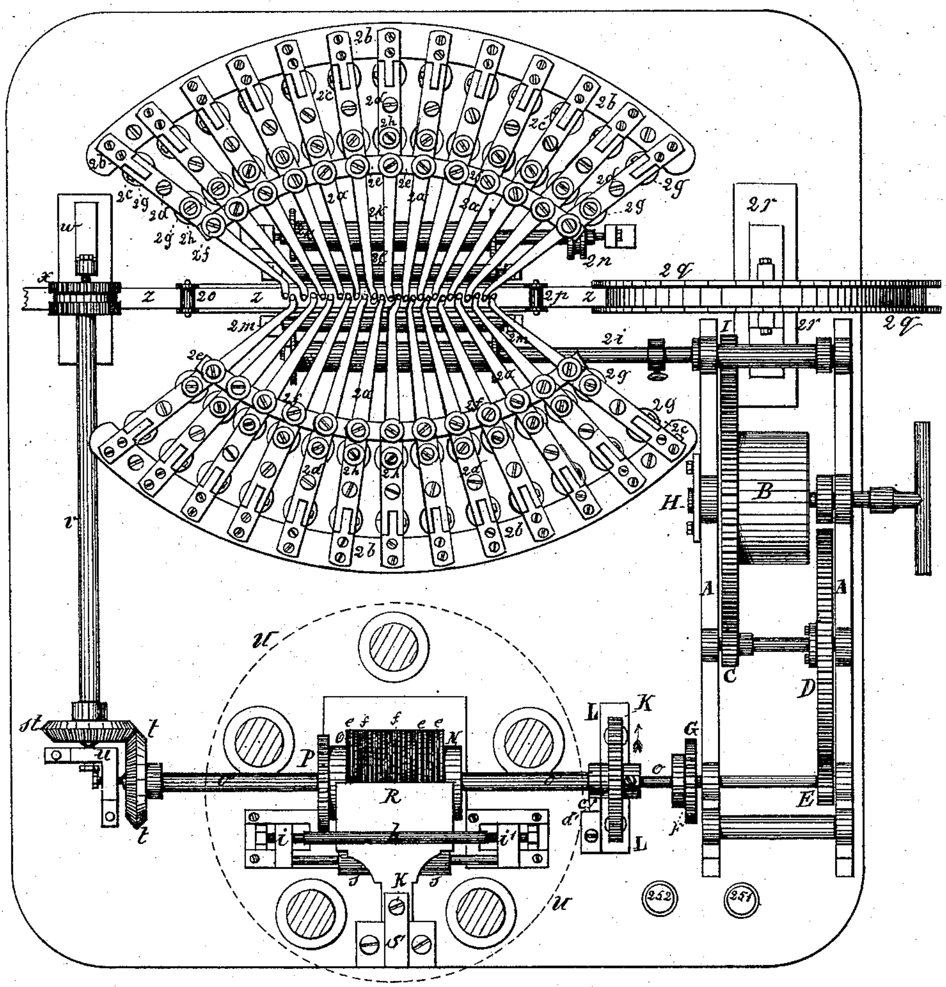
H. R. M. J. HANSEN & C. P. JURGENSEN.

Electro-Mechanical Printing-Instrument.

No. 163,190. Patented May 11, 1875.

Fig. 1.



