioned into a straight line between tensioning means 302 and 303. It can be seen that we have depicted a set of tongs or pliers at each end to indicate the role of tensioning engagement means used to tension the strip. It can be seen that the strip is held close to a base component 206 surface 328 to be bonded to and that the gap or space between the underside or strip back 103 and the base component surface to be bonded to has been filled with a fuseable alloy or other solder like material like a rose alloy 207. We have shown that the space can be filled by a metal alloy or filler type metal alloy composite. The space between the back of the strip and the surface to the base component to be bonded with by the useful fuseable metal may be supplied with

the alloy by means of the through hole 104 in the strip and or via at least one fluid flow gallery 354a or 354b which passes through the base component 206. Obviously there are a number of routes the fuseable alloy may be taken or forced along or through in order that the fuseable alloy is flowed into the gap but we have shown just these two as to list them all would be superfluous to the task of teaching of the invention.

Figure 19a is a sectional schematic side view which shows an embodiment of the invention in the form of a bearing shell 450 which is bonded to a base component 206 by solder/ white metal means 207. The shell has bull nose ends 451a and 451b which are adapted to perform as a type of pin cushion so that if perchance particulate matter makes its way onto the other members of the bearing system it may be picked up and caught in the cushion before it may enter the bearing space proper and cause damage to those surfaces forming the bearing interface.

Figure 19b shows the device of 19a wherein the bull nose ends 451a and 451b have picked up particulate matter as can be seen in balloons 454a and 454b. Particulate matter may be metal shavings, filings, and hard debris or contaminants of any type.

Figure 20 is a sectional schematic side view of the production of an embodiment of the invention 10 which shows a roll or strip of carbon fiber or composite material 461 positioned close to a base component 206 surface 462 to be bonded to in order that it may be bonded to the base component by a bonding agent/glue 207. The fibre strip being a layer in a linear bearing. The strip may be metalized and or have its front surface 488 metalized with bearing metal and the gap between its back face 487 and the surface 462 of the base component 206 may be filled with a suitable fuseable metal. The strips front and back faces may be metalized by electro-deposition means or even ion bombardment if required. The strip may or may not have a metalized bearing surface.

Figure 21a is an isometric view of a bearing shell 421 having an upper face 422 being a bearing face and a lower or underside surface 423 and having side walls 424 and 425. The shell is elongate with the side wall extending parallel to the elongate axis. The shell has at least one oil through hole but it cannot be seen in this view.

Figure 21b is an isometric view of a connecting means 737 of the slider engine and it is the base component to which the bearing shell of Figure 21a is to be mounted on by fuseable metal means. The slider portion 438 of the connecting means is in the form of a T and has at least one oil gallery opening 439 in its top surface 430. The

bearing shell of Figure 21a being adapted to fit the upper surface 430 of the slider portion of the connecting means 737.

Figure 21c is an isometric view of a bearing shell 823 adapted to be fitted and bonded to the underside surface of the slider portion 438 of the connecting means 737 shown in Figure 21b. The shell is in the shape Z. preferably the Z shape is right angular but this need not be so.

Figure 21d is a sectional schematic end view of a connecting means 737 of the slider engine as depicted in isometric view of Figure 21b. It can be seen that the bearing shell of Figure 21a has been bonded to the upper surface of the slider portion and that one of the bearing shells 823a of Figure 21c has been bonded to an underside surface 421a of the slider portion whilst another one of the bearing shell 823b of Figure 21c is in the process of being fitted and bonded to the other underside surface 431b of the slider portion. Axis 11 is the relative position of the cylinder axis.

Figure 22a is a isometric view of a U shaped bearing shell 823.

Figure 22b is a sectional schematic side view of a connecting means 737 looking across the big end bearing axis 276. As can be seen the slider portion 430 of the connecting means has been fitted with more than one bearing shell 823a, 823b such that there are two bearing shells fitted. The bearing shells 823a and 823b have been bonded to the slider portion by fuseable alloy and the shells have each been adapted to provide a upper linear bearing surface 681a and 681b respectively on the upper side of the slider portion underside of the slider portion.

Figure 23 is a sectional schematic side view of the slider portion 430 of a connecting means 737 which has been fitted with a shell 828 which provides both the upper 681 bearing surface and lower 682a and 682b bearing surfaces for the slider portion. The shell is a wrap around shell and it has been bonded to the slider portion by a bonding agent 207. The bonding agent may be a solder/white/rose metal material.

Figure 24a shows a sectional schematic end view of a base component 206 which has a channel 934 formed in it and in this view we are looking along the longitudinal axis of the channel/slot. The slot has fitted within it a bearing shell 823 which has been adapted to wrap around the entire inner surfaces of the slot. A filling means in the form of a reservoir 268 and nozzle means 935 is shown ready to pour in a bonding agent into the gap 936 that exists between the back faces 937a, 937b, 8937c, 937d, 937e of the shell and the respective adjacent walls of the slot. In the reservoir can be seen fluid metal 2077.

Figure 24b shows the base component 206 of the Figure 24a depiction wherein the bonding agent/white metal means has been entered into the gap and set such that the shell is bonded into the slot of the base component.

Figure 25 shows a tri-metal shell of the invention. The shell of the invention may have as many layers of material used in their construction as is deemed necessary. They can have a multiplicity of layers or they can have just one depending on need. The three layers are depicted 874a, 874b, 874c.

Figure 26 shows a sectional schematic view of the top end of the yoke in a slider engine which includes flying cross means in the connection between the piston base 914 and the top end of the yoke. The top end of the yoke includes a white metal bearing which has been bonded to the yoke top end as per the other embodiments of the invention. Shown is a solder layer 207 bonding a white metal bearing 258 layer to the T-slot 288a of the flat joint arrangement linking the piston 7 at its base 914 to the yoke top end region 913. the yoke top end being a base component.

Figure 26b shows the piston and flying cross means 915 used in the Figure 26a depiction.

Figure 27 shows a slightly alternative joint arrangement for the top end of the yoke 913 and it can be seen that the top end 913 has been bonded to with a white metal bearing 258 in which there is a intermediate flash layer 207 between the white metal and the white metal 258

Figure 28 shows a schematic isometric view of a third guide means or channel 206 in the form of a channel which has been bonded to with a bearing 258 of the invention and wherein there is a flash layer 207 fused between the base component and the white metal.

Figure 30 shows a sectional schematic isometric view of a rail or second guide means 206 of the slider engine which has been bonded to by a bearing 258 of the invention. There is a solder layer 207 joining the white metal bearing material 258 with the base component forming the rail 206.

Figure 31 shows a scotch yoke piston 7 and yoke 487 for the slider engine although the second guide means are not displayed for clarity sake in this drawing. Shown is a ball valve 400 preventing oil from returning down the oil galley above the first guide means 489. The ball valve arrangement may be swapped for any other useful form of valve including but not limited to a reed valve.

Figure 32 shows a connecting means 737 for the slider engine in which a gallery 429 leading from the oil supply at the big end journal 424 has in its length a valve means for stopping the return of oil back down to the big end after the oil has passed the valve. The valve is a one way valve and it is depicted as a ball valve 400 but it may be swapped with any other practicable valve including but not limited to a reed valve. Gallery from valve to slider bearing.

Regarding both Figure 31 and Figure 32

The one way valve in the supply line extending from big end boss bearing tunnel to linear bearing system of the slider enables the oil above the valve to stay where it is when the engine is stopped.

One way valve may be included in the yoke also so that the oil above or beyond the valve and between the valve and another valve or head is trapped there so it doesnt have to be bled through wasting time for the pressure to build up. Reed valves instead of ball valves may be used. In fact any practicle valve system may be used.

Statement of Industrial Applicability and Commercial Utility

The invention has industrial utility and commercial applicability in the field and manufacture of scotch yoke engines and pumps.

The Claims defining the Invention

1. A scotch yoke engine or pump which includes a linear guide bearing for guiding the reciprocation of a component being a yoke or slider portion of the connecting means along an axis wherein: the guide bearing is adapted to be bonded by settable means into a fixed position relative to the reciprocating component, and the bonding being to either the yoke, the slider portion of the connecting means, the second guide means or the third guide means.

