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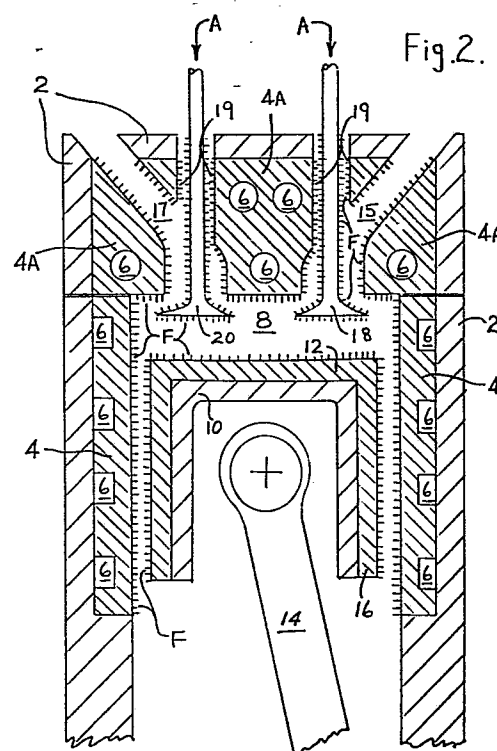
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54 Means of preventing heat of working fluid from flowing into component surfaces of thermodynamic piston engines.

57 In order to prevent heat of working gases or vapours from flowing into components such as cylinder (4), piston (10), cylinder head (4A), valves (18, 20) and other relevant engine components, these surfaces are constructed of fluid-permeable material, with fluid-tight adjacent parts of non-permeable material, represented by cylinder casing (2). A suitable fluid is supplied by a pump (not shown) to channels (6) in cylinder (4) and by other means (not shown) to the piston (10) and to valves (18, 20). This fluid flows through the permeable material, (this material being porous, or non-porous with suitable holes), to form a replenishable layer (F) of fluid upon the components' surfaces. Heat which would otherwise transfer to these surfaces from the working gases or vapours is absorbed by the replenishable fluid as it is forced away from the surface, through the thickness of the static boundary layer, eventually becoming entrained with the working gases or vapours.



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Improvements in or relating to means of preventing heat
of working fluid from flowing into component surfaces of
thermodynamic piston engines

5 This invention relates to thermodynamic piston engines
and more particularly to components of such engines
having surfaces exposed, in use, to high temperature
working fluid. Thus the invention has application to
10 pistons and to cylinder walls and cylinder heads of
internal combustion engines (with spark ignition or
self ignition or hot surface ignition) and to external
combustion engines, inlet and exhaust valves (poppet,
slide and other types) also passageways and combustion
15 chambers, which are subjected, in use, to high
temperature working fluid.

The thermal efficiency of practical thermodynamic piston
engines has hitherto been very much lower than the
efficiency which is theoretically possible from the
20 thermodynamic cycle upon which they are based. The most
significant reason for this is the need, in practice
hitherto, to limit the cycle maximum temperature such
that engine components and also lubricants are not unduly
affected by excessive heat. This has involved the
25 provision of cooling systems which conduct away from the
affected components and lubricants that very substantial
proportion of the heat of the working fluid, which
transfers to the surfaces of such affected components
and lubricants, by radiation and by conduction.

30 An object of the present invention, as claimed, is
intended to remedy these drawbacks. It solves the
problem of how to prevent overheating of components and
lubricants in piston engines. The invention as claimed
35 provides a means of preventing heat from escaping from
the working fluid to the surfaces of components and
lubricants of such piston engines, thus permitting much

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higher thermodynamic cycle temperatures to be used, for longer durations, with the result that thermal efficiency is increased. Also component and lubricant reliability is much improved due to lower and steadier working
5 temperature, and due to smaller and less fluctuating internal thermal stresses inside these components.

According to one aspect of the present invention, a component of a thermodynamic piston engine, having a
10 surface which is subjected to high temperature working fluid in use, has a fluid-permeable structure constituting that surface, and means are provided for forcing a fluid through that structure at a controlled rate of flow, thus causing the surface to become
15 permeated by the fluid and establish a layer of this fluid upon the surface, such that the fluid will function as a "barrier" against heat flow into that surface. (This barrier is hereafter referred to as the "Fluid Thermal Barrier") The fluid would be chosen to suit the
20 circumstances, but would most probably be air or water where the fluid will be lost to engine exhaust and therefore need to be continually replaced.

