

## Description

### Breech drive for a weapon

- 5 The invention relates to drive kinematics with a Scotch-yoke crank drive for a feed, in particular a linear feed, of a breech or of a cartridge into a weapon barrel.
- 10 In externally powered machine guns, the energy for driving the weapon is not obtained from a gas pressure or from weapon recoil, but is provided by an electrical or hydraulic drive.
- 15 Particularly in the case of electrically driven weapons, the rotary movement of the motor must for this purpose be converted to an oscillating movement of the breech. Furthermore, the breech requires times for which it is stationary at the limit positions of its
- 20 displacement movement. In a first limit position, the case of the previous round must be removed in front of the breech, and a new cartridge must be fed in front of the breech before said cartridge is driven into the cartridge chamber of the weapon barrel. In a further
- 25 limit position, the breech must be locked and the cartridge fired. Once the gas pressure in the weapon barrel has fallen, the breech can then be unlocked.

A rigidly locked linear breech for an externally driven machine gun has been published in DE 36 27 361 C1. A control roll is also proposed here, for space-saving locking, without bouncing.

DE 37 12 905 A1 describes a machine gun which, inter alia, has a cam drum which is operated by an external drive and is used for linear movement of a linear breech. The cam drum correspondingly has a control cam which runs endlessly over the circumference.

Furthermore, a short radially acting control cam and a longer axially acting control cam are arranged on the circumference.

5 DE 10 2005 045 824 A1 proposes a physically small weapon whose control roll is integrated on the plane of the barrel bore axis. The control roll has a control body to which at least two control cams are fitted. In this case, the cam information is converted to a linear  
10 feed of the breech.

From DE 10 2007 048 468.4, which was not published prior to this, a drive is preferred for linear feeding of a breech or of the ammunition into a weapon barrel  
15 or a cartridge chamber by means of a chain. In contrast to the bushmaster drive, in which a chain is passed over four sprocket wheels, in the form of a rectangle, and by means of which the stationary times of the breech are defined, the chain is in this case itself  
20 passed tightly around two sprocket wheels in a simple manner. A chain link or a stud on the chain is integrated in a guide or groove which is located under the movable slide. This allows the chain to continue to run during the times when the weapon is stationary,  
25 which are defined by a separate function control means. The chain itself can be driven by an electric motor. A rapid stopping means is in this case integrated in the path of the chain.

30 A linear feed of a breech with respect to the weapon barrel or cartridge chamber is described in DE 10 2007 054 470.9, which was not published prior to this. In this case, a linear guide groove is integrated in the drive kinematics. A means which is physically  
35 connected to the breech is guided in the guide groove. The guide groove is itself surrounded by a circumferential positive guide (slotted link) which itself interprets the necessary times for the breech to

be stationary during locking, firing and unlocking in its front position and during the loading, once the breech has been moved to its rear position. A further means is guided within the positive guide, as drive  
5 means for the breech. The drive transmission can be provided by sliding rollers, gear wheels or the like, which are driven by a motor etc. The drive itself continues to run during the times in which the weapon is stationary, while the breech is moved out and back  
10 in again later during the stationary times.

Although the three last-mentioned solutions themselves already deal with practicable drives, which produce satisfactory results in terms of firing rate and  
15 mechanical wear, the invention is based on the object of specifying a further drive for a breech such as this which is likewise also used for higher firing rates.

The invention is achieved by the features of patent  
20 claim 1. Advantageous embodiments are specified in the dependent claims.

The invention is based on the idea of providing a mechanism which has a low-level of breech acceleration  
25 and operates smoothly and without jerking, thus decreasing the mass forces, reducing the drive power and allowing the firing rate to be increased. The reduction in the drive power furthermore results in a reduction in the braking power when rapid stopping is  
30 required.

An application filed in parallel by the same applicant has already described a further design solution. The principle of the application is that a crank drive is  
35 used to convert the rotary movement, preferably of a motor or the like, to a forward and backward movement of the breech. In order to allow the breech to be stationary for times in the limit positions, a

connecting rod and crank are arranged such that they can be moved radially with respect to one another, such that the crank radius changes with the rotation of the crank. The connecting rod is guided radially by a control cam which is an intrinsically closed structure and has defined areas as a movement profile for the breech.

