PATENT SPECIFICATION

Application Date: Jan. 22, 1932. No. 2052/32. **383,802**

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COMPLETE SPECIFICATION.

Improvements relating to Cryptographic Apparatus.

I, PETER GEORG GROVE BEYER, a Danish Subject, of Valby R.R. Station, Copenhagen, Denmark, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to cryptographic apparatus of the kind wherein a keyboard is so connected to an electrically operated recording mechanism that when a key is operated a recording element in the recording mechanism is operated, a transposing mechanism being connected between the keyboard and recording mechanism for the purpose of varying the relation between the keys and recording elements and wherein the transposing mechanism comprises two commutators, the contacts of one of which are connected individually to the keys of the keyboard and the contacts of the other to the elements of the recording mechanism and wherein shifting means, operated as a consequence of the actuation of any of the keys of the keyboard, are provided for altering the relative position between the two commutators. The use of two movable commutators in the transposing mechanism renders the relation between the original message struck upon the keyboard and the resulting encyphered message more simple than is sometimes desirable and it is an object of the present invention to provide an apparatus that will produce a document in code that is more difficult to de-code than has hitherto been the case when cryptographic apparatus incorporating only two commutators has been used.

Thus, according to the present invention, a movable connecting member, embodying transposing cross-connecting conductors arranged to connect the contacts of the commutators, is interposed between the commutators and is so connected to the shifting means that its position relatively to the commutators is changed from time to time as a result of the operation of the shifting means.

The shifting means may include two or more escapement mechanisms having unequal numbers of pins, preferably unequally spaced, whereby the commutators and connecting member return to their initial relative positions only after a large number of actuations of the shifting means.

An apparatus embodying the above and other features of the invention will now be described by way of example with reference to the accompanying drawings, in which

Figure 1 shows a plan of one example of the apparatus, part of the cover being removed,

Figure 2 shows a cros-section on the line II—II in Figure 1,

Figure 3 shows a detail of the apparatus,

Figure 4 shows a cross-section on the line IV—IV in Figure 1, some parts of the apparatus only being shown,

Figures 5 and 6 show details of the apparatus,

Figure 7 shows a cross-section on the line VII—VII in Figure 1,

Figure 8 shows a cross-section of the annular discs and the cross-field ring on the line VIII—VIII in Figure 5,

Figure 9 is a diagram showing how the apparatus can be arranged to connect two typewriting machines,

Figure 10 is a diagram showing a modification of the arrangement shown in Figure 9,

Figures 11 and 12 show modifications of the apparatus, and

Figure 13 shows a cross-section on the line XIII—XIII in Figure 11.

The apparatus comprises a casing 75 provided with a back cover 76 and a removable front cover 74.

On a reciprocable shifting arm 1, which is guided by a bush and by projections 33, 34, (see Figure 1) are disposed two sets of pins 35, 36 and 37, 38 which, when the shifting arm is moved inwards, cause two reciprocable levers 2 to move. The movement of these levers causes two corresponding spiral spring casings 3, each provided with ninety peripheral ratchet teeth to the rotated because a pawl 4 on each lever 2 acts upon the ratchet teeth and rotates the casings 3 thus giving tension to spiral springs 5 located in the cas-

ings 3 (see Figures 1 and 7).

One of the springs 5 is attached to an escapement wheel 13 carrying a pin-disc 11, and the other spring to an escapement wheel 14, carrying a pin-disc 12. The movement of the pin discs 11 and 12 is controlled by a releaser 8 (see Figures 6 and 7).

The escapement wheels 13 and 14 are mounted on pivots 28 supported between a plate 30 and a yoke 29, and each may be caused to rotate by its individual spiral spring 5. The remote end of each spiral spring is attached to one of the casings 3.

The pin-disc 11 has 10 pins, while the pin-disc 12 has but 9 pins; the escapement wheel 13 carries 62 teeth and the escapement wheel 14 carries 58 teeth, so that the movements which they transmit are not synchronous. The escapement wheels 13 and 14 are provided with squared hubs on which the pin-discs are mounted.

During the last tenth of the inward movement of the shifting arm 1, a pin 6 carried thereby actuates a pivoted lever 7 that is connected by a stud 80 to the releaser 8 which is displaced in a direction opposite that of the shifting arm.

This movement effects the first part of the release of the escapement wheels, which make two distinct movements during each operation of the shifting arm.

On the releaser 8 are mounted two sets of stop pins 9 and 10, (see Figures 6 and 7). When the shifting arm 1 is moved inwards the stop pins 9 release a pin on the pin-disc 11 and a pin on the pin-disc 12, while the next following pins on both wheels are stopped by the stop-pins 10. When the shifting arm 1 is released and therefore allowed to return the releaser 8 is moved in the opposite direction, whereby a pin on each of the pin-discs 11 and 12 slips around a stop-pin 10 and is then stopped by a stop pin 9.

In Figures 1 and 2 is shown a pawl releaser 45 pivoted about the axis of the apparatus and having a catch 46 and a stop-tooth 47 which, when the apparatus is being set, is swung over to catch between the teeth of the escapement wheel 13 or of the escapement wheel 14. Once the setting of the combination has been done then the pawl releaser 45 is moved to the idle position shown in Figure 1.

When the releaser 8 is moved in one direction and releases, for example, a pin on pin-disc 11, the escapement wheel 13 is rotated a fraction of the total distance moved during one complete movement of the releaser 8. This distance corresponds to the distance between the stop-pin 10 and the pin on the pin-disc 11 immediately behind the pin engaged by the stop-pin 9 when the pin-disc is stationary. The remaining distance is rotated when the releaser 8 moves in the opposite direction, which happens when the shifting arm moves outwards upon being released after being moved inwards. The shifting arm 1, (see Figure 1) is moved outwards by a spiral spring 31 which is attached to a pin 39 on the supporting plate 30, and simultaneously therewith the pivoted lever 7 and the releaser 8 are pulled back by a spiral spring 32 that is also attached to the pin 39.