2. A scotch yoke engine or pump according to claim 1 wherein: the settable means is an alloy.

3. A scotch yoke engine or pump according to

4. A scotch yoke engine or pump according to claim 1 wherein: the linear bearing is a prefabricated shell.

5. A scotch yoke engine or pump according to claim 1 wherein: the linear bearing material is a bearing white metal.

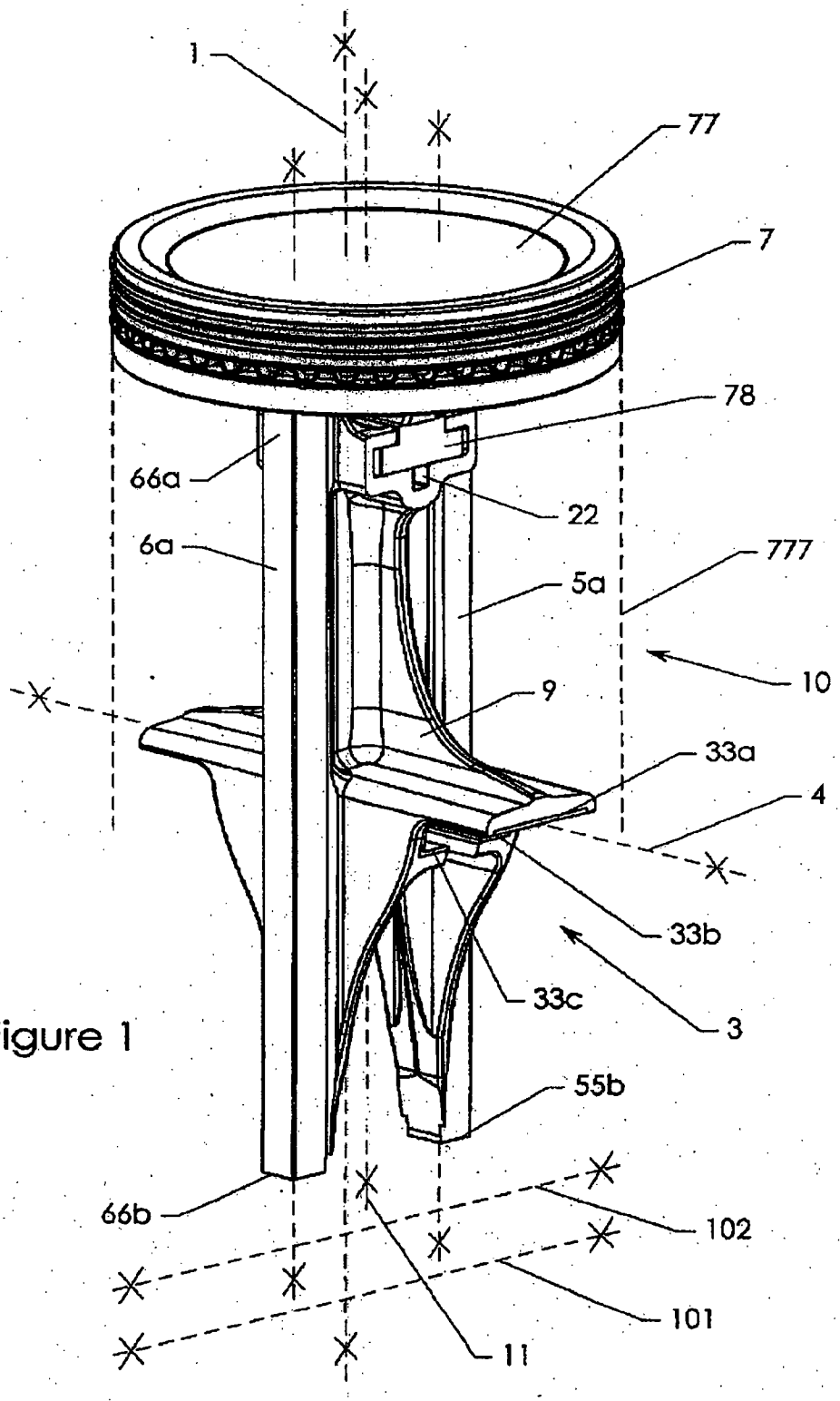
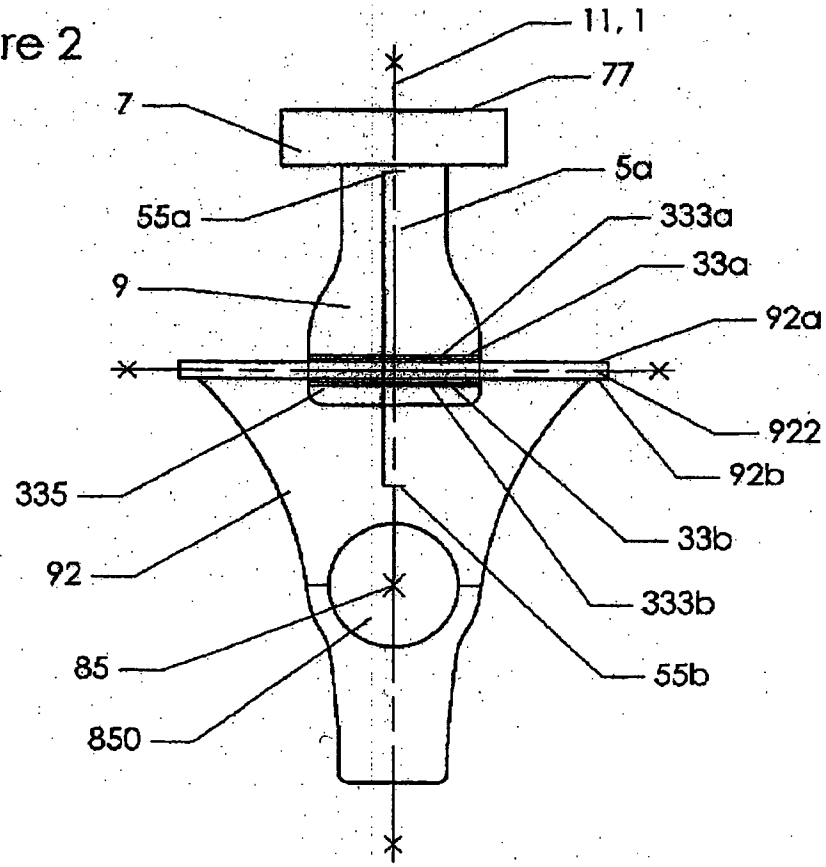


Figure 1

Figure 2



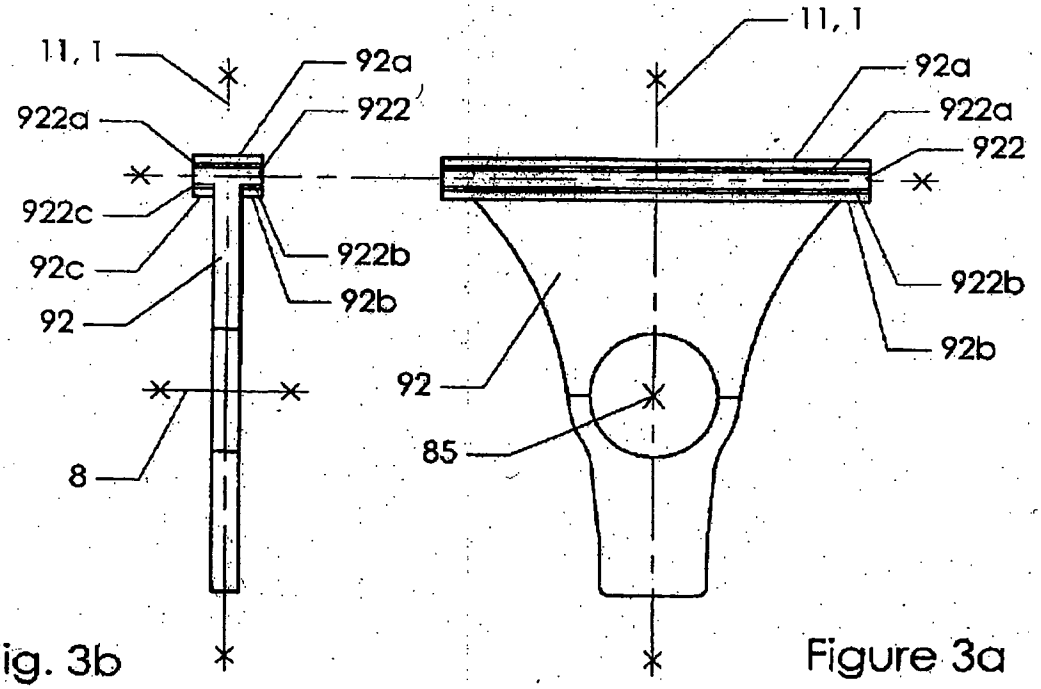
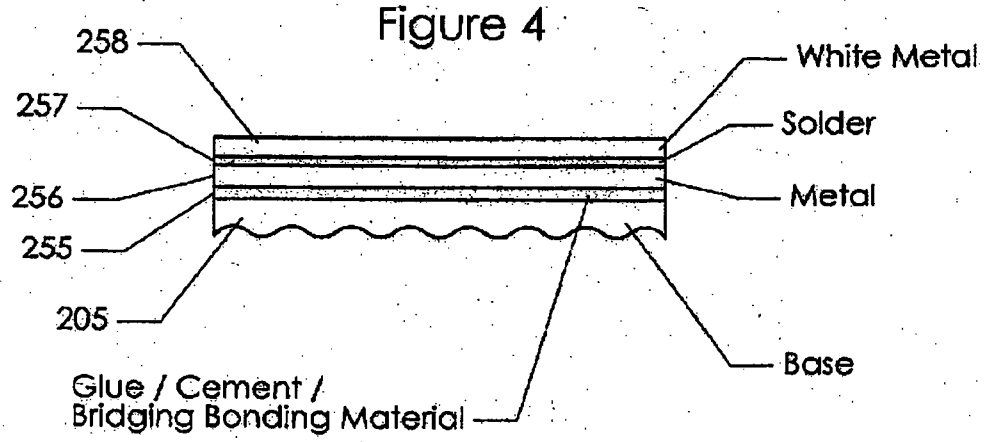


