No. 842,763. PATENTED JAN. 29, 1907.

H. BURG.

CRYPTOGRAPHIC MACHINE.

APPLICATION FILED AUG. 16, 1905.

5 SHEETS—SHEET 1.

fig. 1.

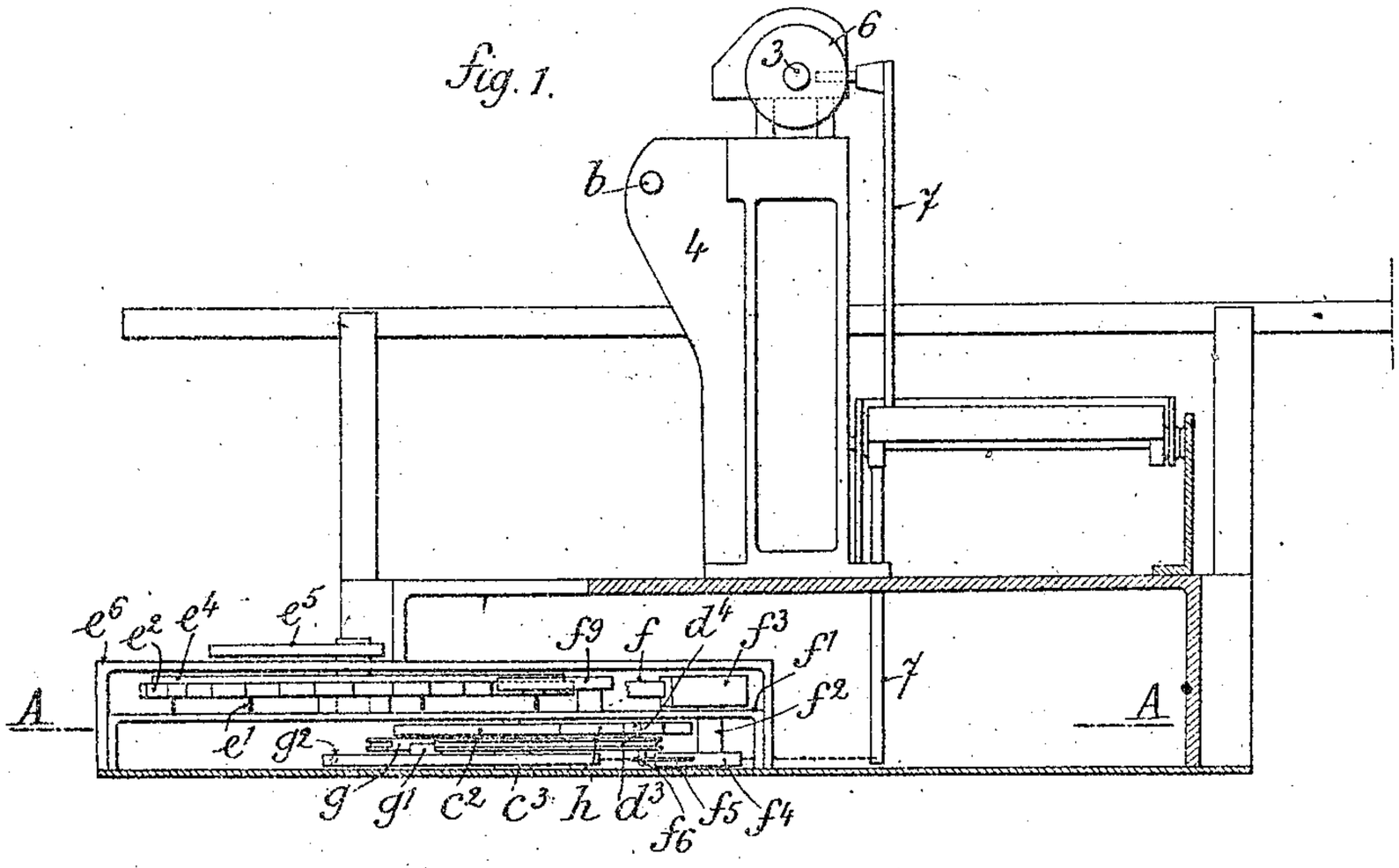


fig. 6.

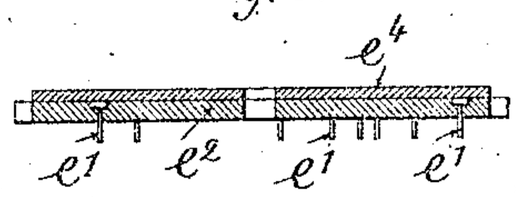


fig. 5.

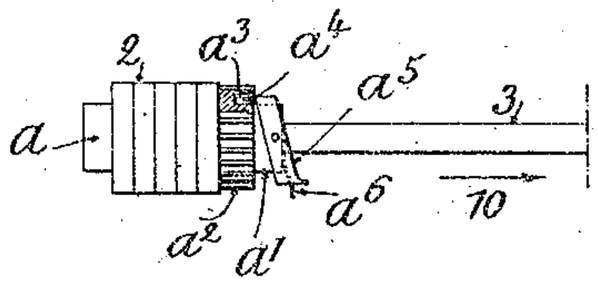
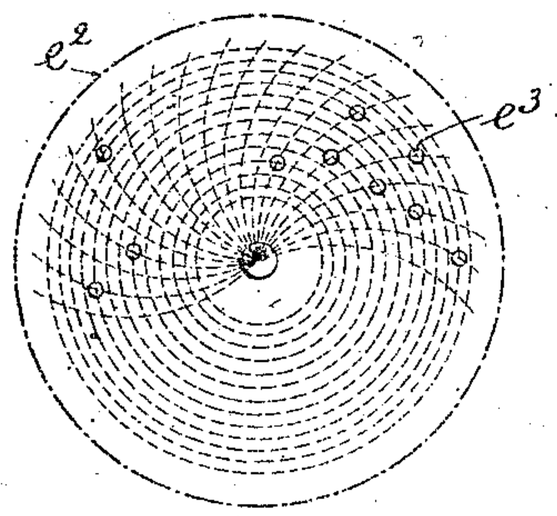


fig. 7.



