July 13, 1937. W. BAUMANN 2,086,520

DEVICE FOR COOLING QUICK FIRING ARMS

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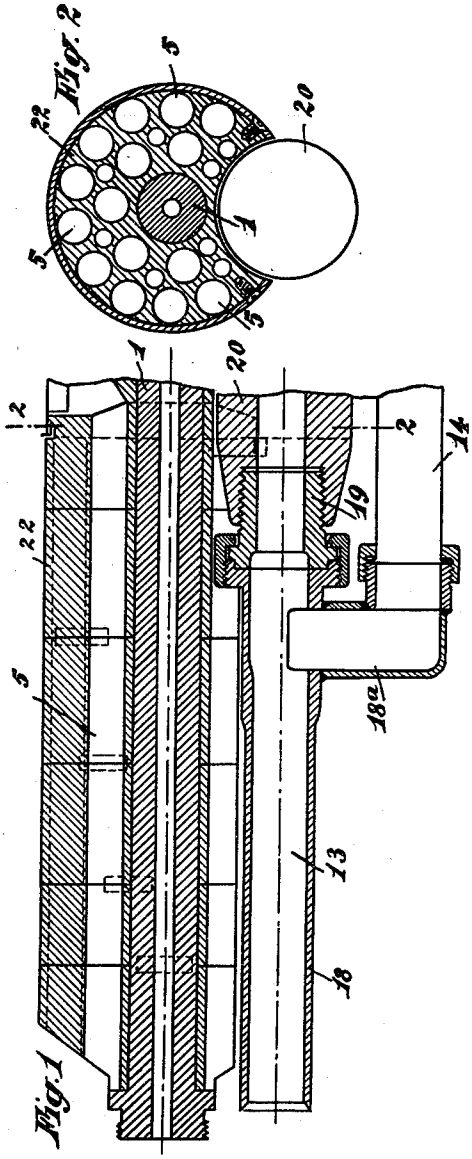

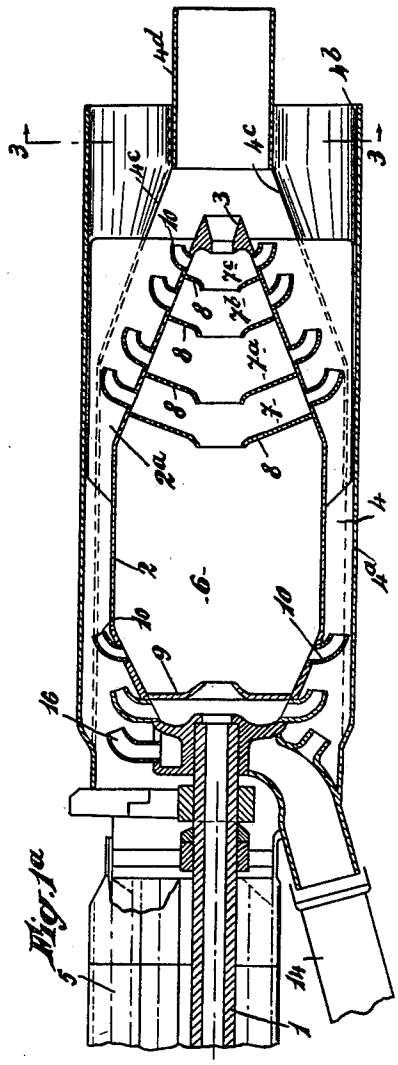

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Fig. 7

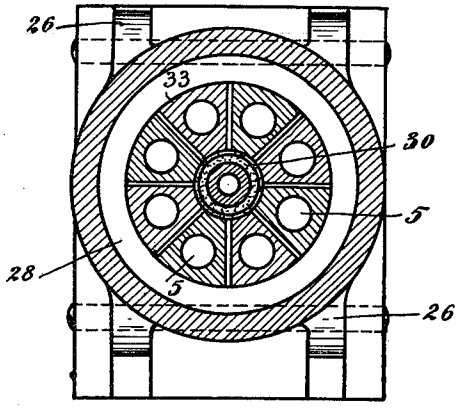


Fig. 8.