Fig. 3b

Figure 3a

Figure 4



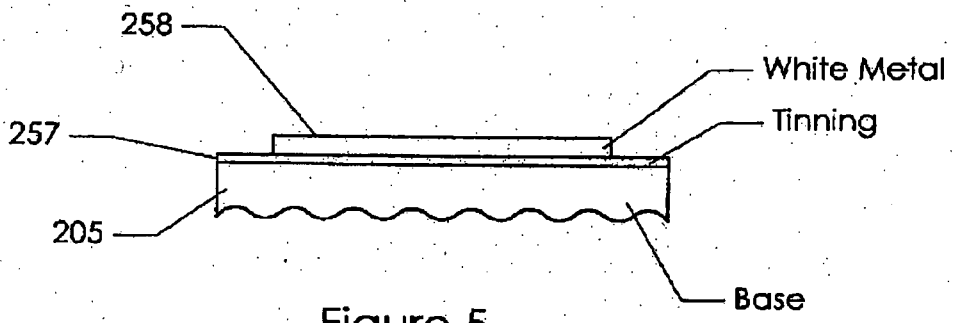


Figure 5

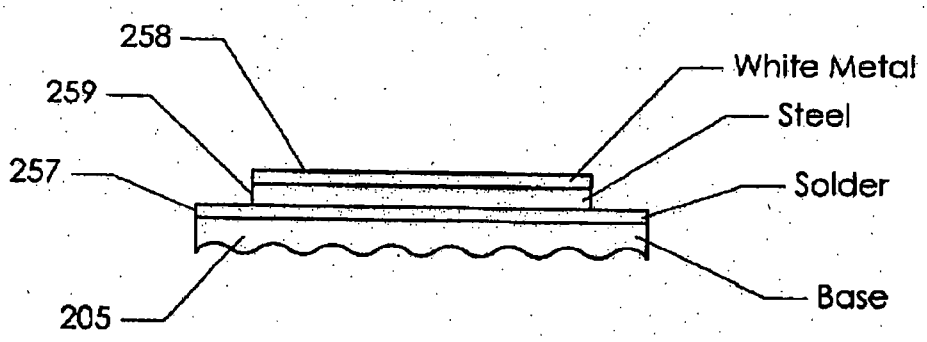


Figure 6

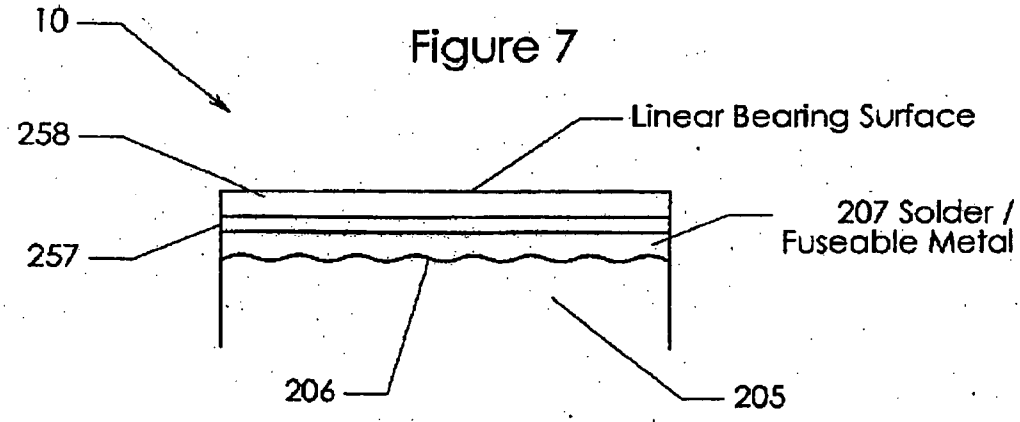


Figure 7

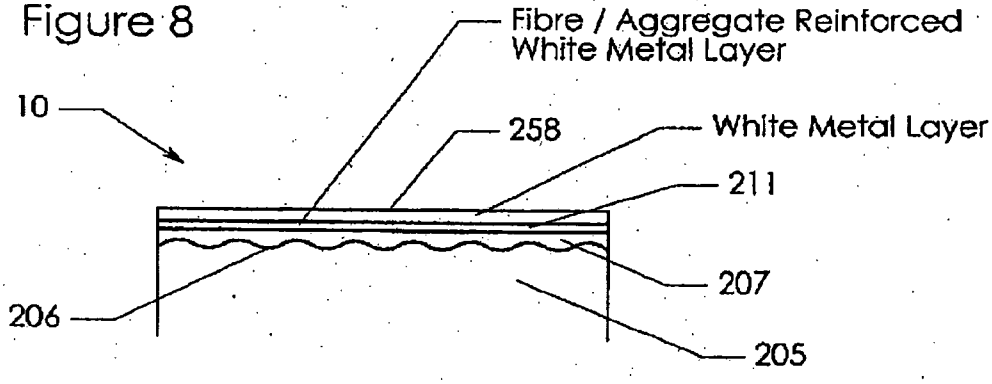


Figure 8

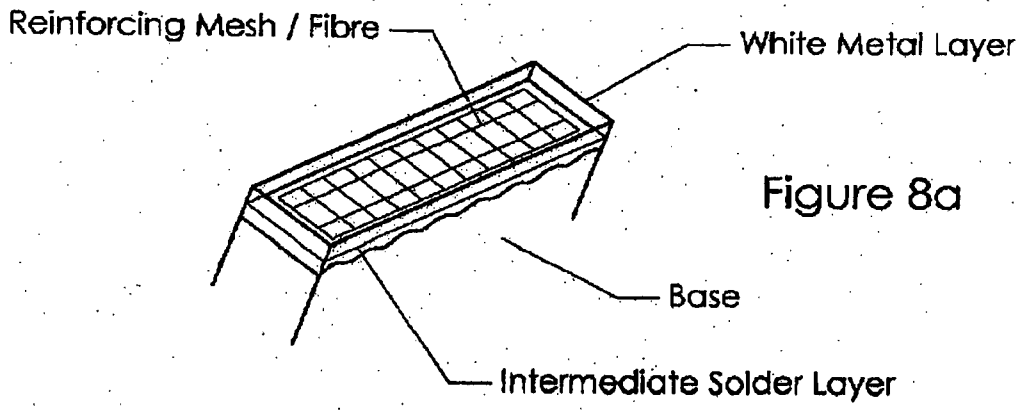


Figure 8a

Figure 9

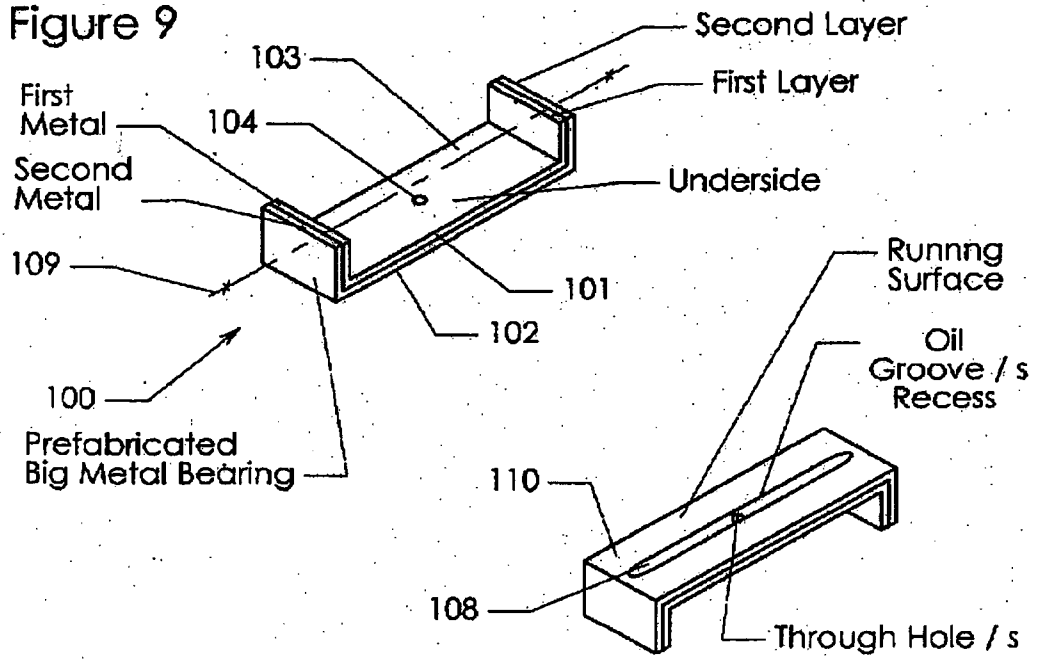


