Sept 17, 1957 W. P. PURCELLA ET AL 2,806,409

COOLING MECHANISM FOR MACHINE GUNS AND THE LIKE

Filed May 29, 1951 2 Sheets-Sheet 1

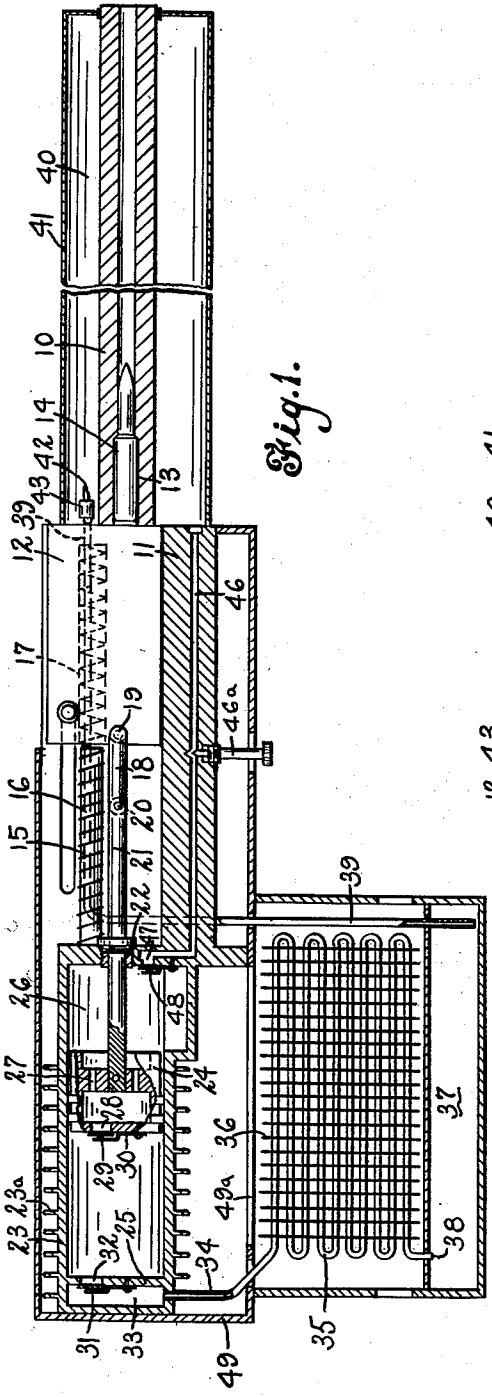


Fig. 1.

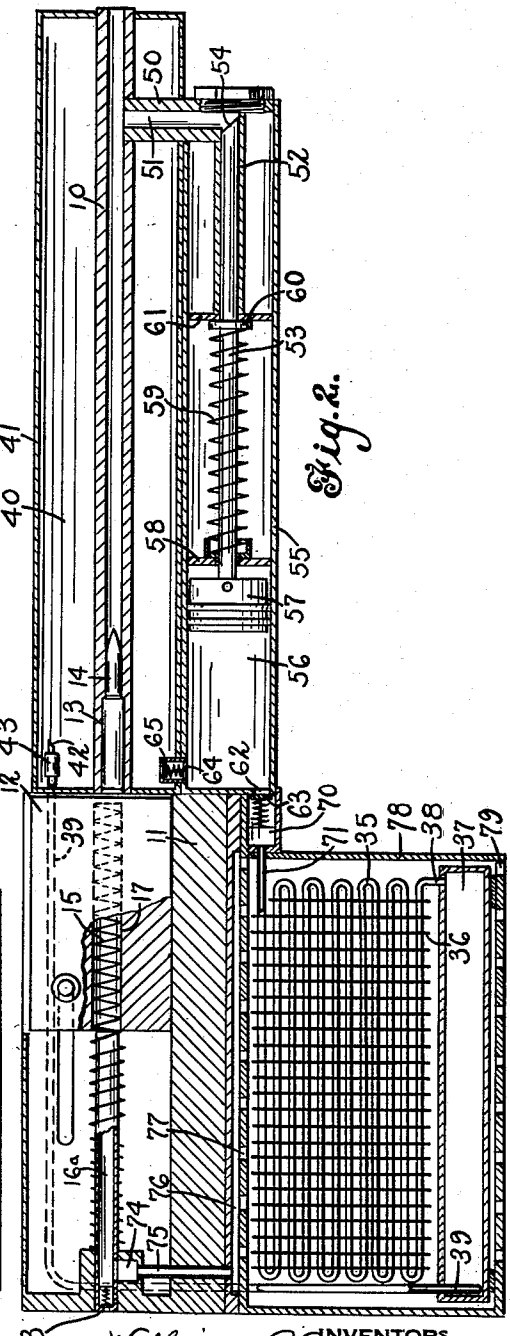


Fig. 2.