A similar solution approach is also adopted here, with the principle of a Scotch-yoke crank drive being used to convert the rotary movement of a motor etc. to a forward and backward movement of the breech, in a simple manner. In order to allow times during which the breech is stationary in the limit positions, the crank radius is predetermined by a control cam, however this does not change with the rotation of the crank.

The shaft on which the crank rotates is driven, externally, for example via a pinion shaft, for example via a motor. A crank pin is arranged such that it can move radially in a groove in the crank and, via a guide block, drives the breech carrier in a groove which runs transversely with respect to the firing direction. Two means, for example rollers, are arranged on the crank pin and run in control cams in the weapon or crank housing. The control cam is in turn subdivided into various sectors/areas, thus achieving the desired movement of the breech. In order to ensure that the breech is stationary for a specific time period when the crank is permanently rotated, specifically in its limit positions, the control cam is straight in these areas, while it is predetermined in the other areas on the basis of any required movement function, in order to optimize the acceleration, maximum speed, smoothness and freedom from impacts, etc. of the breech movement.

The Scotch-yoke crank drive has the advantage that low rotating masses (crank, motor and possibly step-up

transmissions) are provided, which have to be braked in the event of rapid stopping. It has also been found to be a simple design.

- 5 The invention will be explained in more detail using one exemplary embodiment and with reference to the drawing, and in which:

Figure 1 shows a schematic view of a drive with a  
10 preferred control cam,

Figure 2 shows a schematic plan view of drive and breech with weapon barrel,

15 Figure 3 shows an illustration of the crank,

Figure 4 shows a sectional illustration on the barrel center axis from figure 2,

20 Figure 1 schematically illustrates the method of operation and the fundamental principle for movement of a breech 3 in the direction of a weapon barrel 1 (Figure 2). Drive kinematics 100 in general consist primarily of a crank 8 with a groove 17, in which a  
25 crank pin 9 with, for example, two rollers 10, is arranged and is guided positively by a control cam 15. The crank 8 is rotated about a rotation axis M, and is permanently rotated.

30 The areas of the control cam 15 define the movement processes of the breech 3 as follows:

$\alpha_1 - \alpha_2$  breech 3 to the rear,

35  $\alpha_2 - \alpha_3$  forward movement of the breech 3 in accordance with any desired function,

$\alpha_3 - \alpha_4$  breech 3 to the front,

$\alpha_4 - \alpha_1$  rearward movement of the breech 3 in accordance with any desired function.

5 The movement profile of the breech 3 and the duration of the waiting times at the reversal positions (of the breach 3) are predetermined by the shape of the control cam 15. In order to produce the required oscillating movement of the breech 3 with the waiting times at the  
10 reversal positions, the crank 8 is driven and caused to rotate continuously. The shape of the control cam 15 can be compared with an O which has been pulled sideways on two vertical sides.

15 Figure 2 shows a design implementation of the fundamental principle of the breech drive. The weapon barrel 1 is mounted in a barrel locking bush 2 (or a weapon housing), in which the breech 3 can also be locked in its front position. In this case, the breech  
20 3 is arranged on a so-called breech carrier 5, which is in turn guided on breech guides 4. The breech 3 is mounted thereon such that it can move in the direction of the weapon barrel axis.

25 The drive kinematics 100 consist of an upper housing part 7 and a lower housing part 6, which are components of a weapon housing or crank housing. Each housing part 6, 7 has an identical control cam 15, in which the rollers 10 run. A duplicated form was chosen in order  
30 to prevent tilting of the rollers 10. It is self-evident that just one control cam is adequate, provided that this precludes the possibility of tilting.

Figure 3 shows the crank 8 and the crank pin 9 with the  
35 two rollers 10 and a guide block 11, illustrated in detail. The crank pin 9 is arranged such that it can move radially in the groove 17 in the crank 8. A toothed ring 12 is preferably arranged at the bottom on

the crank 8, via which the crank 8 can be driven.