Figure 10

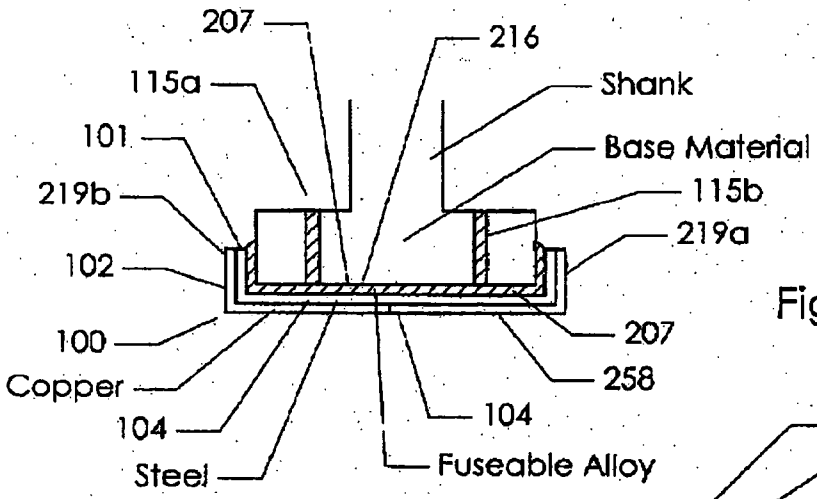


Figure 11

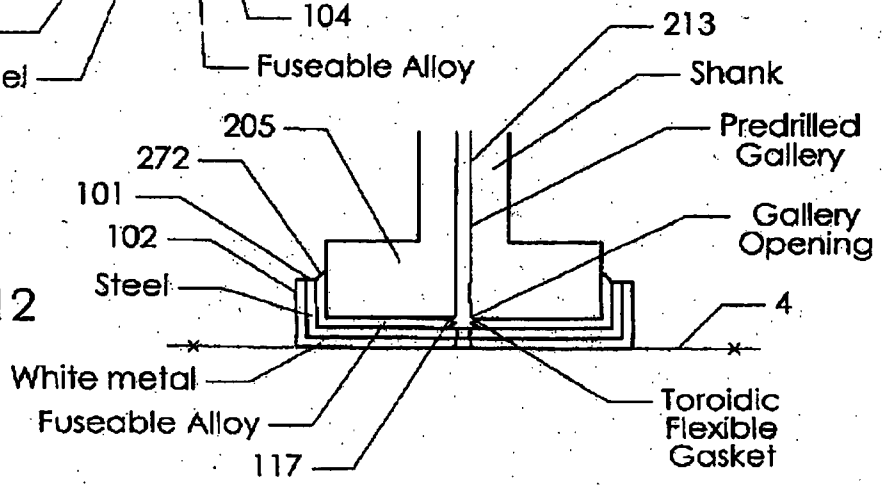


Figure 12

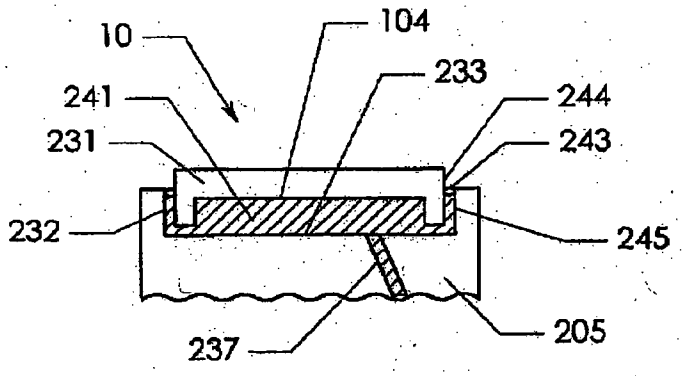


Figure 13

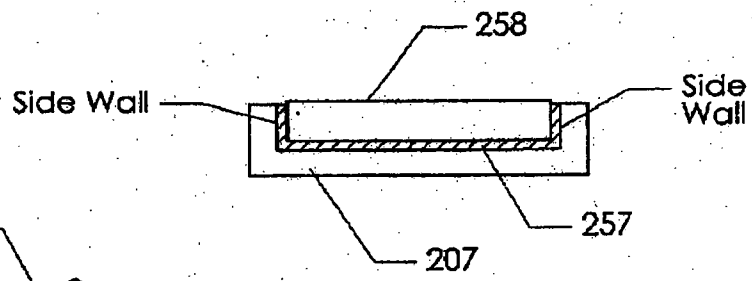


Fig. 16

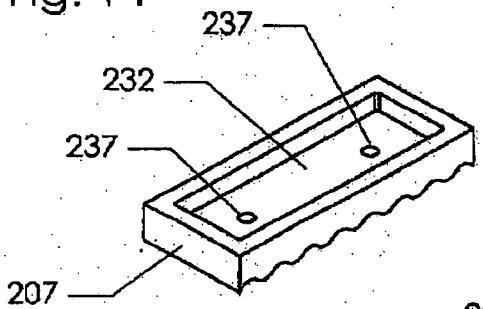


Fig. 14

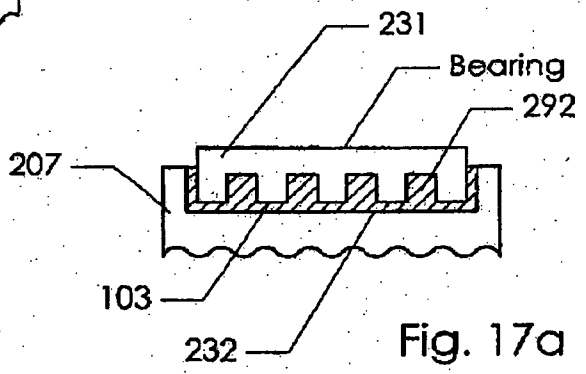