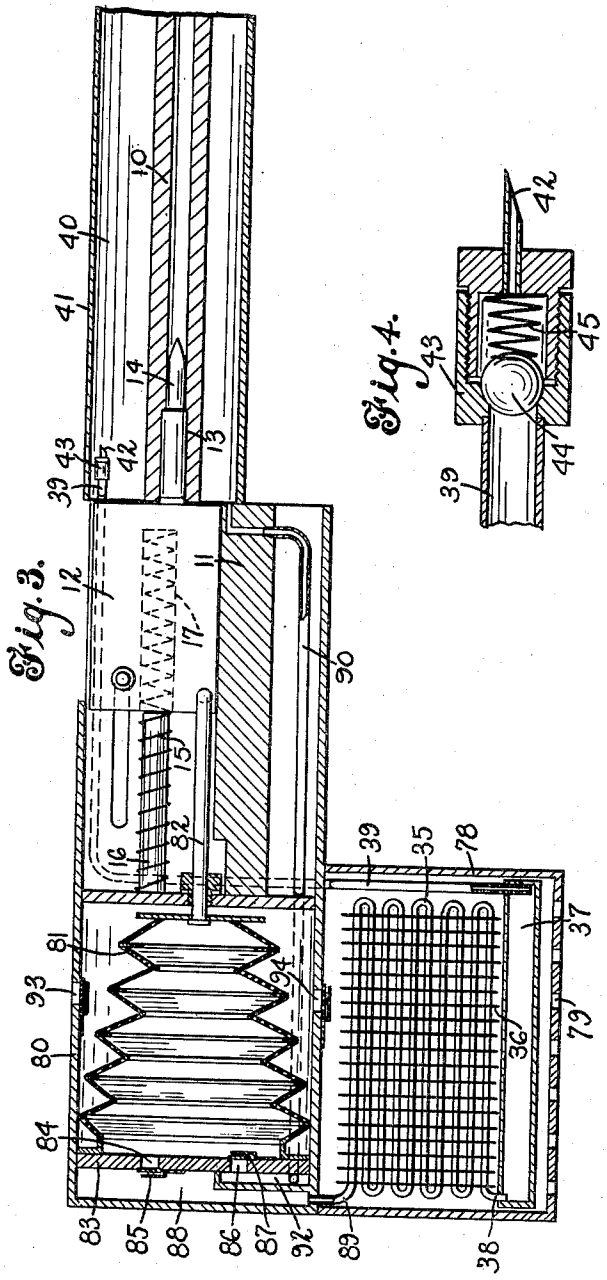
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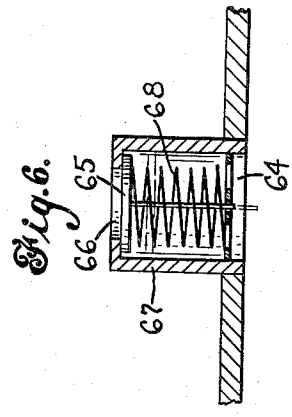
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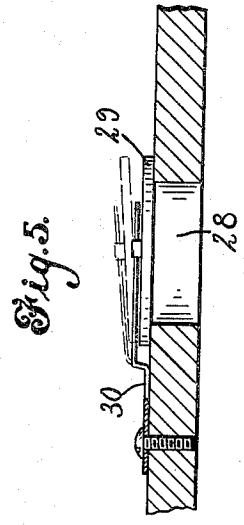
COOLING MECHANISM FOR MACHINE GUNS AND THE LIKE

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2 Sheets-Sheet 2







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COOLING MECHANISM FOR MACHINE GUNS AND THE LIKE

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3 Claims. (Cl. 89—14)

This invention relates to guns and more particularly to an automatic gun or machine gun capable of being fired with rapidity resulting in excessive heating of the gun barrel.

