

Weapon and cooling system for a weapon

The present invention relates to a cooling system for a weapon with a fastening end which can be coupled to a weapon component in the cartridge chamber region of a weapon barrel or weapon tube, and a weapon.

Specifications such as: in front, at the back, above, left, and right, relate to a weapon that is held in the firing position by a rifleman and are specified with respect to this view.

The notion barrel as well as weapon barrel does not only comprise barrels with grooves and lands in the following, but also smooth weapon tubes.

In the case of assault rifles the barrel is usually fixed by means of a generally as a union nut designed barrel nut to a housing component, in the breech housing itself, or to a so-called locking member. Such a barrel nut is, for example, known from DE 1 129 401. In the case of automatic weapons the barrel heats up considerably, in particular, during firing rounds. For higher firing frequency this high thermal load leads to that, in particular, the cartridge chamber and the barrel itself are heated very considerably. Because of this the geometry of the barrel changes; it expands in the longitudinal and the transverse direction. Hot components also deteriorate also the handling and functioning of the weapon. It can even lead to the so-called "cooking off" of the ammunition. The cartridges that are in the cartridge chamber are thereby supplied with so much energy that the propelling charge ignites in an uncontrolled manner and shots are fired unintentionally.

One part of this problem is, for example, solved by that a metal sleeve is provided that surrounds the barrel and which is approximately fastened in the region of the cartridge chamber and on the side of the muzzle

- e.g., on the holder of the front sight. Such a sleeve shields the surrounding hand guard from the heat emitted by the barrel. In addition, an air chamber between the sleeve and the weapon barrel insulates the sleeve itself from the heat that is emitted by the barrel. Openings arranged in the sleeve and, if necessary, in the hand guard can produce a convective heat exchange that leads to additional cooling off. Such an arrangement is also known from DE 1 129 401. Since the sleeve, however, is supported on the barrel nut and on the front sight holder, and thereby the barrel itself, the thermal changes of the barrel and the sleeve can have an effect on each other in such a way that the precision of the weapon suffers from it. The heat introduced into the cartridge chamber is here to a large extent only carried off via the barrel itself as well as via the ejected empty cartridges.

From FR 2 547 040 A1 an insulation sleeve that surrounds the barrel is known that can be coupled to a fastening end either in the weapon housing or on the outside of the barrel and that, progressing in the direction of the barrel muzzle, forms a contactless heat insulating sleeve. The barrel fastening in the weapon housing takes place independently from the insulation sleeve.

The task of the present invention consists in guaranteeing a heat shielding that can be coupled to the weapon, without deteriorating the shooting accuracy, and that at the same time contributes to the barrel fastening.

This task is solved by the cooling system according to claim 1. In addition, at the fastening end of the cooling system a heat insulating sleeve, extending in the direction of the barrel as well as the sleeve muzzle, starts, which surrounds the barrel without touching, so that between the weapon barrel and the heat insulating sleeve an empty space is formed on the side of the muzzle. The barrel extends thus freely straight through the heat insulating sleeve. As a result, the geometrical changes of the barrel as well as changes between the barrel and the heat insulating sleeve have no effect on the shooting accuracy. Because the empty space is, on the side of the muzzle,

constructed open, an air exchange can take place in the empty space and a convective cooling of the barrel and the heat insulating sleeve is favored. At the same time, the heat insulating sleeve shields the barrel and prevents an excessive heat load of a hand guard that surrounds the heat insulating sleeve and barrel. The fastening end of the cooling system is designed as barrel nut and connects the barrel with the weapon or with a weapon housing component, e.g., a locking member. The cooling system guides heat from the cartridge chamber via the barrel nut to the outside and via the heat insulating sleeve to the front in the direction of the muzzle.

The further development according to claim 2 guarantees a radially symmetrical shielding and heat removal. In this way it is prevented that, for example, one sector of the weapon barrel is cooled more or heated more than another, so that a distortion caused by local heat differences in the sleeve can be avoided to a large extent.