The pins 35, 37 press both levers 2 through 36 and 40 degrees respectively during each inward movement of the shifting arm 1. Thus 10 movements of the shifting arm 1 are required to cause a complete revolution of the escapement wheel 13 and 9 movements for the escapement wheel 14. The spring casing 3 associated with the pin-disc 11 thus makes one complete revolution after ten movements of the shifting arm 1, but as the pin-disc 11 carries ten pins it also makes one complete revolution after ten movements of the shifting arm 1. The result is that the net gain in tension of the spiral spring at the end of each revolution of the casing 3 associated with the pin-disc 11 is zero. Similarly the tension in the spiral spring associated with the pin disc 12 does not increase because the casing 3 and the pin disc 12 both make one complete revolution after nine movements of the shifting arm 1. A number corresponding to each pin is marked on each of the pin discs 11 and 12. The numbers are so arranged that they take up positions close to index marks 41 and 42 on the yoke 29. Spring-loaded pawls 43 and 44 hold the casings 3 against revolving backwards.

An exterior annular member 15 (see Figure 2) is integral with a gear-wheel which meshes with teeth on the escapement wheel 13. An interior annular member 17 carries a gear-wheel 19 which is in mesh with the gear wheel of the escapement wheel 14 and is driven thereby. The gear wheel 19 also meshes with the large gear wheel of a change gear 18.

These annular members 15 and 17 rotate equal or unequal distances determined by the distances between the pins on the wheels 11, 12. Thus the amount that the annular members 15 and 17 move relatively to each other, upon each movement of the shifting arm 1, is dependent on the spacing of the pins on the wheels 11, 12. If the distance between the pin that is released on one wheel and the next following pin on that wheel is different from the distance between the equivalent pins on

the other wheel the positions of the wheels 11, 12 relative to each other change.

The interior annular member 17 is fastened to a spindle 48, which carries the gear-wheel 19 which is caused to rotate with the spindle 48 by means of a catch spring 49 which engages two of thirty grooves formed in the gear-wheel 19. This catch spring 49 is fixed to the axle 48 by means of pins 50 and a bush 51.

Between the annular members 15 and 17 is mounted a cross-field ring 16 integral with a gear-wheel which, through the medium of the small gear-wheel of the change gear 18, receives movement from the gear-wheel 19 of the interior annular member 17 in the ratio 1 : 2.

The two gear-wheels of the change gear 18 have 10 and 24 teeth respectively.

The annular members 15, 16 and 17 are divided into 30 sectors. Each sector of the annular member 17 is provided with a letter and a number and each sector of the annular member 15 with a letter, as shown in Figure 5.

Ebonite rings 20, 21 and 22 are mounted on the annular members 15, 16 and 17 respectively by means of dowels 82 and holes 83, (see Figure 3). These ebonite rings 20, 22 are divided into 30 sectors each carrying a contact ball 23 and a coil spring 24, or alternatively a lamina.

A wire leads from each ball 23 or lamina in the ebonite ring 20 to a slip ring on a drum 26 which is fixed to the ebonite ring, and from each ball or lamina 23 in the ebonite ring 22 a wire leads to a slip ring on a drum 25 fixed to the ebonite ring. Each drum has 30 slip rings, which are insulated from each other as well as from their surroundings. Each slip ring corresponds to the one of the thirty sectors of the ebonite rings.

The ebonite ring 21 mounted on the cross-field ring 16 carries two sets of thirty contact pieces 27 (see Figure 8) connected in pairs. Contact pieces that are radially opposite each other may be connected together so that they serve to connect sectors on the rings 20 and 22 that are on the same radial line, or contact pieces that are circumferentially displaced from each other may be connected as shown by the dotted lines in Figure 5.

The drums 25 and 26 each carry a scale with 30 divisions, each marked with a letter corresponding to the letters on the sectors of the annular members 15 and 17 and ebonite rings 20, 22.

The gear-wheel on the cross-field ring 16 is divided into thirty numbered sections and the gear-wheel 19 has an index mark 81 so that by noting the positions of the numbers relatively to the index mark the relative positions of the gear-wheel 16 and the gear-wheel 19 can be noted.

Before starting an enciphering or deciphering operation the pawl releaser 45 is put over to one side, so that the stop tooth 47 engages, for example, the teeth of the escapement wheel 14, and the pawl 44 is raised or released. The setting of the escapement wheel 13 may then be effected.

By reciprocating the shifting arm several times the pin-disc 11 is rotated until a predetermined number, for example "0" stands adjacent to the index mark 41. During this operation the pin wheel 12 is locked in a stationary position by the stop tooth 47 while the associated spring casing 3, which is connected to the pin wheel 12 only through the medium of the spiral spring 5, is rocked to and fro by the arm 2, movement in an anti-clockwise direction being possible because the pawl 44 is held in an inoperative position. The pawl releaser 45 is then swung towards the opposite side so that the escapement wheel 13 is stopped by the stop tooth 47, and simultaneously the pawl 43 of the escapement wheel 13 is released, so that it is possible by reciprocating the shifting arm 1 to rotate the escapement wheel 14 and the pin-disc 12 till the number "1"—or any other predetermined number—stands adjacent to the index mark 42. During this setting operation the spiral spring 5 in the casing 3 swings to and fro and the pin wheel 11 and escapement wheel 13 remain stationary because the stop tooth 47 engages it.

