TITLE: "SYSTEM FOR BRAKING AND RECOVERING PROJECTILES, PROVIDED WITH A COUNTER BARREL ASSEMBLY"

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DESCRIPTION

Technical field

The present invention relates to a system for braking and recovering projectiles.

Technical background

Systems for braking and recovering projectiles, in particular for firearm testing purposes, are known in the art.

With a first type of systems made in accordance with the prior art, naval and terrestrial guns are tested by firing at least one burst of shots at zero sight angle against a heap of sand or in the sea. Of such two different solutions, the burst against sand is at present the least pollutant one, because it allows for subsequent recovery of the shell fragments. In this case, the firing battery must be periodically cleared, sievering the ground for shell fragments, and restored with new sand.

In a second type of systems made in accordance with the prior art, facilities are installed downstream of the firearm which exploit water as a physical means for braking and recovering the projectiles fired, for example, during a gun burst, thereby overcoming the problems related to the cost and time necessary for clearing the ground; moreover, water ensures projectile integrity, even during the bursts, so that the projectiles can be reused after having been appropriately reconditioned, particularly in the area of the forcing band. One example of a system made in accordance with such second type of prior art is described in patent

publication GB 1,078,590. Said patent publication describes a projectile-trapping chamber for a firing range comprising a water tank placed below the line of the floor of a tunnel of the firing range and, above the water tank, a ricochet layer of composite steel plates. The plates are inclined at such an angle that a projectile entering the chamber is deflected by the plates into the water tank. A collecting box having a wire basket therein is provided in the floor of the water tank such that projectiles lying in the tank may be pushed into the basket for emptying the tank. The chamber is further provided with a pump chamber having a sump, a water tank outlet pipe and a water tank overflow.

However, even systems made in accordance with such second type of prior art suffer from a number of drawbacks, which should desirably be overcome.

Summary of the invention

It is one object of the present invention to provide an improved system for braking and recovering projectiles which can overcome the drawbacks of the prior art.

In particular, the present invention solves the technical problem of not having to clear projectiles fired directly into the sea or having to clear projectiles fired in ground or sand after testing according to the prior art.

According to the present invention, this and other objects are achieved through a system having the technical features set out in the appended independent claim.

It is understood that the appended claims are an integral part of the technical teachings provided in the following detailed description of the present invention. In particular, the appended dependent claims define some preferred embodiments of the present invention that include some optional technical features.

Further features and advantages of the present invention will become apparent in light of the following detailed description, provided herein merely as a non-limiting example and referring, in particular, to the annexed drawings as summarized below.

Brief description of the drawings

Figure 1 is a partially transparent perspective view of a system for braking and recovering projectiles made in accordance with an exemplary embodiment of the present invention.

Figure 2 is a view similar to Figure 1, showing further details of the system shown in Figure 1.

Figure 3 is a partial view of the system shown in the preceding figures, wherein the system is represented in a longitudinal section.

Figure 4 is a magnified partial view of the above-mentioned system shown in Figure 3, which shows more clearly some optional construction details of a counter barrel assembly and a recycling apparatus included in such system.

Figure 5 is a further magnified view of the system illustrated in Figure 4, which shows more clearly some optional construction details of the counter barrel assembly.

Figure 6 is a block diagram schematically showing the operation of the counter barrel assembly and of the recycling apparatus shown in the preceding figures.

For completeness' sake, the following is a list of the alphanumerical references used herein to identify parts, elements and components illustrated in the above-summarized drawings.