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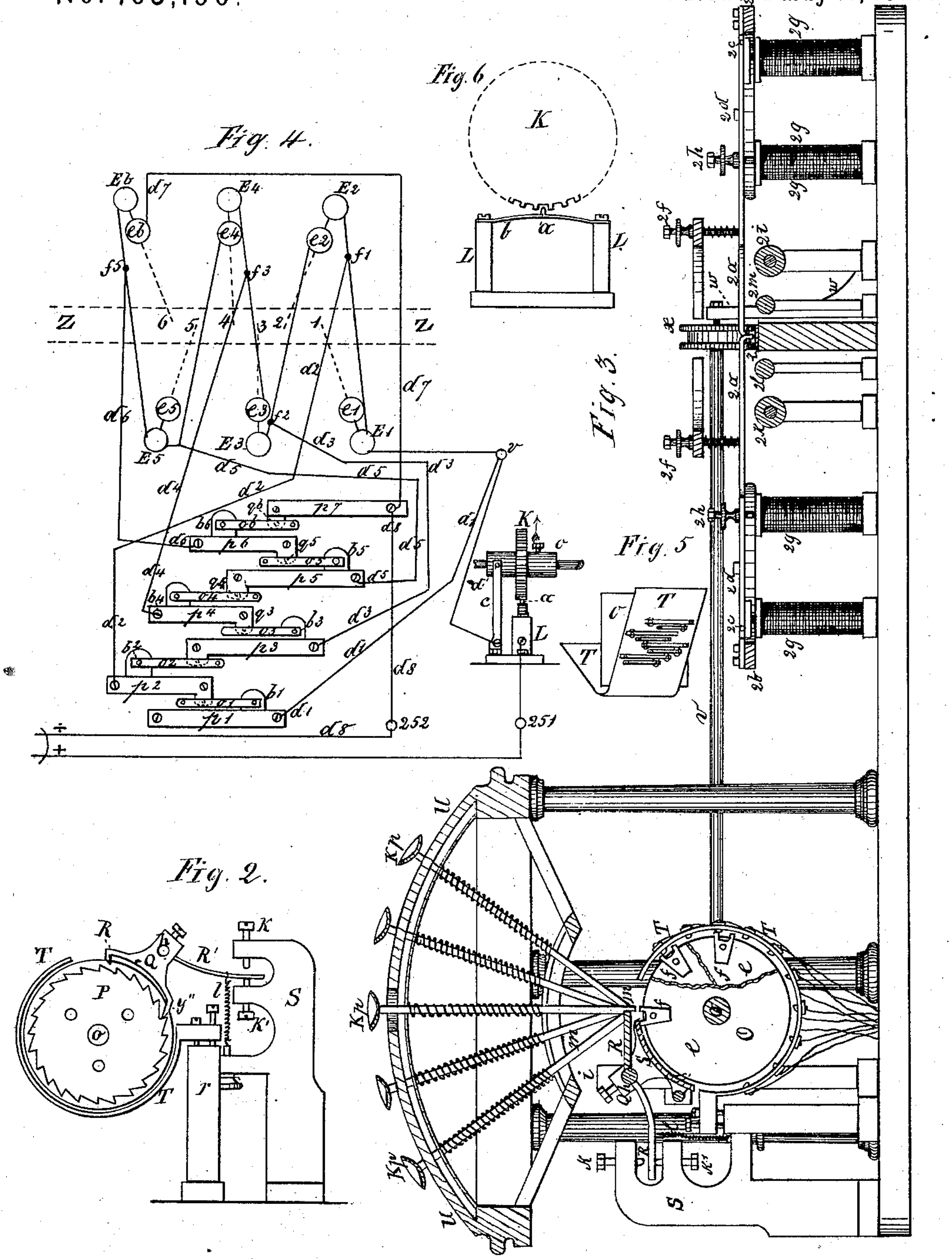
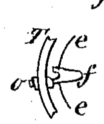


Fig. 7.



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UNITED STATES PATENT OFFICE.

HANS R. M. J. HANSEN AND CHRISTOPHER P. JÜRGENSEN, OF COPENHAGEN, DENMARK.

IMPROVEMENT IN ELECTRO-MECHANICAL PRINTING-INSTRUMENTS.

Specification forming part of Letters Patent No. **163,190**, dated May 11, 1875; application filed February 14, 1874.

To all whom it may concern:

Be it known that we, HANS RASMUS MALLING JOHAN HANSEN and CHRISTOPHER PETER JÜRGENSEN, both of Copenhagen, in the Kingdom of Denmark, have invented a certain Improved Electro-Mechanical Writing-Instrument, of which the following is a specification:

The object of this invention is to report by printing in full, or by any suitable short-hand system, speeches or any oral or other communication. For this purpose we employ an apparatus of the following description. It is illustrated by the accompanying drawings.

Figure 1 is a plan with the writing-ball removed. Fig. 2 is a side elevation of the escapement. Fig. 3 is a longitudinal section of the apparatus; and Fig. 4 is a diagram, showing the arrangement of the contact-pieces on shield T, with the electric circuits and connections; and Figs. 5, 6, and 7 are detail views of separate parts of the apparatus.