Now, when the spindle 48 is turned by a key fitting its square end, the drum 25 turns also because the ebonite ring 22 is attached by means of a dowel 82 and hole 83, similar to that shown in Figure 3. The spindle is turned until two predetermined letters, for example "ϕ" on the drum 25 and "G" on the drum 26 stand adjacent to each other.

Finally, the change gear 18, (see Figure 4) is pulled out against a stop 52 and thus disengages the gear-wheel 19. The gear-wheel of the cross-field ring 16, which remains in mesh with the small gear-wheel of the change gear 18 is then turned until the index mark 81 on the catch gear-wheel 19 stands adjacent to a predetermined cipher, for example, "8", on the gear-wheel of the cross-field ring 16. Lastly, the change gear is slipped down so that it engages both gear-wheels again.

The predetermined key is thus: O.1.ϕ. G.8. and this constitutes the initial setting.

Paper dial rings for attachment to the annular members 15 and 17 are shown in

Figure 5. These can be seen when the assembly constituted by all the parts carried by the plate 30 is removed from the apparatus. When this assembly is removed the annular members 15, 16 and 17 are separated from the ebonite rings 20, 21 and 22. The assembly alone can be used for enciphering and deciphering purposes simply by reading off the code symbol against the letter that it is desired to communicate and reciprocating the shifting arm between each reading.

Figure 5 shows how the wires in the ebonite ring 21 are disposed.

As the spiral spring 5 may be overloaded by not carrying out the last tenth of the depression movement of the shifting arm a modification, in which coil springs 67 and 68 are employed is shown in Figure 11. The shifting arm 1 which in this instance is guided by screws 54 moves the levers 55 and 56 by means of pins 57 and 58, and pawls 59 and 60 are thereby caused to engage the ratchet wheels 61 and 62, which are fastened to the gear-wheels 63 and 64. When the shifting arm is released the coil spring 31 pulls it back, while the pawls 59 and 60 are caused by the coil springs 67 and 68 to rotate the ratchet wheels 61 and 62. The gear-wheels 63 and 64 turn gear-wheels 65 and 66. These latter drive the escapement wheels 13 and 14 provided with the pin discs 11 and 12. During the last tenth of the inward movement of the shifting arm 1 a pin 73 engages the pivoted lever 7 and moves it so as to cause the releaser to move longitudinally in the direction of the lower arrow in Figure 12. This movement causes a wedge-shaped stop 70 to engage the pin which had previously lain behind a stop 69 and move it in the direction of the upper arrow in Figure 12. During the first part of the outward movement of the shifting arm 1 the releaser 8 moves back to its initial position and the pin disc is rotated by the ratchet and pawl associated with it until the next pin abuts against the stop 69. The reciprocating lever 56 is subjected to the tension of a spiral spring 68. The pawls 71 and 72 act in the same manner as the pawls 43 and 44 shown in Figure 1.

Referring to the diagram shown in Figure 9 it will be seen that the G-sector of the ebonite ring 20, the ebonite ring 21, and the ϕ-sector in the ebonite ring 22 are connected in series in an electrical circuit which also includes the "G" slip-ring on the drum 26 and the "ϕ" slip-ring on the drum 25. A brush 84 is provided for every one of the 30 slip rings on the drum 26, and in a similar manner a brush 85 is provided for each slip-ring on the drum 25.

By striking a key 86, which is the letter "ϕ" key in a hand-operated typewriting machine, a circuit is closed which includes a source of current 90, spring contacts 87, wire 89, and a solenoid 97. The shifting arm 1 is thus caused to move through the solenoid 97.

A parallel circuit is also energised upon depression of the key 86. This circuit includes the line 88, a plug contact 91, a brush 85, the ϕ slip-ring on the drum 25, the ϕ-sector in the ebonite ring 22, the ebonite ring 21 of the cross-field, the G-sector in the ebonite ring 20, the G-slip ring on the drum 26, a brush 84, a plug contact 92, a solenoid 93, a contact 94, a contact section 95 of the shifting arm 1, and a contact 96. The current, which passes the solenoid 93 during the first nine tenths of the downward movement of the shifting arm acts upon an electro-magnetic core 98, which is fastened to the "G" keybar of an electrically-operated typewriting machine, and causes the G-typebar 99 to strike against the platen 100. Before the shifting arm 1 has reached the last tenth of its movement, its contact section 95 slides away from the contacts 94, 96, so that the circuit through the electro-magnet 93 is broken and the G-type bar 99 then falls back before the ebonite rings 20, 21 and 22 are rotated.

The movement of the shifting arm winds the spiral springs 5 and releases the pin discs 11 and 12.

The key 86 is attached to the hand operated typewriting machine, and the electrically operated typewriting machine works simultaneously with it.

In order to enable immediate enciphering and deciphering two typewriting machines (see Figure 10) are required, provided with contacts 87, 103 and solenoids 93, 105. These two machines are connected by wires passing through the sectors in the ebonite rings 20, 21, 22 and to the slip-rings on the drums 25 and 26. In Figure 10 is shown a change-over switch which is in the enciphering position for the hand-operated typewriting machine. By sliding the change-over switch to the other contacts a cryptogram received may be deciphered by the other typewriting machine. The connections between the keys 86 and the slip-rings on the drum 25 may be changed over by interchanging plug contacts 91, one located in each wire leading from the keys 86. Similarly the leads between the slip-rings on the drum 26 and the type-bars 99 may be interchanged.

In Figure 5 is shown an extra section 108 which is reserved for a letter, for example "ü" not ordinarily used, and

this sector indicates that instead of letters, the numbers and symbols shown on the interior annular disc 17, should be read off.

By changing the change-over switch 101 the functions of the typewriting machines are changed, so that the one which was previously hand-operated becomes electrically operated and vice versa.