Fig. 17a

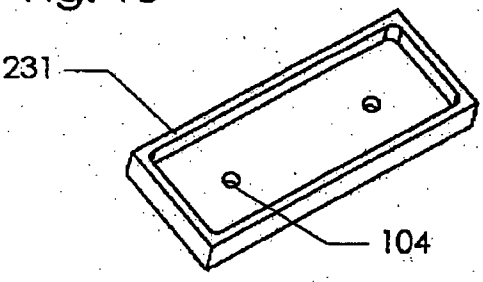


Fig. 15

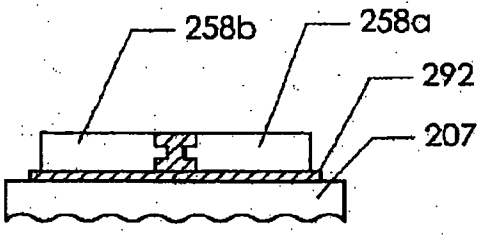


Figure 17b

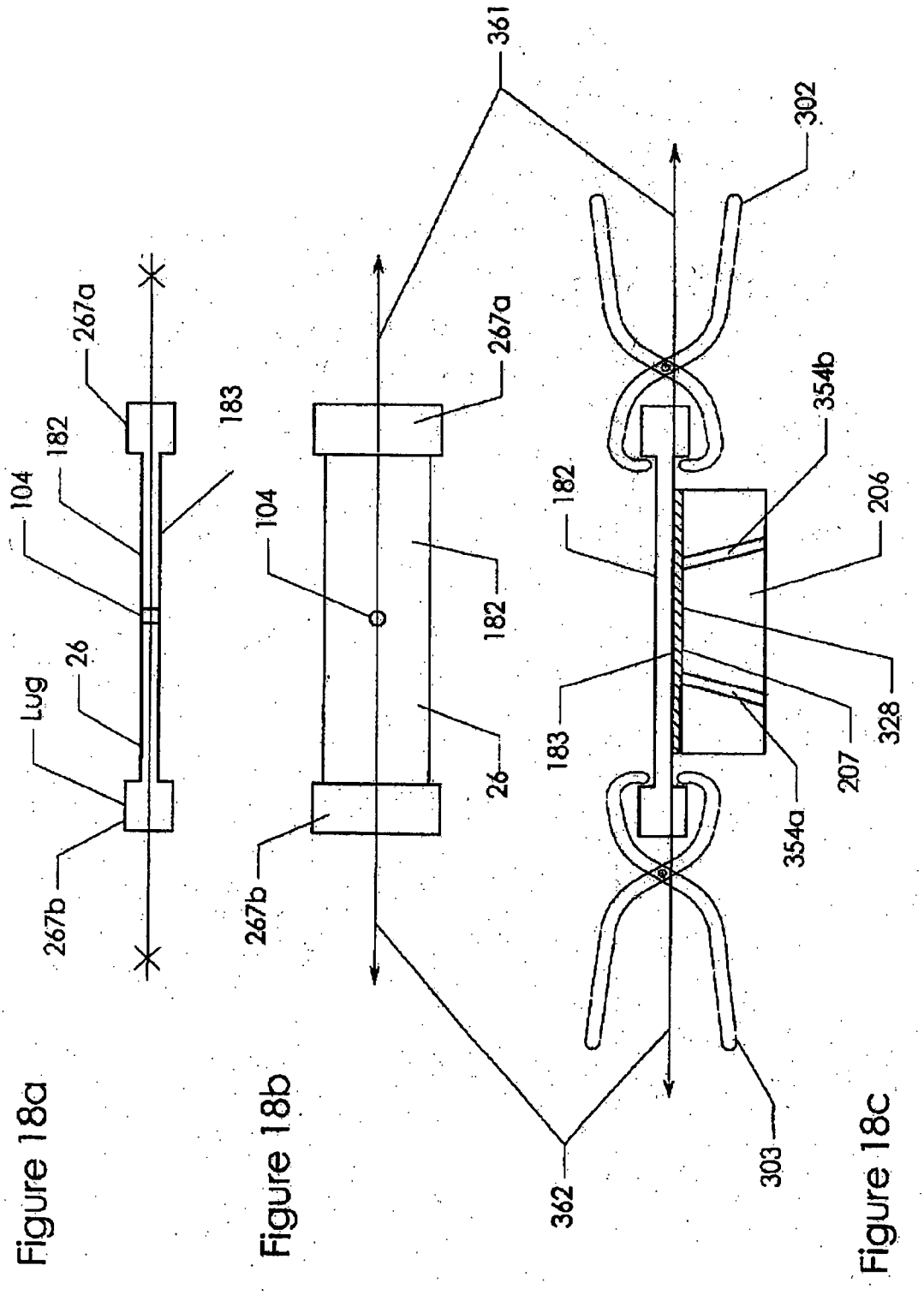
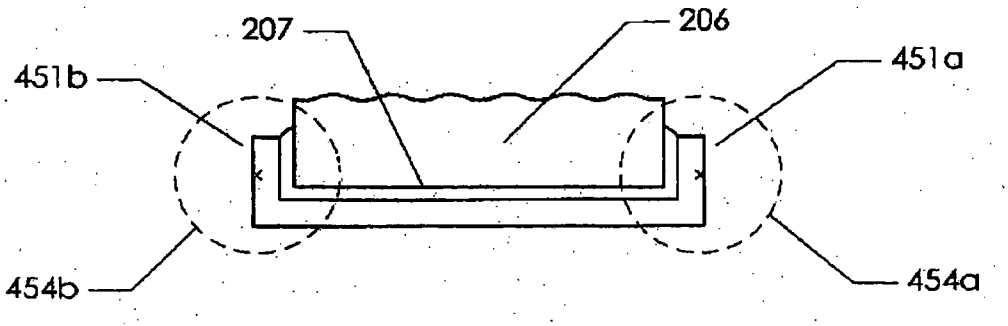


Figure 18a

Figure 18b

Figure 18c

Figure 19b



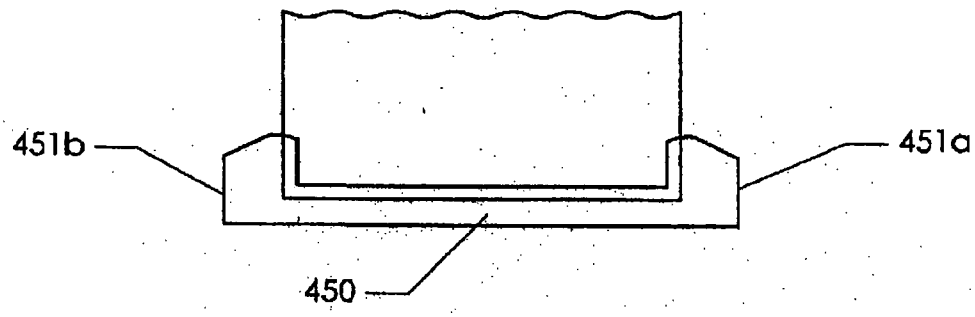
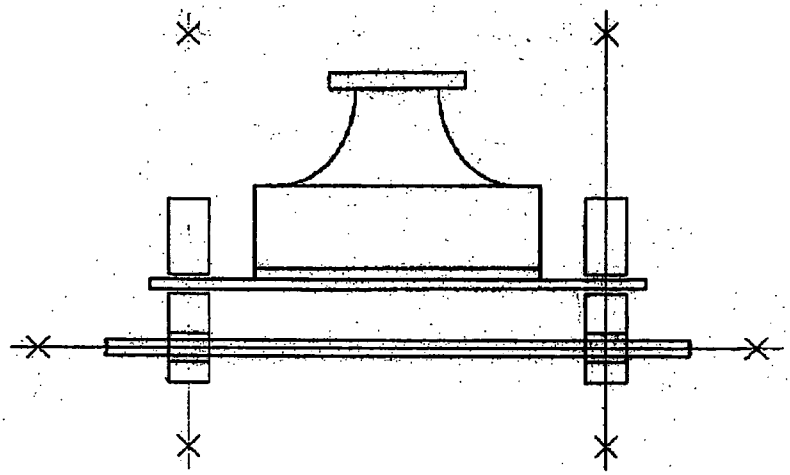