A A are two upright frames, between which is placed a clock-work with fusee B, having a tooth-wheel with one hundred and eighty teeth, gearing into a pinion, I, having eighteen teeth, and a pinion, C, having eighteen teeth, also. The spindle of C has a fixed wheel, D, having eighty teeth, gearing into the pinion E, which lies a little lower and has twenty-one teeth. The spindle of E has a pinion, F, having twenty-seven teeth, and gearing into the wheel G, which has thirty-six teeth, and is fixed on the spindle O. This clock-work, the wheels of which, of course, may be varied, drives the spindle O and the wheel K (see Figs. 1, 4, and 6) in the direction of the arrows. Each tooth of this wheel touches the projecting tooth *a*, Fig. 6, on the steel spring *b*, carried by the frame L, which also carries an elastic tongue, *c*, Figs. 1 and 4, insulated by means of india-rubber, and which, by the point *d*, is in constant contact with the nave of the wheel K. The enlarged part of the spindle O, Figs. 1 and 5, has as many metal disks *e* as there are required letters and signs—here twenty-six. The disks are placed at a slight distance apart. (See Figs. 1 and 7.) Between them, all round, are arranged flat sectors or wings *f*, Figs. 3 and 7, which are hung on pins between each two disks. By the side of this disk-cylinder is the escapement-wheel P, Figs. 1 and 2, into which gears the escapement Q, hung on its axis *h* on the standards $i\ i^1$. This axis has a plate, R, Figs. 1, 2, and 3, fixed to it, a prolongation of which passes between two screws, k and k^1, on the frame S. These screws serve to regulate the movement of the escapement, which each time is drawn back into the position of rest by the spiral spring *t*. The five columns which are arranged round the disk-cylinder, and which are shown in section on Fig. 1, carry the ball U, Figs. 3 and 4, having a series of keys, *m m*, the lower points of which all lie in a straight line, $n\ n^1$, close over the disk-cylinder on O, Fig. 1. Each point is right over a corner of one of the said sector-pieces *f*, Fig. 6. The keys are held in position of rest by spiral springs, Fig. 3, and have a knob, K *p*, to receive the finger-pressure of the writer. Each knob has a letter, number, or sign corresponding to the type-lever system presently to be described. The form of the key-points is as shown at Figs. 3 and 6, whereby the edge of a point each time it is struck hits the plate R, while the extreme lower point hits one corner of one of the sectors *f*, depressing same, and thereby raising the other corner. The depression of the plate R causes the movement of the escapement.

The disk-cylinder is partly surrounded by a shield, T, carried by the standard *r*, Fig. 2, Fig. 7, and Fig. 3. The shield has a series of metallic current-contacts, which close or, according to circumstances, break the electric current during the working of the apparatus. They are shown at Fig. 5, and to an enlarged scale at Fig. 4. They are all insulated from the shield by india-rubber. The electric current (direction left out of question) enters the metal piece p^1 at bottom of Fig. 4, then passes into the thereto-connected piece b^1, thence into the steel spring o^1, which at one end is screwed fast to b^1, and at the other or free end (marked by a double circle) has a small ivory point, Fig. 7, which passes through a hole in the shield T. When one of the sectors *f*, by pressure on the keys during the movement of the disk-cylinder, touches the aforesaid ivory point, then the spring o^1 is raised a little, so that it, till the sector *f* has passed by, does not rest on little metal point q^1 on p^2, and the electric current is broken. On the other hand, when the apparatus is at rest, and the spring o^1 rests on the point q^1, then the current passes from the spring o^1, through the point q^1; thence through p^2 b^2, the spring o^2, (which, like o^1 o^2 o^4, &c., protrudes through the shield T,) from the spring o^2, through the point q^2, through p^3 b^3 o^3 q^3, &c. The shield T has as many springs, o^1 o^2 o^2 to o^{26}, as the ball U has keys. The free end of each spring stands, while the apparatus is at rest, with its ivory point right over its sector *f*, and between its pair of disks *e*, in diagonal direction around the disk-cylinder; hence, for instance, the end of the spring o^2, Fig. 4, stands the distance of one sector before the spring o^1, and also the width of one disk to the right of the end of the spring o^1. *s s*, Fig. 1, is a drum between the standards *i* i^1. It presses lightly against the disk-cylinder on *o*, so that the corners of the sectors *f*, pushed forward by pressing on the keys, are pressed back into their position of rest, passing by this drum.