The "fluid thermal barrier" will usually be supplied at a
25 temperature which is within the reliable working temperature range of the material used for the component. Such temperature will usually be considerably lower than that of the thermodynamic working fluid.

30 The "fluid thermal barrier" supply pressure may exceed the maximum pressure of the thermodynamic cycle, or it may be supplied at certain different levels of pressure at different times or positions within such a cycle; also the pressure may be controlled so as to remain steady,
35 or it may be made to fluctuate as required by the circumstances.

In addition to protecting the components of a piston

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- engine from working fluid heat, the "fluid thermal barrier" will absorb that heat which would otherwise be lost to the surface of those components and thence to a cooling system or atmosphere, so that this heat will now take part in the thermodynamic cycle. The "fluid thermal barrier" will absorb the heat, and fluid from it will expand with the working fluid to provide additional useful work at the piston.
- 10 It is not suggested that the air, water or other fluid used for the "fluid thermal barrier" be fed into the thermodynamic working fluid so that the whole volume of the latter becomes diluted; this merely reduces the initial temperature throughout the working fluid before expansion and reduces the amount of useful work done.
- 15 On the contrary, the invention provides an extremely thin barrier of molecule of air, water or other fluid at the surface of the component only. The well known "boundary layer effect" prevents the molecules of the fluid thermal barrier from being immediately swept away from the
- 20 surface through which they have permeated, even though there maybe violent swirling taking place within the bulk of the working fluid.
- 25 As the fluid thermal barrier molecules are forced by their supply pressure, away from the surface and through the thickness of the static boundary layer they absorb the outflowing heat and their temperature will gradually rise to almost that of the mass of hot working fluid. The
- 30 fluid thermal barrier molecules then become entrained with the working fluid, both being at approximately the same temperature at the time of mixing, and thus the working fluid will not suffer a substantial drop in temperature as a result.
- 35 The fluid thermal barrier will usually need to be replenished at a rate which balances, in its required

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function, the heat energy tending to escape from the working fluid.

5 It is important to note that the molecules of the air, water or other fluid used as the fluid thermal barrier absorb only that heat which would otherwise be lost to the surfaces under consideration. The fluid thermal barrier molecules do not take that heat from the hot working fluid which would normally be retained by the
10 working fluid if the fluid thermal barrier were not present.

Also this invention does not relate to any means of cooling components, such as the well documented "sweat
15 cooling" system. Rather, it does provide a means of preventing heat from transferring to the surfaces of piston engine components.

Regarding construction materials, in connection with the
20 present invention it has been found that heavier gases (air in particular) and water can be made to permeate course-grained crystalline metals such as cast iron, given sufficient pressure which is by no means too high to be a practical proposition. The provision of a
25 "fluid thermal-barrier" opens the way to the use of materials, designs and methods of manufacture which have not hitherto been considered feasible for components which are subjected to high-temperature working fluid. Thus these components could well be made by sintering of
30 powdered metals to provide the necessary degree of fluid permeability or by forming fine holes in impermeable material.

Furthermore, it is envisaged that certain plastics
35 materials (perhaps foamed) could be used in suitable situations, such as for cylinders with a backing reinforcement of stronger material capable of withstanding

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the pressure of the working fluid.

5 In situations where lubricants are used upon or between surfaces, it may be considered advantageous to make such lubricants compatible with whatever fluid is used for the "fluid thermal barrier". Soluable oil could be used in the crank cases of reciprocating piston engines.

10 Alternatively, however, the water or other fluid used for the fluid thermal barrier may itself provide a sufficient lubrication to the sliding surfaces, if made of a suitable material, so that the use of lubricating oil could be dispensed with. Indeed, with compressed air (or other gas) used to provide the fluid barrier, this itself could provide an 'air bearing' effect between the
15 sliding surfaces and thus no further lubrication would be needed.

The best mode contemplated for carrying out the invention will now be described, using several embodiments of the
20 invention by way of example, with reference to the accompanying diagrams, in which:

Figure 1 Shows a cross-section view of part of a permeable solid structure with fluid thermal
25 barrier molecules permeating through it to form a layer upon its surface.