Figure 19a

Figure 20a



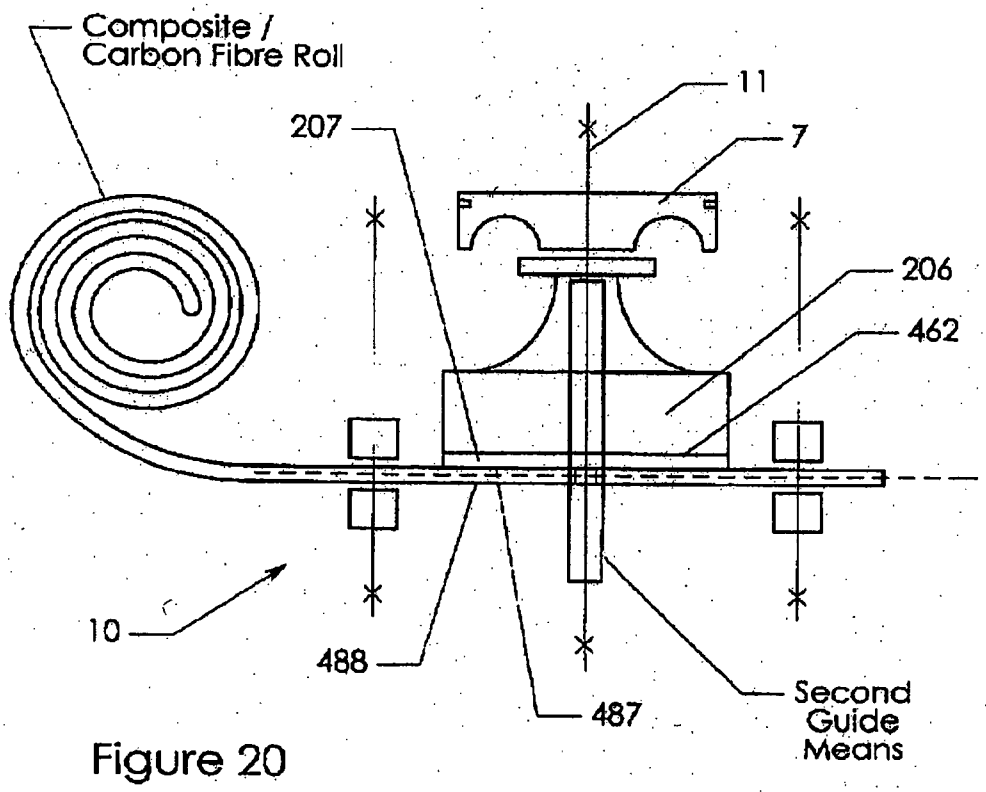


Figure 20

Figure 21a

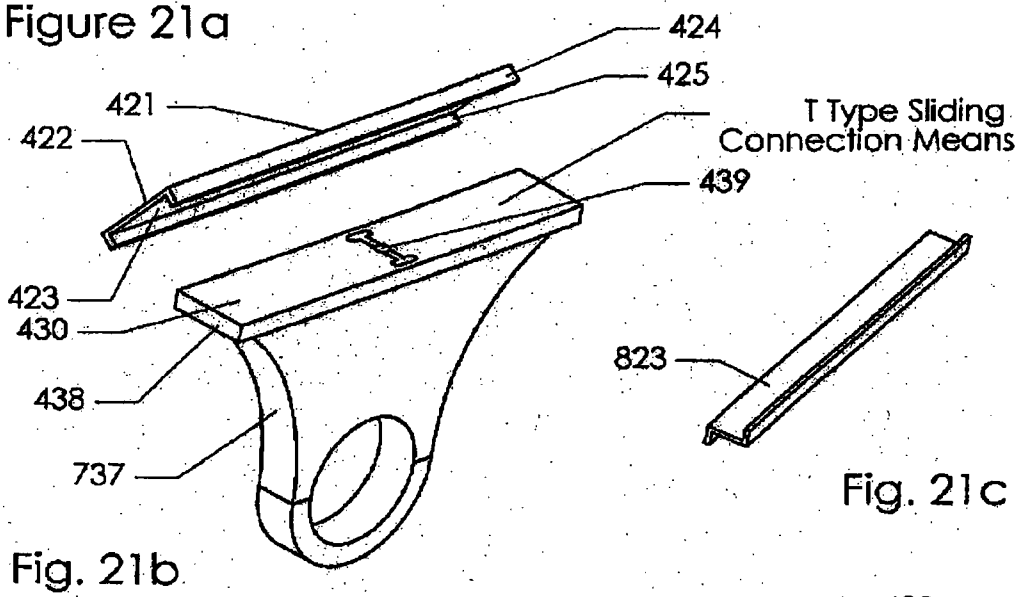
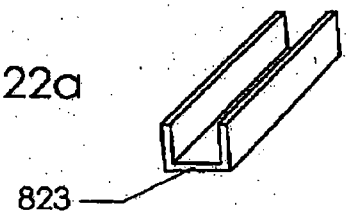


