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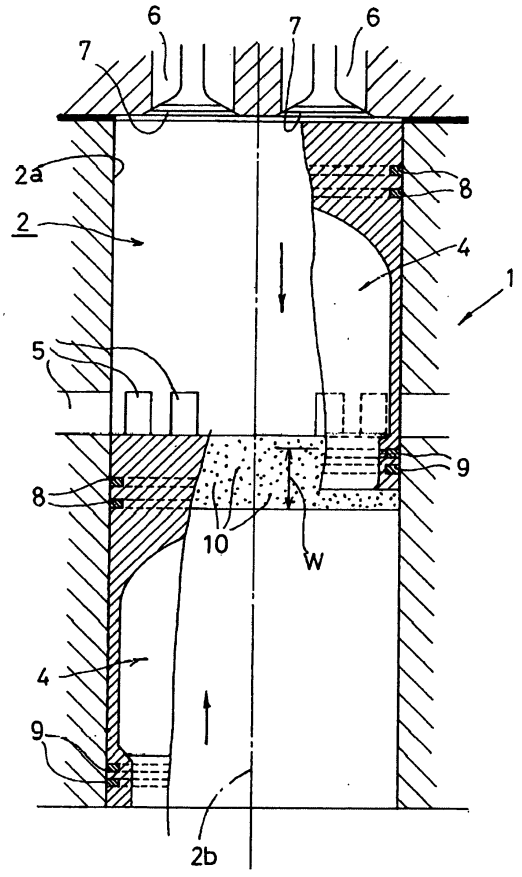
(54) LUBRICATION DEVICE FOR CYLINDER INNER WALL IN TWO-STROKE CYCLE INTERNAL COMBUSTION ENGINE

(57) A plurality of dimples 10 are provided at the region of an overlap stroke section W, where piston rings 8 provided at an upper end of a piston around an outer circumference thereof and oil rings 9 provided at a lower end of the piston around the outer circumference thereof overlap each other as the piston reciprocates, on a portion of a cylinder inner wall surface 2a which lies below lower edges of opening holes in scavenging ports, or a surface roughness of the region of the overlap stroke section W is increased higher than that of the remaining region of the cylinder inner wall surface 2a.

FIG. 2



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Description

Technical Field

[0001] The present invention relates to a lubricating system for a cylinder inner wall surface in a two-stroke cycle uniflow-scavenged or loop-scavenged internal combustion.

Background Art

[0002] In general, as is conventionally known, there exist in two-stroke cycle internal combustions a uniflow scavenging system in which scavenging in a cylinder is performed by scavenging flows which enter from scavenging ports which are opened in a cylinder inner wall surface and flow up toward exhaust ports in a cylinder head and a loop or cross scavenging system in which scavenging in a cylinder is performed by scavenging flows which enter from scavenging ports which are opened in a cylinder inner wall surface, flow up toward a top portion of the cylinder and then flow down toward exhaust ports which are also opened in the cylinder inner wall surface. In the former system, a configuration is adopted in which the scavenging ports in the cylinder inner wall surface are opened when a piston lowers to the vicinity of its bottom dead point, while in the latter system, a configuration is adopted in which both the scavenging ports and exhaust ports in the cylinder inner wall are opened simultaneously when the piston lowers to the vicinity of its bottom dead point.

[0003] In addition, in the two-stroke cycle internal combustions, as is described in Patent Document No. 1 and the like, the following configurations are adopted for lubrication to the cylinder inner wall surface. Namely, lubricant oil is injected into an interior of a piston which reciprocates inside the cylinder for cooling the piston as well as lubrication of the cylinder inner wall surface, and part of the lubricant oil so injected is supplied to the cylinder inner wall surface, or lubricant oil is directly injected to be supplied on to a portion of the cylinder inner wall surface which lies below the piston when it is at the top dead center or is splashed up from the inside of a crank case to be supplied to the relevant portion, so that the lubricant oil so supplied thereto is then entrained upwards by an oil ring provided at a lower end of the piston around an outer circumference thereof as the piston rises from the bottom dead point, whereby the lubricant oil so entrained up is then transferred from the oil ring to a piston ring which is provided at an upper end of the piston around the outer circumference thereof at a portion which lies adjacent to lower edges of opening holes in the scavenging ports or the scavenging ports and exhaust ports, that is, an overlap stroke section where the oil ring and the piston ring overlap each other as the piston reciprocates inside the cylinder, whereafter the lubricant oil so transferred is entrained upwards across the region of the overlap stroke section, that is, the opening holes in the scavenging ports or the scavenging ports and exhaust ports to a portion on the cylinder inner wall surface which lies thereabove by the piston ring as the piston rises.

[0004] However, the cylinder inner wall surface is honed over the whole area along the piston stroke so as to finish it into a uniformly smooth surface, whereby since the lubricant oil cannot be held in the region of the overlaps stroke section of the piston ring and the oil ring on the cylinder inner wall surface and hence little of the lubricant oil so supplied is transferred from the oil ring to the piston ring in the region of the overlap stroke section, a sufficient amount of lubricant oil cannot be entrained upwards across the region of the overlap stroke section, that is, the opening holes in the scavenging ports or the scavenging ports and exhaust ports to the portion on the cylinder inner wall surface which lies thereover, resulting in insufficient lubrication to the relevant portion.

[0005] To cope with this drawback, Patent Document No. 2 describes a configuration in which an innumerous number of minute dimples are provided on the whole area of a portion on the cylinder inner wall surface which lies below the lower edges of the scavenging ports or the scavenging ports and exhaust ports so that lubricant oil can be stored in the respective dimples.

Patent Document No. 1: JP-UM-A-5-214918
Patent Document No. 2: JP-UM-A-52-21354

[0006] According to the configuration of Patent Document No. 2, due to the innumerous number of dimples existing in the region of the overlap stroke section on the cylinder inner wall surface where the oil ring, which is provided at the lower end of the piston around the outer circumference thereof, and the piston ring, which is provided at the upper end of the piston around the outer circumference thereof, overlap each other, the cylinder inner wall surface is allowed to have the lubricant oil holding characteristic, so that much lubricant oil can be transferred from the oil ring to the piston ring of the piston, and, therefore, the lubricant oil so transferred can be supplied across the region of the overlap stroke section, that is, the opening holes in the scavenging ports or the scavenging ports and exhaust ports to the portion on the cylinder inner wall surface which lies thereabove as well in an ensured fashion.

[0007] On the contrary, however, due to the configuration adopted by Patent Document No. 2 in which, as has been described above, the dimples are provided over the whole area of the portion on the cylinder inner wall surface which lies below the lower edges of the scavenging ports or the scavenging ports and exhaust ports, as will be described below, there is caused a problem that not only is the consumption of lubricant oil increased but also exhaust emissions are deteriorated.

[0008] Namely, as the piston lowers towards the bottom dead point, lubricant oil is entrained by the piston to be stored in the respective dimples, and following this, as the piston rises from the bottom dead point, the lubri-

cant oil stored in the respective dimples is entrained up towards the region of the overlap stroke section by the piston, whereby more than required lubricant oil is carried up towards the region of the overlap stroke section.

[0009] As a result of this, since much of the lubricant oil entrained up to the region of the overlap stroke section by the piston comes to flow out into the scavenging ports or the scavenging ports and exhaust ports, increased consumption of lubricant oil and deteriorated exhaust emissions are called for.

Disclosure of the Invention

[0010] A technical problem that the invention is to solve is to solve this problem.

[0011] With a view to solving this technical problem, according to a first aspect of the invention, there is provided a "lubricating system for a cylinder inner wall surface in a two-stroke cycle internal combustion which is configured such that opening holes of either or both of scavenging ports and exhaust ports which are made to open to the cylinder inner wall surface are uncovered in the vicinity of a bottom dead point of a piston which reciprocates inside a cylinder, while lubricant oil is made to be supplied to a portion of the cylinder inner wall surface which lies below the piston when it is being at a top bottom center thereof, wherein a plurality of dimples are provided in the region of an overlap stroke section where as the piston reciprocates, a piston ring which is provided at an upper end of the piston around an outer circumference thereof and an oil ring which is provided at a bottom end of the piston around the outer circumference overlap each other on a portion of the cylinder inner wall surface which lies below lower edges of the opening holes of the scavenging ports or the opening holes of the scavenging ports and the exhaust ports while no dimples are provided on a portion which lies below the region, or a surface roughness of the region of the overlap stroke section on the cylinder inner wall surface which lies below the lower edges of the opening holes of the scavenging ports or the opening holes of the scavenging ports and the exhaust ports is made rougher than a surface roughness of the portion which lies below the region."

[0012] In addition according to a second aspect of the invention, there is provided a "lubricating system for a cylinder inner wall surface in a two-stroke cycle internal combustion as set forth in the first aspect of the invention, wherein the region where the dimples are provided or the region where the surface roughness is made rougher is expanded to the vicinity of upper edges of the opening holes of the scavenging ports or the opening holes of the scavenging ports and the exhaust ports."

[0013] Additionally, according to a third aspect of the invention, there is provided a "lubricating system for a cylinder inner wall surface of a two-stroke cycle internal combustion as set forth in the first or second aspect of the invention, wherein the plurality of dimples are arranged in at least two stages in an axial direction of the piston, the respective dimples in an upper stage and the respective dimples in a lower stage being made to deviate from one another by half a pitch in a circumferential direction so as to be formed into a staggered arrangement."

[0014] In addition, according to a fourth aspect of the invention, there is provided a "lubricating system for a cylinder inner wall surface in a two-stroke cycle internal combustion as set forth in any of the first to third aspects of the invention, wherein the dimple is formed to have a length (L) in a circumferential direction of about 0.6 mm to 4.0mm, a width (S) of 0.03 to 0.08 mm and a depth (T) of 0.005 to 0.05 mm, a gap (R) between the dimples along the circumferential direction is 0.5 to 2.0 mm, and a pitch (P) between the dimples along an axis of the cylinder is about 1.0 mm."

[0015] Additionally, according a fifth aspect of the invention, there is provided a "lubricating system for a cylinder inner wall surface in a two-stroke cycle internal combustion as set forth in the first or second aspect of the invention, wherein regions of the cylinder other than the overlap stroke section are formed to the standard of JISB0601 such that the ten point mean roughness Rz becomes 1 to 3 μm, while the region of the overlap stroke section is formed to the standard of JISB0671 such that Rk + Rpk becomes 0.5 μm or less, Rk becomes 0.2 to 0.4 μm, Rpk becomes 0.1 to 0.3 μm, Rvk becomes 2 to 7 μm, Mr1 becomes 9 to 12%, Mr2 becomes 82 to 88%, and A2 becomes 0.54 to 1.26."

[0016] In addition, according to a sixth aspect of the invention, there is provided a "lubricating system for a cylinder inner wall surface in a two-stroke cycle internal combustion which has a piston having a piston ring and an oil ring which are arranged vertically in this order from a top thereof and which is configured such that opening holes of either or both of scavenging ports and exhaust ports which are made to open to the cylinder inner wall surface are uncovered in the vicinity of a bottom dead point of a piston which reciprocates inside a cylinder, while lubricant oil is made to be supplied to a portion of the cylinder inner wall surface which lies below the piston when it is being at a top bottom center thereof, wherein a plurality of dimples are provided or a surface roughness is made rougher at part of a movable region of the piston ring, and wherein the part of the movable region includes a movable region of the oil ring."

[0017] The advantages of the invention will be as described below.

[0018] According to the configuration set forth in the first aspect of the invention, since by providing the plurality of dimples or making the surface roughness rougher in the region of the overlap stroke section on the portion of the inner wall surface of the cylinder which lies below the lower edges of the opening holes of the scavenging ports or the opening holes of the scavenging ports and the exhaust ports a lubricant oil holding characteristic can be imparted to the relevant region, much of the lubricant oil which is entrained up towards the region of the overlap stroke section by the oil ring provided at the lower

end of the piston around the outer circumference thereof as the piston rises from the lower dead center thereof can be transferred to the piston ring which is provided at the upper end of the piston around the outer circumference thereof in the region of the overlap stroke section.

[0019] In this case, since a problem, which would be caused by a configuration such as the one described in Patent Document No. 2, that more than required lubricant oil is entrained up towards the region of the overlap stroke section by the oil ring at the lower end of the piston around the outer circumference thereof as it rises from the bottom dead point thereof can be avoided in an ensured fashion by limiting, as has been described above, the region where the plurality of dimples are provided or the surface roughness is made rougher to the region of the overlap stroke section, the amount of lubricant oil which flows out from the lubricant oil which has been so entrained up to the region of the overlap stroke section into the scavenging ports or the scavenging ports and the exhaust ports can be decreased in an ensured fashion.

[0020] In short, according to the invention, both the reduction in lubricant oil consumption and the prevention of deterioration of exhaust emissions can be attained in an ensured fashion while ensuring the lubrication of the portion of the cylinder inner wall surface which lies above the opening holes of the scavenging ports or the opening holes of the scavenging ports and the exhaust ports.

[0021] In addition, according to the configuration set forth in the second aspect of the invention, the lubricant oil holding characteristic can be imparted to portions on the cylinder inner wall surface which lie between the scavenging ports or the scavenging ports and the exhaust ports so as to ensure the lubrication of those portions.

[0022] Additionally, according to the configuration set forth in the third aspect of the invention, the lubricant oil holding characteristic imparted by the dimples can further be promoted.

[0023] In addition, according to the configuration set forth in the fourth aspect of the invention, the prevention of seizing of the engine and the increase in the performance of exhaust emissions can be made compatible with each other.

[0024] Additionally, according to the configuration set forth in the fifth aspect of the invention, the prevention of seizing of the engine and the increase in the performance of exhaust emissions can be made compatible with each other.

[0025] In addition, according to the configuration set forth in the sixth aspect of the invention, while ensuring the lubrication of the portion of the cylinder inner wall surface which lies above the opening holes of the scavenging ports or the scavenging ports and the exhaust ports, both the reduction in lubricant oil consumption and the prevention of deterioration of exhaust emissions can be attained in an ensured fashion.

Brief Description of the Drawings

[0026]

Fig. 1 is a vertical front sectional view which shows a first embodiment of the invention.
Fig. 2 is a vertical front sectional view which shows a state in which the motion of a piston is added to the first embodiment.
Fig. 3 is an enlarged view of a main part of Fig. 1.
Fig. 4 is a vertical sectional view taken along the line IV-IV in Fig. 3.
Fig. 5 is a vertical front sectional view which shows a second embodiment of the invention.
Fig. 6 is a vertical front sectional view which shows a modified example made to the first embodiment.

Best Mode for Carrying out the Invention

[0027] Hereinafter, embodiments of the invention will be described by reference to the drawings.

[0028] Figs. 1 to 4 show a first embodiment of the invention.

[0029] This first embodiment illustrates a case where the invention is applied to a uniflow scavenging system.

[0030] In the figures, reference numeral 1 denotes a cylinder block in an interior of which a cylinder 2 is defined, and reference numeral 3 denotes a cylinder head which is fastened on to an upper surface of the cylinder block 1 in such a manner as to cover a top portion of the cylinder 2. Then, a piston 4 is provided inside the cylinder 2 in such a manner as to reciprocate therein, and this piston 4 and a crankshaft, not shown, are connected together by a connecting rod, not shown, in such a manner that the crankshaft is rotated by virtue of the reciprocating motion of the piston 4.

[0031] A plurality of scavenging ports 5 are provided in the cylinder block 1 in such a manner as to be uncovered when the piston 4 lowers to the vicinity of a bottom dead point thereof to thereby be made to open to the interior of the cylinder, while in the cylinder head 3, exhaust ports 6 from the cylinder 2 are provided, and exhaust valves 7 are provided in the exhaust ports 6, respectively, in such a manner as to be opened at a timing at which the respective scavenging ports 5 are opened.

[0032] On the other hand, two piston rings and two oil rings are provided at an upper end and a lower end of the piston 4 around an outer circumference thereof, respectively, and as is shown in Fig. 2, the piston rings 8 are made to be situated below the opening holes of the scavenging ports 5 when the piston 4 is being at the bottom dead point, while the oil rings 9 are made to be situated below the opening holes of the scavenging ports 5 when the piston 4 is being at the top dead center, whereby the piston rings 8 and the oil rings 9 are configured to overlap each other at a portion on a cylinder inner wall surface 2a of the cylinder 2 which lies adjacent to the lower edges of the scavenging ports 5 over only a stroke

section W of an appropriate distance which extends along a direction of an axis 2b of the cylinder 2.

[0033] In addition, lubricant oil is designed to be supplied to a portion on the cylinder inner wall surface 2a which lies below the piston when it is being at the top dead center, and the supply of lubricant oil is made to be implemented by, as is described in Patent Document No. 1, by injecting lubricant oil into an interior of the piston for cooling and lubricating the piston (through a configuration in which lubricant oil is supplied from the crankshaft to the portion of a piston pin of the piston through an oil passage provided in the connecting rod which connects the crankshaft with the piston pin, whereafter lubricant oil so supplied is injected into the interior of the piston) , or injecting lubricant oil directly through a nozzle, not shown, or splashing up lubricant oil from the interior of the crankcase.

[0034] Then, as is shown in Figs. 3 and 4, a configuration is adopted in which a plurality of minute dimples 10 are provided at appropriate intervals and pitches on the cylinder inner wall surface 2a over only the region of the overlap stroke section W and no dimples 10 are provided on a portion on the cylinder inner wall surface 2a which lies below the region of the overlap stroke section W.

[0035] In this configuration, since the lubricant oil holding characteristic can be imparted to the cylinder inner wall surface 2a by providing the plurality of dimples 10 on the cylinder inner wall surface 2a over the region of the overlap stroke section W, much of lubricant oil that is entrained up towards the region of the overlap stroke section W by the oil rings 9 at the lower end of the piston 4 around the outer circumference thereof when the piston 4 rises from the bottom dead point can be transferred to the piston rings 8 provided at the upper end of the piston 4 on the outer circumference thereof in the region of the overlap stroke section W.

[0036] In this case, a problem, which would be caused by a configuration such as the one described in Patent Document No. 2 (in which the dimples for storing lubricant oil are provided over the whole area of the portion of the inner wall surface of the cylinder which lies below the lower edges of the opening holes of the scavenging ports), that more than required lubricant oil is entrained up towards the region of the overlap stroke section W by the oil rings 9 at the lower end of the piston 4 around the outer circumference thereof as the piston 4 rises from the bottom dead point thereof can be avoided in an ensured fashion through the configuration in which, as has been described above, the region where the plurality of dimples 10 are provided is limited to the region of the overlap stroke section W on the inner wall surface 2a of the cylinder 2 and no dimples 10 are provided at the portion which lies below the relevant region.

[0037] In addition, the provision of the plurality of dimples 10 on the limited portion on the cylinder inner wall surface 2a can be attained through the following method.

[0038] In this method, firstly, the whole of the cylinder inner wall surface 2a is roughly honed in such a manner that a resulting inside diameter is smaller by an appropriate amount in diameter (which is equal to an amount to be honed subsequently for finishing as will be described later on) than a predetermined inside diameter, and following this, a laser beam is intermittently shone on to the portion on the inner wall surface 2a which coincides with the region of the overlap stroke section W by moving the laser beam round the axis 2b of the cylinder 2 while moving it in the direction of the axis 2b so as to apply a laser machining to the region of the overlap stroke section W to provide a plurality of dimples 10 thereon. Then, the whole of the inner wall surface 2a is honed further to be finished so that a resulting inside diameter becomes the predetermined inside diameter.

[0039] In this case, according to experiments carried out by the inventor of the invention and the like, the dimple 10 was preferably formed to have a length L in a circumferential direction of 0.6 to 4.0mm, a width S of 0.03 to 0.08 mm and a depth T of 0.005 to 0.05 mm, and a gap or interval R between the dimples 10 along a circumferential direction was preferably 0.5 to 2.0 mm, while a pitch P between the dimples 10 along the axis 2b was preferably 1.0 mm, the most preferable values for the respective dimensions being L = 1.0 mm, S = 0.05 to 0.06 mm, T = 0.01 to 0.02 mm, R = 1.0 mm, and P = 1.0 mm.

[0040] In addition, the dimples 10 are, as is shown in Fig. 3, provided in a staggered arrangement by causing the dimples 10 in an upper stage to deviate from the dimples in a lower stage by half a pitch in the circumferential direction, so as to promote further the lubricant oil holding characteristic by the dimples 10.

[0041] Note that while the embodiment described heretofore is such that the plurality of dimples 10 are provided on the portion of the inner wall surface 2a of the cylinder 2 which coincides with the region of the overlap stroke section W, in place of this, a configuration can be adopted in which a surface roughness of the region of the overlap stroke section W on the inner wall surface 2a of the cylinder 2 is made rougher than a surface roughness of a portion excluding or other portion than the overlap stroke section on the inner wall surface 2a of the cylinder 2.

[0042] Namely, since the lubricant oil holding characteristic can be imparted to the region of the overlap stroke section W by making the surface roughness of the region of the overlap stroke section W rougher than that of the other portion, an advantage similar to the advantage obtained with the aforesaid embodiment can be obtained.

[0043] In this case, according to the experiments, based on the fact that the whole of the inner wall surface 2a of the cylinder 2 is normally honed to be finished to the standard of JISB0601 such that the ten point mean roughness Rz becomes 1 to 3 μm, the region of the overlap stroke section W was preferably finished to have a rough surface roughness which is specified under the standard of JISB0671 as follows:

Rk + Rpk .... 0.5 μm or less;
Rk .... 0.2 to 0.4 μm;
Rpk .... 0.1 to 0.3 μm;
Rvk .... 2 to 7 μm;
Mr1 .... 9 to 12%;
Mr2 .... 82 to 88%;
A2 .... 0.54 to 1.26

Note that when used in this specification, the standard of JISB0601 denotes JISB0601, 2001, which corresponds to IS04287, 1997. However, the ten point mean roughness (Rz) is the standard used only under JIS. Similarly, the standard of JISB0671 denotes JISB0671, 2002, which corresponds to ISO1356 1996.

[0044] The roughening of the surface of the region of the overlap stroke section W or increasing the surface roughness thereof can be attained by, for example, roughly honing the whole of the cylinder inner wall surface 2a, sandblasting or etching with a chemical the region of the overlap stroke section W with the other portion on the cylindrical inner wall surface 2a masked so as to increase the surface roughness of the relevant region and thereafter honing the whole of the cylinder inner wall surface 2a for finishing.

[0045] In addition, while the amount of lubricant oil that is entrained up towards the region of the overlap stroke section by the piston 4 as it rises from the bottom dead point can be increased by expanding the region where the plurality of dimples 10 are provided or the region whose surface roughness is increased towards a lower end side of the cylinder 2, when the expansion directed towards the lower end side exceeds a limit, it results in an excessive amount of lubricant oil being entrained up to the region of the overlap stroke section W, an increase in consumption of lubricant oil being thereby called for, and therefore, the expansion of the region of the overlap stroke section W towards the lower end side of the piston 2 should be limited to a range in which the relevant region does not exceed substantially a height-wise central portion of the piston 4 when it is being at the bottom dead point.

[0046] Next, Fig. 5 shows a second embodiment of the invention.

[0047] This second embodiment is such that the region where the dimples 10 are provided or the region whose surface roughness is increased is expanded to a portion on the cylinder inner wall surface 2a which lies in the vicinity of upper edges of the opening holes of the scavenging ports 5, and by adopting this configuration, portions on the cylinder inner wall surface 2a which lie between the opening holes of the scavenging ports 5 can be imparted a lubricant oil holding characteristic so as to ensure the lubrication of the cylinder wall inner surface 2a.

[0048] Note that while the embodiments have been described as the invention being applied to the uniflow-scavenged two-stroke cycle internal combustion in which only the scavenging ports 5 are provided in the cylinder 2, the invention is not limited thereto and hence, needless to say, the invention can be applied to a loop-scavenged or cross-scavenged two-stroke cycle internal combustion. In Fig. 6, scavenging ports and exhaust ports 6 are provided in an inner wall surface of a cylinder.

Industrial Applicability

[0049] According to the lubricating system for the inner wall surface of the cylinder, the reduction in consumption of lubricant oil and prevention of deterioration of exhaust emissions can be attained in an ensured fashion while ensuring the lubrication of the portion on the cylinder inner wall surface which lies above the opening holes of the scavenging ports or the scavenging ports and exhaust ports.

Claims

1. A lubricating system for a cylinder inner wall surface in a two-stroke cycle internal combustion which is configured such that opening holes of either or both of scavenging ports and exhaust ports which are made to open to the cylinder inner wall surface are uncovered in the vicinity of a bottom dead point of a piston which reciprocates inside a cylinder, while lubricant oil is made to be supplied to a portion of the cylinder inner wall surface which lies below the piston when it is being at a top bottom center thereof, wherein a plurality of dimples are provided in the region of an overlap stroke section where as the piston reciprocates, a piston ring which is provided at an upper end of the piston around an outer circumference thereof and an oil ring which is provided at a bottom end of the piston around the outer circumference overlap each other on a portion of the cylinder inner wall surface which lies below lower edges of the opening holes of the scavenging ports or the opening holes of the scavenging ports and the exhaust ports while no dimples are provided on a portion which lies below the region, or a surface roughness of the region of the overlap stroke section on the cylinder inner wall surface which lies below the lower edges of the opening holes of the scavenging ports or the opening holes of the scavenging ports and the exhaust ports is made rougher than a surface roughness of the portion which lies below the region.

2. A lubricating system for a cylinder inner wall surface in a two-stroke cycle internal combustion as set forth in Claim 1, wherein the region where the dimples are provided or the region where the surface roughness is made rougher is expanded to the vicinity of upper edges of the opening holes of the scavenging ports or the opening holes of the scavenging ports and the exhaust ports.

3. A lubricating system for a cylinder inner wall surface of a two-stroke cycle internal combustion as set forth in Claim 1 or 2, wherein the plurality of dimples are arranged in at least two stages in an axial direction of the piston, the respective dimples in an upper stage and the respective dimples in a lower stage being made to deviate from one another by half a pitch in a circumferential direction so as to be formed into a staggered arrangement.

4. A lubricating system for a cylinder inner wall surface in a two-stroke cycle internal combustion as set forth in any of Claims 1 to 3, wherein the dimple is formed to have a length in a circumferential direction of about 0. 6 mm to 4.0mm, a width of 0.03 to 0.08 mm and a depth of 0.005 to 0.05 mm, a gap (R) between the dimples along the circumferential direction is 0.5 to 2.0 mm, and a pitch between the dimples along an axis of the cylinder is about 1.0 mm.

5. A lubricating system for a cylinder inner wall surface in a two-stroke cycle internal combustion as set forth in Claim 1 or 2, wherein regions of the cylinder other than the overlap stroke section are formed such that the ten point mean roughness, Rz, becomes 1 to 3 μm, while the region of the overlap stroke section is formed such that Rk + Rpk becomes 0.5 μm or less, Rk becomes 0.2 to 0.4 μm, Rpk becomes 0.1 to 0.3μm, Rvk becomes 2 to 7 μm, Mr1 becomes 9 to 12%, Mr2 becomes 82 to 88%, and A2 becomes 0.54 to 1.26.

6. A lubricating system for a cylinder inner wall surface in a two-stroke cycle internal combustion which has a piston having a piston ring and an oil ring which are arranged vertically in this order from a top thereof and which is configured such that opening holes of either or both of scavenging ports and exhaust ports which are made to open to the cylinder inner wall surface are uncovered in the vicinity of a bottom dead point of a piston which reciprocates inside a cylinder, while lubricant oil is made to be supplied to a portion of the cylinder inner wall surface which lies below the piston when it is being at a top bottom center thereof, wherein a plurality of dimples are provided or a surface roughness is made rougher at part of a movable region of the piston ring, and wherein the part of the movable region includes a movable region of the oil ring.

FIG. 1

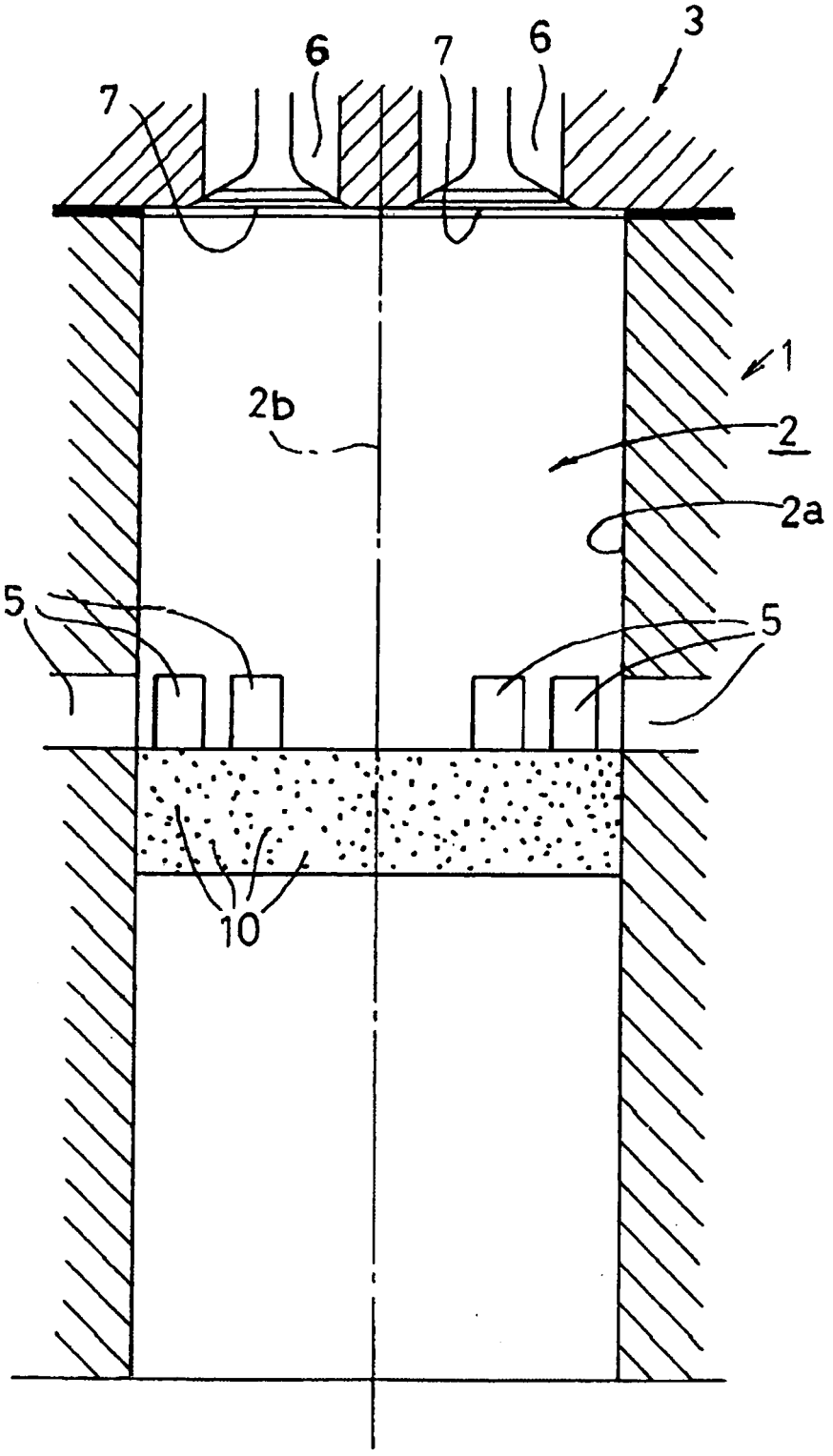


FIG. 2

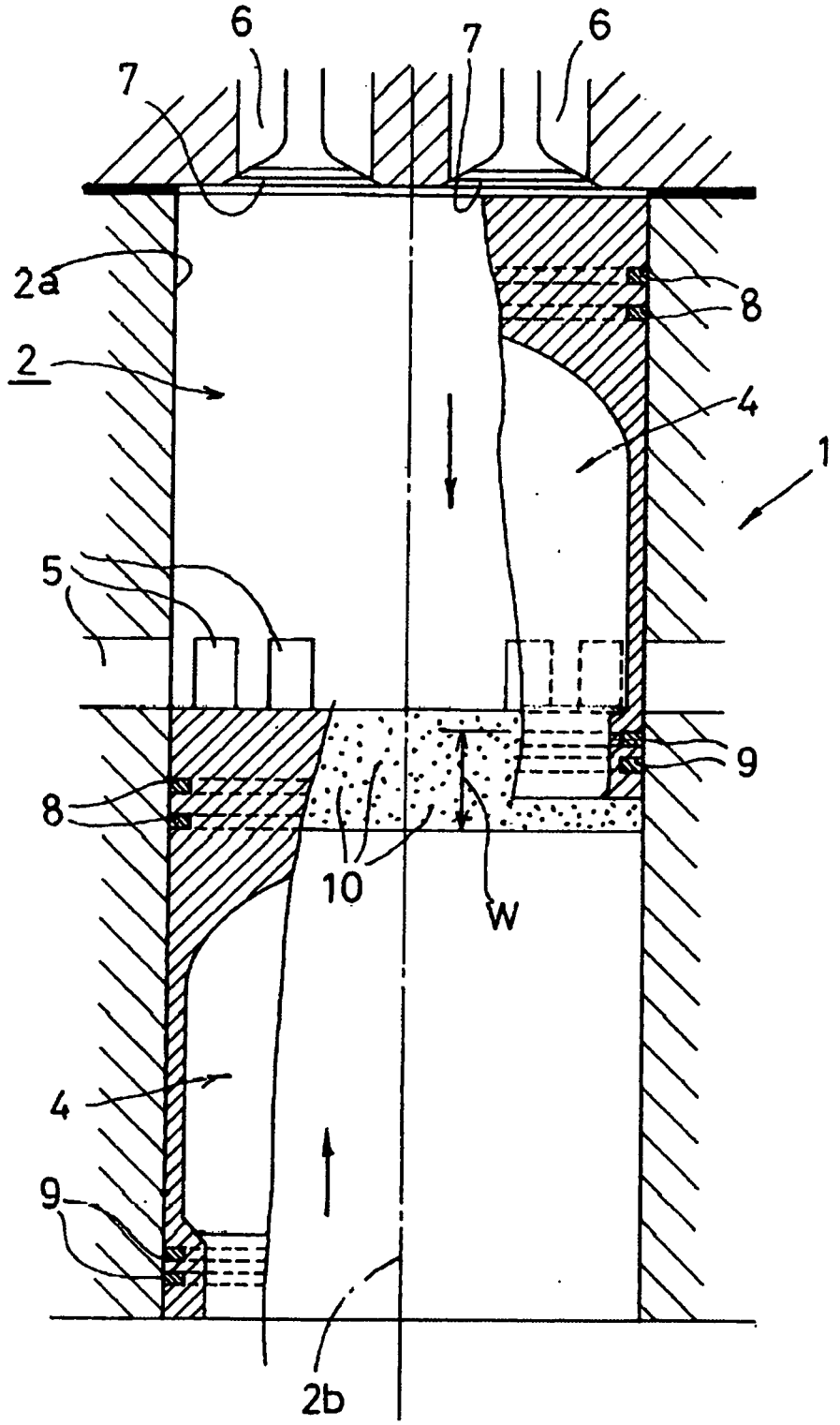


FIG. 3

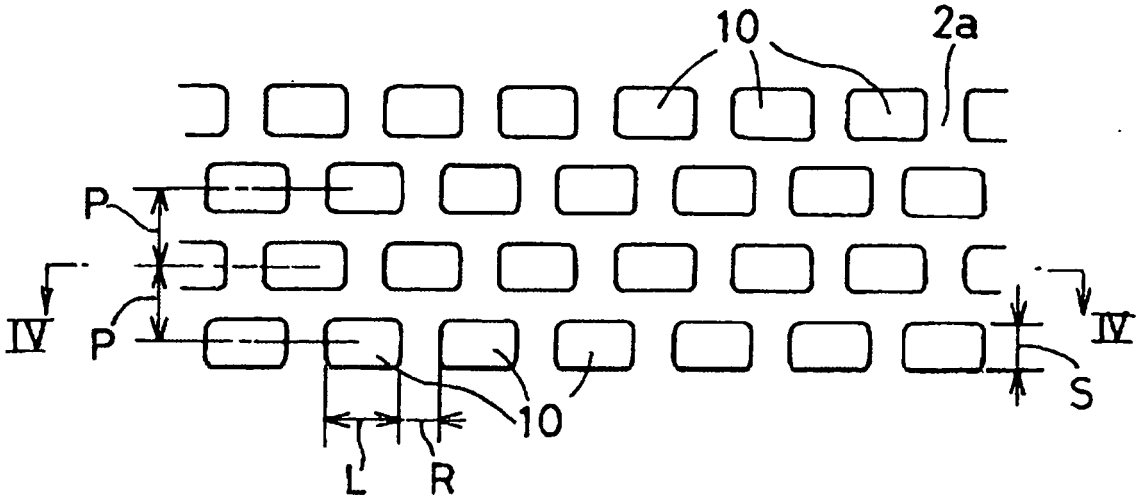


FIG. 4

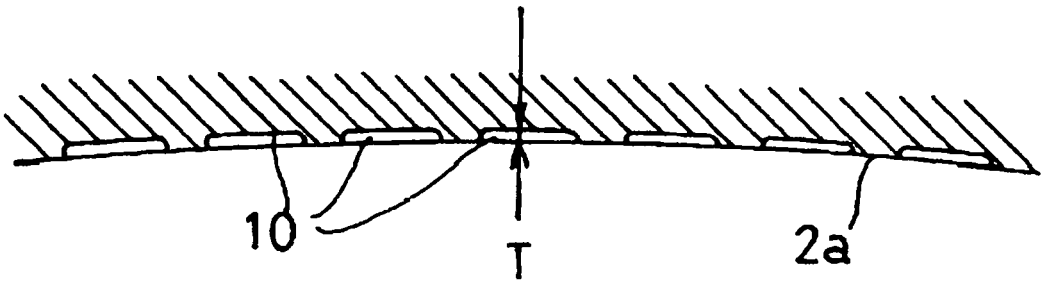


FIG. 5

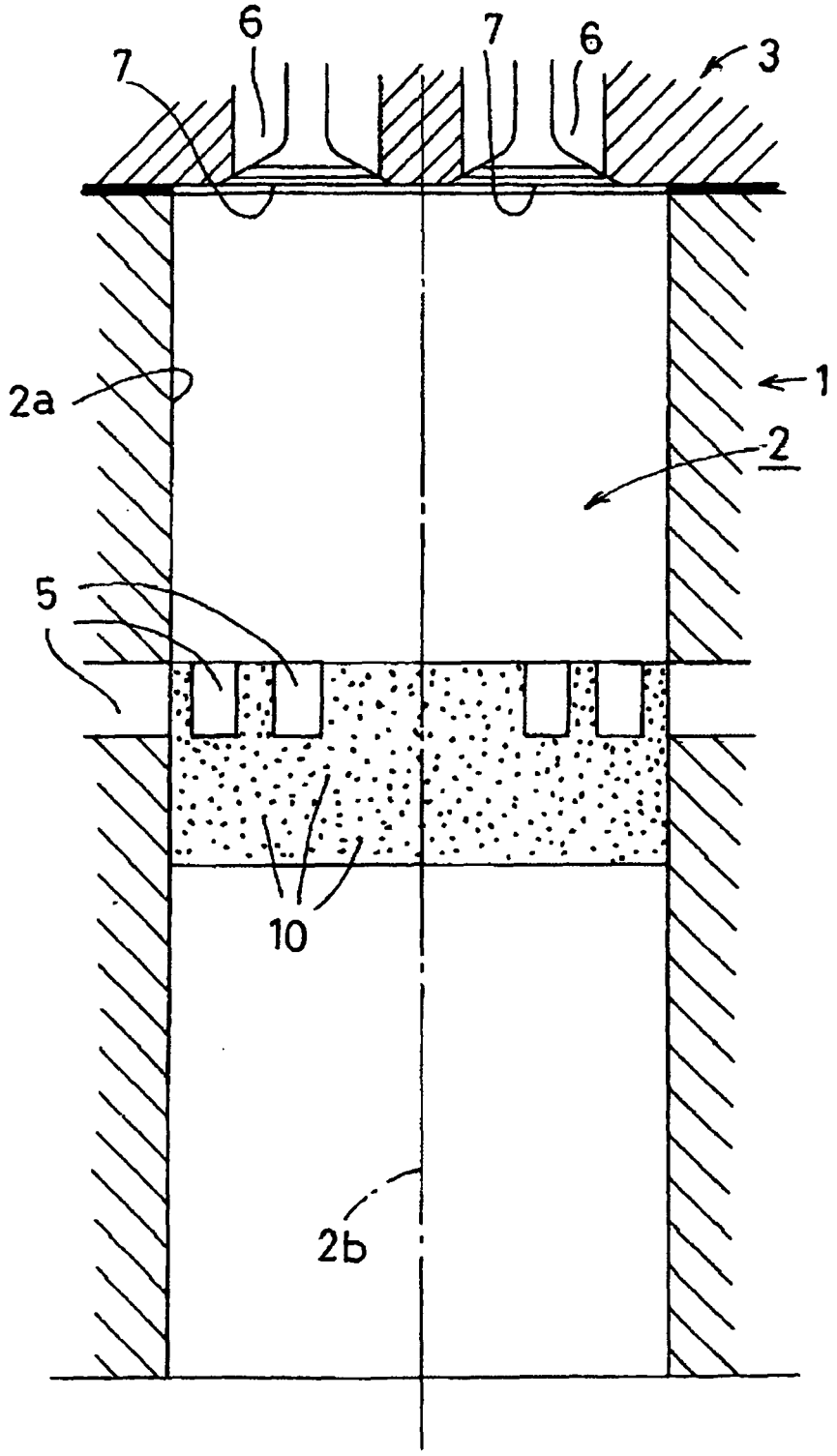
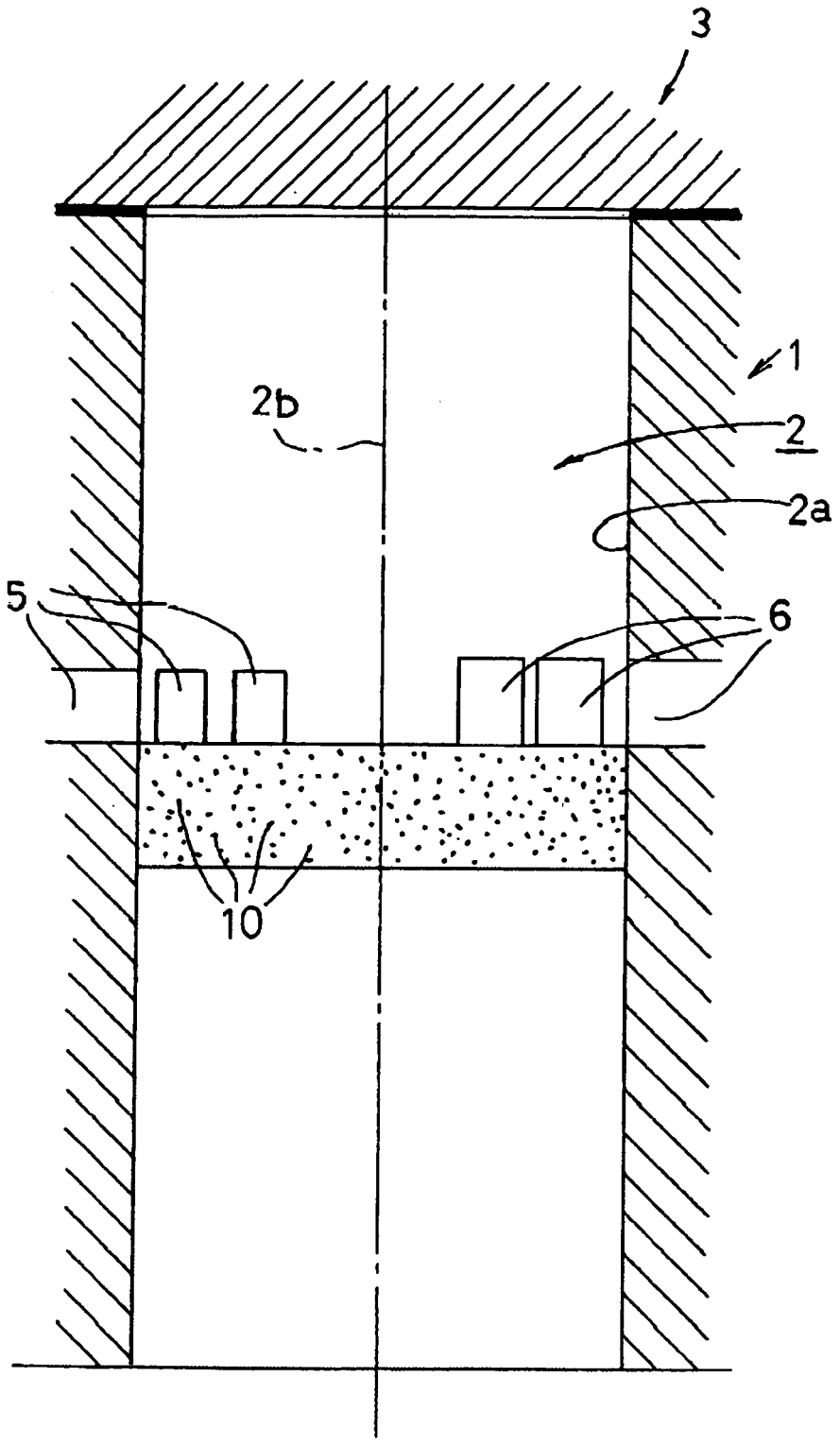


FIG. 6



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2005/022501

A. CLASSIFICATION OF SUBJECT MATTER
F02F1/20(2006.01), ***F02F1/22***(2006.01), ***F16J10/04***(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)
F02F1/00-11/00, F01M1/08, F01M9/06, F16J10/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2006
Kokai Jitsuyo Shinan Koho 1971-2006 Toroku Jitsuyo Shinan Koho 1994-2006

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 6-264814 A (Mitsubishi Heavy Industries, Ltd.), 20 September, 1994 (20.09.94), Fig. 1 (Family: none)	1-6
A	JP 54-5114 A (Mitsubishi Heavy Industries, Ltd.), 16 January, 1979 (16.01.79), Page 1, right column, lines 8 to 16; Fig. 1 (Family: none)	1-6

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
13 March, 2006 (13.03.06)	20 March, 2006 (20.03.06)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (April 2005)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 5214918 A **[0005]**
- JP 52021354 A **[0005]**