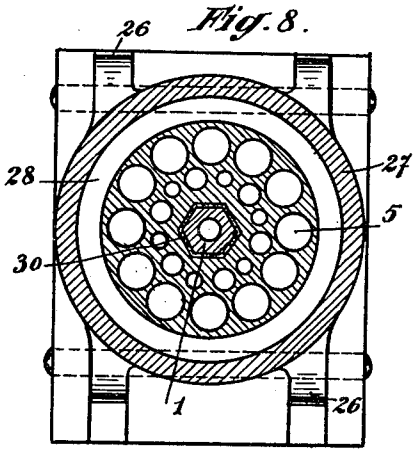


Fig. 3

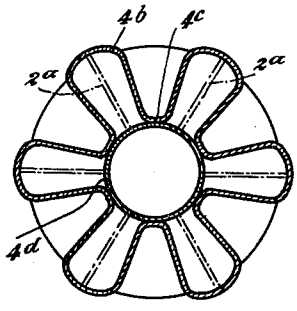
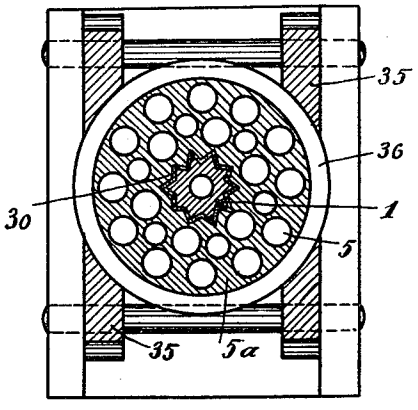


Fig. 9.



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DEVICE FOR COOLING QUICK FIRING ARMS

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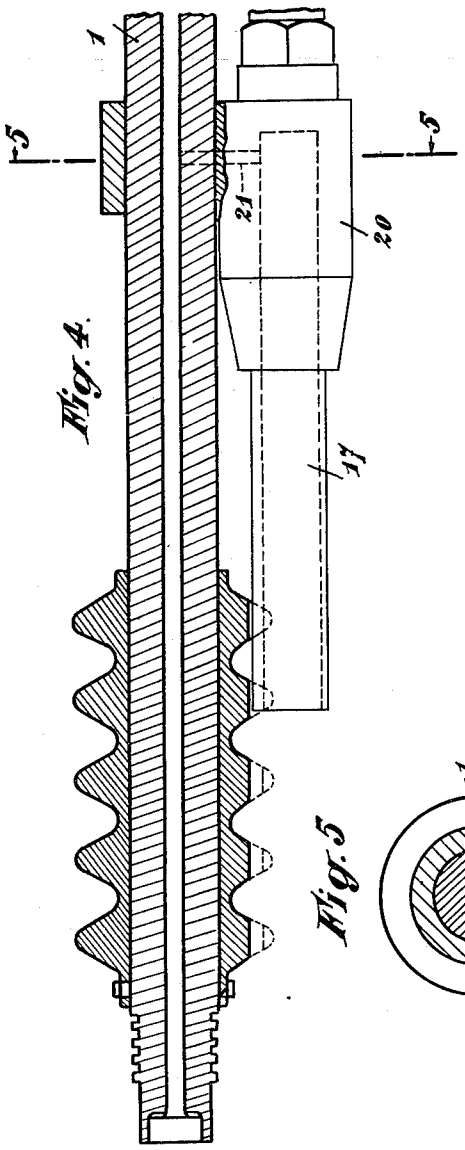

Fig. 4.

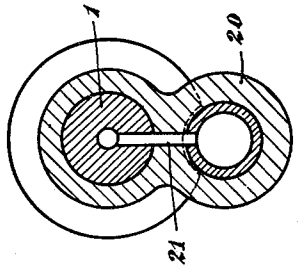

Fig. 5

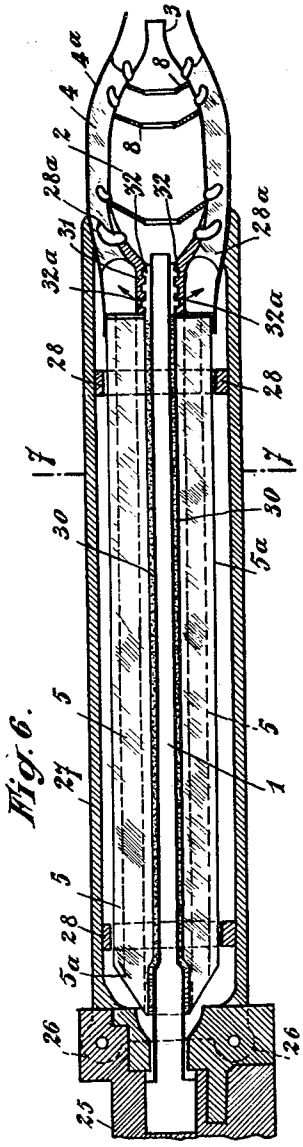

Fig. 6.