Figure 2 Show a cylinder and piston, and poppet valves,
30 of an internal combustion reciprocating engine.

Figure 3 Shows an expansion cylinder and piston, and a sliding or rotating metering type inlet valve,
of an external combustion reciprocating engine.

35 Referring first to Figure 1, there is shown a surface 9A having a permeable solid structure 7, supported by a non-permeable solid structure 7A. Fluid molecules F are

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supplied via channels 6, and then permeate the permeable structure as shown by arrows K to form a protective layer 9 within the thickness of the boundary layer T upon the surface 9A. The fluid thermal barrier molecules are shown by arrows H passing as a result of their supply pressure, from the cold side of the boundary layer 9A to the hot side of the boundary layer 9B, carrying with them that heat of the working fluid 5 which tends to escape from the latter as shown by arrows N.

10

Referring now to Figure 2, there is shown a fluid tight casing 2 surrounding a cylinder 4 of material (possibly cast iron) which allows air, water and other fluid to permeate through it at a sufficient rate under pressure.

15

The drawing shows fluid feed channels 6 which would be connected to a pump (not shown) capable of providing the required pressure over and above the pressure developed inside space 8, between the cylinder head 4A and piston 10. Figure 2 also shows piston 10 having a head portion

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12 of fluid permeable material; this would also have fluid feed channels (not shown) fed from flexible or telescopic pipes or via transfer channels at the connecting rod 14 or across the piston skirt 16 from the cylinder wall 4. Inlet and exhaust poppet valves 18 and 20 are also made, at least in those necessary parts, of fluid permeable material, the fluid in this case being fed through a channel in the valve stem as indicated by the arrow A, or via a side port (not shown).

25

For a sliding or rotating valve, instead of a poppet type, see Figure 3 and the related description. The drawing(Figure 2) shows a fluid thermal barrier F established by permeating of fluid through the permeable material of the cylinder 4, cylinder head 4A, piston head 12, valves 18 and 20, valve guides 19 and passageways 15 and 17.

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Referring now to Figure 3, there is shown an expansion

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cylinder 22 with piston 24 of an external combustion engine, having fluid thermal barrier feed channels 6.

This drawing also illustrates a sliding or rotating metering valve 26 whose fixed and movable parts 26A

5 and 26B are cooled by permeating of fluid forced through permeable material (from which, at least, the surface parts are made) to form fluid thermal barriers F.

10 The movable part 26B of the valve 26 could have fluid fed through a central channel indicated by the arrow A, or via a side port (not shown). Figure 3 also illustrates a poppet type exhaust valve 28; as shown this valve may also be constructed for permeation by fluid thermal barrier molecules and thus be protected
15 from receiving heat, as may the walls of the exhaust passageway 29 and inlet passageway 25.

Taken to its optimum development, this invention, simple in its concept, could be beneficially exploited in the
20 field of internal and external combustion piston engines, as follows:-

1. Prevent working-fluid heat energy being lost to cooling systems or to atmosphere, but instead, by absorbing this
25 heat energy, cause it to take part in the thermodynamic cycle (expansion) thereby adding to the useful work done per unit of fuel consumed. The "Fluid Thermal Barrier" thus provides an important means of dramatically improving the thermal efficiency of piston engines.

30 2. Prevent working-fluid heat energy reaching the surface of engine components and thus damaging them.

3. Provide a means of keeping certain components from
35 rubbing against one another, without the need for any other forms of lubrication where the components are made of suitable materials.