In this case the current passes from the source 90 through the change-over switch 101 to a wire 102, and then through three spring contacts 103, a wire 104, plug contact 92, brush 84, a slip ring on the drum 26, ebonite rings 20, 21 and 22, a slip ring on the drum 25, brush 85, the plug contact 91, the line 88, a solenoid 105, a wire 106, the change-over switch 101, contact 94, contact section 95, and the contact 96 to the source.

The other branch of the current passes from the spring contacts 103, through a wire 107, change-over switch 101, to the solenoid 97 and back to the source of current 90.

It will be understood that the invention is in no way limited to the precise construction shown. Particularly it will be seen that the annular members may be caused to turn either separately or simultaneously in the same or in opposite directions and in a regular or irregular manner.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. Apparatus of the kind described wherein a movable connecting member, embodying transposing cross-connecting conductors arranged to connect the contacts of the commutators, is interposed between the commutators and so connected to the shifting means that its position relatively to the commutators is changed from time to time as a result of the operation of the shifting means.

2. A cryptographic apparatus according to Claim 1 wherein the shifting means for altering the positions of the commutators and the connecting member relatively to each other includes two or more escapement mechanisms having unequal numbers of pins, preferably unequally spaced, whereby the commutators and the connecting member return to their initial relative positions only after a large number of actuations of the shifting means.

3. A cryptographic apparatus according to Claims 1 and 2 wherein the connecting member is actuated by one of the escapement mechanisms through the medium of gearing and is so arranged that it can be disconnected from the escapement mechanism for the purpose of enabling it to be set initially in a predetermined position.

4. A cryptographic apparatus according to Claim 2 or Claim 3 wherein spiral springs are used for the purpose of driving escapement wheels in the escapement mechanism, the shifting means being so arranged that each time it is operated movement of the escapement wheels occurs, and means being provided whereby the springs are wound up to a small extent upon each operation of the shifting mechanism so that the tension in the springs remains substantially constant.

5. A cryptographic apparatus according to any of Claims 2 to 4 wherein the escapement mechanisms each make two distinct intermittent movements during each operation of the shifting means for altering the relative positions aforesaid.

6. A cryptographic apparatus according to Claim 4 wherein means are provided whereby the winding means of either one of the spiral springs can be rendered ineffective and thus prevent the spring being overwound while its associated escapement wheel is held stationary and the shifting means is being operated so as to move the escapement mechanism driven by the other spiral spring to a predetermined initial position.

7. A cryptographic apparatus according to Claim 2 or Claim 3 wherein ratchets and pawls, loaded by springs, are used for the purpose of rotating escapement wheels in the escapement mechanisms and the shifting means incorporates a reciprocable member which, when moved in one direction, moves the pawls freely and causes energy to be stored in the springs and, when moved in the other direction, permits the springs to cause the pawls to move the ratchets until the escapement wheels are prevented by stops from moving further.

8. A cryptographic apparatus according to any of the preceding claims wherein the two commutators and the shifting means therefor are constructed as a unit readily detachable from the apparatus for use alone as a manually-operated deciphering device.

9. Apparatus according to any of the preceding claims wherein each segment of one commutator has an electrical connection to a slip ring in one slip ring drum, and each segment in the other commutator has an electrical connection to a slip ring in a second drum, and brushes are provided which co-operate with the individual slip rings of the two drums which brushes are connected to the keyboard and the recording mechanism respectively.

10. Cryptographic apparatus accord-

ing to any of the preceding claims wherein means are provided whereby the electrical connections leading from the commutator segments to the keyboard and also the electrical connections to the recording mechanism, can be readily interchanged.

Dated the 22nd day of January, 1932.

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51/52, Chancery Lane, London, W.C. 2.

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Fig. 1.

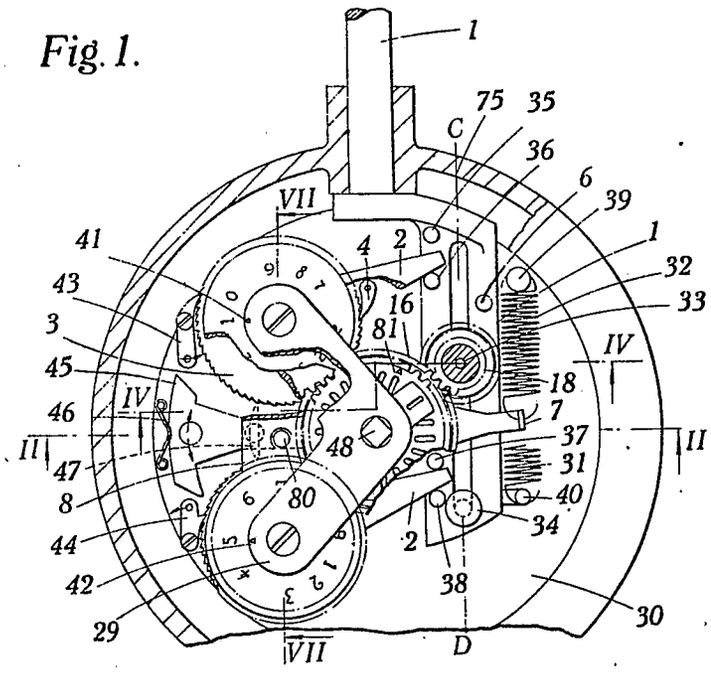

Fig. 2.