The further development according to claim 3 produces the heat removal from the cooling system itself and thus also from the region of the cartridge chamber. An embodiment with different materials can take into account different requirements on the firmness as well as the heat conductivity. Thus, the fastening end of the cooling system is a mechanically loaded component, whereas in certain embodiments the heat insulating sleeve takes over first of all thermal functions (shielding, abducting). For weight reasons, the heat insulating sleeve can be made also, for example, from a lighter material than the fastening of the cooling system, which, e.g., is made from steel (claim 4). According to claim 5, the cooling system can also be designed in one piece with the heat insulating sleeve, either by mechanical or other suitable treatment of a corresponding semi-finished product (e.g., a sleeve) or also by welding the heat insulating sleeve and fastening end, and a subsequent processing of the complete cooling system.

The according to claim 6 provided openings in the heat insulating sleeve can increase and improve the convection in the empty space between the heat insulating sleeve and the weapon barrel. In order to improve the heat emission of the heat insulating sleeve, its surface can, according to claim 7, be increased by appropriate elements. To these belong, in particular, longitudinal ribs, ring-shaped ribs, pegs, knurlings, and/or other suitable surface structurings. In the further development according to claim 8 also advantageous coatings can be provided. Thus, e.g., the outer surface can be blackened in order to increase the heat emission and the inside surface of the heat insulating sleeve can, for example, be provided with a reflecting coating in order to reduce the heat input of the heat radiation that is emitted by the tube (claim 9). In this way, for example, the heat removal from the region of the cartridge chamber via the fastening end and the heat insulating sleeve can be increased, whereas the heat removal from the sleeve itself takes place to a large extent via the air layer that progresses and, if necessary, flows between the heat insulating sleeve and tube.

Claims 10-11 concern preferred geometrical properties of the heat insulating sleeve with respect to the barrel.

Claims 12-15 concern weapons with a cooling system according to the invention in which advantageous interfaces between the cooling system and other components of the corresponding weapon are chosen. Thus, according to claim 13 the heat insulating sleeve can be surrounded by a hand guard, whereby for a weapon according to claim 14 an insulation layer can be provided between the outside of the heat insulating sleeve and a hand guard. This insulation layer can be constructed from an air cover and/or an air layer; however, it can also be provided as an insulation layer from a suitable insulating material. Advantageously designed contact surfaces can be constructed in the heat transfer region between the weapon barrel and the weapon component that accommodates the weapon barrel as well as in the heat transfer region between

the weapon component and the cooling system. These promote the heat transfer between the respective components (claim 15).

According to claim 16 thereby spline profiles that correspond to each other are constructed on the weapon barrel and the accommodating weapon component, which each, thermally conducting, mutually touch each other at their flanks and/or front surfaces. Appropriate, to each other corresponding, threaded surfaces are provided between the weapon component and the barrel nut.

In the following an embodiment example of the present invention is described with the aid of drawings, in which

- Fig. 1 shows a longitudinal section through a front weapon section with a cooling system according to the invention,
- Fig. 2 shows a measurement report of the temperature variation for different barrel nut variants at a measurement location that lies in the region of the fastening end,
- Fig. 3 shows the temperature variation for the barrel nut variants from fig. 2 at a measurement location that lies in the vicinity of the heat insulating sleeve end (on the side of the muzzle).
- Fig. 4 shows a longitudinal section (similar to that of fig. 1) through a front weapon section with an alternative cooling system according to the invention, and
- Fig. 5 shows a longitudinal section through a front weapon section with another cooling system.

Fig. 1 shows the front side of a weapon 1, in which the barrel 2 is fixed by means of a cooling system 4 in the locking member 6.

The locking member 6 is thereby shaped in a synthetic material housing 8 and provided with ribs for better anchoring. At the front end of the barrel 2 a muzzle flash damper 12 and a gas remover 14 are provided, from which a gas operated loading mechanism 16 starts in order to actuate the, not represented, breech.