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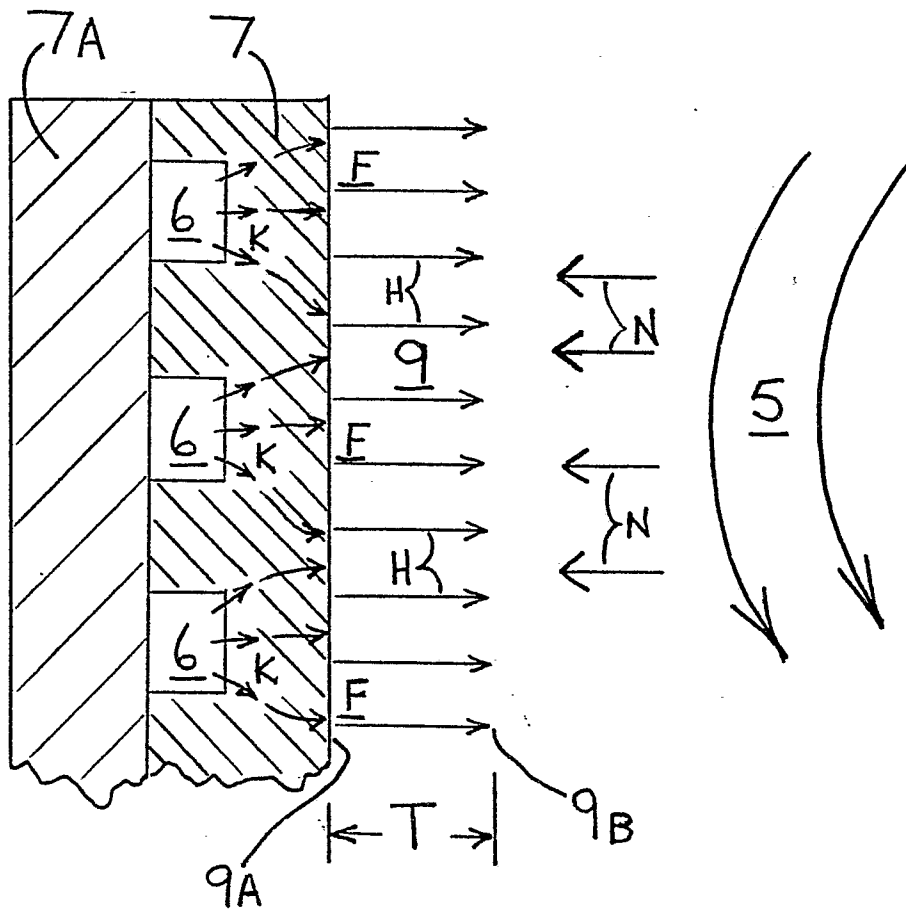
4. Make possible the use of materials hitherto regarded as unsuitable for use in components of piston engines, such as thermoplastic materials, perhaps foamed (polycarbonates, PVC, Nylon, etc), sintered metals and ceramic materials; all of which can be easier and cheaper to form into components than steel, cast iron or aluminium, with a lower quality-rejection rate.
5. Engines can be more reliable and less costly to manufacture because the thermal stresses inside the components will be very much reduced; also the auxiliary units which are necessary for the functioning of present engines, such as cooling systems, timed ignition or timed fuel injection systems, can be made unnecessary by using the "Fluid Thermal Barrier" system as a means of making it possible to redesign the layout of engines.
6. Piston engines working directly upon steam or other vapours produced above that temperature at which the latent heat of evaporation diminishes to nothing become feasible when the invention is used in their construction. Furthermore, the invention can be expected to be applicable to thermodynamic systems not yet devised.

CLAIMS:

1. A fluid-permeable structure constituting at least part of the surface of a piston-engine component which is in
5 close proximity to thermodynamic working gases or vapours, characterised in that the said fluid-permeable structure can be permeated by a suitable fluid to form a replenishible layer of said fluid upon the surface, substantially as
10 hereinbefore described with reference to the accompanying drawings.
2. A replenishible layer of fluid upon the surface of a piston-engine component which is in close proximity to the thermodynamic working gases or vapours, characterised
15 in that the said replenishible layer of fluid functions as a heat insulator to the said surface by absorbing heat which would otherwise transfer to the said surface from the thermodynamic working gases or vapours, substantially
20 as hereinbefore described with reference to the accompanying drawings.
3. A replenishible layer of fluid, as claimed in claims 1 and 2, upon the surface of a piston-engine component which tends to slide in contact with another such surface
25 in close proximity to thermodynamic working gases or vapours, characterised in that the said replenishible layer of fluid, which having permeated through the fluid-permeable structure constituting the first said surface, functions as a means of preventing said surfaces from
30 contacting one another, substantially as hereinbefore described with reference to the accompanying drawings.