10. System for braking and recovering projectiles

12. Main structure

14. Firing chamber
16. Braking and recovery tank
18. Firearm
20. Barrel
22. Opening
24. Counter barrel assembly
26. Closure device
28. Shutter
30. Recycling apparatus
32. Pipeline
34. Pumping device
36. Collecting assembly
38. Basket
40. Passageway
42. Pushing device
44. Blade
46. Rail
48. Covering panel
49. Lateral guides
50. Air piping
52. Tubes
54. Filtering device
56 Lifting apparatus
58. Overhead crane
60. Tubular unit
62. Protection wall
64. Outer tubular member
66. Inner tubular member
68. Outflow portion
70. Inflow portion
71. Annular recess
72. Lateral slot

74. Annular channel
76. Lateral nozzles
78. Buffer tank
80. Level sensor
82. Control unit

Detailed description of the invention

With reference to the annexed drawings, and particularly to Figures 1 and 2, numeral **10** designates as a whole a system for braking and recovering projectiles, which is made in accordance with an exemplary embodiment of the present invention.

System **10** comprises a main structure **12**, e.g. a buried or underground structure. In main structure **12** there are a firing chamber **14** and a braking and recovery tank **16**, adjacent to firing chamber **14**.

Firing chamber **14** is intended for housing a firearm **18** configured for firing a projectile **P** into braking and recovery tank **16**.

Firearm **18** is to be installed on the floor of firing chamber **14**. Such firearm **18** may be of a type suitable for shooting bursts of projectiles into braking and recovery tank **16**. In particular, firearm **18** is equipped with a barrel **20**, through which a projectile **P** is directed and fired towards braking and recovery tank **16**. For example, firearm **18** may be an artillery gun (any vehicle-mounted terrestrial gun and/or any naval gun) of small to medium calibre.

Braking and recovery tank **16** is configured for containing a liquid, in particular water, capable of braking projectile **P** coming from firing chamber **14** and fired by firearm **18**. In particular, braking and recovery tank **16** lies substantially higher than the support plane of firearm **18** on the floor of firing chamber **14**, and is installed in front of

barrel **20**. In the illustrated embodiment, braking and recovery tank **16** is constructed as a closed tank or reservoir capable of containing the liquid that will be used for braking projectile **P**. For example, braking and recovery tank **16** may have a length of approximately 20m to 30m, a width of approximately 2m and a depth of approximately 2m, and the projectiles are braked by the water contained therein. Generally, the resistance encountered in water by fired projectiles is about 1,000 times greater than the resistance encountered in air and, in the typical operating conditions of artillery guns, it has been estimated that they can stop in approximately 20m.

Furthermore, with particular reference to Figure 3, braking and recovery tank **16** has an opening **22** placed in front of barrel **20** of the firearm **18** and configured to allow projectile **P** to gain access thereto after the shot. For example, the opening **22** is placed at approximately half the height of braking and recovery tank **16**.

System **10** comprises a counter barrel assembly **24** placed between firing chamber **14** and braking and recovery tank **16**. Counter barrel assembly **24** is configured for receiving and guiding through itself projectile **P** fired by firearm **18**, so as to cause projectile **P** to enter braking and recovery tank **16** through it, in particular by crossing opening **22**. Counter barrel assembly **24** is configured in a manner such that it can be aligned between opening **22** of braking and recovery tank **16** and barrel **20** of firearm **18**. The position of counter barrel assembly **24** may be adjustable, e.g. height-adjustable, to align its axis with the axis of barrel **20** (in particular, when barrel **20** is arranged at zero sight angle or in a substantially horizontal position relative to the floor of firing chamber **14**) and with the axis of opening **22**.

Advantageously, counter barrel assembly **24** also allows the braking and recovery tank to withstand the blasts caused by the firing of the projectiles. Other features and the operation of counter barrel assembly **24** will be described in more detail below.

System **10** comprises also a closure device **26** associated with opening **22**. Closure device **26** is configured to selectively open opening **22** when firearm **18** fires projectile **P**. In this way, projectile (or the burst of projectiles) **P** fired by firearm **18** will enter braking and recovery tank **16** through opening **22**. Closure device **26** is placed between opening **22** and counter barrel assembly **24**.