The spindle O, Fig. 1, has its bearing on the left-hand side in a bracket, *u*, and has a bevel-wheel, *t*, gearing into wheel *s t*, which is fast on the spindle *v*, having its bearings in the brackets *u* and *w*. This spindle carries a roller, *x*, with milled edge, which drags the paper band Z along, winding it off the roll 2*q*. The bracket *w* also carries another roller with milled edge, (not seen on the drawing,) which is beneath the roller *x*, and by a spiral spring is pressed up against the under side of the paper band to assist its action.

The apparatus has a series of electro-magnets, 2*g*, which are placed in two half-circles, twenty-six electro-magnets in all, corresponding to the twenty-six keys in the ball U, and to the twenty-six spaces between the disk. The latter may have a larger number, the ball more keys, and the number of electro-magnets may be larger in accordance. The long metal arms 2*a* at one end are fastened to the curved flanges 2*b*, and are jointed at 2*c*. The armatures 2*d* are fastened to the under side of the arms 2*a*. The curved flanges have screws 2*f*, each with a spiral spring below, (not shown on the drawing,) which keeps the arm 2*a* and armature up from the electro-magnets. 2*h* are regulating-screws, the lower points of which touch each its arm, and thus prevent the spiral springs from drawing the arm 2*a* too far up from the electro-magnets.

On the under side of the end of each arm which reaches over the paper band a type is applied, which is printed on the paper band each time the electro-magnet attracts the armature. 2*i*, Fig. 1, is a roller moved by the wheel I, and round which is wound a carbonized piece of paper, which is wound off the movable roller 2*k*. This carbonized band goes under the types and over the two small rollers 2*l* and 2*m*, which hold the band at a short distance from the paper band Z. When the carbonized band is wound on the roller 2*i*, the latter is pushed a little to one side, so as to be out of gear with the wheel I. Thereupon, by turning the mill-edged screw 2*n*, the carbonized paper runs off the roller 2*i* and onto the roller 2*k*. 2*o* and 2*p* are two small rollers, which hold the paper band *z* down against a bench, which the paper glides over, under the types. 2*q* is a roller, off which the paper band is rolled. It runs on two center-points on the bracket 2*r*. Fig. 4 shows particularly the mode of applying the wires, and the motion and breaking of the currents. To make the drawing clear, only six pairs of electro-magnets, with their six sets of contact-pieces, (to an enlarged scale,) are shown. E^1 e^1, Fig. 9, is then the first electro-magnet couple, the same which, in Fig. 1, is denoted by 2*g*. A dotted ascending line from e^1 denotes the arm 2*a* on Fig. 1, at the end of which is the number 1, denoting that this arm at its point has a type with the number 1 on, which can be printed onto the paper band Z, (dotted.) E^2 e^2 is the second electro-magnet, the arm of which can print the number 2 on the band *z*, and so on. It is then here, for the sake of clearness, assumed that the machine prints numbers, and not letters. The contact-pieces p^1 b^1 o^1 q^1 p^2, &c., drawn to an enlarged scale, have already been explained.

We will now describe the wire-connections on Fig. 4. From any positive pole of an electric battery a wire passes through the pinching-screw 251, Figs. 4 and 1, to the frame L, Figs. 4, 1, and 6, whence there is connection through the arched spring *b*, Fig. 6, to the tooth *a*, Figs. 4 and 6. When the apparatus is at rest the tooth *a* is between two teeth in the wheel K; but if one of the pistons *m* in the ball U be depressed, then the tooth *a* touches the point of one of the teeth in wheel K, and connection is established from K through the spindle O, the point *d*, the spring *c*, and thence through wire to the screw *v*, whence two wires pass on farther. The one goes to the electro-magnet E^1, winds round it, goes to e^1, round the same to E^2, round the same to e^2, thence to E^3, &c., to e^6, round the same, thence as d^7 to the pinching-screw on the contact-piece p^7, thence as d^8 to the negative pole of the battery. The other wire coming from the pinching-screw *v*, Fig. 4, goes as d^1 to the contact-piece p^1. A wire, d^2, next leads from p^2 to the wire which unites e^1 and E^2. A wire, d^3, goes from p^3 to the connecting-wire between e^2 and E^3, &c.