In using rapid fire guns such as machine guns, considerable difficulty is encountered in maintaining the gun at a temperature which will permit it to be operated. For this reason various means have been provided to cool the barrels of guns of this type. In some instances gun barrels have been cooled by a circulation of air, but this in many cases has not proved sufficient. In other cases the barrels have been cooled by circulation of water thereover. If, however, a supply of water is used over and over again, it soon becomes hot and loses much of its cooling effect, and it is not practical to employ a continuous circulation of fresh water.

In the present invention it is contemplated to provide a cooling means for the barrels of rapid fire guns such as machine guns wherein a refrigerant will be employed and a refrigerating system embodied in or attached to the gun itself. As illustrated, this system will be operated by the operation of the gun, use being made either of the movement of the breech bolt or of the gas pressure produced by the discharge of the gun.

The refrigerating system comprises a compressor of some type which will compress the refrigerant which is delivered to a condenser and is cooled. After the refrigerant passes through the condenser and the heat extracted therefrom, it is delivered to a casing surrounding the gun barrel through a valve structure which permits the refrigerant to expand, thus effecting a lowering of its temperature and cooling the barrel of the gun. From this casing which surrounds the barrel of the gun, the refrigerant is returned to the compressor and again compressed to initiate another cycle.

The compressor is the only operating part of the mechanism, and power is supplied to the compressor, which power is obtained either from the reaction of the explosion or from the gas pressure resulting from the explosion.

In the construction of automatic guns, the breech bolt is usually driven rearwardly by the reaction from the discharge of the gun, and is returned forwardly by the bolt spring, a new cartridge being fed into the chamber during this operation. In the present construction, use is made of the movement of the bolt to operate the compressor in that the piston of the compressor is connected to the bolt so that when the bolt is driven rearwardly by the discharge of the gun, an operative or compressing stroke of the piston will result to compress the refrigerant and deliver it in this form to the condenser. The piston is then returned to its original position by the return of the bolt under influence of the bolt spring so that each time the gun is discharged a complete operation or rear and forward movement of the piston will result.

In the form of the invention wherein the gas pressure is employed to operate the compressor, a portion of the explosion gases will be taken off from the barrel of the gun forwardly of the chamber and used to supply power for the working stroke of the piston of the compressor. The return stroke may then be effected by a spring provided for that purpose so that, as before, a complete stroke of the piston will be effected upon each discharge of the gun.

Also, provision is made for passing a current of air over the condenser to assist in the extraction of heat from the compressed refrigerant. This air propelling means may also be operated from the bolt of the gun during its movement in a rearward direction upon the discharge of the gun.

One object of the present invention is to provide new and improved cooling means for rapid fire guns.

A still further object of the invention is to provide a cooling means for rapid fire guns which will comprise a refrigerating system operated by the mechanism of the gun itself.

A still further object of the invention is to provide a new and improved cooling system for rapid fire guns which comprises a refrigerating system carried by or built into the gun, comprising a compressor for a refrigerating fluid and a condenser, the compressor being actuated either from the movement of the gun bolt or by pressure of the gas developed upon the discharge of the gun.

A still further object of the invention is to provide a cooling system for guns of the character previously described which shall not only be provided with a compressor, but also with a condenser, both compressor and condenser being built into the gun and operated from the mechanism of the gun so that a cooling fluid or refrigerant will be compressed, passed through the condenser, permitted to expand into a casing or chamber surrounding the gun barrel, and then delivered to the compressor for use again in the refrigerating system.

To these and other ends the invention consists in the novel features and combinations of parts to be hereinafter described and claimed.

In the accompanying drawings:

Fig. 1 is a sectional view of a rapid fire gun embodying our improvements;

Fig. 2 is a view similar to Fig. 1 showing a modified form of our invention;

Fig. 3 is a sectional view of a rapid fire gun showing a further modified form of our invention;

Fig. 4 is an enlarged sectional view of a conventional form of expansion valve to admit the compressed refrigerant to the barrel;

Fig. 5 is a sectional view of one of the valves employed in connection with the compressor; and

Fig. 6 is a sectional view of the valve shown in Fig. 2 to admit the refrigerant into the compressor cylinder from the cooling chamber or jacket about the barrel.