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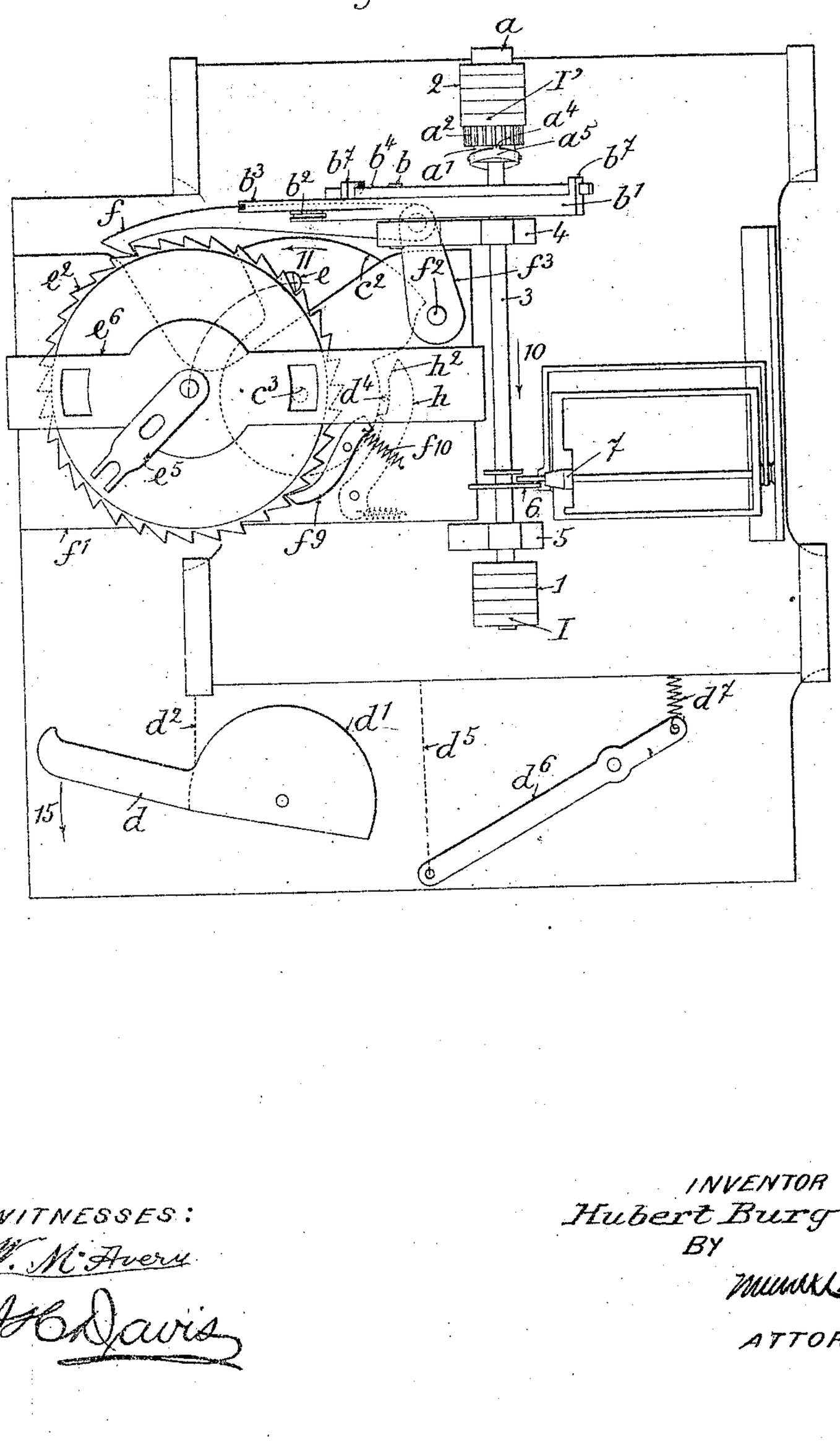
5 SHEETS—SHEET 2.

fig. 2.



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5 SHEETS—SHEET 3.

Fig. 3.