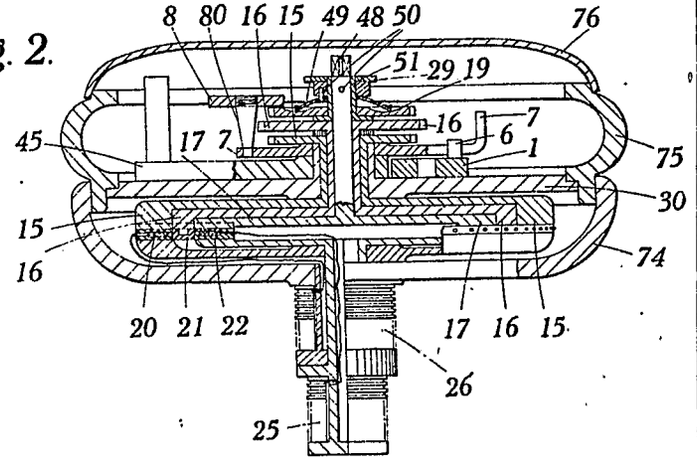

Fig. 3.

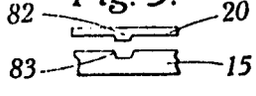

Fig. 4.

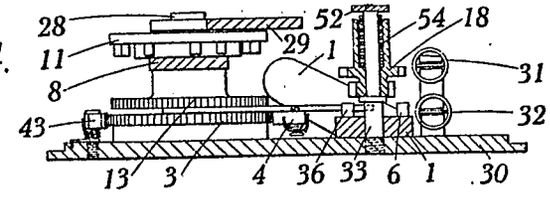

Fig. 5.

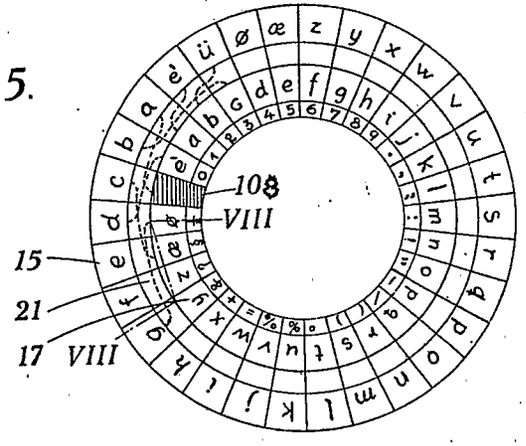

Fig. 6.

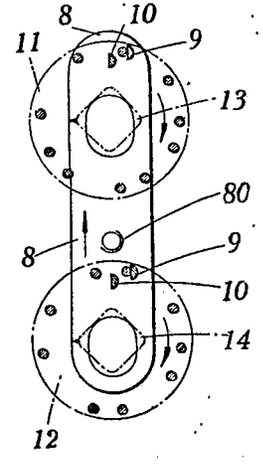

Fig. 7.

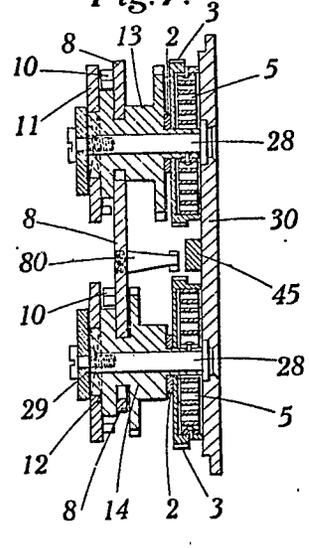

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Fig. 1.

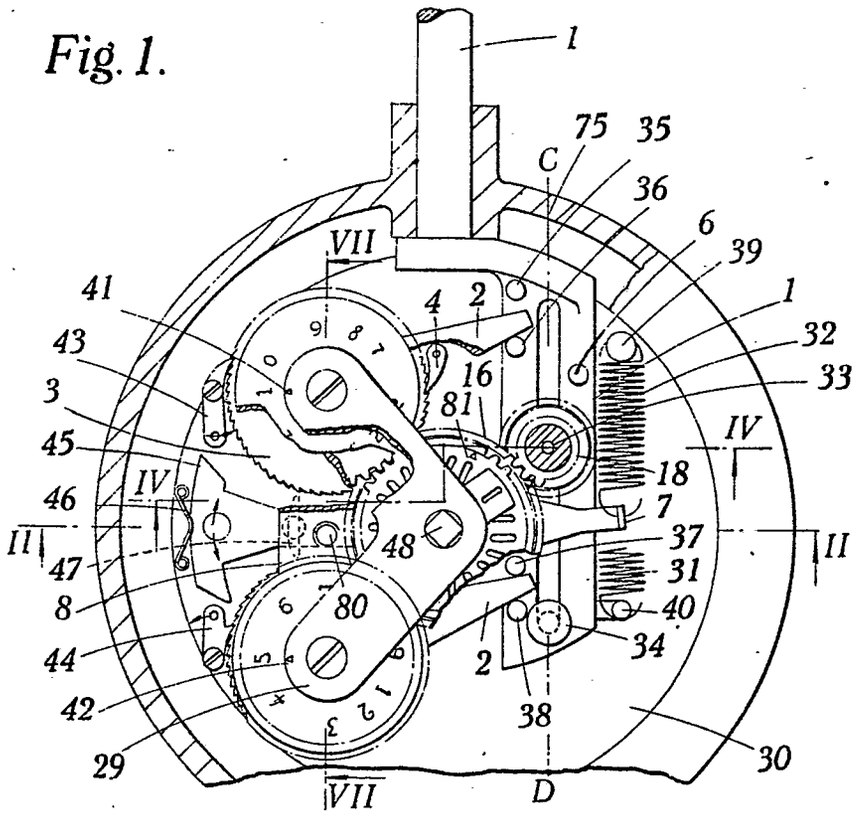


Fig. 2.