To illustrate a preferred embodiment of our invention, we have shown in Fig. 1 of the drawings a rapid fire gun comprising a barrel **10** having a receiver **11** and a bolt **12** reciprocably mounted in the receiver, the bolt closing the rear end of the chamber **13** in which is shown the cartridge **14**.

It will be understood that the bolt **12** is reciprocable in the receiver **11** and is urged in a forward direction or to the position shown in Fig. 1 by the bolt spring **15** which surrounds a spring guide pin **16** which may be secured to the rear end of the receiver. The bolt is provided with a bore or recess **17** extending thereinto but not completely therethrough to receive the front end of the spring **15** and also to receive the guide pin **16** when the bolt is driven rearwardly by the discharge of the gun as is usual.

A link **18** is pivoted to the bolt at **19**. The rear end of this link is pivoted at **20** to the forward end of a piston rod or plunger **21**. This piston rod extends rearwardly through a suitable packing **22** into the cylinder **23** of the

compressor. Upon the end of the piston rod 21 is the reciprocable piston 24. The cylinder may be provided with cooling fins 23a.

With this construction it will be apparent that upon reciprocation of the bolt 12 the piston 24 will be reciprocated and serve to compress fluid between the rear end of the piston and the rear wall 25 of the cylinder.

The cylinder 23 is provided with a chamber 26 forwardly of the piston, and from this chamber passages 27 lead into the piston and also through the piston by virtue of the opening 28 normally closed by the spring pressed valve 29. This valve is shown in Fig. 5 and is provided with a spring 30 herein shown as a leaf spring which normally holds the valve against the opening 28, but it will be understood that the spring allows the valve to open when the pressure on the right hand side of the valve (as shown in Fig. 1) exceeds the force of the spring.

A similar valve 31 is provided upon the rear wall 25 of the cylinder to control the opening 32 which leads into a chamber 33 rearwardly of the cylinder.

From the chamber 33 a duct 34 leads into a condenser 35, the pipes of which may be provided with cooling fins or plates 36 so as to cool the fluid delivered to the condenser by the compressor, which latter member comprises the cylinder 23 and piston 24. From the condenser the fluid passes into the reservoir 37 through the outlet pipe 38 where, if sufficiently cool, it may be in liquid form depending, of course, upon the refrigerant employed, and in any event will be under pressure from the gaseous refrigerant delivered to the condenser.

The refrigerant passes from the reservoir 37 through a pipe 39 into a chamber 40 formed about the gun barrel 10 by the cooling jacket 41. The outlet of the pipe 39 into the chamber 40 is shown at 42. The outlet is controlled by an expansion valve shown more especially in Fig. 4, the valve mechanism comprising a housing 43 having therein an expansion valve 44 controlling the outlet of the pipe 39 and urged against the outlet by the spring 45. It will be understood that when the pressure builds up behind the valve to a predetermined amount, it will open against the pressure of the spring 45 and permit the refrigerant to enter within the cooling jacket 41.

From this jacket 41 a passage 46 leads through a portion of the receiver and communicates, through an opening 47, with the chamber 26 through a spring pressed valve 48 similar to the valve structure shown in Fig. 5 and designed to open to the left, as shown in Fig. 1, so that when the excess pressure on the right hand or forward side of the valve exceeds the force of the spring which holds it to its seat, the refrigerant will enter the chamber 26 and thus be delivered again to the compressor. The passage 46 is controlled by an adjustable needle valve 46a to control the rate of cooling.

The casing 49 of the receiver is provided with an opening 49a adjacent the condenser so that air driven rearwardly by the rearward movement of the bolt will be caused to flow over the condenser and assist in the cooling and condensing operations. This air will also be blown over the fins 23a of the cylinder and assist in keeping the cylinder cool.

The operation of the device so far described is as follows.

Upon operation of the gun the bolt 12 will be driven back by the discharge and will carry with it the piston 24. This will serve to lower pressure in the chamber 26 and refrigerant will be drawn in from the chamber 40 through the passage 46 and valve opening 47. When the bolt 12 is returned to the right or to the position shown in Fig. 1 by its spring 15, the piston 24 will be drawn to the right, and the refrigerant within the chamber 26 will pass through the openings 27 and the valved opening 28 into the cylinder 23, the valve 48 being closed at this time by its spring. Upon a further actuation of the piston to the left, the refrigerant in the cylinder 23 will be compressed and forced outwardly past the valve 31 into the condenser where it will be cooled and passed down into the reservoir. From the reservoir the refrigerant will pass through the valve 44 and outlet 42 into the chamber 40 provided within the jacket 41 and cool the barrel of the gun, from which chamber it will again be returned to the compressor through the passage 46.