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DEVICE FOR COOLING QUICK FIRING ARMS

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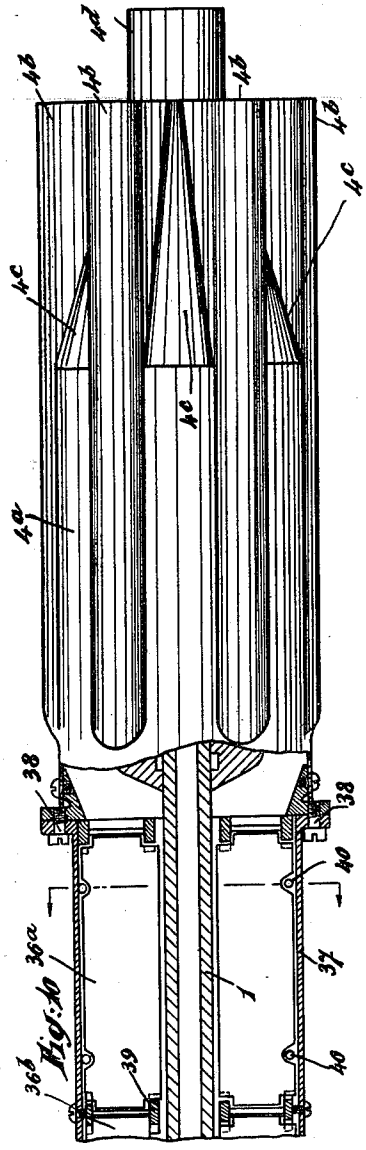

Fig. 10

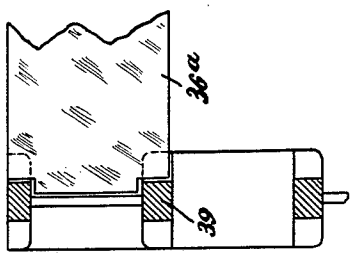

Fig. 12

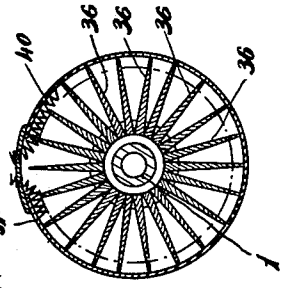

Fig. 11

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UNITED STATES PATENT OFFICE

2,086,520

DEVICE FOR COOLING QUICK FIRING ARMS

Werner Baumann, Paris, France

Application July 17, 1934, Serial No. 735,702
In France July 18, 1933

5 Claims. (Cl. 89—14)

In my U. S. patent application Ser. No. 654,072, of January 28, 1933, I have described a device for cooling quick firing arms, which makes use of the waste energy of the powder gases, owing to a preliminary expansion of these gases in a reservoir located at the front end of the barrel and to the passage of the expanded gases through an ejector, which causes a stream of cooling air to flow through a cooling device disposed around the barrel of the firearm.

The object of the present invention is to provide improvements in the device for cooling quick firing arms of the type above referred to, with a view to increasing the efficiency thereof.

A first improvement according to the present invention consists in fractionating the expansion of the gases prior to their being admitted into the ejector, by causing said gases to pass through several successive expansion chambers, or, which is the equivalent, through a single expansion chamber divided into a plurality of spaces, separated by partitions, through which the gases pass successively. These chambers, or some of them, may be provided with auxiliary ejectors, which serve to improve the stream of cooling air, owing to the provision of several outlets for the expanded gases opening into passages through which cooling air circulates.

Owing to the use of a plurality of ejectors connected with the various expansion chambers through which the gases flow successively, I increase the number of points at which the powder gases act on the cooling air, and therefore I improve the action on said cooling air. The partitions that separate these elementary chambers from one another then act for braking the outflow of the powder gases through the nozzle provided coaxially with the barrel and thus render the maximum portion of the mass of gases available at the desired places. Besides, ejectors may if desired be provided at suitable points of the passages provided about the barrel for the flow of air, gases from the expansion chambers being fed to these local and individual ejectors through suitable conduits.