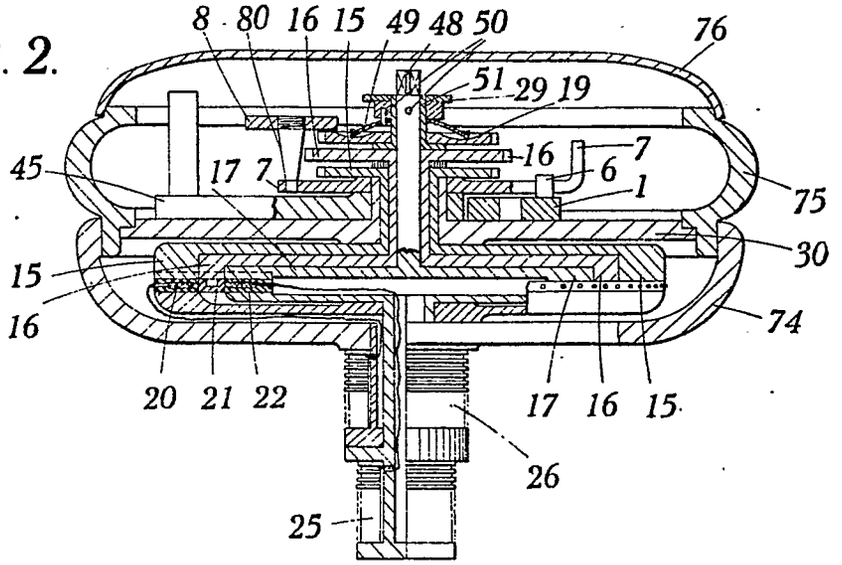
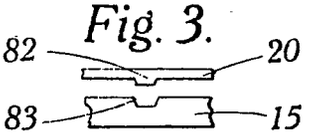
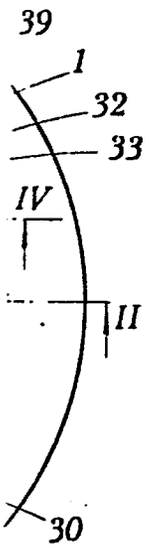


Fig. 3.





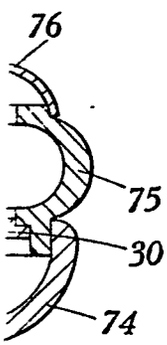


Fig. 4.

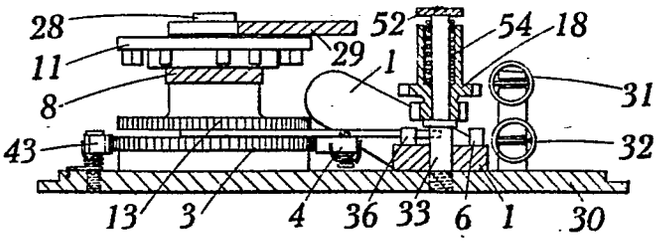


Fig. 5.

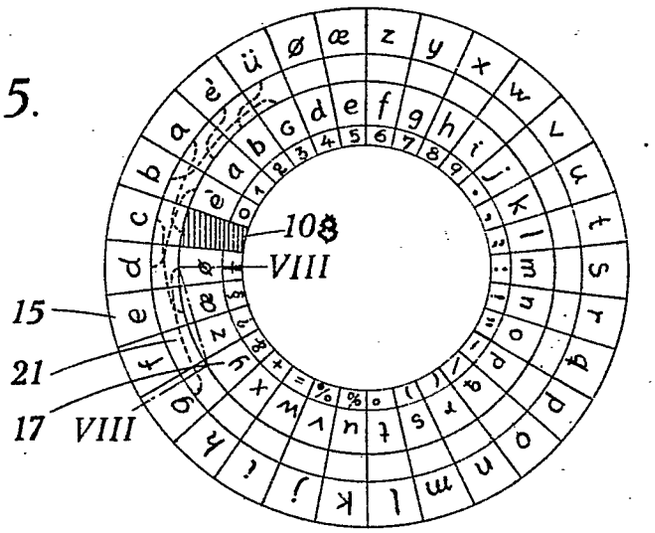


Fig. 6.

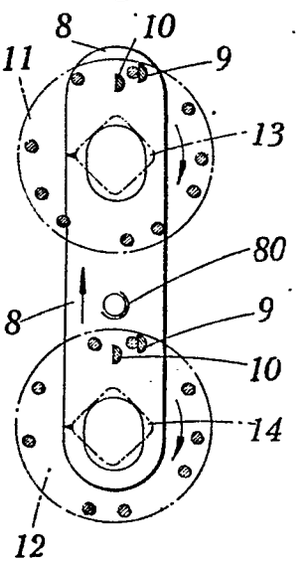


Fig. 7.

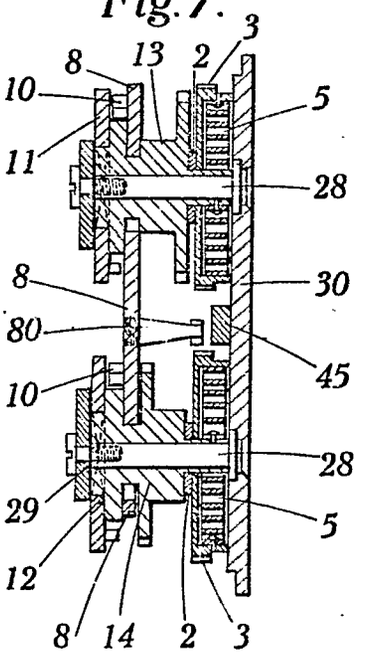


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Fig. 8.

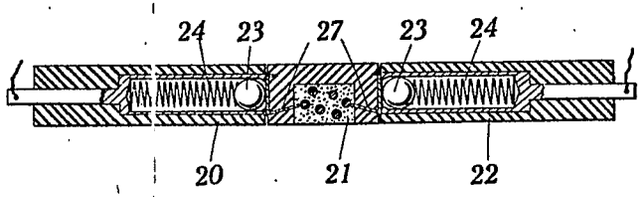


Fig. 9.