Fig. 21b

Fig. 21c

Fig. 22a



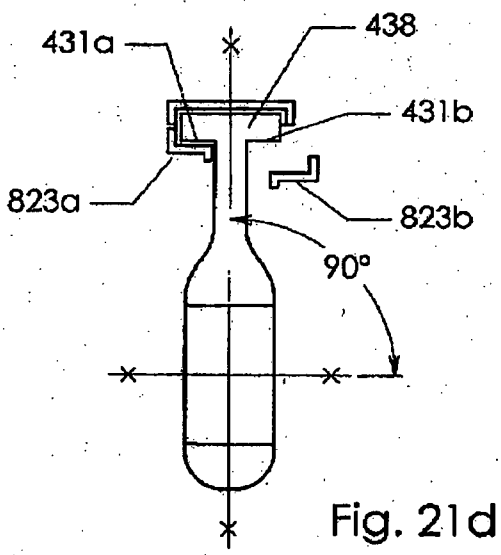


Fig. 21d

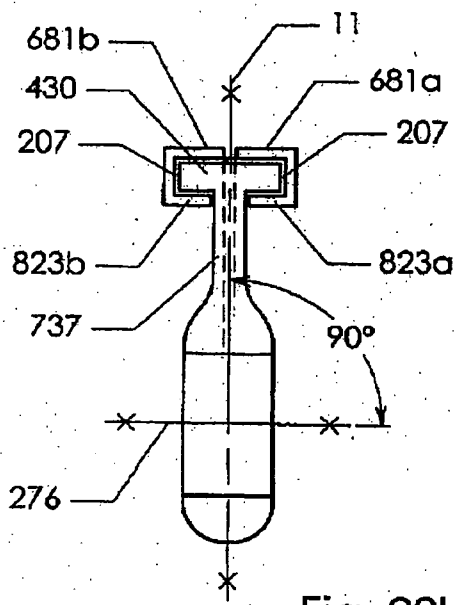


Fig. 22b

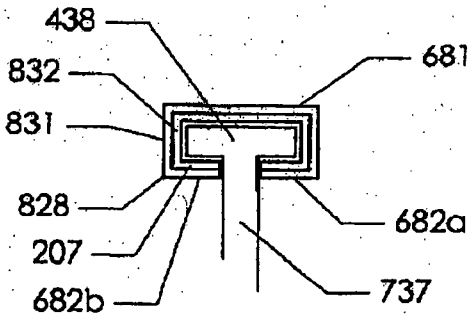


Fig. 23

Figure 24b

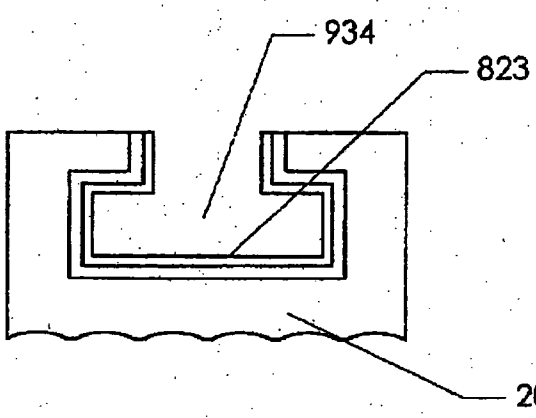


Figure 24a

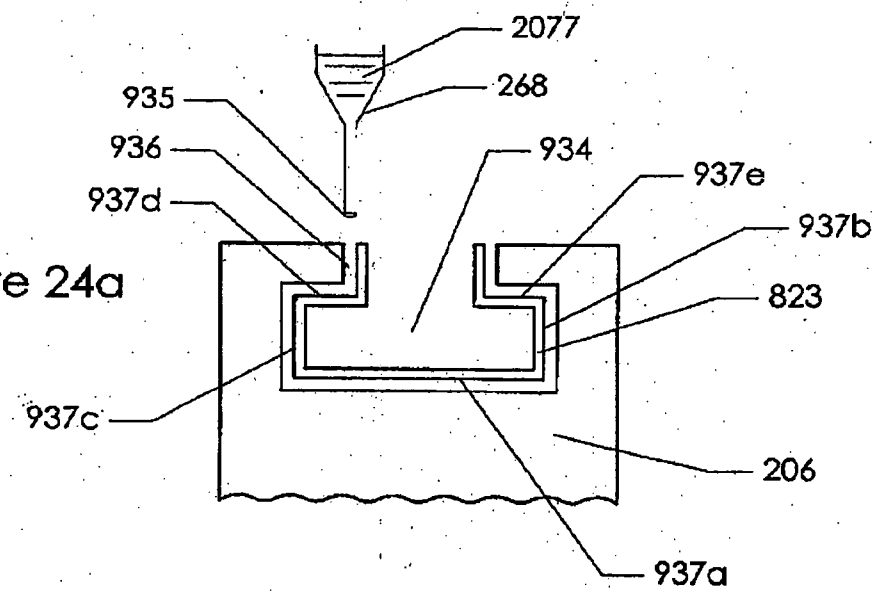
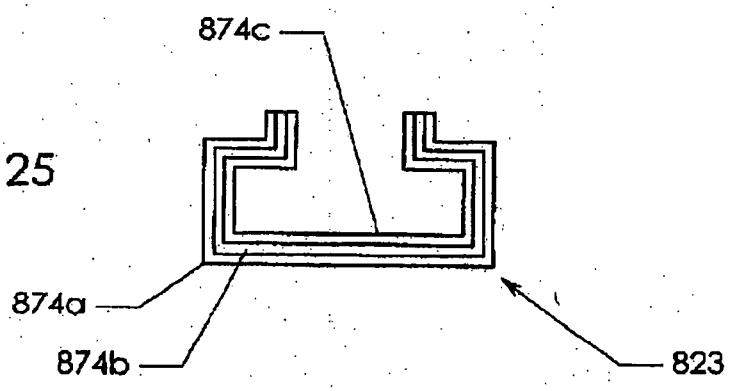


Figure 25



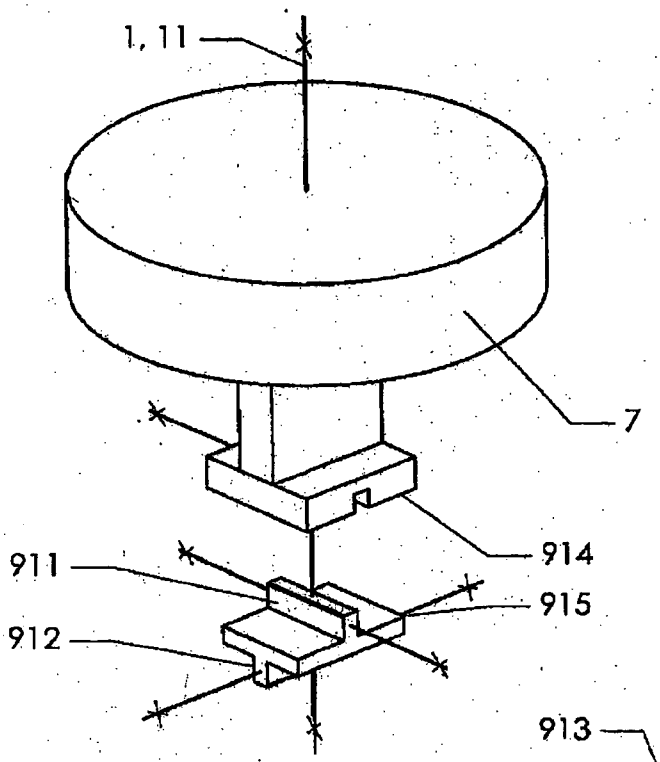


Figure 26b

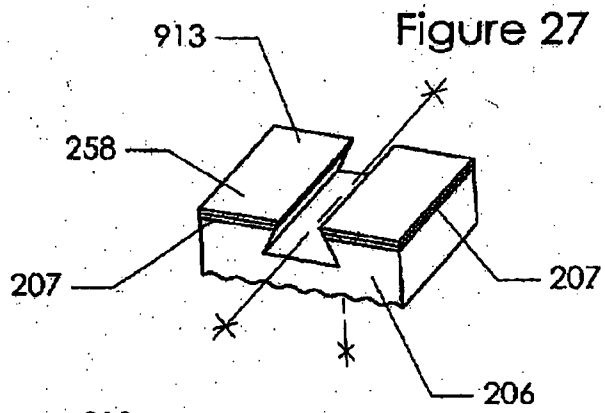


Figure 27

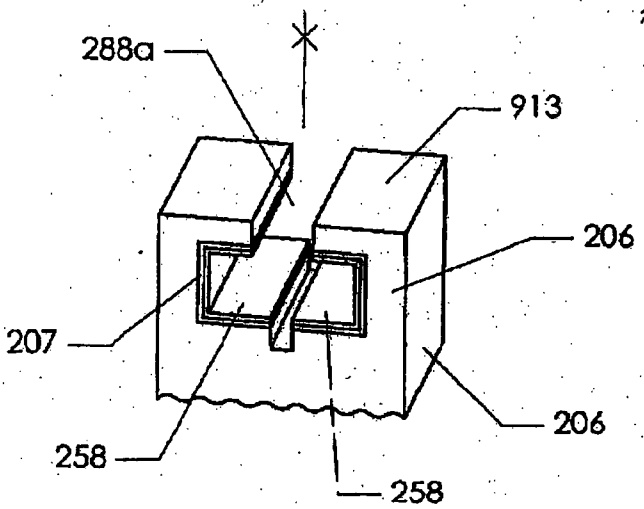
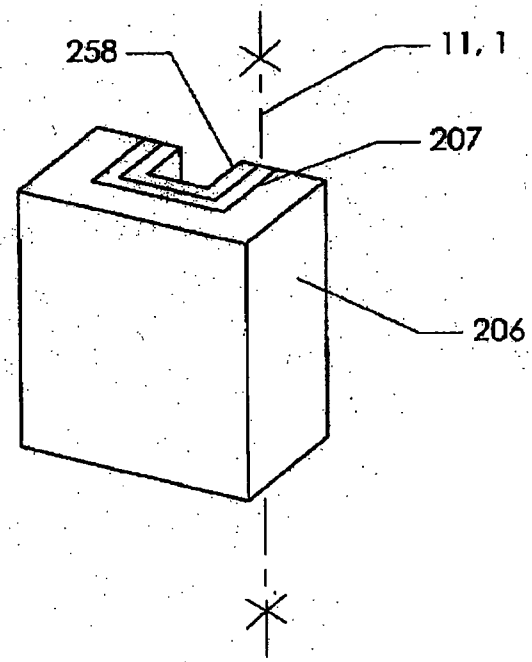