According to another improvement I provide cooling ribs or fins on the outer walls of the expansion chambers so as to obtain a cooling of these walls through the circulation of air and thus to prevent ignition of the outflowing powder gases. On the other hand I provide corrugations, or projections and hollows, in the sleeve that surrounds the expansion chambers, with a view to creating, under the action of the outflowing gases, a stream of atmospheric air, which mixes with the gaseous mass and cools it.

Other improvements according to the present invention concern the fitting of the cooling device on firearms having a moving barrel. I may for instance fix the expansion chamber, the ejector, and also the set of cooling ribs or fins through which air is caused to flow, to a stationary part of the firearm, for instance the breech, while the axially movable barrel is mounted axially within said set of ribs or fins, with a certain clearance space which permits said barrel to move freely but which can be filled with a matter having a good thermic conductivity, in the form of a powder or of shavings, so as to ensure a thermic connection between the barrel and the cooling fins.

Preferred embodiments of the present invention will be hereinafter described, with reference to the accompanying drawings, given merely by way of example, and in which:

Fig. 1 is an axial sectional view of the portion of the cooling device that is nearer to the breech, said cooling device being shown as applied to a machine gun having a stationary barrel, of the Hotchkiss type;

Fig. 1*a* is a similar view of the portion of the cooling device that is located nearer to the muzzle of the barrel;

Fig. 2 is a partial sectional view on the line 2—2 of Fig. 1;

Fig. 3 is a sectional view on the line 3—3 of Fig. 1*a*;

Fig. 4 is a sectional view, given merely for the sake of comparison, of a portion of an ordinary Hotchkiss machine gun;

Fig. 5 is a sectional view on the line 5—5 of Fig. 4;

Fig. 6 is a sectional view of another embodiment of the invention, as applied to a machine gun in which the barrel has a reciprocating motion;

Fig. 7 is a sectional view, on an enlarged scale, of the structure shown in Fig. 6, on the line 7—7 of Fig. 6;

Figs. 8 and 9 are cross sectional views of modifications;

Fig. 10 is a side view, partly in longitudinal section of another embodiment of the cooling device according to the invention. The tubular piece or sleeve shown in side view on the right of said figure is the same as that shown in cross-section on Fig. 1*a*;

Fig. 11 is a sectional view on the line XI—XI of Fig. 10;

Fig. 12 is a sectional view of a detail of this embodiment.

As shown by Figs. 1 and 1*a*, the powder gases escaping from the muzzle of the barrel 1 of the firearm penetrate into a chamber 2 in which they expand and out of which they issue through an ejector 3 provided at the outlet end of this chamber. The powder gases expand in this chamber 2 so that the flow thereof through ejector 3 is slower than the flow at the muzzle of the barrel. Therefore the gases flowing out through said ejector can cause an efficient stream of air to take place through the annular interval 4 that surrounds chamber 2 and therefore through the passages 5 that surround barrel 1, as it was explained in the prior U. S. patent application above referred to.

According to the present invention, the expansion of the powder gases in chamber 2 is fractionated by dividing said chamber into a plurality of elementary chambers, such as 6, 7, 7^a, 7^b, 7^c, which are separated from one another by partitions 8 provided, in their central part, with a passage for the bullets and for the gases. Chamber 6 itself can be divided into two compartments by a partition 9, which is shown in the drawings, (Fig. 1*a*). The efficacy of the isentropic expansion is increased owing to the fact that said expansion is fractionated successively in chambers 6, 7, 7^a, 7^b, 7^c and owing to the action of partitions 8, which break the jet of powder gases issuing from the barrel, so that, finally, the stream of gases escaping through ejector 3 tends to be continuous, which is particularly advantageous for obtaining an efficient stream of cooling air through the passages 5 that surround the barrel.