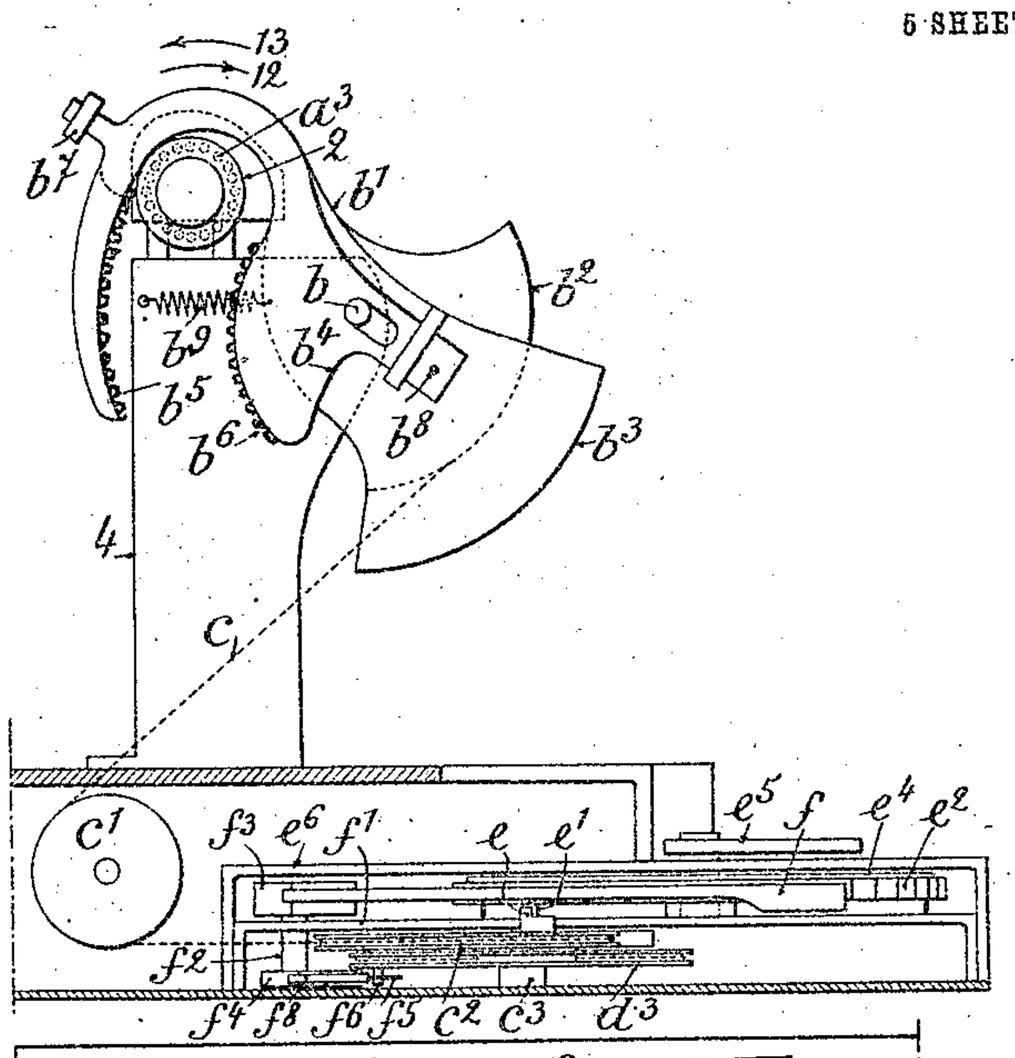
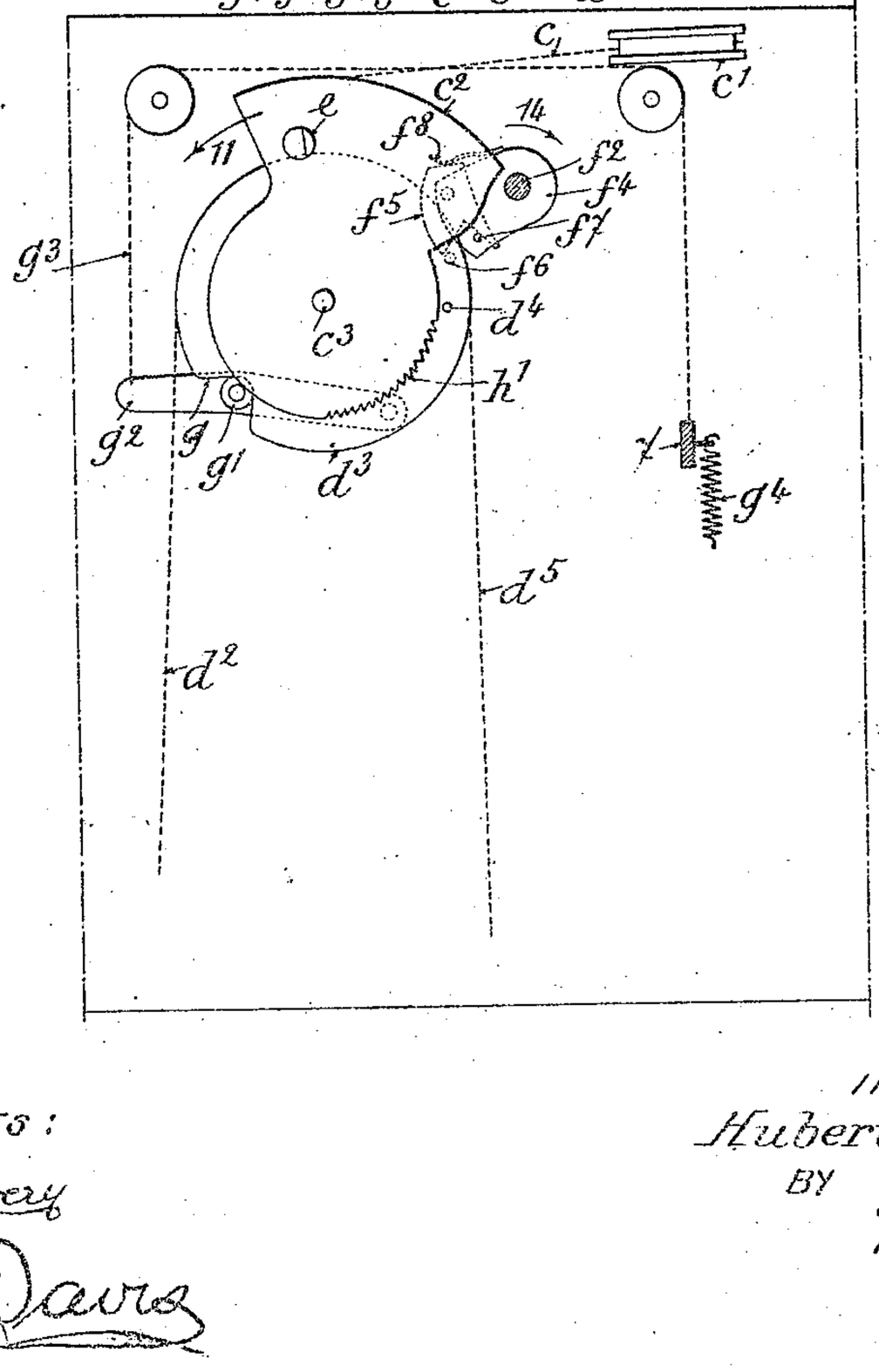


Fig. 4.