Closure device **26** comprises a shutter **28** configured to selectively open and sealingly close opening **22** of braking and recovery tank **16**. In particular, shutter **28** can take an opening position and a closing position. In the opening position, shutter **28** allows projectile **P** to gain access, through opening **22**, to braking and recovery tank **16**. In the closing position, shutter **28** sealingly closes opening **22**. Shutter **28** may be a gate shutter, in particular it may be able to slidably translate against opening **22** between the opening position and the closing position.

System **10** further comprises a recycling apparatus **30** configured to induce a forced circulation of liquid, in particular water, through braking and recovery tank **16**. In particular, recycling apparatus **30** allows the liquid to forcedly circulate in and out through same opening **22**. With particular reference to Figure 6, recycling apparatus **30** comprises a pipeline **32** defining a closed path for the liquid contained in braking and recovery tank **16**, and a pumping device **34** configured to induce the forced circulation through pipeline **32**. Other features and the operation of recycling

apparatus **30** will be described in more detail below.

Furthermore, with reference to Figure 3, system **10** comprises a collecting assembly **36** placed in braking and recovery tank **16**. Collecting assembly **36** is configured for recovering projectiles **P** which have been braked by the liquid contained in braking and recovery tank **16** and which have fallen to the bottom of braking and recovery tank **16**.

Collecting assembly **36** comprises a basket **38** configured for receiving and collecting projectiles **P** that have fallen to the bottom of braking and recovery tank **16**. Basket **38** is normally in a collection position (represented in Figure 3), in which it can collect the fallen projectiles **P**. Basket **38** can be moved – in particular, lifted – between said collection position and a pick-up position, in which it brings projectiles **P** into an accessible position, where they can be picked up by an operator. In the collection position, basket **38** lies on the bottom of braking and recovery tank **16**. In the pick-up position, basket **38** lies above the bottom of braking and recovery tank **16**.

In particular, in the pick-up position basket **38** is placed at an extraction passageway **40** (also visible in Figures 1 and 2) formed through a wall of braking and recovery tank **16**. In particular, extraction passageway **40** is obtained through the top of braking and recovery tank **16**. Through extraction passageway **40**, projectiles **P** contained in and lifted by basket **38** can then be picked up by an operator; thus, such projectiles **P** can be recovered and disposed of in an environmentally friendly manner and/or recycled for further use, whether partially or in full. In the illustrated embodiment, extraction passageway **40** is provided with a reclosable door that allows an entrusted operator to gain access to and pick up te projectiles **P** that have to be

recovered from braking and recovery tank **16**.

Collecting assembly **36** further comprises a pushing device **42** configured for pushing towards basket **38** projectiles **P** fired by firearm **18** and deposited on the bottom of braking and recovery tank **16**. Pushing device **42** is placed inside – in particular, on the bottom of –braking and recovery tank **16**.

Pushing device **42** comprises a blade **44** configured to move, in particular in a guided manner, along an inner wall of braking and recovery tank **16**, so as to push and bring projectiles **P** towards basket **38**. In particular, blade **44** is configured to move along the bottom of braking and recovery tank **16**. For example, blade **44** is movable in a reciprocating manner in a direction of movement **X**, towards or away from the portion of braking and recovery tank **16** in which basket **38** is movable.

In addition, pushing device **42** comprises one or more movement guides, e.g. one or more rails **46**, whereon blade **44** can move, e.g. slide, in a guided manner. Movement guides or rails **46** are formed in braking and recovery tank **16**, in particular on the bottom of the latter.

With particular reference to Figures 1 to 3, system **10** further comprises a covering panel **48** configured for removably and reversibly closing the open top of firing chamber **14**. Covering panel **48** is movably mounted on main structure **12**. Also, covering panel **48** is mounted in a manner such that it can be raised with respect to main structure **12**.