Figure 4 shows a view sectioned on the barrel axis, in which the arrangement of the crank 8 in the drive kinematics 100 can be seen. The end with the crank pin 9 is located on the side of the weapon, which is not illustrated in any more detail here. The crank 8 is mounted on a pin 13 on the housing upper part 7 such that it can rotate, with the crank 8 being driven externally, for example by a motor, via a pinion shaft 14. The crank 8 drives the crank pin 9 in the rotation direction. The rollers 10 in this case run in the two identical control cams 15 in the housing upper part 7 and in the housing lower part 6, and in doing so guide the crank pin 9. The guide block 11, which is mounted on the crank pin 9 at the top, engages in a groove 16, which is arranged transversely with respect to the firing direction, in the breech carrier 5. In this way, the movements which are predetermined by the control cam 15 in the firing direction are transmitted via crank pin 9 and breech carrier 5 directly to the breech 3, while movements transversely with respect to the firing direction result in a relative movement of the guide block 11 of the guide pin 9 with respect to the groove 16 in the breech carrier 5.

An even more compact physical form for the control cam or cams 15 can be achieved by arranging a pair of, for example eccentric, gearwheels (not illustrated in any more detail) between the pinion shaft 14 and the crank drive. To this end, the step-up ratio of the toothed ring 12 of the crank 8 to the pinion shaft 14 is selected for example such that the pinion 14 rotates at twice the rotation speed of the crank 8. Eccentric gearwheels result in a continuously varying step-up ratio, as a result of which, when the motor rotation speed is constant, the crank 8 rotates more slowly during the waiting time phases, and more quickly during

the breech movement phases. The angle ranges  $\alpha_1$  to  $\alpha_2$  and  $\alpha_3$  and  $\alpha_4$  of the control cam or cams 6 can therefore be made smaller, without shortening the waiting times of the breech 3 in the front and rear positions.

**Claims:**

1. A drive operably connected to a breech carrier, of a weapon, wherein a breech is moveable with the breech carrier in an axial direction with respect to a weapon barrel of the weapon, wherein the drive comprises
  - (a) a motor;
  - (b) a crank operably connected to be driven by the motor, wherein the crank is provided with a first groove formed in the crank;
  - (c) a crank pin having at least one roller and a guide block fitted to the crank pin, wherein the crank pin is disposed in the first groove of the crank; and
  - (d) a first control cam, wherein the crank pin is positively guided in the first control cam, wherein the crank is rotated about a rotation axis by the motor, and the guide block is disposed to engage in a second groove formed in the breech carrier, wherein the second groove is arranged transversely with respect to a firing direction of the weapon, so that movements of the breech in the firing direction are predetermined by the first control cam and are transmitted to the breech via the crank pin and the breech carrier, and movements of the crank pin transversely with respect to the firing direction result in relative movement of the guide block of the crank pin with respect to the second groove formed in the breech carrier.
2. The drive as claimed in claim 20, wherein the first control cam comprises an open groove facing upward integrated in the housing lower part.
3. The drive as claimed in claim 2, further comprising a second control cam integrated in a housing upper part of the weapon housing or of the crank housing, wherein the second control cam is identical to the first control cam in the housing lower part except that the second control cam is in mirror-image form with respect to the first control cam.

4. The drive as claimed in claim 1, wherein the first control cam comprises four different sectors or areas, wherein these four different sectors or areas produce a desired movement of a feed for the breech.
5. The drive as claimed in claim 4, wherein the shape of the first control cam corresponds to an "O" shape that has been pulled sideways on two vertical sides.
6. The drive as claimed in claim 3, wherein the second control cam integrated in the housing upper part comprises an open groove that faces in a direction of the housing lower part.
7. The drive as claimed in claim 1, wherein the crank is operably connected to be driven by the motor via a pinion shaft connected to the motor, and a pair of eccentric gear wheels are located between the pinion shaft and the motor, and rotate at twice the rotation speed of the crank.
8. The drive as claimed in claim 1, wherein the crank is continuously rotatable about the rotation axis by the motor.
9. The drive as claimed in claim 20, further comprising a second control cam integrated in a housing upper part of the weapon housing or of the crank housing, wherein the second control cam is identical to the first control cam in the housing lower part except that the second control cam is in mirror-image form with respect to the first control cam.
10. The drive as claimed in claim 1, further comprising a second control cam integrated in a housing upper part of a weapon housing or of a crank housing of the weapon, wherein the second control cam is identical to the first control cam that is integrated in a housing lower part of the weapon housing or the crank housing, except that the second control cam is in mirror-image form with respect to the first control cam.