In Fig. 2 of the drawings, we have shown a modified form of our invention in which the compressor is actuated by gas drawn from the barrel of the gun between the chamber and the muzzle. In this figure of the drawings the parts of the gun are given the same reference characters as before, such, for example, as the barrel 10, the receiver 11, the bolt 12, the cartridge chamber 13, the cooling chamber 40 and jacket 41. In this instance also the bolt 12 is driven rearwardly by the recoil or reaction from the discharge of the gun and is urged forwardly or to closed position by the spring 15 as before, which spring in this instance surrounds a hollow guide rod 16a and the bolt is provided with an opening 17 to receive this rod and the forward end of the spring.

Between the chamber 13 and the muzzle of the barrel 10, and preferably at a point near the muzzle, a tubular member 50 extends down from the barrel, the bore of which communicates with the bore of the gun so that a part of the explosion gases will pass into the bore 51 of the member 50. The bore 51 communicates with the bore of a tubular member 52 disposed in parallel relation with the barrel of the gun which leads rearwardly from the member 50 and in which is reciprocably mounted the forward end of a piston rod 53, the extreme end of this rod being beveled, as shown at 54, so that the explosion gases will act on the beveled surface 54 and drive the rod 53 rearwardly.

Below the jacket 41 is a casing 55 providing a cylinder 56 within which is mounted a piston 57, the latter being secured to the rear end of the piston rod 53. The forward end of the cylinder is formed by the member 58, and a spring 59 acting against this member and against a collar 60 secured to the piston rod 53 urges the latter in a forward direction or to the position shown in Fig. 2 wherein the collar 60 lies against an abutment 61 provided in the casing 55. The cylinder 56 is closed at its rear end except for an outlet opening 62 which is normally closed by the spring pressed valve 63 and an inlet opening 64 controlled by the spring pressed valve 65. The valve 65 may be of the form shown in Fig. 6 wherein it is shown as controlling an opening 66 in a casing 67, and is pressed upwardly to close this opening by the spring 68, the opening 66 also controlling the opening 64 leading into the cylinder and covered by the casing 67. It will be understood that the opening 64 leads into the chamber 40 within the cooling jacket 41 to receive the used refrigerant therefrom.

The outlet opening 62 leads into a small chamber 70 connected by the tube 71 with a condenser 35 similar in form to that shown in Fig. 1, this condenser also being connected at its lower end to a reservoir 37 from which a pipe 39 leads upwardly to an expansion valve 44 controlling the outlet opening 42 into the jacket 41. It is believed that the operation of this form of our device will be understood from the foregoing description, as with the exception of the operation of the compressor, it is similar to the device shown in Fig. 1. In this instance the gas from the discharge of the cartridge moves into the bore 51 of the tube 50 and drives rearwardly the piston rod 53 against the force of the spring 59 to compress the refrigerant in the cylinder 56. When the pressure of the gas is relieved, the spring 59 will drive the piston rod and piston forwardly to the positions shown in Fig. 2, and during this forward or intake stroke of the piston, refrigerant will be drawn therein through the valve 65 from the interior of the jacket 41. Upon the rear or operative stroke of the pistons, it is understood that the valve 65 will be closed, and the valve 63 will

be opened when the pressure in the cylinder overcomes that of the spring.

In this form of our invention we have also shown means for forcing a cooling draft of air over the condenser. It is for this purpose that the guide rod 16[a] of the bolt spring 15 is made hollow, and the rear end of this hollow rod is provided with a spring pressed inlet valve 73. Upon the forward movement of the bolt 12, air will be drawn past the valve 73 into the bore of the rod 16[a] and upon the rearward movement of the bolt 12, this air will be driven into a chamber 74 connected by a tube 75 to a chamber 76 above the condenser and from which the air may pass over the condenser coils through the openings 77. The condenser is provided in a jacket or casing 78 which has outlet openings 79 to permit the escape of the cooling air.