Covering panel **48** is configured for sealingly closing the top of firing chamber **14**, e.g. by means of a perimetric gasket (not numbered) placed on the face of covering panel **48** and operatively facing towards main structure **12**. The

gasket is configured to be compressed between covering panel **48** and the top of main structure **12**, so as to seal firing chamber **14**.

In Figures 1 and 3, covering panel **48** is shown in a closing position, wherein it has been lowered and closes the top of firing chamber **14**, whereas in Figure 2 such covering panel **48** is in an opening position, wherein it has been raised to open the top of firing chamber **14**. Covering panel **48** is mounted on main structure **12** guidedly movable, in particular slidable, between the closing position and the opening position.

Operationally, covering panel **48** can move in a longitudinal direction oriented from firing chamber **14** towards braking and recovery tank **16**. In the closing position covering panel **48** is lowered against main structure **12** above firing chamber **14**, whereas in the opening position covering panel **48** is raised from main structure **12** and positioned above braking and recovery tank **16**.

In the illustrated embodiment there are a pair of lateral guides **49** (e.g. in the form of rails) on the top of main structure **12**, whereon covering panel **48** is configured to slide between the two above-described operating positions by means of *per se* known mechanisms.

Furthermore, covering panel **48** is made of sound-absorbent material; it is thus possible to deaden the noise generated by the firing of firearm **18** in firing chamber **14** and perceivable from the outside environment.

System **10** further comprises an air piping **50** configured to put firing chamber **14** in communication with the outside environment. In this way, the pressure generated in firing chamber **14** when firing firearm **18** can be vented outside. This also reduces the noise generated by firearm **18**. In

addition, the powder and particles generated by the firing can be conveyed out of firing chamber **14**.

Air piping **50** comprises one or more tubes **52** allowing air to escape firing chamber **14** towards the outside environment. Each one of tubes **52** is connected with firing chamber **14** at one end and communicates with the outside environment at the other end.

In particular, air piping **50** is equipped with a filtering device **54**, e.g. one for each one of tubes **52**, configured for filtering the air coming from firing chamber **14**. In this manner, the powder and particles generated by the firing are trapped into filtering device **54**.

Moreover, air piping **50** is configured to act as a silencer upon the noise generated by the shots occurring in firing chamber **14**.

System **10** further comprises a lifting apparatus **56** (only schematically represented in Figure 2) mounted on main structure **12** and configured for moving firearm **18** in and out relative to firing chamber **14**, in particular when covering panel **48** is in the opening position, thus clearing the top of firing chamber **14** and allowing access thereto. In particular, lifting apparatus **56** permits taking tested firearm **18** out of firing chamber **14**, e.g. in order to replace it with another firearm **18** to be tested and fired.

In particular, lifting apparatus **56** comprises an overhead crane **58** mounted on main structure **12** above firing chamber **14** and configured for lifting and displacing firearm **18** contained in firing chamber **14**.

With particular reference to Figures 4 and 5, counter barrel assembly **24** comprises a tubular unit **60** configured to be operationally interposed and aligned between barrel **20** of the firearm **18** and opening **22** of braking and recovery tank

16, so that projectiles P fired by firearm 18 will pass through tubular unit 60 prior to entering braking and recovery tank 16. Furthermore, preferably, counter barrel assembly 24 comprises also a protection wall 62 mounted on tubular unit 60 and configured to contain the explosion or blast generated by the close firing of projectile P from barrel 20. Protection wall 62 is configured to be placed in a position facing towards barrel 20 and, in particular, extends around tubular unit 60. In the illustrated embodiment, protection wall 62 has a substantially funnel-like shape tapering towards tubular unit 60.