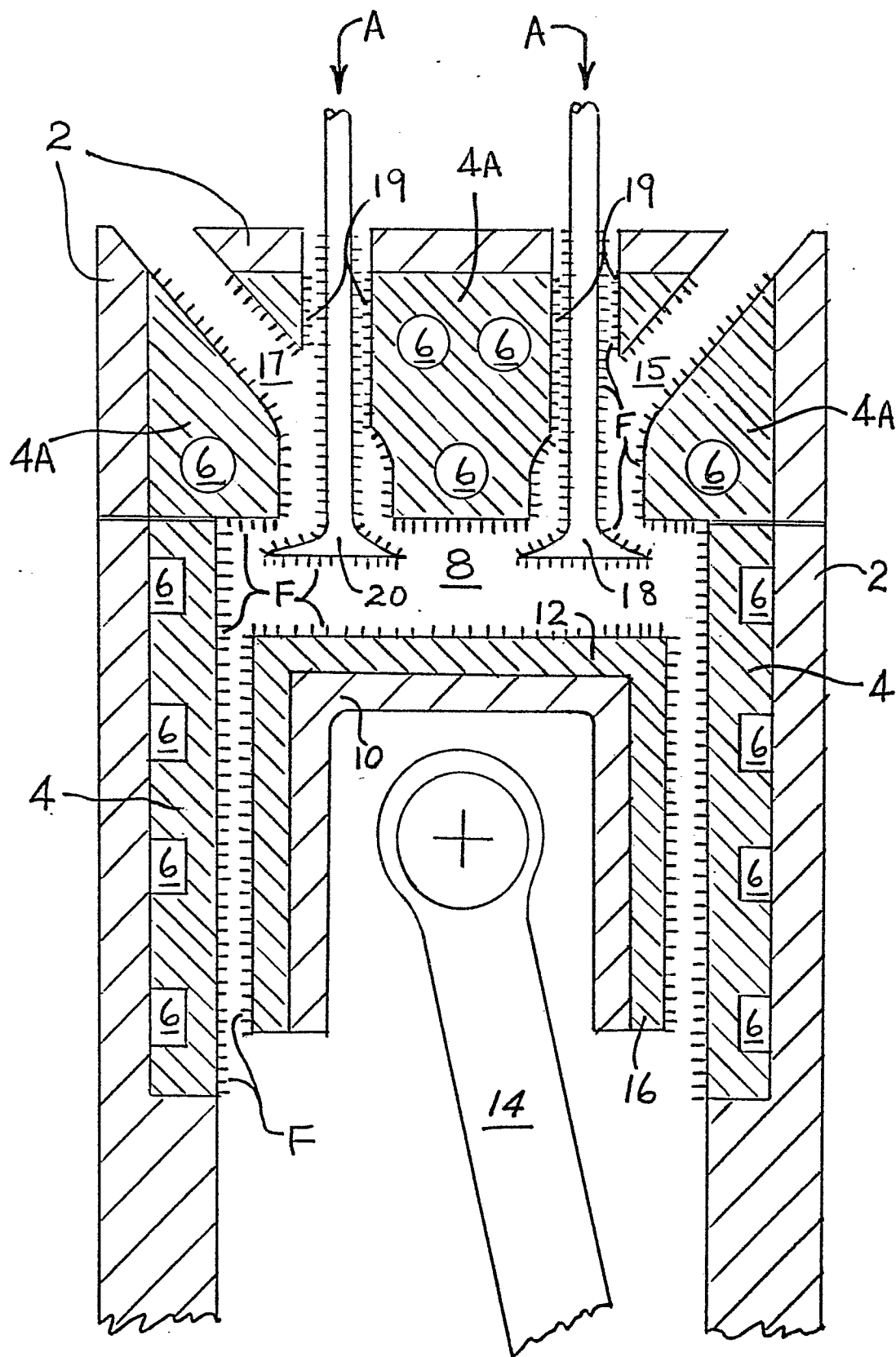
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Fig. 1.