The barrel 2 sticks with its cartridge chamber end 18 in the locking member 6, the correct angular position of the barrel is guaranteed by a double deadbolt lock 20. The barrel 2 is axially fixed by means of an external collar 22, on which a corresponding internal collar 24 of the fastening end 26 of the cooling system 4 rests, against a corresponding front surface of the locking member 6. The fastening end 26 is thereby by means of a thread 28 screwed onto the locking member 6. And in fact so far, until the barrel 2 is clamped with its external collar 22 in between the locking member 6 and the internal collar 24 of the fastening end 26 of the barrel nut 4.

A tube shaped sleeve structure, the so-called heat insulating sleeve 30, extends from the front end of the fastening end 26 of the barrel nut 4.

The heat insulating sleeve 30 surrounds the barrel 4 at such a distance that around the heat insulating sleeve 30 a hand guard (not shown) can be arranged that still has an easy to handle outer diameter. The distance can be 2-10 mm for a caliber of 5.56 mm and an outer barrel diameter of ca. 16-18. As a result an empty space 36, that surrounds the barrel 2 in the shape of a cuff, extends between the inside 32 of the heat insulating sleeve 30 and the outside 34 of the barrel 2. This empty space 36 that is open in the front allows the exchange of the air in it with the environment. This air exchange can be increased by additional, not represented, openings in the heat insulating sleeve 30. If these openings are, for example, arranged in the transition region between the heat insulating sleeve and

the fastening 26, then as a result the air circulation and/or convection can take place throughout the whole empty space 36 at the inside 32 of the heat insulating sleeve 30 and along the outside 34 of the barrel 2.

The outside 38 of the heat insulating sleeve 30 can be provided with elements that increase the surface area in order to improve the heat emission. This can be (not represented) longitudinal ribs, ring-shaped ribs, knurling structures, knurls and/or other suitable surface structurings. There are also embodiments in which the outside and/or inside 38, 32 of the heat insulating sleeve 30 is coated in order to improve the thermal properties. In one embodiment the inside 32 is for this provided with a reflecting coating and/or the outside is provided with a heat emission increasing coating. In this context also suitable surface processing methods, which lead to similar results, are considered. For example, polishing, grinding, sand blasting, or similar methods.

The heat insulating sleeve 30 is designed thinner than the fastening end 26 in the represented embodiment example. A wall thickness of 0.5 to 4 mm in cooperation with the specified sleeve distance has proven to be effective for the barrel in the embodiment example. A wall thickness of about 1-2 mm is particularly favorable.

The fastening end 26 and the heat insulating sleeve 30 form here integrally the cooling system 4. It is made from a steel material that is suited to accommodate the high required mechanical stress for the fastening of the barrel. In other embodiments the heat insulating sleeve 30 is made from another material (e.g., a metal material with other thermal properties); both the heat insulating sleeve 30 and the fastening end 26 components can then, for example, be welded together. However, also other materials such as, e.g., aluminum,

copper, or titanium can be used for the heat insulating sleeve 30, which then is attached to the fastening 26 in another appropriate manner (screwing, shrinking, sintering, or the like).

In addition, in a weapon 1 that is provided with a cooling system 4 according to the invention, a hand guard (not represented) is provided around the heat insulating sleeve 30 that in addition protects the rifleman against burns. The hand guard can be fastened, for example, by means of suitable devices on the heat insulating sleeve 30 itself, without that the forces that act on the hand guard can deteriorate the shooting accuracy. In addition, an additional insulation layer can be also provided between such a hand guard and the heat insulating sleeve 30. This layer can consist of an air layer or an additional insulation layer of a suitable material.

In order to remove the heat from the cartridge chamber end 18 of the barrel 2 very effectively - the heat input is here very high due to the charge ignition - contact surfaces that promote the heat transfer can be constructed that, in the present embodiment example, are designed as spline profiles 40 that rest against each other at their front and/or side surfaces. Between the locking member 6 and the barrel nut 4 also a large heat transfer surface, in the form of the threading 28, is available. There are also embodiments in which the thermal conductivity as well as the heat transfer between these elements is improved by means of additional measures (thermally conducting pastes or the like).