Tubular unit 60 comprises an outer tubular member 64 and an inner tubular member 66 mounted in outer tubular member 64 and configured to be crossed by projectile P fired by firearm 18. Outer tubular member 64 is fixed in tubular unit 60 and is configured to internally support inner tubular member 66. Conversely, inner tubular member 66 is advantageously mounted in such a way that it is removable from outer tubular member 64, so that it can be replaced in tubular unit 60. Thus, on the one hand, inner tubular member 66 can provide a "sacrificial" portion of tubular unit 60, which can be easily replaced in case of damage and/or wear caused by the operation of counter barrel assembly 24 during repeated operation of system 10 when firearm 18 is fired. On the other hand, it is possible to envisage the use of a plurality of interchangeable inner tubular members 66 having different characteristics or properties, each one being suitable for installation inside outer tubular member 64, according to different specific operating requirements of counter barrel assembly 24. For example, such interchangeable inner tubular members 66 may have different inside diameters for use with projectiles P of corresponding

different calibres to be fired from barrel 20 of firearm 18. In particular, for this purpose the outside diameter of the plurality of interchangeable inner tubular members 66 may always remain the same diameter suitable for insertion into outer tubular member 64.

In the illustrated embodiment, inner tubular member 66 protrudes axially towards firing chamber 14 relative to outer tubular member 64 that supports it. In particular, protection wall 62 is axially fixed onto outer tubular member 64 and surrounds an end portion of inner tubular member 66, which protrudes axially beyond such protection wall 62.

With particular reference to Figure 6, recycling apparatus 30 is connected in a loop with braking and recovery tank 16 through counter barrel assembly 24, in particular forming a circuit between pipeline 32 and tubular unit 60. In fact, a liquid can flow through at least a part of counter barrel assembly 24, coming from – and also directed towards –braking and recovery tank 16. In the illustrated embodiment, pipeline 32 is advantageously connected, on one side, to an outflow portion 68 formed in counter barrel assembly 24 and configured for receiving the outflowing liquid from braking and recovery tank 16 and, on the other side, to an inflow portion 70 formed in the same counter barrel assembly 24 and configured for directing the inflowing liquid towards braking and recovery tank 16. When pumping device 34 is activated (and closure device 26 clears opening 22), it pushes the liquid that has arrived from outflow portion 68 towards inflow portion 70, thereby recirculating the liquid in braking and recovery tank 16 through pipeline 32. Particularly, outflow portion 68 and inflow portion 70 are formed in tubular unit 60, e.g. through tubular members 64 and 66.

In the illustrated embodiment, outflow portion **68** is defined by an annular recess **71** formed inside outer tubular member **64** and communicating with the inlet of pipeline **32**, and by a lateral slot **72** transversally crossing inner tubular member **66** and communicating with annular recess **70**. In operation, inner tubular member **66** is crossed axially by the liquid coming from braking and recovery tank **16**, which flows radially towards lateral slot **72** and into annular recess **71**, to end up by the inlet of pipeline **32**.

In the illustrated embodiment, inflow portion **70** is defined by an annular channel **74** formed internally to outer tubular member **64** and communicating with the outlet of pipeline **32**, and by one or more lateral nozzles **76** transversally crossing inner tubular member **66** and communicating with annular recess **70**. In particular, lateral nozzles **76** converge transversally towards the axis of inner tubular member **66**, in the direction of braking and recovery tank **16**. In operation, pipeline **32** ends transversally into annular channel **74** and the liquid flows through the latter and into the lateral nozzles **76**, so that the liquid will accelerate and return into braking and recovery tank **16** through inner tubular member **66**. Moreover, the flow of liquid through lateral nozzles **76** contributes to creating an accelerated counter current flow of liquid opposing the liquid flow exiting braking and recovery tank **16** through opening **22**, and this will tend to reduce the liquid flow out of the latter. In this manner, closure device **26** can clear opening **22** for a longer time, in particular to allow firing a burst of projectiles **P** into braking and recovery tank **16**, without the latter tending to drain too quickly. In the illustrated example, lateral nozzles **76** substantially act as a hydraulic plug – in particular because the liquid flowing

out through them counters the draining of braking and recovery tank 16.

In addition, with reference to Figures 3, 4 and 6, recycling apparatus 30 comprises a buffer tank 78 placed in an intermediate tract of pipeline 32, between outflow portion 68 and inflow portion 70Buffer tank 78 is configured for storing a quantity of liquid coming from outflow portion 68 and for delivering, by means of a pumping device 34, the stored quantity of liquid towards inflow portion 70. In particular, buffer tank 78 is hydraulically connected upstream of pumping device 34 along pipeline 32. Furthermore, recycling apparatus 40 comprises a level sensor 80 (e.g. of the float type) placed in buffer tank 78 and configured for detecting the level of the liquid contained in the latter. In particular, recycling apparatus 30 comprises also a control unit 82 configured for controlling pumping device 34 as a function of the liquid level detected by level sensor 80. For example, when the liquid level detected by level sensor 80 exceeds a predetermined threshold value, control unit 82 will activate pumping device 34, which will push the liquid from buffer tank 78 through pipeline 32 and towards inflow portion 70. Thus, the level of the liquid in braking and recovery tank 16 is always controllably kept above a certain predetermined height.

Of course, without prejudice to the principle of the invention, the embodiments and the implementation details may be extensively varied from those described and illustrated herein by way of non-limiting example, without however departing from the scope of the invention as set out in the appended claims.

CLAIMS

1. System (10) for braking and recovering projectiles, wherein said system comprises a main structure (12) in which a firing chamber (14) and a braking and recovery tank (16), adjacent to said firing chamber (14), are positioned;

said firing chamber (14) being intended for housing a firearm (18) configured for firing at least one projectile (P) into said braking and recovery tank (16);

said braking tank (16) being configured for containing a liquid capable of braking said projectile (P) coming from said firing chamber (14) and fired by said firearm (18); said braking and recovery tank (16) having an opening (22) in front of which a barrel (20) of said firearm (18) is to be positioned; said opening (22) being configured to allow said projectile (P) to gain access to said braking and recovery tank (16) when said projectile (P) is fired by said firearm (18);

said system being **characterized in that** it further comprises a counter barrel assembly (24) placed between said firing chamber (14) and said braking and recovery tank (16), and configured for receiving and guiding through itself said projectile (P) fired by the firearm (18), so as to cause the projectile (P) to enter said braking and recovery tank (16).

2. System according to claim 1, wherein said counter barrel assembly (24) can be aligned between said opening (22) and said barrel (20).

3. System according to claim 1 or 2, wherein said counter barrel assembly (24) comprises a tubular unit (60) configured to be operationally interposed and aligned between said barrel (20) and said opening (22).

4. System according to claim 3, wherein said counter barrel assembly (24) further comprises a protection wall (62)

mounted on said tubular unit (60) and configured to be positioned in a position facing towards said barrel (20), so as to contain the explosion generated by the firing of said projectile (P).

5. System according to claim 4, wherein said protection 0wall (62) extends around said tubular unit (60).

6. System according to claims 3 to 5, wherein said tubular unit (60) comprises an outer tubular member (64) and an inner tubular member (66) mounted in said outer tubular member (64) and configured to be crossed by said projectile (P).

7. System according to claim 6, wherein said inner tubular member (66) is removable from said outer tubular member (64).

8. System according to any one of the preceding claims, further comprising a recycling apparatus (30) configured to induce a forced circulation of liquid through said braking and recovery tank (16).

9. System according to claim 8, wherein said recycling apparatus (30) is connected in a loop with said braking and recovery tank (16) through said counter barrel assembly (24).

10. System according to claim 8 or 9, wherein said recycling apparatus (30) comprises a buffer tank (78) configured for storing a quantity of liquid and hydraulically positioned between said braking and recovery tank (16) and said counter barrel assembly (24).

11. System according to any one of the preceding claims, wherein said counter barrel assembly (24) has at least one lateral nozzle (76) configured to act as a hydraulic plug for said braking and recovery tank (16).