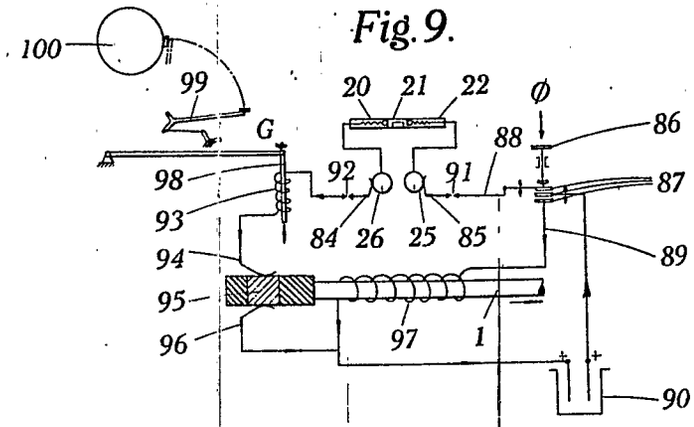


Fig. 10.

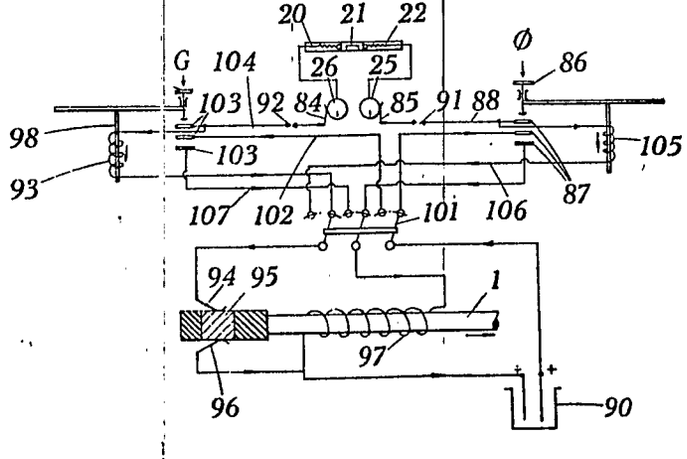
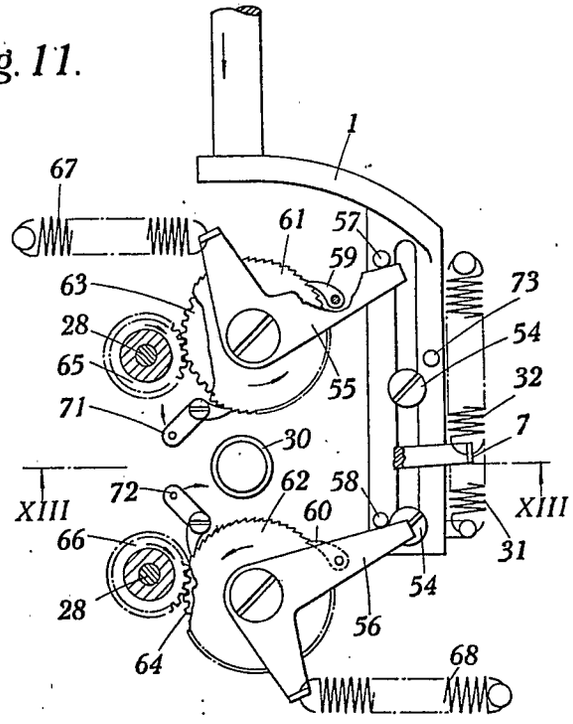


Fig. 11.



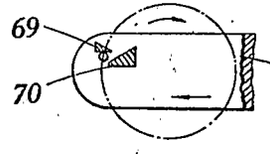


Fig. 12.

Fig. 13.

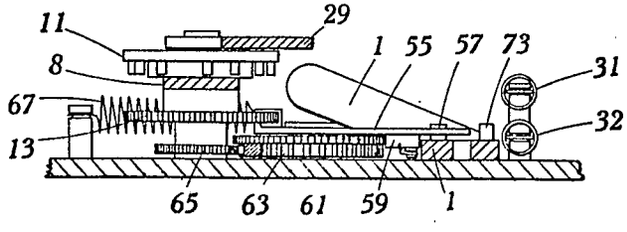


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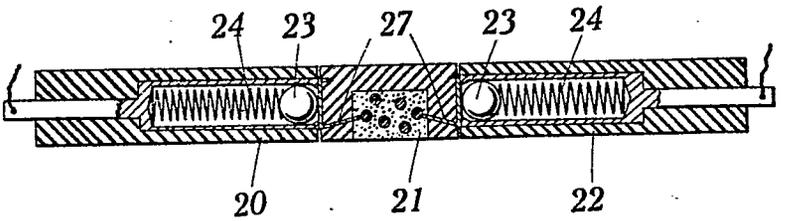
Fig. 8.



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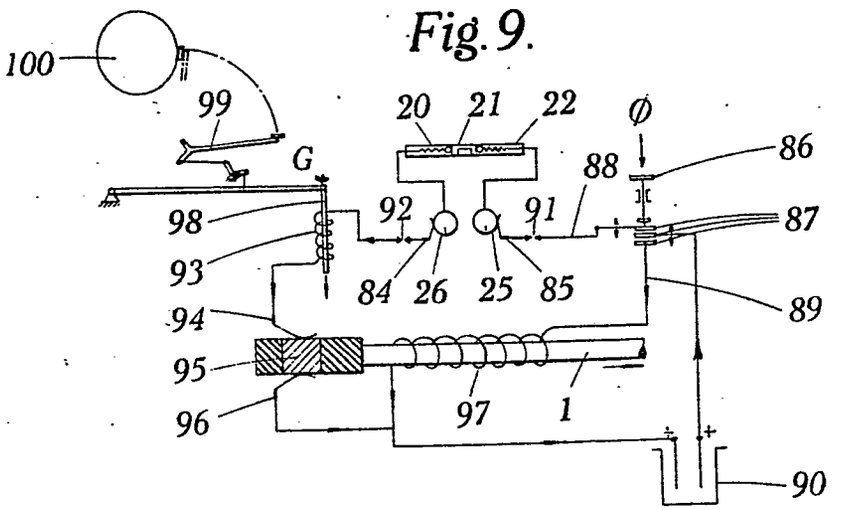

