HYDROPNEUMATIC RECUPERATOR FOR PIECES OF ORDNANCE

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ABSTRACT

A hydropneumatic recuperator for pieces of ordnance, having pressure spaces for a pressure gas and a pressure liquid separated by a piston which comprises a recuperator cylinder containing pressure liquid and guided during the recoil of a gun barrel. A recuperator piston is provided within the recuperator cylinder. The recuperator piston has a piston rod which is adapted to be connected with the gun barrel. A storage cylinder is adapted for attachment to a gun cradle and defines the pressure space for pressure gas. An annular piston is provided on the periphery of the recuperator cylinder effecting the separation of the pressure gas and the pressure liquid.

3 Claims, 2 Drawing Figures
HYDROPNEUMATIC RECUPERATOR FOR PIECES OF ORDNANCE

The present invention relates to a hydropneumatic recuperator for pieces of ordnance. The recoil of the barrel of a piece of ordnance resulting from the gas pressure after firing, is retarded in a buffer brake, the energy necessary for the forward movement simultaneously being stored in the recuperator. In pieces, which fire with varying charges, as is the case, for example, with howitzers, the construction of the recuperator is difficult in so far that due to the different charges, recoil displacements of very different lengths occur. Due to this, unfavorable pressure ratios result between the initial and final pressure, which unfavorable ratios can be removed again only by increasing the external dimensions. This is particularly the case when, during the forward movement of the barrel of the piece, greater forces have to be used, for example for opening and cocking the breech and for actuating a loading device. Furthermore, with both pneumatic and hydropneumatic recuperators, the sealing of the gas piston is frequently a problem, in particular when firing with elevation. In this case, it can happen that the contact surface of the gas piston is not adequately lubricated, so that they run dry and leak.

It is therefore one object of the present invention to provide a hydropneumatic recuperator for pieces of ordnance, which, with comparatively small external dimensions and a favorable pressure ratio, allows trouble-free firing even with different charges.

It is another object of the present invention, to provide a hydropneumatic recuperator for pieces of ordnance, having pressure spaces for a pressure gas and a pressure liquid separated by a piston, wherein a recuperator cylinder which contains the pressure liquid, is guided during the recoil of the barrel, to slide in opposition to the movement of a recuperator piston within the cylinder, the piston having a piston rod adapted for connection to the gun barrel, and wherein a storage cylinder adapted for attachment to the gun barrel forms the pressure space for the pressure gas. An annular piston is provided on the periphery of the recuperator cylinder effecting the separation of the gas and liquid. Firstly, due to this construction, a relatively short working stroke of the separating piston is achieved and in addition a favorable pressure ratio is obtained, which required only a relatively small volume of fluid. Thus, the recuperator can also be kept comparatively small in its external dimensions.

It is still another object of the present invention to provide a hydropneumatic recuperator wherein a bush is provided in the rear end wall of the storage cylinder, which bush serves simultaneously for guiding the piston rod and extends in the direction of the recuperator cylinder, this bush projecting into the recuperator cylinder through a non-return valve provided at the rear end of the recuperator cylinder, and that at its periphery the bush has longitudinal grooves with a cross section which varies along their length, such that, in cooperation with the non-return valve sliding with the recuperator cylinder, a variable throttle cross section, depending on the displacement, results.

This is particularly of advantage whenever, due to the forward movement of the barrel, other devices have to be actuated by the latter, for example the opening and cocking of the breech and the actuation of a loading device. Due to this construction, a throttle cross section depending on the forward displacement is created, by which means the magnitude and development of the forward speed can be determined, so that a forward speed varying over the length of the forward path can be achieved. A forward movement braking pin which is generally provided in the buffer brake can be dispensed with in this case.

It is yet another object of the present invention to provide a hydropneumatic recuperator which has the possibility, in a particularly space-saving construction, of providing, in the end wall of the storage cylinder, a spring-loaded indicator device, which is actuated by the end face of the recuperator cylinder in the case of a fluid loss.

A further advantage achieved by the invention is the fact that a relatively thin and therefore elastic piston rod can be used, by which means slight alignment inaccuracies can be taken up without harm.

With these and other objects in view which will become apparent in the following detailed description, the present invention which is shown by example only, will be clearly understood, in connection with the accompanying drawings, in which:

FIG. 1 is an axial section of the recuperator in longitudinal section after a completed counterrecoil; and FIG. 2 is an axial section of the recuperator shown in FIG. 1 in the position of the recuperator cylinder at the beginning of the counterrecoil.