The partitions 8 that serve to divide the expansion chamber 2 into a plurality of elementary expansion chambers further serve to prevent a back flow of the gases to the barrel in the time between the shots. As a matter of fact, it is known that, by suitably shaping the orifices through which the gases pass, it is possible to obtain a good coefficient of flow in one direction, say for instance 0.97, and a smaller coefficient in the opposite direction, say for instance 0.55, so that the flow is facilitated in one direction and braked in the opposite direction. From this point of view, the existence, in the vicinity of the muzzle of the barrel, that is to say immediately before chamber 6, which is of relatively large volume, of partition 9, shown in Fig. 1*a*, is important for preventing the backflow of gases from chamber 6 to the barrel.

The various chambers 6, 7, 7^a, etc. will be advantageously provided, on their periphery, with ejectors such as 10, which open into the space 4 and therefore improve the flow of cooling air, since the latter is sucked in at different points of its path by escaping expanded gases.

Partitions 8 then further perform the function of deflecting an important portion of the gaseous mass away from axial ejector 3, directing said mass to the peripheral ejectors 10. Besides it is possible to lead a portion of the gases through suitable passages, from any of the chambers to ejectors disposed at any desired point of passages 5 through which the cooling air flows, so as to improve the driving action exerted on said air at this point, if necessary.

It is important that chamber 6, before which can be eventually provided a small chamber limited by partition 9, should have a volume several times greater than that of the barrel of the firearm, so as to obtain a considerable expansion of the gases in said chamber.

Furthermore, in the embodiment shown by Figs. 1*a* and 3 I provide fins 2^a fixed to the outer wall of chambers 6, 7 and 7^a, which fins are intended to prevent said wall from reaching too high a temperature, which might cause the powder gases to again ignite. These fins 2^a, which are placed in interval 4, are cooled by the stream of air induced by the ejectors.

In order to afford sufficient room for these fins, the tubular piece or sleeve 4^a that surrounds chamber 2 and limits between itself and said chamber the space 4 through which the cooling air flows is given the shape of a cylinder the walls of which are longitudinally corrugated. The ridges 4^a of these corrugations afford room for fins 2^a while, near the end of this cylinder, the grooves 4^c are of progressively increasing depth and are directed along the generatrices of a cone converging toward nozzle 4^d through which the bullets issue (see the sectional views of Figs. 1*a* and 3 and the side view of Fig. 10). These corrugations are freely open at the end of the cylinder so as to permit the passage of the gases escaping from the peripheral ejectors 10 and of the cooling air driven along by said gases. The gaseous jets escaping from these orifices create a draught of the atmospheric air surrounding the device, and this air, flowing along the outer wall of piece 4^a, cools it, after which it also cools the gaseous mass by mixing with it.

In the example shown by Figs. 1 to 5 of the drawings, the gases that act on piston 13 so as to ensure the automatic working of the firearm (machine-guns of the Hotchkiss type, having a stationary barrel) are recuperated after expansion, through a tube 14, so as to cooperate in producing a stream of air through the annular space 4. To this effect, this tube 4 is provided at its end with nozzles 16 opening into space 4. For the sake of simplicity of construction, the ordinary cylinder 17 of piston 13, as shown by Fig. 4, is done away with and replaced by a tube 18 provided with a coupling adapted to screw at 19 on the usual sleeve 20 into which opens the gas outlet 21 communicating with the barrel (Fig. 4). This cylinder 18 carries a bent tube 18*a* through which the exhaust gases are fed to tube 14.

In the embodiment that is shown, the passages 5 are provided in rings 22 which are slipped on the barrel of the firearm, in such manner that the passages in the different rings are disposed in line with one another. These rings may be made of a light alloy which is a good conductor of heat, for instance an alloy of aluminium and silver, containing preferably about 9% of silver. This cooling arrangement may of course be given any other form; it may for instance include fins.

Figs. 6 and 7 concern the application of the cooling device to machine guns in which the barrel moves in a backward direction after each shot. On the breech 25 of the firearm, which is generally of parallelepipedal shape, a tube 27 is fixed by means of fixation members 26. This tube carries, through rings 28, the whole of the cooling conduits 5, expansion chamber 2 with its ejector 3, and box 4^a. Chamber 2 may be divided into a plurality of elementary chambers by means of suitable partitions, as above explained. This chamber 2 is connected to box 4^a through radial fixation members 28^a. The inner diameter of sleeve 5^a in which conduits 5 are provided is chosen sufficiently large for leaving

between the inner face of this sleeve and the movable barrel of the firearm a certain clearance space 30 which permits this barrel to reciprocate freely. This clearance space is filled with powder and shavings of a matter which is a good conductor of heat, for instance iron filings, silver filings, etc.