The effectiveness in connection with the preceding embodiment example described measures was determined on the basis of test series whose results are summarized in fig. 1 and 3. Hereto a temperature sensor was placed on the outside of the housing at the location that is denoted by MS1 in fig. 1 and an additional one was arranged in the front region of a hand guard that surrounds the heat insulating sleeve 30

(in fig. 1 denoted by MS2). The curves show the temperature variation for different configurations of the cooling system 4:

- (1) concerns an arrangement 4 without heat insulating sleeve 30. It consists in practice only of the fastening end 26 that is constructed as a barrel nut.
- (2) concerns a cooling system 4 in which the fastening end 26 consists of steel and the heat insulating sleeve 30 of a 3 mm thick aluminum sleeve that is screwed onto the fastening end 26.
- (3) concerns a cooling system 4 in which the fastening end 26 and the heat insulating sleeve 30 are fabricated from steel, the heat insulating sleeve 30 has thereby a wall thickness of 3 mm.
- (4) concerns a cooling system 4 in which the fastening end 26 and the heat insulating sleeve 30 are fabricated from steel, the heat insulating sleeve 30 has thereby a wall thickness of 1.5 mm.
- (5) concerns a cooling system 4 in which the fastening end 26 and the heat insulating sleeve 30 are manufactured from steel. The heat insulating sleeve 30 has a wall thickness of 3 mm and is on the outside provided with a 0.5 mm thick ceramic coating.
- (6) concerns a cooling system 4 that is completely manufactured from titanium, whereby the heat insulating sleeve 30 has a wall thickness of 3 mm.

In the measurement series always eight magazines with NATO standard ammunition of caliber 5.56 (ca. 240 rounds) were fired at room temperature in a time span of approximately 60-80 sec.

The temperature variation in time were thereby recorded for booth measurement locations MS1 and MS2. In particular, it turned out that, for the measurement location MS1 arranged in the region of the fastening end 26 of the barrel nut 4, the embodiment (4) exhibits in this region a considerably better (smaller) temperature variation than the comparison embodiment without heat insulating sleeve. The result shows that the "boiling effect" mentioned in the above can be reduced strongly by a cooling system 4 with heat insulating sleeve 30 according to the invention.

The temperature variations at the measurement location 2 also show the favorable effect of the embodiment (4), whereby here a very favorable effect of the thin wall embodiment (1.5 mm) with respect to the other embodiments was observed.

Fig. 4 shows an embodiment example of the cooling system 4 in which the thermal coupling to the cartridge chamber end 18 takes place by means of a thermally conducting housing 8'.

The barrel 2 sticks with its cartridge chamber 18 into a locking member 6 that is arranged in the housing 8' in the embodiment according to fig. 4. The barrel 2 and the locking member 6 are fastened in the housing 8' by means of an internal collar 24 to the fastening 26 that engages an external collar 22 of the barrel 2. A thread 28 on the fastening end 26 is thereby screwed onto a corresponding coupling support on the housing 8'. The heat transfer in the cooling system 4 takes place from the inside to the outside radially, through the cartridge chamber end 18' via the locking member 6, through the housing 8' in the fastening end 26 of the cooling system 4, from where the heat is carried off axially towards the front by the heat insulating sleeve 30.

The thermal coupling and the barrel fastening are functionally separated in the embodiment realization represented in fig. 5. The cartridge chamber 18 of the barrel 2 is here fastened by means of a barrel nut 40 in the housing 8'. In this embodiment a

locking end 6' is constructed integrally on the cartridge chamber end 18 of the barrel 2. The cooling system is fastened by means of a fastening end 26' to a connection support that is constructed in the housing 8'. The heat current flows here starting from the cartridge chamber end 18 radially outwards in the housing 8', axially towards the back through the housing 8' and axially towards the front in the connection support, and from there radially outwards via the thread 28 in the fastening end 26 of the cooling system 4, and from there further axially towards the front in the heat insulating sleeve 30.