In Fig. 3 of the drawings we have shown a further modification of our invention which in many respects is like that form shown in Fig. 1. In this form the gun also comprises a barrel 10, a receiver 11, a reciprocable bolt 12 urged forwardly by the spring 15 which surrounds the spring guide pin 16. Surrounding the barrel is the cooling jacket 41 providing the chamber 40 between it and the barrel.

Rearwardly of the chamber is provided a casing 80 within which is mounted a collapsible bellows 81, and a plunger 82 is secured at its rear end to the forward end of the bellows and secured at its forward end to the bolt 12 so that when the bolt reciprocates, the bellows will be collapsed by the rearward movement of the bolt, and expanded by the forward movement. The base of the bellows is secured to a member 83 which is provided with an outlet opening 84 controlled by a spring pressed valve 85 and an inlet opening 86 controlled by the spring pressed valve 87, the valves 85 and 87 being similar to the valve 29 shown in Fig. 5. The outlet port 84 leads into a chamber 88 from which a tube 89 leads to the condenser 35 of a form similar to that described in connection with Fig. 1, the condenser being in comunication at its other end with the reservoir 37.

From the reservoir 37 the pipe 39 leads to the expansion valve 44 and outlet opening 42 within the jacket 41 as previously described to deliver the cooling fluid to the cooling chamber 40.

A tube 90 communicates at its forward end with the interior 40 of the cooling jacket 41, and leads into a chamber 92 with which the interior of the bellows 81 communicates through the opening 86.

The casing 80 is provided with a valved inlet port 93 and a valved outlet port 94, the former affording communication between the atmosphere and the interior of the casing 80 while the latter affords communication between the interior of the casing 80 and the interior of the casing 78 about the condenser so that air which is forced from the opening 94 will flow over the condenser coils and be discharged through the ports 79.

In operation it will be seen that as the bolt 12 is driven rearwardly, the bellows will be collapsed and will force the refrigerant therein out through the opening 84 under pressure to the coils of the condenser 35, from which it will be forced into the reservoir 37 and thence through the pipe 39 to the interior of the jacket 41. Upon the return stroke of the bolt 12, the bellows will be expanded and the refrigerant will be drawn into the bellows through the valve port 87, chamber 92 and tube 90 from the cooling chamber 40. Also when the bellows is collapsed, air will be drawn through the port 93 into the casing 80 around the bellows, and when the latter is expanded upon the closing movement of the bolt 12, this air will be driven through the port 94 over the condenser coils to assist in extracting the heat from the compressed refrigerant.

While we have shown and described some preferred embodiments of our invention, it will be understood that it is not to be limited to all of the details shown, but is capable of modification and variation within the spirit of the invention and within the scope of the claims.

What we claim is:

1. A cooling mechanism for rapid fire guns having a barrel and a jacket surrounding the barrel to provide a cooling chamber, a casing adjacent the barrel and secured thereto, said cooling mechanism including a compressor in the casing for compressing a refrigerant, means carried by the casing for delivering the refrigerant to the cooling chamber, an expansion valve located between the compressor and the cooling chamber through which the refrigerant enters the cooling chamber, said compressor including a reciprocating plunger, a member reciprocated by power delivered upon discharge of the gun, means for connecting the plunger to said member for reciprocation thereby, means in the casing returning the refrigerant to the compressor from the cooling chamber, a condenser located between the compressor and the expansion valve, and means to conduct the refrigerant from the compressor through the condenser in its passage to the cooling chamber.

2. A cooling mechanism for rapid fire guns as in claim 24 wherein means are provided for forcing air over the condenser to absorb heat from the refrigerant therein.

3. A cooling mechanism for rapid fire guns having a barrel and a reciprocating bolt, a jacket surrounded by the barrel to provide a cooling chamber and a casing adjacent the barrel and secured thereto, said mechanism comprising a compressor in the casing for compressing the refrigerant, said compressor comprising a bellows connected to and actuated by the bolt, means carried by the casing for delivering the refrigerant from the compressor to the cooling chamber, said bolt being actuated by power developed upon the discharge of the gun, means in the casing for returning the refrigerant to the compressor from the cooling chamber, an expansion valve through which the refrigerant enters the cooling chamber, a condenser provided between the compressor and the cooling chamber through which the refrigerant is led, and means for forcing air over the condenser by contraction and expansion of the bellows.

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