Referring now to the drawing, the recuperation designed in accordance with the present invention comprises a storage cylinder for receiving the pressure gas of the hydropneumatic recuperator, which is attached at its front end by means of a bayonet flange 2 to the gun cradle shown in dot-dash line. A recuperator cylinder 4 of lesser diameter containing the pressure liquid is arranged to slide axially in the storage cylinder 1, the recuperator cylinder 4 being closed at its front end and guided in the storage cylinder 1 by means of a guide ring 6 provided with bores 5. At its rear end the recuperator cylinder 4 has its periphery an annular piston 7, which forms the separation between the pressure gas space 8 surrounding the recuperator cylinder 4 and the pressure liquid located inside the recuperator cylinder 4 behind the piston 9 and behind the piston 7.

In the recuperator cylinder 4 the recuperator piston 9 is arranged to displace longitudinally, the associated piston rod 10 being connected to the barrel at 11. The space 24 between the end wall of the recuperator cylinder 4 and the piston 9 is connected to the atmosphere by a longitudinal bore in the piston rod. The rear end wall 12 of the storage cylinder 1 is formed by a piston-like insert introduced into the storage cylinder 1 and held by a screw coupling 13. At the same time the end wall 12 forms the seal of the pressure liquid space. In the end wall 12, a bush 14 is centrally fixed, in which the piston rod 10 is guided. This bush 14 projects into the recuperator cylinder 4 through a spring-loaded non-return valve 15 located at the open end of the recuperator cylinder 4. Along its periphery the bush has two opposing longitudinal grooves 16 with a cross section which varies along their length.

The operation of the hydropneumatic recuperator is as follows: The recuperator piston 9, which by means of the piston rod 10, is carried along by the barrel which itself is thrust back by the pressure of the explosive charge gases, brings about an accumulation of the
pressure liquid in the recuperator cylinder 4, the non-return valve 15 having lifted from its seat, so that the liquid passes through slot apertures 23 behind the annular piston 7. As a result, the recuperator cylinder 4 is displaced in opposition to the direction of movement of the piston 9 (of FIG. 2) and the pressure gas located in the pressure gas space 8 is compressed.

After the recoil is completed, the pressure of the compressed gas on the annular piston 7 brings about the counterrecoil of the barrel. In this case, firstly the non-return valve 15 closes, so that the liquid moved by the piston 7 can enter the recuperator cylinder 4 only through the longitudinal grooves 16 and actuate the recuperator piston 9. The respective cross section of the grooves 16 in the region of the bore in the non-return valve thus effects a counterrecoil speed which can be varied by the length of the counterrecoil displacement.

Finally, in the end wall 12 of the storage cylinder 1, parallel to the longitudinal axis, there is provided a spring-loaded plunger 17, which plunger represents an indicator device for a possible loss of fluid. In its front end position (normal position) the plunger 17 with its collar 18 abuts against a shoulder 19 in the end wall 12. An extension 20 of the plunger 17 projects into the space filled with pressure liquid behind the recuperator cylinder 4. When the volume of fluid is low, the plunger 17 is actuated by the end face 21 of the recuperator cylinder 4 and is displaced against the spring force, so that the rear end 22 of the plunger 17 extends behind the end wall 12, so that a possible fluid loss is indicated.

While we have disclosed one embodiment of the present invention it is to be understood that these embodiments are given by example only and not in a limiting sense.

We claim:

1. A hydropneumatic recuperator for pieces of ordnance, having pressure spaces for a pressure gas and a pressure liquid separated by a piston, comprising a recuperator cylinder containing pressure liquid and guided for longitudinal axial movement during the recoil of a gun barrel,
a recuperator piston within said recuperator cylinder, said recuperator piston having a piston rod connected with said gun barrel,
a storage cylinder attachable to a gun cradle and defining the pressure space for pressure gas, and
an annular piston provided on the periphery of said recuperator cylinder effecting the separation of said pressure gas and said pressure liquid.

2. The hydropneumatic recuperator, as set forth in claim 1, wherein said storage cylinder has a rear end wall, a bush is provided in said rear end wall and serving for guiding said piston rod and extending in the direction of said recuperator cylinder,
a non-return valve assembly provided at the rear end of said recuperator cylinder,
said bush projecting into said recuperator cylinder through said non-return valve and having longitudinal grooves with cross-sections varying across their length, whereby in cooperation with said non-return valve assembly sliding with said recuperator cylinder a variable throttle cross section depending upon the displacement is provided.

3. The hydropneumatic recuperator, as set forth in claim 2, which includes a spring-biased indicator arrangement is provided in said rear end wall of said storage cylinder, and said spring-biased indicator arrangement is actuated by the end face of said recuperator cylinder, when a loss of fluid occurs.

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