The cooling system 4 is provided with multiple, with respect to each other concentrically arranged, heat insulating sleeves 30 in an additional (not represented) embodiment. The heat insulating sleeves 30 in such an embodiment start from the fastening 26 and progress in the direction of the barrel towards the front. Between the individual heat insulating sleeves intermediate spaces extend which are filled with air or also can accommodate insulation layers. The individual sleeves can be provided, in particular in the connection region on the fastening end 26, with radial openings in order to improve the convection in the air-filled intermediate spaces between the individual heat insulating sleeves 30. The heat insulating sleeves 30 can be connected to each other at the front end by means of ridges as well as spacers for stabilization. Such a cooling system 4 improves the shielding of a hand guard that surrounds the outermost heat insulating sleeve 30 against the heat emitted by the barrel 2. At the same time, multiple heat insulating sleeves improve the heat transport from the cartridge chamber region into the direction of the weapon muzzle, due to the increased thermal conduction.

Additional alternative embodiments and variants follow for the expert from the following patent claims.

Claims

1. Cooling system (4) for a weapon with a fastening end (26) that can be coupled in the cartridge chamber region of a barrel (2) to a weapon component (6, 8'), whereby, starting from the fastening end (26), a heat insulating sleeve (30) progresses in the direction of the barrel muzzle and surrounds, at least partially, the barrel (2) without touching, so that between the barrel (2) and the heat insulating sleeve (30) an open empty space (36) is formed on the side of the muzzle, characterized by that the fastening end (26) is designed as a barrel nut for the connection of the barrel (2) with the weapon component (6, 8').
2. Cooling system (4) according to claim 1, in which the heat insulating sleeve (30) is arranged concentrically with respect to a bore axis of the barrel (2).
3. Cooling system (4) according to claim 1 or 2, in which the fastening end (26) and the heat insulating sleeve (30) are thermally conducting connected to each other.
4. Cooling system (4) according to one of the preceding claims, in which the heat insulating sleeve (30) and the fastening end (26) are manufactured from different materials.
5. Cooling system (4) according to one of the preceding claims, in which the fastening end (26) and heat insulating sleeve (30) are constructed integrally.
6. Cooling system (4) according to one of the preceding claims, in which the heat insulating sleeve (30) comprises openings.
7. Cooling system (4) according to one of the preceding claims, in which the outside (38) of the heat insulating sleeve (30)

is provided with elements that increase the surface, in particular, with longitudinal ribs, ring-shaped ribs, pegs, knurls, and/or surface structurings.

8. Cooling system (4) according to one of the preceding claims, in which the heat insulating sleeve (30) is provided with a coating.
9. Cooling system (4) according to the preceding claim, in which the inside (32) of the heat insulating sleeve is provided with a heat reflecting coating and/or the outside (38) is provided with a coating that increases the heat emission.
10. Cooling system (4) according to one of the preceding claims, in which the distance between the outside (34) of the barrel and the inside (32) of the heat insulating sleeve (30) is 2-10 mm.
11. Cooling system (4) according to one of the preceding claims, in which the wall thickness of the heat insulating sleeve (30) is 0.5-4 mm.
12. Weapon (1) with a cooling system (4) according to one of the preceding claims, which, in particular, comprises a hand guard that surrounds the heat insulating sleeve (30).
13. Weapon (1) according to claim 12, in which an insulation layer is provided between the heat insulating sleeve (30) and the hand guard.
14. Weapon (1) according to claim 12 or 13, in which between the barrel (2) and the weapon component (6, 8'), as well as between the weapon component (6) and the barrel nut (4), always heat transfer promoting contact surfaces (28, 40) are constructed which correspond to each other.

15. Weapon (1) according to claim 14, in which the contact surfaces are formed by, to each other corresponding, spline profiles (40) between the barrel (2) and the weapon component (6, 8'), and/or in which the contact surfaces that are constructed between the cooling system (4) and the weapon component (6, 8') are constructed as, to each other corresponding, threaded surfaces (28).