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5 SHEETS—SHEET 4

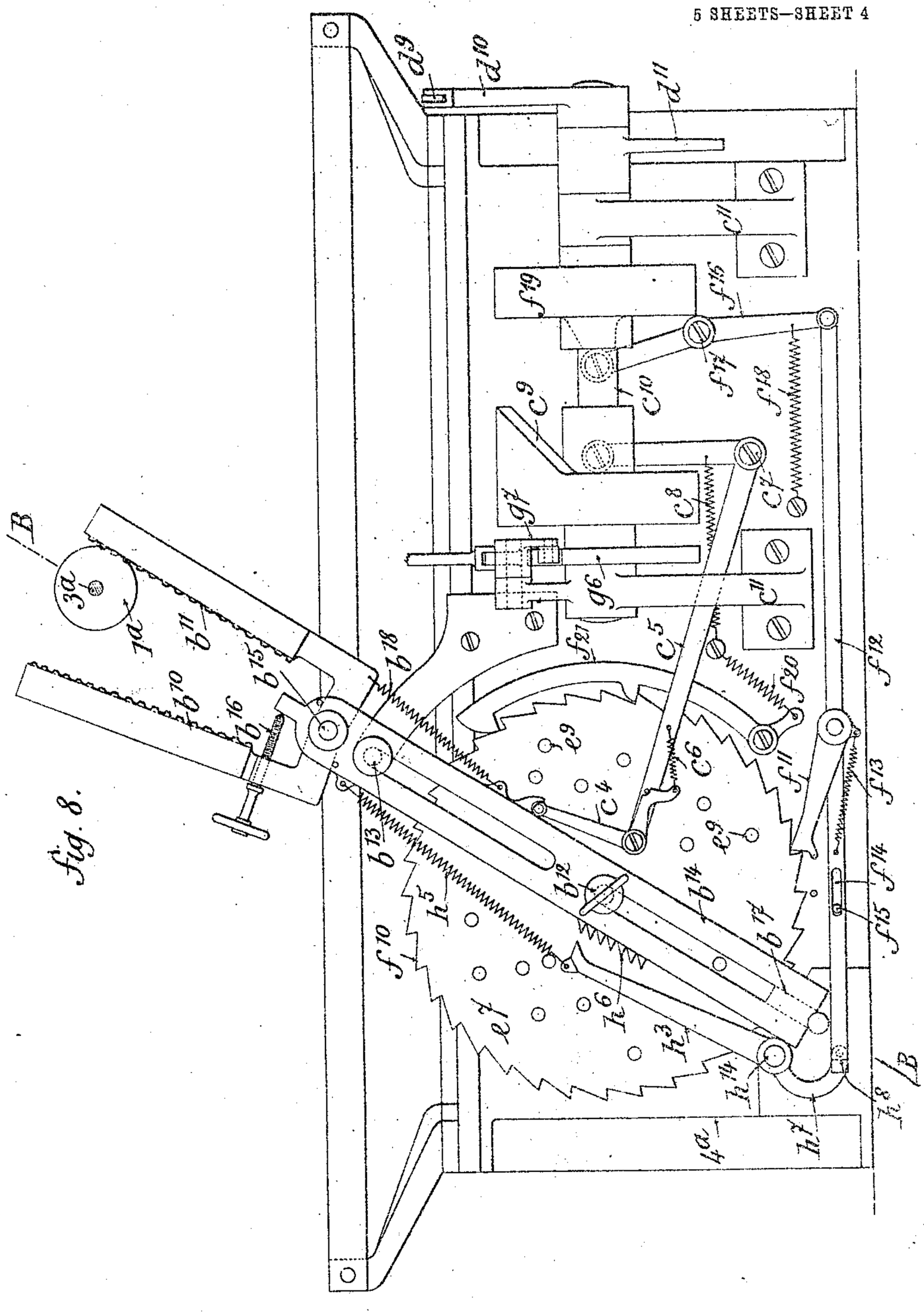

Fig. 8.

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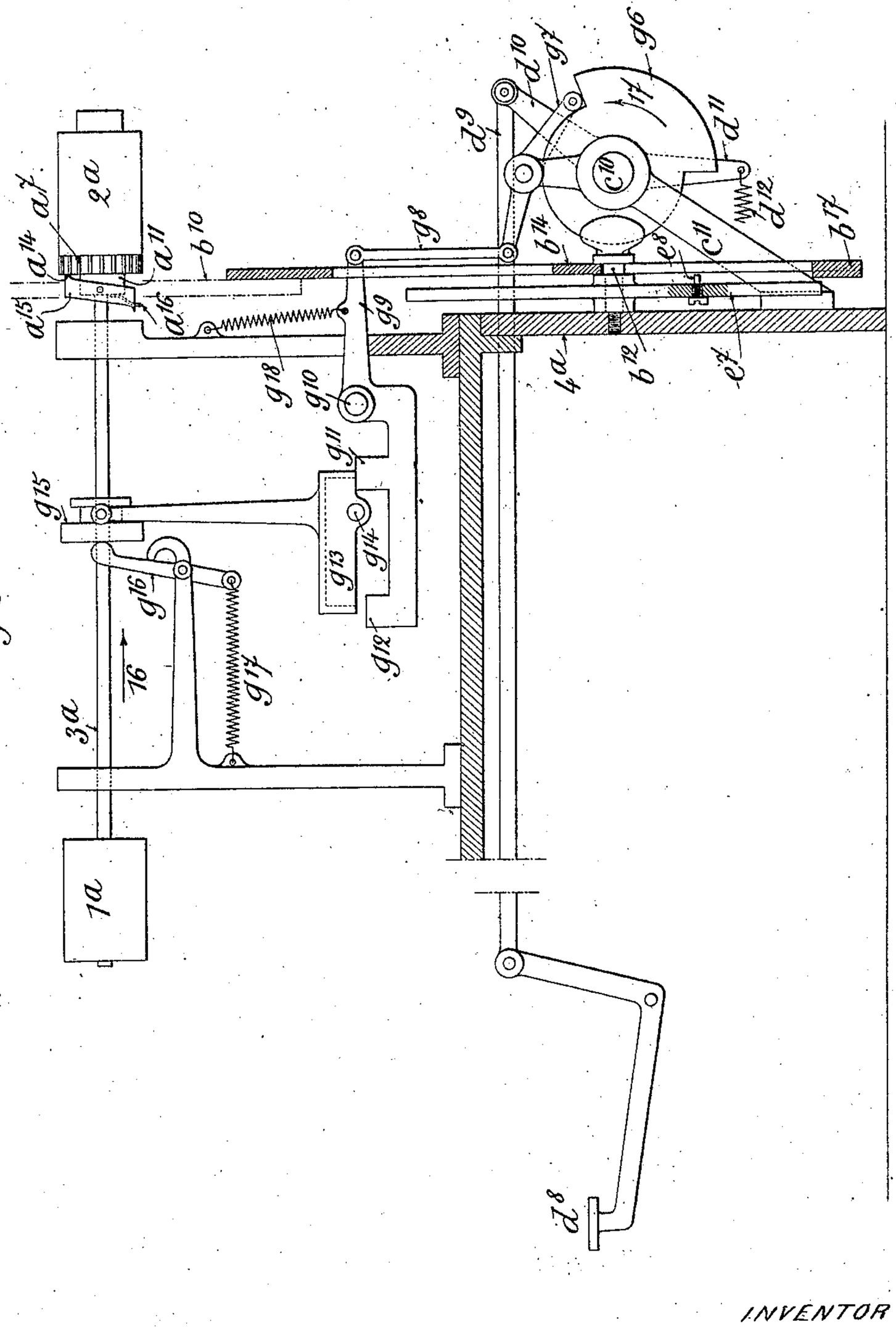
6 SHEETS—SHEET 5.