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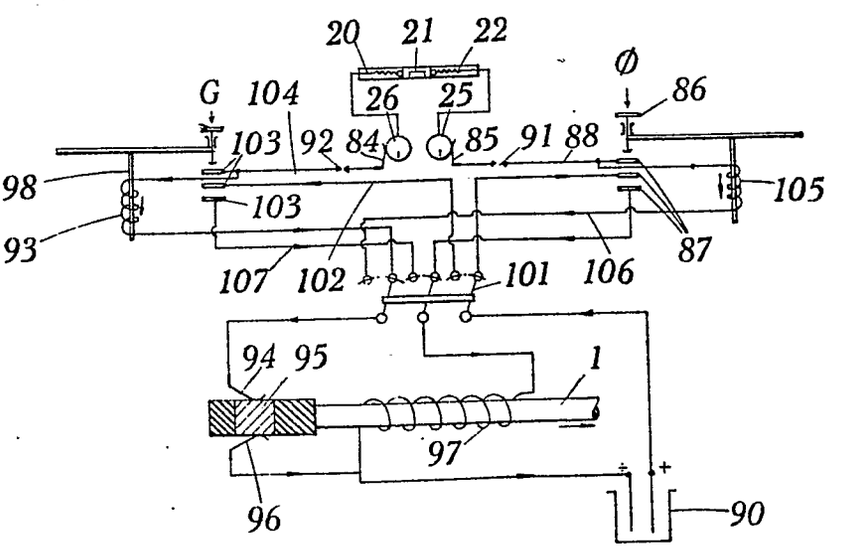

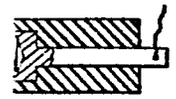

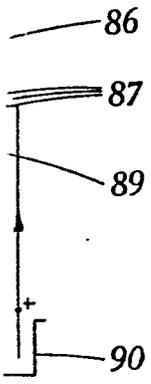

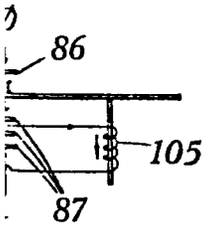

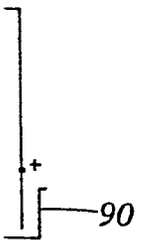

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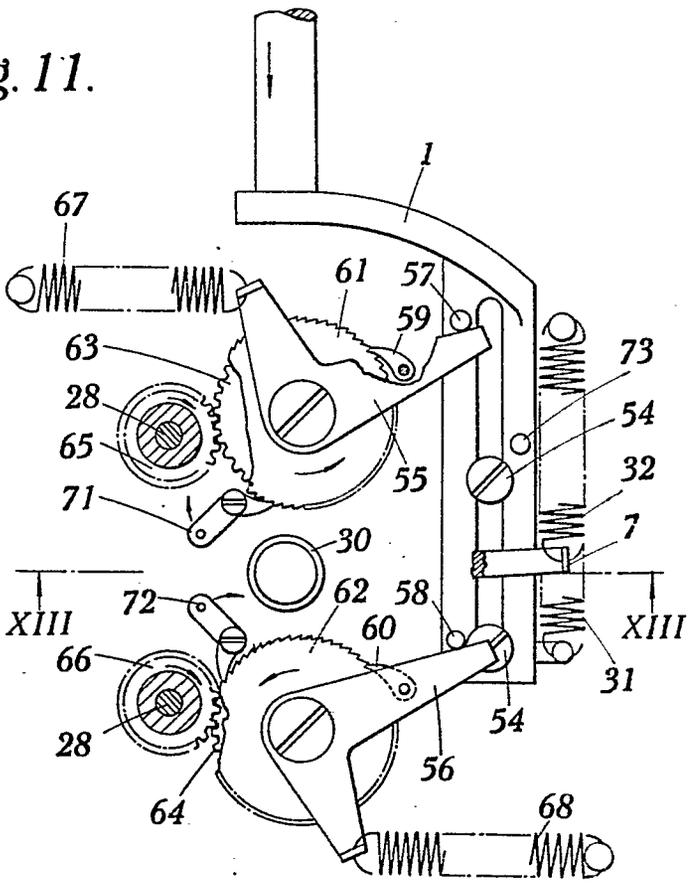


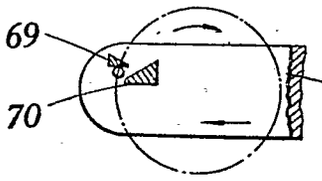
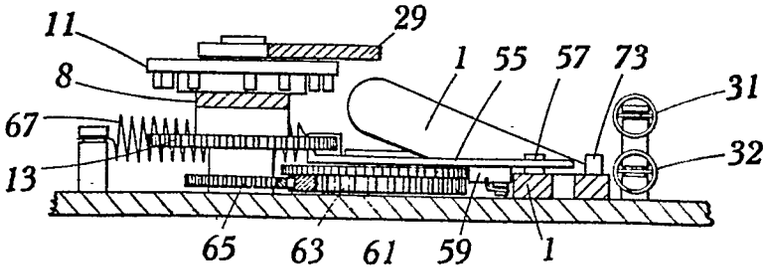


Fig. 12.

Fig. 13.



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