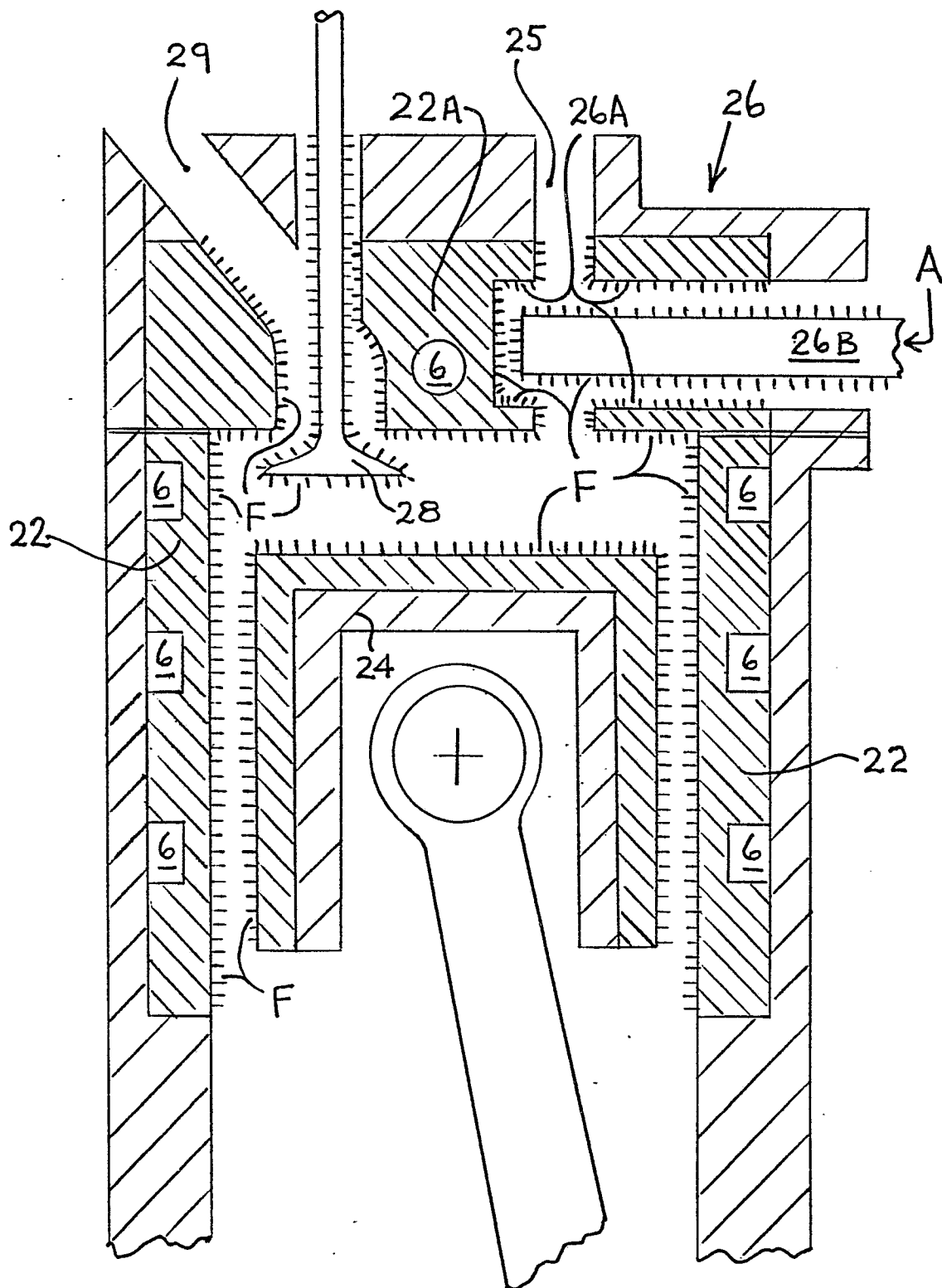
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Fig.2.



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Fig. 3.





European Patent
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EUROPEAN SEARCH REPORT

0049941

Application number
EP 81 30 2994

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
X	<u>DE - C - 489 034</u> (SCHATTANECK) * Page 1, line 1 - page 2, line 86 *	1,2	F 02 B 77/11 41/00
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	<u>GB - A - 828 552</u> (MAN) * Page 1, lines 1-78 *	1	
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	<u>US - A - 3 300 139</u> (FELDMAN) * Column 2, line 50 - column 2, line 35 *	1	TECHNICAL FIELDS SEARCHED (Int. Cl. ³)
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	<u>GB - A - 730 260</u> (CARBORUNDUM) * Page 1, lines 12-77 *	1	F 02 B F 02 F F 02 K F 01 D

			CATEGORY OF CITED DOCUMENTS
			X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons
			&: member of the same patent family, corresponding document
The present search report has been drawn up for all claims			
Place of search	Date of completion of the search	Examiner	
The Hague	01-09-1981	WASSENAAR	