Fig. 9.



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UNITED STATES PATENT OFFICE.

HUBERT BURG, OF MOLLKIRCH, NEAR ROSHEIM, GERMANY.

CRYPTOGRAPHIC MACHINE.

No. 842,763. Specification of Letters Patent. Patented Jan. 29, 1907.

Application filed August 16, 1905. Serial No. 274,413.

To all whom it may concern:

Be it known that I, HUBERT BURG, a subject of the German Emperor, curate at Mollkirch, near Rosheim, in the Province of Alsace-Lorraine, Germany; have invented certain new and useful Improvements in Cryptographic Machines, of which the following is a specification.

This machine relates to a cryptographic machine designed to be used as an ordinary type-writing machine and so arranged as to enable it to translate a letter-text into a cipher or cryptographic text or a cipher-text into a letter-text.

The invention will be described, by way of example, in its application to a type-writing machine comprising two type-cylinders which are so connected to a key mechanism as to enable them to receive simultaneously from the latter equal movements of translation and rotation before the printing of each type in order to bring a determined type of each cylinder above the printing of point on each of the sheets of paper used. Type-writing machines of this kind are already known in the art.

In this application the invention consists in so fitting one of the cylinders that it may be moved a variable angle with respect to the other cylinder and in combining with the type-writing machine a mechanism which produces a predetermined series of motions of the movable cylinder with respect to the fixed cylinder, the said motions having various values. The said mechanism is, moreover, so fitted as to enable it to produce a same series of motions of the movable cylinder in a determined direction and in the opposite direction in order to allow of the composition of a text in cipher or cryptography and of the translation afterward of the said text into letter-text.

The invention is applicable to a type-writing machine provided with a single type-cylinder; but then the advantage is lost of being able to obtain simultaneously a letter-text and a cipher-text, which is useful for verifying purposes.

In a broader sense the invention is applicable to all type-writing machines in which the type are carried by a circle, even when they are mounted on type-bars or movable levers, and, indeed, all that need be done is to render movable the type-carrying circle and to connect the same with a mechanism of the kind which will be described to produce a predetermined series of various motions of the said circle or of the said cylinder in order to obtain the required discrepancy between the types marked on the keys struck and the types printed.

In the accompanying drawings, Figure 1 is a front elevation of one embodiment of the present invention. Fig. 2 is a plan view of the same. Fig. 3 is a rear elevation of the machine. Fig. 4 is a horizontal section on the line A A of Fig. 1. Fig. 5 is a detail of a type-carrying cylinder. Figs. 6 and 7 show in vertical section and in plan, respectively, a pin-carrying ratchet-disk. Fig. 8 is a rear elevation of a second embodiment of the invention, and Fig. 9 is a part-sectional view on the line B B of Fig. 8.

The type-writing machine which forms a part of the cipher or cryptographic machine (shown in Figs. 1 to 7) is only represented by certain members which are useful as to the comprehension of the invention, and particularly by two type-cylinders 1 and 2, mounted on a shaft 3, journaled in standards 4 5 of the main frame. On the shaft is secured a grooved plate 6, in which is engaged a lever 7, designed to impart a movement of translation to the shaft and to the cylinders 1 and 2.

In the drawings has been left out a key mechanism designed to operate the lever 7, as well as another key mechanism serving to direct the shaft 3, according to the types which are to be printed, because the said mechanisms have no essential relation to the present invention. They may be similar, for instance, to those of the type-writing machine patented in United States on January 18, 1901, No. 681,036.

The cylinder 2, instead of being invariably secured to the shaft 3, as is the cylinder 1, is so mounted as to enable it to revolve between two fixed rings a a', which prevent it from sliding along the shaft. A portion a^2 of the said cylinder is toothed and provided laterally with a series of holes a^3 to receive the nose a^4 of a dog a^5, which serves to lock the cylinder with respect to the shaft. The said dog is pivoted to the ring a', so that on its being engaged in one of the holes a^3 by the action of its spring a^6 (see Fig. 5) it locks the cylinder to the shaft. When the latter is pushed in the direction of the arrow 10, (see Figs. 2 and 5,) the stem of the dog a^5 comes and impinges against the standard 4, so that the nose a^4 is

disengaged from the cylinder and releases the same. When the shaft is brought back again, the dog again locks the cylinder to the shaft.