The end of barrel 1 penetrates into chamber 2 by passing through an annular member 31 forming a prolonged portion of said chamber and provided on its inner surface with circular grooves 32 which act to prevent the powder gases from leaking from chamber 2 into clearance space 30. Besides, losses are reduced owing to the expansion of the gases and to their being caused to flow through the ejectors. The sleeve 5^a that carries conduits 5 may be made of several elements assembled together which have, in section the shape of sectors 33, as shown by Fig. 7. Advantageously, the surface through which heat is interchanged between the barrel and said sleeve is as large as possible and for this purpose the barrel is given a polygonal (Fig. 8) or starlike (Fig. 9) shape, the central bore of the sleeve being given a corresponding shape.

Finally, in the modification of Figs. 10 to 12, which also relates to the case of a firearm having a movable barrel, the cooling of the barrel is obtained through fins 36 disposed between the barrel 1 and a sleeve 37 fixed at 38 to the stationary parts portions of the firearm. These fins are disposed radially with respect to the axis of the barrel and they are divided, in the longitudinal direction into a plurality of groups 36^a, 36^b disposed in line with one another. They are maintained in position in the sleeve by rings 39 provided with radial grooves into which the ends of the fins engage with a certain play. Springs 40, disposed around the fins and fixed to sleeve 37, push the fins toward the centre so that they are strongly applied against the outer surface of the barrel.

The whole of the expansion chambers, the tubular piece or sleeve 4^a and the ejectors is fixed to sleeve 37 through screws 38, or any other simple means of fixation. The sleeve 4^a is provided with corrugations freely open at the end of the sleeve, as in Fig. 1*a*.

While I have, in the above description disclosed what I deem to be practical and efficient embodiments of the present invention, it should be well understood that I do not wish to be limited thereto as there might be changes made in the arrangement, disposition, and form of the parts without departing from the principle of the present invention as comprehended within the scope of the appended claims.

What I claim is:

1. A device for cooling the barrel of a quick firing arm having at least one barrel, which comprises, in combination, a plurality of walls forming chambers connected in series with the end of said barrel for allowing the powder gases issuing therefrom to expand successively through said chambers down to a pressure higher than atmospheric pressure, a wall of each chamber being provided with a restricted opening constituting a discharge passage through the chamber to keep the pressure in said chambers above atmospheric pressure for a predetermined time after the passage of a projectile through said barrel, air conveying means opening at the rear into the atmosphere for leading air along said barrel, a sleeve surrounding said chambers connected at the rear to said air conveying means and opening in the front into the atmosphere, forming an annular space between said sleeve and the outer wall of said chambers, and at least one outlet jet means connected with at least one of said chambers and opening frontwardly into said annular space between said sleeve and the outer wall of said chambers, to induce a flow of cooling air into said annular space and said conveying means.

2. A device for cooling the barrel of a quick firing arm having at least one barrel, which comprises, in combination, a plurality of walls forming chambers connected in series with the end of said barrel for allowing the powder gases issuing therefrom to expand successively through said chambers down to a pressure higher than atmospheric pressure, a wall of each chamber being provided with a restricted opening constituting a discharge passage through the chamber to keep the pressure in said chambers above atmospheric pressure for a predetermined time after the passage of a projectile through said barrel, air conveying means opening at the rear into the atmosphere for leading air along said barrel, a sleeve surrounding said chambers connected at the rear to said air conveying means and opening at the front into the atmosphere, forming an annular space between said sleeve and the outer wall of said chambers, and a plurality of peripheral ejectors connected with at least several of said chambers and opening frontwardly into the annular space between said sleeve and the outer wall of said chambers, to induce a flow of cooling air into said annular space and said conveying means.

3. A cooling device according to claim 1 further including cooling fins carried by the outer wall of said chambers and extending in said annular space.

4. A cooling device according to claim 1 in which said sleeve is provided with at least one longitudinal corrugation in register with said jet.

5. A cooling device according to claim 2 further including cooling fins carried by the outer wall of said chambers and in which said sleeve is provided with longitudinal corrugations corresponding with said fins.

WERNER BAUMANN.