11. The drive as claimed in claim 5, wherein the "O" shape that has been pulled sideways on two vertical sides corresponds to a composite shape consisting of a rectangle with semi-circular ends.
12. The drive as claimed in claim 20, wherein the first control cam comprises four different sectors or areas, wherein these four different sectors or areas produce a desired movement of a feed for the breech.
13. The drive as claimed in claim 12, wherein the shape of the first control cam corresponds to an "O" shape that has been pulled sideways on two vertical sides.
14. The drive as claimed in claim 2, wherein the first control cam comprises four different sectors or areas, wherein these four different sectors or areas produce a desired movement of a feed for the breech.
15. The drive as claimed in claim 14, wherein the shape of the first control cam corresponds to an "O" shape that has been pulled sideways on two vertical sides.
16. The drive as claimed in claim 3, wherein the first control cam and the second control cam each comprises four different sectors or areas, wherein these four different sectors or areas produce a desired movement of a feed for the breech.
17. The drive as claimed in claim 16, wherein the shape of the first control cam and the shape of the second control cam corresponds to an "O" shape that has been pulled sideways on two vertical sides.

18. A drive operably connected to a breech of a weapon, wherein the breech is moveable in an axial direction with respect to a weapon barrel of the weapon, wherein the drive comprises

- (a) a motor;
- (b) a crank operably connected to be driven by the motor, wherein the crank is provided with a first groove formed in the crank;
- (c) a crank pin having at least one roller and a guide block fitted to the crank pin, wherein the crank pin is disposed in the first groove of the crank; and
- (d) a first control cam, wherein the crank pin is positively guided in the first control cam, wherein the crank is rotated about a rotation axis by the motor, and the guide block is disposed to engage in a second groove formed in the breech, wherein the second groove is arranged transversely with respect to a firing direction of the weapon, so that movements of the breech in the firing direction are predetermined by the first control cam and are transmitted directly to the breech, and movements of the crank pin transversely with respect to the firing direction result in relative movement of the guide block of the crank pin with respect to the second groove formed in the breech.

19. A drive operably connected to a breech carrier of a weapon, wherein a breech is moveable with the breech carrier in an axial direction with respect to a weapon barrel of the weapon, wherein the drive comprises

- (a) a motor;
- (b) a crank operably connected to be driven by the motor, wherein the crank is provided with a first groove formed in the crank;
- (c) a crank pin having at least one roller and a guide block fitted to the crank pin, wherein the crank pin is disposed in the first groove of the crank; and
- (d) a first control cam, wherein the crank pin is positively guided in the first control cam, wherein the crank is rotated about a rotation axis by the motor, and the guide block is disposed to engage in a second groove formed in the breech carrier, wherein the second groove is arranged transversely with respect to a firing direction of the weapon, so that movements of the breech in the firing direction

are predetermined by the first control cam and are transmitted to the breech via the crank pin and the breech carrier, and movements of the crank pin transversely with respect to the firing direction result in relative movement of the guide block of the crank pin with respect to the second groove formed in the breech carrier, and wherein the first control cam is integrated in a housing lower part of a weapon housing or of a crank housing of the weapon.

20. A drive operably connected to a breech of a weapon, wherein the breech is moveable in an axial direction with respect to a weapon barrel of the weapon, wherein the drive comprises

- (a) a motor;
- (b) a crank operably connected to be driven by the motor, wherein the crank is provided with a first groove formed in the crank;
- (c) a crank pin having at least one roller and a guide block fitted to the crank pin, wherein the crank pin is disposed in the first groove of the crank; and
- (d) a first control cam, wherein the crank pin is positively guided in the first control cam, wherein the crank is rotated about a rotation axis by the motor, and the guide block is disposed to engage in a second groove formed in the breech, wherein the second groove is arranged transversely with respect to a firing direction of the weapon, so that movements of the breech in the firing direction are predetermined by the first control cam and are transmitted directly to the breech, and movements of the crank pin transversely with respect to the firing direction result in relative movement of the guide block of the crank pin with respect to the second groove formed in the breech, and wherein the first control cam is integrated in a housing lower part of a weapon housing or of a crank housing of the weapon.