The mechanism which serves to move the cylinder 2 a predetermined angle previous to each printing operation is as follows: On a stud b, secured to the standard or upright 4, is mounted a lever b', one end of which carries two grooved segments b^3 b^5. On the said lever is secured a plate b^4, provided with two toothed segments b^5 b^6, meshing alternatively with the wheel a^3. For this purpose the plate b^4 is slidable on the lever b' in slideways b^7, and is locked in the one or other of its positions by means of a pin b^8. A spring b^9, attached to the main frame and to the lever b' tends to bring the latter back into its position of rest. (Shown in the drawings.) On the other hand, one end of a chain c, passing over a roll c', can be attached either to the segment b^2 or to the segment b^3, according as to whether the wheel a^2 can mesh with the segment b^5 or with the segment b^6. The other end of the chain is attached to a grooved segment c^2, pivotally mounted on the main frame, as at c^3, in such a manner that the rotation of the said segment in the direction of the arrow 11 (see Figs. 2 and 4) produces, through the medium of the chain c, the rotation of the wheel a^2 in the direction of the arrow 12 or the arrow 13, according as to whether the segment b^5 or the segment b^6 is put in mesh with the said wheel. The segment c^2 receives a rocking motion of variable extent by the action of the hand of the operator on a lever d, located alongside the keyboard of the type-writing machine. For that purpose the lever d carries a grooved segment d', which is connected by a chain d^2 to a grooved disk d^3, loosely mounted on the stud c^3 and provided with a pin d^4, arranged to meet with and carry forward the segment c^2 in the direction of the arrow 11. Another chain d^5 connects the disk d^3 with a balance d^6, fitted to a fixed stud $b^\times$ and subjected to the action of a retracting spring d^7, so as to retract the disk and the lever d into the position of rest (shown in the drawings) when the operator releases the lever d. The extent of the rocking or swinging motion of the segment c^2 is limited in a variable manner by means of a pin e, secured thereto and arranged to meet with the stop-pins e', secured to a ratchet-disk e^2. Through the effect of a mechanism hereinafter described the disk e^2 is moved forward to the extent of a tooth each time the lever d is operated, so that a fresh pin e' presents itself each time in front of the pin e to limit its stroke, and consequently the swinging motion of the segments c^2 b^2 b^3 b^5 b^6, as well as that of the cylinder 2, so the latter can, as will be better understood farther on, be subjected to a series of motions, the values of which depend on the position of the pins e'. In order to be able to vary the position of the said pins at will, use is made of a disk e^2, provided with holes e^3 at all the intersections of the circles concentric to c^2 and of the arcs of a circle described by the pin e, and there is placed on each of the said arcs of a circle a pin in any one of the corresponding holes. The pins e' are preferably provided with heads and maintained in place by a disk e^4, forming a lid, so that they can be easily withdrawn and changed as to the holes they are in.

The forward motion of the ratchet-disk is produced by means of a pawl f, operated by the following device: On a plate f', secured to the main frame, is mounted a stud f^2, carrying a lever f^3, to which the pawl f is pivoted, and another lever f^4, on which is mounted a swinging finger f^5, the end of which can be met with by a pin f^6, integral with the disk d^3, whereby when the said disk moves in the direction of the arrow 11 the pin f^6 carries forward first the finger f^5 and then with the latter the lever f^4 through the medium of an impinging-pin f^7. The stud f^2 and the lever f^3 then revolve in the direction of the arrow 14 and pull the pawl f, so as to cause the disk e^2 to move forward to the extent of a tooth. Then the pin f^6, passing the finger f^5 and releasing the same, is enabled to continue its way without further displacement of the pawl f. When the disk d^3 comes back to its position of rest by the action of the spring d through the medium of d^6 d^5, the pin f^6 slides against the finger f^5 and pushes the same in spite of the tension of the spring f^8, but without operating the pawl. The ratchet-disk is prevented from revolving backward by a retaining-pawl f^9, subjected to the action of a spring f^{10}.

In the position of rest of the shaft 3 the wheel a^2 is separated from the segments b^5 b^6 of the lever b', as shown in Fig. 2, in order that the rotation of the cylinders 1 and 2 and of the shaft 3 may take place in the usual manner under the influence of the key mechanism of the type-writing machine. It is therefore necessary to put the wheel a^2 in and out of gear successively with the segments b^5 or b^6. This result is obtained as follows: On the disk d^3 is formed a cam g, arranged to act on a roll g', mounted on the lever g^2, one end of which is pivoted to the main frame and of which the other end is connected by a chain g^3 to the lever 7. As soon as the operator acts on the lever d in the direction of the arrow 15 the disk d^3 revolves and the cam g causes the lever g^2 to swing in such a manner that the lever 7 carries the shaft 3 in the direction of the arrow 10. The wheel a^2 is thus brought into mesh with one of the segments b^5 b^6. Then the dog a^5 impinges against the upright 4 and sets the wheel a^2 free and enables the same to be revolved, with the cylinder 2, by the segment b^5 or b^6 independently of the shaft 3 and of the cylinder 1. During the

further rotation of the disk d^3 in the direction of the arrow 11 the roll g' runs on the circular portion of the disk. Consequently the lever g^2 is kept away, and the wheel a^2 remains in mesh with the segment b^5 or b^6, which at that moment is moved to a certain extent on account of the segment c^2 being carried forward by the pin d^4 until one of the pins e' stops the pin e and the divers members which are in motion. Afterward when the disk d^3 is allowed to come back into its position of rest under the action of the spring d^7 it is indispensable to prevent the segment b^5 or b^6 from causing the wheel a^2 from revolving in a direction opposite to that of the previous movement. For that purpose there is arranged under the plate f' a retaining-pawl h, which under the action of a spring acts on a ratchet-wheel h', formed on the segment c^2, so that in spite of the retracting action of the spring b^9 the segments b^5 and b^6, the chain c, and the segment c^2 are not brought backward when the disk d^3 itself recedes. Toward the close of the return movement of the latter the cam g is presented in front of the roll g' and allows a spring g^4 to bring the lever 7, the chain g^3, and the lever g^2 back into their positions of rest, so that the shaft 3 is pushed back and the wheel a^2 moved away from the segment b^5 or b^6. It is only after the wheel a^2 has been moved away that the pin d^4, secured to the disk d^3, comes onto an inclined plane h^2 of the pawl h and moves the latter away from the teeth h'. Then the spring b^9 brings the segments b^5 b^6 back into the position of rest shown in Fig. 3.