Figure 26a

Figure 28



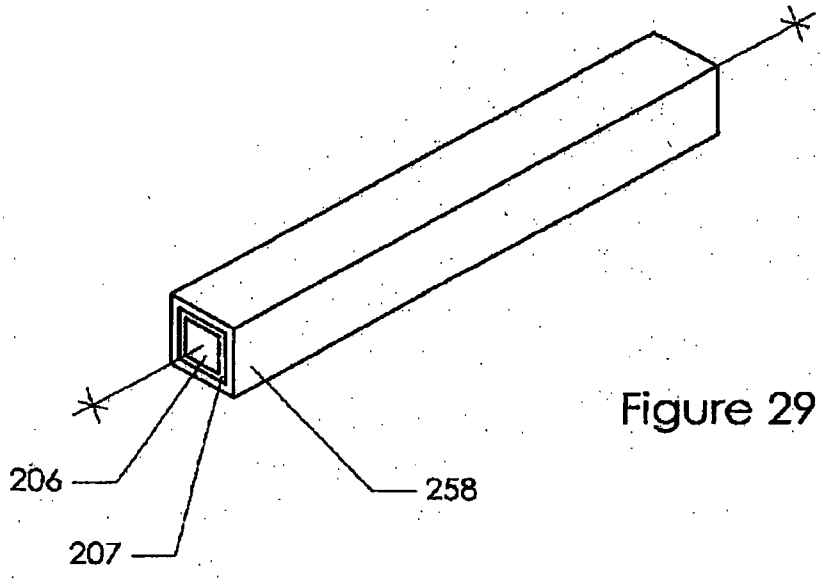
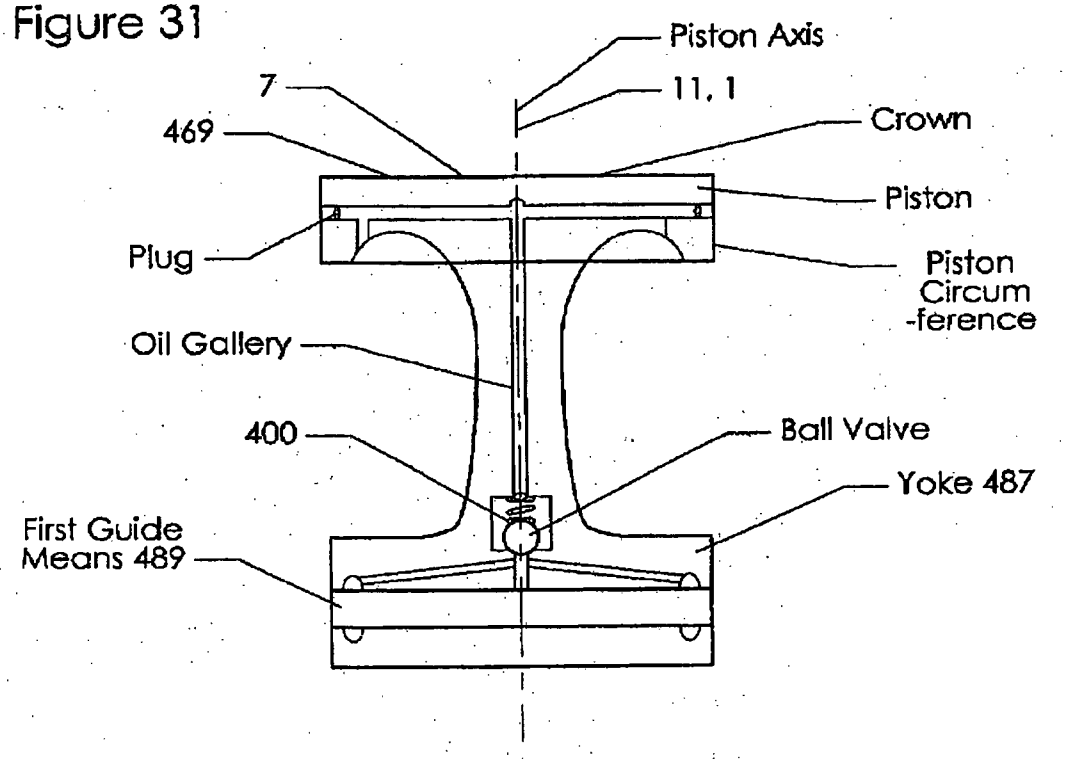


Figure 29

Figure 31



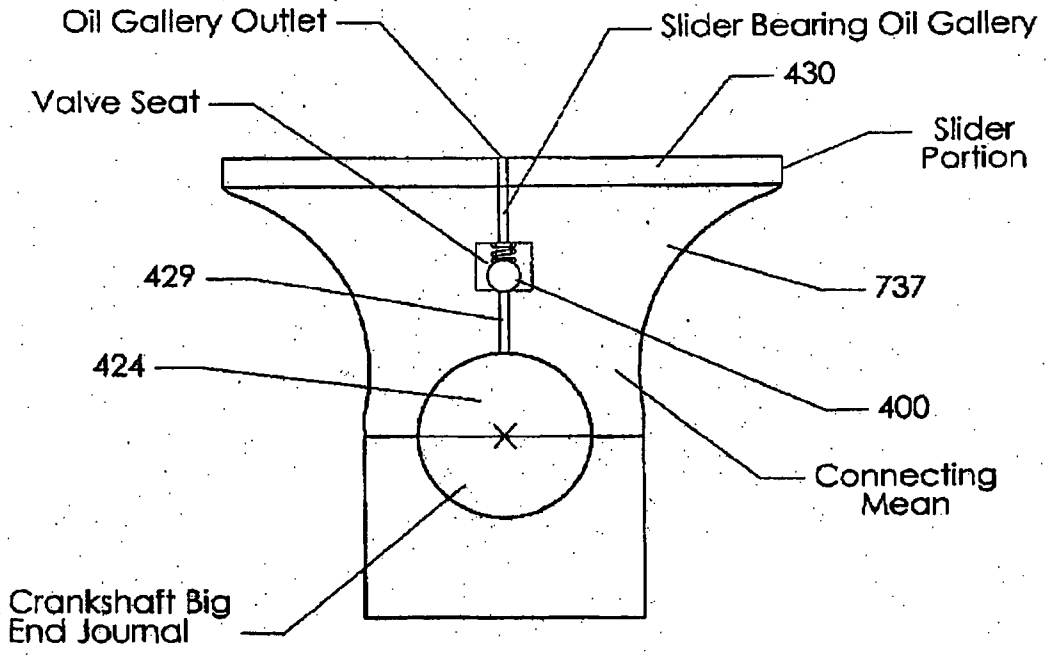


Figure 32

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2008/001664

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. ***F16C 33/02*** (2006.01) ***F16C 33/06*** (2006.01) ***F16C 33/28*** (2006.01) ***F02B 75/32*** (2006.01) ***F16C 33/12*** (2006.01) ***F01B 9/02*** (2006.01) ***F16C 33/08*** (2006.01) ***F16C 43/02*** (2006.01) ***F16C 33/04*** (2006.01) ***F16C 33/14*** (2006.01 ***F01B 9/04*** (2006.01) ***F16C 33/10*** (2006.01) ***F16H 21/36*** (2006.01))

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)
REFER TO ELECTRONIC DATABASE CONSULTED BELOW

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 practicable, search terms used)
EPODOC & DWPI - IPC F16C33/-, F16C43/-, F02B75/-, F01B9/-, F16H21/- & Keywords (scotch yoke, bond, bind, fuse, adhesive, join, attach, fasten, secure, glue, cement, epoxy, resin, cyan acetylene, settable, connect, solder, braze, guide, rail, channel, slot, track, carriage, carrier, slide, bearing, rail, track, groove) & like terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4776310 A (GRAY) 11 October 1988 Entire document E.g. Column 1 lines 6-12, figures 2, 10, 16 items 10, 22, 25, 30, 35, 35')	1-5
Y	US 4626299 A (KNIGHT ET AL.) 2 December 1986 Entire document E.g. Column 1 lines 31-50 & column 2 lines 27-53; figure 4 items 10, 40, 70	1, 3
Y	WO 2001/019549 A1 (FEDERAL-MOGUL CORPORATION) 22 March 2001 Entire document E.g. Page 2 lines 11-19, Page 10 lines 6-25, Page 11 lines 10-16, figure 6 items 26, 60	1-5
A	DE 102006020795 A1 (MAHLE INT GMBH) 8 November 2007 Entire document E.g. Abstract, figures 1-4B	2, 3

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"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
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
04 February 2009	26 FEB 2009
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. +61 2 6283 7999	Authorized officer **B. VAFA** AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No : +61 2 6225 6132

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2008/001664

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6330835 B1 (KLAVA ET AL) 18 December 2001 Entire document E.g. Figures 1-5, column 3 lines 35-40, column 4 lines 3-10	1-5
A	GB 2046850 A (FURSTLICH HOHENZOLLERNSCHE HUTTENVERWALTUNG LAUCHERTHAL) 19 November 1980 Entire document E.g. claims 1-4	2-5
A	US 4941758 A (OSAWA) 17 July 1990 Entire document E.g. Figures 1-2, column 4 lines 15-19	1-5
A	DE 102004039476 A1 (DAIMLER CHRYSLER AG) 14 December 2006 Entire document E.g. Abstract, figure 1	1-5
A	US 5200014 A (PETERS) 6 April 1993 Entire document E.g. Abstract, figure 4	2-4

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/AU2008/001664

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	4776310	AU	17039/88	WO	1988/008484		
US	4626299	US	4726103				
WO	2001/019549	NONE					
DE	102006020795	NONE					
US	6330835	AU	29286/01	CA	2395696	WO	2001/050037
GB	2046850	DE	2902682				
US	4941758	JP	2022417U				
DE	102004039476	NONE					
US	5200014	US	5118204				

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX