

Machine part belonging to a sliding match and methods of producing it

This invention relates to a machine part belonging to a pair of mechanical members in sliding contact with each other, hereinafter referred to as sliding matches, composed of two mutually movable machine parts of a heavy internal combustion engine, especially a heavy two stroke cycle diesel engine, and at least in the area of the side facing the mating machine part being of a wear resistant structure comprising particles embedded in a metallic matrix, such particles consisting of a comparatively hard material and having a rough and uneven surface, and being designed as a piston ring or a cylinder liner or a piston having at least one piston ring groove or as any other sliding element of a heavy engine.

DE 10 2006 023 396 (not published) discloses a part of a heavy engine, which has a wear resistant structure in the form of an anti-wear coat. Such anti-wear coat consists of ceramic particles embedded in a matrix formed by a Ni alloy. On the upper side of such coat provision is made for a thin cover layer, which only consists of the matrix material. However, practical use has shown that the surface of such cover layer is very rough and uneven, a fact that is unfavorable for running-in the engine. This makes it necessary to provide for a machining operation in the form of a grinding process. Experience has shown that this is extremely time consuming and costly. In addition, the Ni alloy, due to its hardness, is rather unfavorable for run-in purposes anyway.

On these premises it is therefore the object of this invention to improve the arrangement mentioned initially above in such a way that the manufacturing effort and expenditure is reduced and a good run-in behavior is achieved. A further object aims at providing a simple and low cost process for the manufacture of a machine part according to the invention.

In accordance with the invention, the first object is achieved by coating the wear resistant structure with a run-in coating which levels out the unevenness and roughness at the top surface of the said structure and consists of a run-in material suitable for wearing off during a run-in process, such material being different from the wear resistant structure underneath and adhering to the wear resistant structure by metallurgical bond, and further being softer than the said wear resistant structure and at most being of the same degree of wear resistance as the sliding surface of the opposite machine part.

These measures will completely eliminate the above disadvantages of the known arrangement. Since the run-in coating consists of a run-in material, it can be expected to possess good sliding properties. Since the run-in coating levels out the roughness and unevenness of the wear resistant structure underneath, a subsequent grinding operation is in a favorable manner dispensable. Moreover, it is in this way ensured that the hard particles of the wear resistant structure, which are also present in the upper zone thereof, are reliably retained even when their surface is getting exposed towards the end of the run-in process, so that breaking out of such particles is not to be feared. The non-ground surface furthermore in an advantageous manner provides gas tight contact from the very beginning, a fact that is very desirable especially in the case of sliding matches between a piston ring and a cylinder liner. A further advantage of the measures in accordance with the invention can be seen in the fact that as a result of the metallurgical bond of the run-in coating with its support a reliable adhesion of the run-in coating to the wear resistant structure provided underneath is ensured, so that peeling off is safely avoided.

Advantageous embodiments and expedient further developments of the generic part measures are listed in the subclaims.

Thus the run-in coating may expediently possess a diamond point hardness (DPH) of between 100 and 200. In such a case, a particularly good run-in behavior can be expected. Nevertheless a sufficient degree of durability is ensured to provide for a sufficiently long run-in time.

A further development of the invention of the generic part measures may consist in that the material forming the run-in coating possesses a melting point below 1050 degrees centigrade, preferably between 600 and 800 degrees centigrade. This permits in a favorable manner a simple production of the run-in coating in which only the material of the run-in coating is caused to fuse, while the material of the wear resistant structure underneath remains in solidified condition. This ensures that the boundary layers constituting the metallurgical bond between the run-in coating and the wear resistant structure underneath thereof can be kept very thin. The brittleness which is frequently to be expected in these boundary layers will thus in an advantageous manner have only a slight effect on the total result.

Favorably the run-in coating, when newly applied, may have an average thickness of between 50 and 300 microns (μm). Experience has shown that this thickness is sufficient for a run-in period of 1000 to 2000 hours, in which case the abrasiveness of

the mating opposite sliding surface can be taken into account by adapting the coating thickness accordingly. The greater the abrasiveness of the opposite sliding surface, the greater the thickness of the run-in coating can be.

A further development of the generic term measures may consist in that the run-in coating, when new, has a surface roughness of between Ra 1 and Ra 20. This completely eliminates the necessity of finish machining the surface and nevertheless from the very outset provides a particularly good sealing effect.

An especially favorable further development of the generic term measures may consist in making provision for the run-in material used for the run-in coating to embed harder particles, preferably of some ceramic material, such as Al_2O_3 and/or CrO and/or Cr_2C_3 . These may serve to increase the service life of the run-in coating and thus extend the run-in period. Expediently the proportion of the embedded particles contained in the total volume may be somewhere between 5 and 30 percent by volume. This will ensure that the embedded particles will not impermissibly impair the run-in behavior.

Favorably the material used for the run-in coating may contain at least copper (Cu) and/or tin (Sn). This permits the optimization of the desired run-in properties to suit the conditions in each individual case.

A particularly favorable effect can be obtained if the run-in coating contains approx. 70 percent copper (Cu) and approx. 30 percent tin (Sn). Such a composition is in a favorable manner usable for a wide variety of applications. It is also conceivable to additionally add a certain quantity of antimony (Sb). This will produce what is generally referred to as babbitt metal, which is in practice widely used as a bearing metal and is thus readily available.

The wear resistant structure receiving the run-in coating may expediently contain a matrix formed by a Ni alloy in which the particles consisting of a ceramic material are embedded, with the proportional volume of the ceramic material in the total volume of the wear resistant structure may be more than 60 percent, preferably 85 percent. These measures result in a particularly high load capacity and wear resistance. By adding minor quantities of phosphor (P) and/or silicon (Si) the melting point of the matrix can be reduced below that of cast iron which may facilitate the deposition of the run-in coating on the wear resistant structure and/or of the latter on a base body.

In accordance with the invention, the process related object is achieved in that the machine part possessing a wear resistant structure is coated with a run-in coating covering such wear resistant structure and that in the course of the coating process so much energy is supplied to the wear resistant structure and/or the material forming the run-in coating that a desired metallurgical bond between the run-in coating and the wear resistant structure is obtained. If a thick boundary layer between the wear resistant structure and the run-in coating is desirable, the volume of energy should be such that the run-in coating is partially alloyed on to the wear resistant structure. Where this is not desirable, the volume of energy is reduced to such an extent that the run-in coating is diffused on the wear resistant structure. The volume of energy required therefor is only such that the material forming the run-in coating is fused, while the wear resistant structure underneath remains in solidified condition. The boundary layers resulting from such a procedure will in this case be relatively thin. Moreover, an impairment of the supporting structure is in this way excluded.

In an advantageous manner, the wear resistant structure can be coated with the aid of a heating facility that is movable relative to the wear resistant structure and produces a hot spot, with the material forming the run-in coating being moved into such hot spot or to an area immediately neighboring the latter. This provides for a simple design of the coating arrangement and a controlled energy supply within narrow limits. The material fed to the hot spot or to an area immediately neighboring the same may be supplied in the form of powder and/or in the form of a wire or strip.

It is especially advantageous if for the coating of a base material of wear resistant structure the latter and the run-in coating are deposited in a like manner on their respective supports. This can be done either simultaneously or with a certain time interval. Such a procedure will at any rate minimize the equipment expenditure.

Further advantageous embodiments and expedient developments of the generic term measures will be described in the remaining subclaims and will be evident from the descriptions of various examples in conjunction with the accompanying drawings wherein —

- Figure 1 is a sectional view showing an example of application in the form of a piston ring cooperating with a cylinder liner and possessing a supporting structure coated with a run-in coating;
- Figure 2 is a partial view of the run-in coating with the neighboring area of the wear resistant structure;

- Figure 3 is a partial view of a run-in coating with embedded ceramic particles;
 Figure 4 shows a coating arrangement with two laser guns and their associated feeding arrangements for the material forming the wear resistant structure and the material forming the run-in coating; and
 Figure 5 is a variant of the arrangement in Figure 4 with one laser gun and a two-channel feeding arrangement.

The invention is advantageously usable in all cases in which sliding matches with a long service life require a certain run-in period, e.g. in machines in the iron and steel industry, millwright industry, food and drink industry, engine construction, etc. A particularly preferred field of application is the construction of heavy engines, especially two stroke cycle diesel engines, and within this field especially the piston rings cooperating with a cylinder liner and associated piston ring grooves.

Figure 1 is a schematic partial view of a cylinder liner 1 in which a reciprocating piston 2 is provided. The latter is fitted with circumferential piston ring grooves 3 each receiving an associated piston ring 4 whose circumferential surface is in contact with the inside surface of the cylinder liner 1. In Figure 1, only one piston ring groove 3 and one piston ring 4 are indicated. The piston ring 4 consists of a base portion 5 made of cast steel and in the area facing its opposite member, in this case the cylinder liner 1, comprises a wear resistant structure 6, in this case in the form of a protective coating deposited on the base member 5. It would, of course, likewise be conceivable that the wear resistant structure is already integrated in the base member. The said wear resistant structure 6 is on its circumferential surface provided with a run-in coating 7 facing the internal surface of the cylinder liner 1.

The wear resistant structure 6, as can be seen from Figure 2, consists of particles 9 of a hard material, embedded in a matrix 8. Such hard material may be a ceramic material, such as tungsten carbide (WC) possessing a vickers hardness (DPH) of between 3000 and 5000. The matrix 8 is expediently composed of a nickel alloy with phosphor (P) and/or silicon (Si). These materials are non-toxic, a fact that would also permit their use in the food and drinks sector. Expediently the nickel alloy may contain between 1 and 15, preferably 3.65, percent by volume of P, between 1 and 6, preferably 2.15, percent per by volume of Si, and the rest nickel. The percentage by volume of ceramic particles in the total volume of the wear resistant structure 6 is higher than 60 percent and may preferably amount up to 85 percent. The embedded ceramic particles 9 are preferably of spherical configuration with a diameter of between 40 and 160 microns (μm). The thickness of the coating formed by the wear resistant

structure 6 may be adapted to the requirements in each given application. In the case of the piston rings of the kind under discussion here the coat formed by the wear resistant structure 6 has a thickness of between 0.2 and 2 mm.

The radial surface of the wear resistant structure 6 before the application of the run-in coating 7 is comparatively rough and uneven, as can be seen from Figure 2, that is to say it comprises raised portions 10 between which there are "valleys" 11, a factor that would be detrimental to the run-in process. It is therefore the function of the run-in coating 7 deposited on the wear resistant structure 6 to level out the valleys 11, so that, towards the end of the run-in period, a surface without protruding edges and corners is produced, as indicated by a broken line 12 in Figure 2. Since the valleys 11 are in this way filled up, the hard particles, which laterally limit the valleys 11 and protrude in an upward direction, are reliably embedded in the surrounding material, so that there is no danger that they might break out of their bond. The run-in coating 7 renders a finish machining process for smoothing the surface of the wear resistant structure 6 superfluous. The application of the run-in coating 7 thus provides a surface 13 having only a slight degree of roughness, as is indicated in Figure 2. This is expediently between 1 and 20 Ra. This slight roughness provides gas-tight contact between the piston ring 4 and the associated internal surface of the cylinder liner 1. An additional finish machining process is thus not necessary.

The run-in coating 7 may consist of any suitable run-in material, which latter, is slowly worn off in the course of the run-in phase and disappears. In the case of heavy engines, such as two stroke cycle diesel engines used for the propulsion of ships, the run-in period is approx. 1000 to 2000 hours of operation. For such applications the thickness of the run-in coating 7 is preferably between 50 and 300 microns [μm]. The material used for such run-in coating 7 should be substantially softer than the wear resistant structure 6 underneath, and at any rate not harder, preferably likewise slightly softer, than the opposite sliding surface, in this case the internal surface of the cylinder liner 1. Expediently the run-in coating 7 possesses a hardness of between DPH 100 and 200.

For forming the run-in coating 7 use can be made of a metallic material containing copper (Cu) and/or tin (Sn). Good results were obtained in testing a bronze material in the form of a Cu-Sn alloy containing 70 percent Cu and 30 percent Sn. Also conceivable would be the use of babbitt metal, which in addition to copper and tin also contains antimony (Sb) and/or zinc (Zn) in the proportions usual for babbitt metal materials. The melting point of such materials lies in the range between 600 and 900

degrees centigrade, a fact that facilitates the coating process. The lower limit of the melting point of the run-in coating should not be less than 200 degrees centigrade.

In order to extend the run-in period, i.e. the service life of the run-in coating 7, the latter may be provided with embedded hard particles 14, as indicated in Figure 3. These may expediently be ceramic particles, preferably of spherical configuration, having a diameter of up to 50 microns [μm]. The ceramic material used for such particles may be Al_2O_3 , CrO , Cr_3C_2 or the like. The proportion of the hard particles 14 contained in the total volume of the run-in coating 7 may be somewhere between 5 and 30 percent by volume, depending on the desired service life thereof.

The layer forming the run-in coating 7 is deposited on the wear resistant structure 6 in such a manner that a metallurgical bond is obtained in the boundary range between the wear resistant structure 6 and the run-in coating 7. This metallurgical bond is achieved by a boundary layer 15 formed, as indicated in Figure 2, in the boundary area between the wear resistant structure 6 and the run-in coating 7, such boundary layer being composed of elements of the two neighboring materials. In Figure 1 this boundary layer is merely indicated by a broken line. Such boundary layer 15 may be obtained either by the formation of an alloy or by providing for a diffusion process. In the former case the run-in coating 7 is alloyed onto the base body 5, in the latter case it is diffused into it. The same applies to bonding the coat forming the wear resistant structure 6 with the base body 5. Here, too, a boundary layer is formed, either by an alloying process or a diffusion process, as the case may be, which layer is indicated by a broken line in Figure 1 only. The alloying process yields a comparatively great thickness of the boundary layer 15, in such a way ensuring very good mutual bonding. In many cases, however, this boundary layer is characterized by the formation of brittle crystals, thus increasing the danger of brittle fracture. This danger can be avoided by using a diffusion process for forming the boundary layer. A diffusion layer merely has a thickness corresponding to the diffusion depth, so that on the one hand the proportion by volume of brittle crystals is kept within narrow limits, and on the other hand good metallurgical bonding is nevertheless ensured between the coatings. Depending on the desired coating method used, a greater or lesser volume of energy is employed in the process. When alloying is used, both the coating material and an upper zone of the material underneath are fused. When diffusion is used, only the coating material is fused, while the material underneath thereof is heated, but remains in solidified condition.

Ceramic material in the form of carbides may decompose at higher temperatures or change over into other carbides of different geometrical shape. If the hard particles 9 of the wear resistant structure 6 are formed by carbides, the run-in coating 7 is expediently formed in such a way that the wear resistant structure 6 is not heated beyond the decomposition temperature of the carbides. The same, of course, applies to the application of the wear resistant structure 6 to the base body 5. This is expediently achieved in such a manner that the heat transfer to the surface to be coated and to the coating material supplied to the latter is controlled in such a way that only the coating material is fused completely, while the material underneath thereof remains in solidified condition, a process that, in accordance with the above explanations, results in a diffusion bond.

Coating may also be effected by spaying, fusing or sintering the coating material onto the base surface.

For applying the wear resistant structure 6 to the base body 5, and likewise of the run-in coating 7 to the wear resistant structure 6, use can expediently be made of a heating arrangement producing a hot spot and being movable relative to the surface to be coated. Such a heating arrangement may expediently be at least one laser gun producing a laser beam and/or at least one induction coil. Alternatively, a so-called plasma transfer arc (PTA) may be used instead of a laser beam. The wear resistant structure and the run-in coating may be applied either in separate operations or in a common operation. At any rate, the two operations may expediently be carried out in the same manner, so that the same equipment, or equipment in the same setup, is used for applying the coat forming the wear resistant structure 6 and for applying the run-in coating 7.

The coat forming the wear resistant structure 6 and/or the run-in coating 7 may, as mentioned earlier herein, either be alloyed to or diffused on their respective supports. For using the alloying method, a melt forming a transition area is produced, which contains constituents of both the receiving layer and the coating applied thereto. To this end, both the material to be applied and the near-surface zone of the support are heated to such a temperature that the material changes over into the liquid phase. When using the diffusion method, only the coating material to be applied is transferred into the liquid phase.

Suitable equipment for such operations is indicated in Figures 4 and 5. In both cases, the wear resistant structure 6 is applied to a base body 5 in the form of a coating, and

the run-in coating 7 is applied to the wear resistant structure 6 in the form of a further coating.

In the embodiment shown in Figure 4, two tandem-arranged energy sources in the form of two tandem-arranged laser guns 16, 17 are provided, each of which produces a laser beam 16a, 17a. Instead of a laser gun provision it is also possible to employ a PTA (plasma transfer arc) burner and/or an induction coil or the like. Associated with each energy transmission beam is a material feeder arrangement 18 or 19, respectively, which comprises a material input 18a, 19a and a material feeder to the energy transmission beam indicated as material transmission beams 18b, 19b.

The coating material may be fed to the surface to be coated in the form of a round or cornered wire, a strip or in the form of powder. In the example shown, use is made of a powdered material. In this case, the feed arrangements 18, 19 are supplied with suitable powdered material via the inputs 18a, 19a and effect a flow of powdered material 18b, 19b. To protect such material from oxidation, the material flow should expediently lead through an inert gas atmosphere.

The energy transmission beam 16a and 17a, respectively, in the example shown in the form of a laser beam, produces a hot spot on the support to be coated, with the associated material transmission beam 18b, 19b being directed in such a manner that the coating material is directly fed to the hot spot or an area immediately neighboring the same. In the former case, the material supplied is hit by the energy transmission beam and will therefore be applied to the associated support in a fused condition whereby the said support is also heated up by the residual energy. If a boundary layer 15 formed by an alloy is desirable, the energy source 16 or 17, respectively, is adjusted in such a way that the energy supplied is sufficient to fuse both the coating material and a near-surface zone of the support. If, on the other hand, the intermediate layer 15 is to be merely in the form of a diffusion zone the energy source 16 or 17, respectively, is adjusted in such a way that only the coating material is fused, while the associated support remains in a solidified condition. When a laser gun is used, the amount of energy supplies can be controlled in a simple manner.

The energy sources 16, 17 shown in Figure 4, with associated material transmission arrangements 18, 19 are positioned in tandem, with a certain distance between them. This distance may be selected so as to ensure that the wear resistant structure 6 has already completely solidified before the run-in coating 7 is applied, or that the wear

resistant structure 6 has not yet solidified at least at the top surface when the run-in coating 7 is applied.

In the example shown, a wear resistant structure 6 composed of a nickel alloy with embedded ceramic particles attached to a ferrous metal base body 5 and a run-in coating 7 made of a copper and tin containing bronze material, both the wear resistant structure 6 and the run-in coating 7 are bonded with their respective support material by diffusion. The above-mentioned distance between the energy transmission arrangements 16, 17 is selected such that the initially applied wear resistant structure 6 has completely solidified before the run-in coating 7 is applied. The transmission of energy is in this case, as has already been mentioned earlier herein, controlled in such a way that only the material to be applied is fused, while the support material underneath remains in a solid state.

In Figure 4 a third energy transmission beam is indicated by the reference numeral 20, which is arranged behind the energy transmission beam 17a. This energy transmission beam 20 transmits only so much energy that the surface of the run-in coating 7 is smoothed and levelled, in order to make it suitable for the run-in process. Instead of the use of a separate energy transmission beam 20 for such a smoothing and levelling operation it would also be conceivable to obtain the smoothing effect after the coating operation with the aid of the energy transmission beam 16a and/or 17a without feeding any coating material.

In the example shown, the energy sources 16, 17, as well as the material feed arrangements 18, 19 associated with them, and the energy source producing the subsequent energy transmission beam 20, are designed as stationary units. Accordingly, the base body 5 is moved in the direction of the arrow v for obtaining the desired coating operation. However, it would also be conceivable to arrange the base body 5 as a stationary element and move the coating arrangement. In such a case, all energy producing units with associated material feeder units, if any, may be combined to a coating head forming a jointly movable assembly.

In the embodiment shown in Figure 5, provision is made for only one energy source 21 in the form of a laser gun, which produces an energy transmission beam 21a. Fed thereto are two material beams for carrying out a first coating operation for obtaining the wear resistant structure 6, and a second coating operation for obtaining the run-in coating 7. To this end, provision may be made for two material feeder arrangements. In the example shown, only one material feeder arrangement 22 is provided which is of

the two-channel type. Accordingly, such material feeder arrangement 22 has two material inputs 22a and 22a' for the material forming the wear resistant structure 6 and the material forming the run-in coating 7, respectively. The material feeder arrangement 22 thus also produces two material feeder beams 22b and 22b', which are arranged one behind the other, for supplying the material for the wear resistant structure 6 and the run-in coating 7, respectively.

Such material feeder beams 22b, 22b' are positioned in such a way that the material feeder beam 22b forming the wear resistant structure 6 impinges on the not yet coated surface of the base body 5, and subsequently the feeder beam 22b' forming the run-in coating 7 impinges on the top side of the wear resistant structure 6 previously produced by the beam 22b. The distance between the beams 22b and 22b' may in the case under consideration be so small that the already applied coating which forms the wear resistant structure 6 can still dissipate sufficient energy to fuse the material applied for forming the run-in coating 7.

For obtaining a surface that is well suitable for the run-in process, a subsequently arranged energy transmission beam 20 may be used in the same manner as in the embodiment in accordance with Figure 4. The same applies to the provision of a combined coating assembly and to the movement of the base member 5 or the coating head, respectively.

PATENT CLAIMS

1. A machine part belonging to a pair of mechanical members in sliding contact with each other, composed of two mutually movable machine parts of a heavy internal combustion engine and, at least in the area of the side facing the mating machine part, being of a wear resistant structure (6) comprising particles (9) embedded in a metallic matrix (8), such particles consisting of a comparatively hard material and having a rough and uneven surface, and being designed as a piston ring (4) or a cylinder liner (1) or a piston (2) having at least one piston ring groove (3), or as any other sliding element of a heavy engine, **characterized in that** the wear resistant structure (6) is coated with a run-in coating (7) which levels out such unevenness and roughness of the said wear resistant structure, such coating consisting of a run-in material suitable for wearing off during a run-in process and being different from the material of the wear resistant structure (6) underneath and metallurgically bonded thereto, and further being softer than the said wear resistant structure (6) and at most being of the same degree of wear resistance as the sliding surface of the opposite machine part.
2. A machine part as claimed in claim 1, **characterized in that** the run-in coating (7) possesses a hardness of between DPH 100 and 200.
3. A machine part in accordance with any of the preceding claims, **characterized in that** the material forming the run-in coating (7) has a melting point of max. 1050 degrees centigrade.
4. A machine part as claimed in claim 3, **characterized in that** the material forming the run-in coating (7) has a melting point of between 600 and 800 degrees centigrade.
5. A machine part in accordance with any of the preceding claims, **characterized in that** the run-in coating (7), when new, has an average thickness of 50 to 300 microns (μm).
6. A machine part in accordance with any of the preceding claims, **characterized in that** the run-in coating (7), when new, has a surface roughness of between 1 and 20 Ra.

7. A machine part in accordance with any of the preceding claims, **characterized in that** the run-in material of the run-in coating (7) comprises embedded particles (14) consisting of a material of greater hardness.
8. A machine part as claimed in claim 7, **characterized in that** the embedded particles (14) consist of a ceramic material.
9. A machine part as claimed in claim 8, **characterized in that** the embedded particles (14) consist of Al_2O_3 and/or CrO and/or Cr_3C_2 .
10. A machine part in accordance with any of the preceding claims 7 to 9, **characterized in that** the proportion of the embedded particles (14) in the total volume of the run-in coating (7) is between 5 and 30 percent by volume.
11. A machine part in accordance with any of the preceding claims, **characterized in that** the run-in material forming the base of the run-in coating (7) contains at least copper and/or tin.
12. A machine part as claimed in claim 11, **characterized in that** the run-in material forming the base of the run-in coating (7) is a bronze material composed of 70 percent of Cu and 30 percent of Sn.
13. A machine part as claimed in claim 11, **characterized in that** the run-in material of the run-in coating (7) is babbitt metal which contains antimony (Sb) in addition to copper and tin.
14. A machine part in accordance with any of the preceding claims, **characterized in that** the wear resistant structure (6) receiving the run-in coating (7) contains a Ni alloy as a matrix (8) in which the particles (9) of a ceramic material are embedded.
15. A machine part in accordance with any of the preceding claims, **characterized in that** the wear resistant structure (6) receiving the run-in coating (7) is formed as a coating on a metallic base body (5) preferably consisting of a ferrous material.

16. A machine part as claimed in claim 14 or 15, **characterized in that** the Ni alloy forming the matrix (8) contains between 1 and 15 percent by volume of P, between 1 and 6 percent by volume of Si and the rest Ni.
17. A machine part as claimed in claim 16, **characterized in that** the Ni alloy forming the matrix (8) contains 3.65 percent by volume of P, 2.15 percent by volume of Si and the rest Ni.
18. A machine part in accordance with any of the preceding claims, **characterized in that** the proportion by volume of the ceramic particles (9) in the total volume of the wear resistant structure (6) receiving the run-in coating (7) is higher than 60 percent by volume, preferably up to 85 percent by volume, or 85 percent by volume.
19. A machine part in accordance with any of the preceding claims, **characterized in that** the ceramic particles (9) of the wear resistant structure (6) at least partially consist of tungsten carbide (WC) and possess a hardness of between DPH 3000 and 5000.
20. A machine part in accordance with any of the preceding claims, **characterized in that** the preferably ceramic particles (9) of the wear resistant structure (6) are of spherical configuration and have a diameter of preferably 40 to 160 microns (μm).
21. A machine part in accordance with any of claims 7 to 20, **characterized in that** the preferably ceramic particles (14) embedded in the run-in coating (7) are of spherical configuration and preferably have a diameter of 20 to 50 microns (μm).
22. A machine part as claimed in claim 1, **characterized in that** such machine part belongs to a pair of mechanical members in sliding contact with each other arranged in a heavy two stroke cycle diesel engine.
23. A machine part as claimed in claim 22, **characterized in that** such machine part is designed as a piston ring (4).
24. A machine part as claimed in claim 22, **characterized in that** such machine part is designed as a cylinder liner (1).

25. A machine part as claimed in claim 22, **characterized in that** such machine part is designed as piston (2) comprising at least one piston ring groove (3).
26. A process for the manufacture of a machine part in accordance with at least one of the preceding claims, **characterized in that** the machine part having a wear resistant structure (6) is coated with a run-in coating (7) covering the said wear resistant structure (6), with the amount of energy supplied in the coating process being such that a metallurgical bond of the run-in coating (7) with the wear resistant structure (6) is obtained.
27. A process as claimed in claim 26, **characterized in that** the run-in coating (7) is alloyed onto the wear resistant structure (6).
28. A process as claimed in claim 27, **characterized in that** the run-in coating (7) is diffused onto the wear resistant structure (6), with only so much energy being supplied in the coating process that merely the run-in material forming the basis of the run-in coating (7) is fused, while the material of the wear resistant structure (6) underneath remains in solidified condition.
29. A process in accordance with any of the preceding claims 26 to 28, **characterized in that** the run-in coating (7) is sprayed onto the wear resistant structure (6).
30. A process in accordance with any of the preceding claims 26 to 28, **characterized in that** the run-in coating (7) is fused onto the wear resistant structure (6).
31. A process in accordance with any of the preceding claims 26 to 30, **characterized in that** for coating the wear resistant structure (6) with the run-in coating (7) a heating unit (17; 21) is used which is movable relative to the wear resistant structure (6) and produces a hot spot on the latter, and that the material forming the run-in coating (7) is fed into such hot spot or an area directly neighboring the latter.
32. A process as claimed in claim 31, **characterized in that** a laser gun or a PTA burner is used for producing the hot spot.

33. A process as claimed in claim 31 or 32, **characterized in that** the material constituting the run-in coating (7) is fed to the hot spot in the form of powder, of a wire or a strip.
34. A process in accordance with any of the preceding claims 26 to 33, **characterized in that** in the case of a wear resistant structure (6) designed as a coat on a base body (5), the said wear resistant structure and the run-in coating (7) received thereon are applied to their respective supports in the same manner.
35. A process as claimed in claim 34, **characterized in that** the wear resistant structure (6) and the run-in coating (7) are produced in a single operation.