From the foregoing it will be understood that if the lever d is operated several times in succession there will be produced a series of movements of the cylinder 2 from the temporary initial direction relatively to the cylinder 1, these movements taking place in the same direction, being of different values and being added to one another. The term "temporary initial direction" means the position occupied by the cylinder before the operator presses one of the keys of the keyboard. If after each of these unsetting movements the keys of the type-writing machine are so acted upon as to bring the cylinder 1 into the proper position for the printing of a determined type, the cylinder 2 is at the same time brought into such a position that the type put in front of the printing-point will vary each time. In other words, to any letter—"x" for instance—of the row I of the cylinder 1 may correspond alternatively all the types of the corresponding row I of the cylinder 2 in any order whatever.

To write in cryptography or cipher, use is made of one of the segments—b^5, for instance—in so locating the plate b^4 on the lever b' that the said segment will be enabled to mesh with the wheel a^2. The unsetting movements then take place in a certain direction. The cylinder 1, corresponding to the keys of the keyboard, furnishes a letter-text, and the cylinder 2 furnishes a cipher or cryptographic text. On the contrary, when it is required to translate or transfer a cipher-text the plate b^4 is so located that the other segment—b^6, for example—will operate the wheel a^2. The operator acts on the keys of the type-writing machine in following the cipher-text. The cylinder 1 then gives a reproduction of the said text, while the cylinder 2 furnishes a translation in letter-text. It will be understood that when the cylinders are used in the reverse order the direction of the unsetting movements must be reversed also to obtain the required result.

In order that the translation shall be suitable, the machines used for sending and receiving must of course be identical, and the several members of parts of the same must be located identically at the beginning of the transcription of a text. It is therefore necessary that the initial relative setting of the cylinders shall be agreed upon beforehand or indicated otherwise, that the position of the pin-disk e^2 shall be agreed upon beforehand or indicated, and that the arrangement of the pins shall be the same in both machines.

In order to increase the number of possible combinations and the security of the correspondence, the cylinders 1 2 may each be made of several movable parts—for instance, of several type-disks—the relative positions of which may be varied at will. Furthermore, the initial position of the disk e^2 may be determined by means of a hand e^5, pivoted on a fixed ciphered dial e^6 and the end of which moves on a ciphered graduation of the disk e^2. Finally, the pins e' may be secured to the disk e^2 in a variable manner, as hereinbefore described.

In the embodiment of the invention shown in Figs. 8 and 9, where the members or parts of the "type-writing machine," properly so called, are supposed to be arranged in the same manner as in the previous case, the toothed segments b^5 b^6 are replaced by toothed racks b^{10} b^{11}, moving in straight lines, and the means for operating the segments, for displacing the shaft of the cylinders, for varying the extent of the unlocking motions of the cylinder 2, and the like are replaced by means which are substantially equivalent. 1^a and 2^a designate the cylinders, one of which is fixedly mounted on the shaft 3^a and the other loosely mounted on the same. In the rear part of the main frame 4^a are secured two pins b^{12} b^{13}, engaged in the longitudinal slideways of a plate b^{14}, at the upper end of which the racks b^{10} b^{11} are carried on a stud b^{15}. The said racks are stamped out of a single piece of metal and are enabled to so swing around the stud b^{15} as to mesh alternatively with a pinion a^7, secured to the cylinder 2^a. The position of the said racks is regulated by means

of a screw b^{16} acting against the tension of a spring b^{18}, as is clearly shown in Fig. 8. The slidable plate b^{14} can be raised by means of a dog c^4, pivoted to a bent lever c^5, and subjected to the action of a spring c^6. The lever c^5 swings around a stud c^7, secured to the main frame, and is applied by a spring c^8 against a cam c^9, secured to a rock-shaft c^{10}. The latter, carried in bearings c^{11}, is operated from a key d^8 through the medium of a link d^9 and of a lever d^{10}, secured to the end of the shaft. It carries also a lever d^{11}, connected by a spring d^{12} to the main frame in such a manner as to return the shaft c^{10} and the connected parts into the position shown in the drawings when the key d^8 is released. On the stud b^{12} is pivoted a disk e^7, carrying the pins e^8. The latter are screwed into the holes e^9, arranged in radial rows in the disk, and the plate b^{14} is provided with a heel b^{17}, arranged to come into the path of the said pins. When the operator moves the key d^8 down, and thus causes the shaft c^{10} to swing, the cam c^9 pushes the lever c^5, which raises, by means of its dog c^4, the plate b^{14} until the heel b^{17} meets with one of the pins e^8. The said members or parts are thus stopped rigidly. Around the disk e^7 are formed the ratchet-teeth f^{10}, on which acts a pawl f^{11}, mounted on a movable rod f^{12} and raised by a spring f^{13}. The rod f^{12} is guided in a slideway f^{14} on a fixed stud f^{15} and is pivoted to a lever f^{16}, swinging on a fixed stud f^{17}. The said lever is pressed by a spring f^{18} against a cam f^{19}, secured to the shaft c^{10}, whereby each time the shaft c^{10} is revolved in an inverse direction to that of the arrow 17 the pawl f^{11} is pulled back and takes hold of a fresh tooth of the disk. When the shaft is revolved in the direction of the arrow 17 by the downward pressure exercised on the key d^8, the pawl f^{11}, pushed by the action of the spring f^{18}, causes the disk to revolve to the extent of a tooth. A retaining-pawl f^{21}, pressed against the teeth f^{10} by a spring f^{20}, prevents the disk from turning backward when the pawl f^{11} moves back. When the machine is at rest, the pinion a^7 does not lie in the plane of the racks b^{10} b^{11}. To bring it into the said plane, the following device is used. The shaft c^{10} carries a cam g^6, acting on a swinging lever g^7, connected by a link g^8 to another lever g^9, which swings on a fixed stud g^{10}. The said lever acts by means of two projections g^{11} g^{12} on a T-shaped piece g^{13}, swinging on a fixed stud g^{14}. The end of the said piece is engaged in a grooved disk g^{15}, secured to the shaft 3^a. Against the said disk acts a lever g^{16}, pulled by a spring g^{17}, so that the shaft 3^a is normally pushed in the direction of the arrow 16, and the pinion a^7 is moved away from the racks. When the cam g^6 pushes the lever g^7, the lever g^9 causes the T-shaped piece g^{13} to swing and to thus displace the shaft 3^a in an inverse direction to that of the arrow 16, so that the pinion a^7 meshes with one of the racks b^{10} b^{11}. When the cam g^6 returns to its initial position, the lever g^9 is brought to rest by a spring g^{18}, and the disk g^{15}, the shaft 3^a, a pinion a^7, and the piece g^{13} are brought to rest by a spring g^{17}. As in the embodiment described in the first instance, the cylinder 2^a is normally engaged with the shaft 3^a by means of a dog a^{15}, which is mounted on the ring a^{11}, and the nose a^{14} of which is engaged in the holes a^{13} of the cylinder under the influence of a spring a^{16}. When the shaft 3^a is displaced in a direction inverse to that of the arrow, the dog a^{15} impinges against the main frame and moves up straight, so as to remove the nose a^{14} from the holes a^{13}. The cylinder 2^a is then free to turn independently of the cylinder 1^a. To hold the plate b^{14} up until the pinion a^7 is out of gear with the rack b^{10} or b^{11}, a pawl h^3 is arranged on a fixed stud h^4 and pressed by a spring h^5 against inclined teeth h^6 of the plate b^{14}. The said pawl has a stem h^7 arranged in the path of a heel-piece h^8 of the rod f^{12}.

The operation is as follows: When the operator acts on the key d^8, he causes the shaft c^{10} to swing in the direction of the arrow 17. This swinging motion causes the cams f^9, g^6, and c^9 to operate successively the levers f^{16}, g^7, and c^5, whereby the disk e^7 is first turned to the extent of a tooth by the pawl f^{11}. At the same time the stem h^7 of the pawl h^3 is released by the heel-piece h^8, so that the pawl is applied against the plate b^{14}. Then the shaft 3^a is displaced through the medium of g^7 g^8 g^9 g^{13}, so that the pinion a^7 meshes with either of the racks b^{10} b^{11}. Finally, the plate b^{14} is raised, through the medium of c^5 c^4, until the heel-piece b^{17} strikes one of the pins e^8. The cylinder 2^a is thus revolved by the rack b^{10} or the rack b^{11} to an extent which corresponds to the position of the pin which has been struck. The operator then releases the key d^8, and the members of parts return to their initial positions as follows: The spring d^{12} causes the shaft c^{10} to move back in the first place. The pinion a^7 moves out of gear with the rack b^{10} or b^{11} under the action of the spring c^8. The pawl c^4 moves down under the action of the spring e^8; but the plate b^{14} remains held up by the pawl h^3. Then the rod f^{12} moves back under the action of the spring f^{18}, so that the pawl f^{11} takes hold of another tooth of the disk e^7. Finally, the heel-piece h^8 of the rod f^{12} strikes the stem h^7 of the pawl h^3 and causes the same to release the plate b^{14}, so that the latter moves down under the action of the spring h^5. The mechanism is then ready to operate again as just described.

It will be evident that without departing from the present invention the structural arrangements of the several members or parts of the hereinbefore-described mechanism may be modified—as, for instance, the means to produce the displacement of the

shaft 3 or 3^a, the movement of the cylinder 2 or 2^a into gear or out of gear, the variation in the extent of the unsetting movement of the cylinder, and the like may be replaced by any other equivalent means; nor is it necessary, furthermore, that the unsetting movements shall all be made either in the same direction or accumulated. Some of the said movements may be positive and others may be substractive. The cylinders may also be so fitted that after each unsetting movement they shall take up a relative position which is invariable.

In the embodiment of the invention shown and described the mechanism is operated by hand through the medium of a lever *d* or of a key d^8. These operative means may be replaced by any other suitable means—such, for instance, as any one of the members or parts of the type-writing machine which shall be put in motion after the printing of each type or after the printing of a certain number of types or the like.

I claim—

1. In a cryptographic machine, having a keyboard, a revolving type-cylinder, and means for causing the said cylinder to swing, as from a temporary initial position, predetermined distances corresponding to each key of the keyboard, the combination of a disk having holes arranged according to several concentric circles and in radial rows, pins fixed in the said holes, at the rate of one pin for each radial row of holes, a member movable in a radial or nearly radial direction and adapted to impinge on the said pins successively, in having on that account, each time, a different amount of motion, and means for changing the temporary initial direction of the cylinder to a variable extent corresponding to the amount of motion of the said movable member each time the latter is moved to a fresh pin of the disk.

2. In a cryptographic machine, the combination of a type-cylinder, a toothed wheel coacting with the said cylinder, of a slidable plate, a fork with toothed arms and jointed upon the said plate, means for adjusting the position of the said fork upon the plate so as to engage the one or the other arm with the type-cylinder, means for reciprocating the said plate, and a disk having pins on its face for limiting the movement of the plate.

3. In a cryptographic machine, the combination of a keyboard, a shaft in operative connection with the keys of the said keyboard, two type-cylinders on the said shaft, one of the cylinders adapted for moving invariably in the same direction with respect to the shaft, and the other cylinder adapted for moving in a variable direction with respect to the shaft, and means for changing the direction in which the latter cylinder moves with respect to the shaft.

In testimony that I claim the foregoing as my invention I have signed my name in presence of two subscribing witnesses.

HUBERT BURG.

Witnesses:
HANSON C. COXE,
MAURICE ROUX.