We will now describe the direction of current during the interruption of contact on the shield T, Fig. 4. When one or more of the springs *o* o^1 o^2 o^3, &c., while the machine is at work, is raised by the sector piece or pieces *f* in question, whereby the connection between the raised spring or springs *o* and the contact-point q is broken off, then, as long as this connection is interrupted, the tooth a stands on one of the teeth of the wheel K, and the electric current passes through this way, as will be presently further explained.

For instance: Supposing the spring o^1 be raised by one of the sectors f, which passes under it when the spring o^1 is raised, then the connection between o^1 and the point q^1 is interrupted, while the connection is established between the tooth a and the wheel K. The current hence goes from the positive pole through L, Fig. 4, the tooth a, wheel K, spring c, and through the wire to E^1, through the coils of the electro-magnets E^1 e^1. The armature then is attracted, and the arm prints the number 1 on the paper band; from e^1 the current goes to f^2; thence through d^2 p^2 o^2 q^2 p^3 b^3, &c., through all the contact-pieces of the shield to p^7; thence through the wire d^8 over the negative pole of the battery.

Second example: The spring o^6 is raised; hence the connection interrupted between o^6 and q^6, the current passing from the positive pole through L a k d c, wire V d^1 p^1 b^1 o^1 q^1 p^2 b^2 o^2 q^2 p^6, through wire d^6 to f^5, through the coils E^6 c^6; the armature closes, and the number 6 is printed on the paper band, whence the current passes through d^7, the screw on p^7, and the wire d^8, into the negative pole.

Third example: The springs o^2 and o^3 are raised simultaneously; the current then passes from the positive pole the way just described to the screw V; thence through d^1 p^1 b^1 o^1 q^1 p^2, through the wire d^2 to f^1; through the electro magnet coils E^2 e^2; through the junction-wire between e^2 and E^3; through the electro-magnet coils E^3 e^3. Both armatures of the electro-magnets are thus simultaneously attracted, and the numbers 2 and 3 printed on the paper band. From e^3 the current goes through f^3 d^4 p^4 b^4 o^4 p^7 d^8 and battery.

Fourth example: The springs o^2 and o^4 are raised simultaneously. The current then passes through L a K O d c; wire V d^1 p^1 b^1 o^1 q^1 p^2 d^2 f^1; coils E^2 e^2; from e^2 to f^2; through d^3 to p^3 b^3 o^3 q^3 p^4; wire d^4 f^3; through the coils on E^4 e^4, (the numbers 2 and 4 hence printed together;) through f^4 d^5 p^5 b^5 o^5 q^5 p^6 p^7 d^8, battery.

Fifth example: All springs raised simultaneously by the sector-pieces corresponding thereto. After that the current, by the usual route, has come to the screw V. It passes to E^1, and thence through all the electro-magnets, (hence all the armature-arms printing their respective numbers on the paper band, producing the number 654321;) from e^6 to e^7, the screw on p^7, and through d^8 into the battery.

Sixth example: The tooth a stands on one of the teeth of the wheel K, while at the same time all the contact-springs are in position of rest, or all down. The current then passes to L; through a K O d c V d^1 p^1 b^1 o^1 q^1, &c.; through all the contact-pieces to p^7, and thence through d^8 to the battery. The current in this case does not come to the electro-magnets; hence no printing takes place.

We will now describe the process of writing or printing by the means of this apparatus: When the apparatus is at rest the tooth a stands between two teeth of wheel K, and does not touch K; hence the circuit from the battery is broken at this place. Secondly, the lower arm y, Fig. 2, of the escapement stands against the wheel P, and prevents the clock-spring from moving the apparatus.

We now propose to write the number 6132, and we use a machine having six keys, as at Fig. 9.

First, then, the knob on piston 6 is depressed on the ball U, Fig. 3; the consequence of this is—

First, the lower edge of the piston 6 depresses the plate R, Figs. 2 and 6.

Second, the extreme lower point of the said piston depresses the rear corner of the wing f underneath, Fig. 6, thereby slightly tilting up the front corner.

Third, the plate R being depressed, the escapement is moved, the arm y of same slips out of the wheel, while the upper arm catches in between two teeth of the wheel P.

Fourth, during the said escapement movement the clock-spring acts momentarily, first, driving the axle O, the wheel K, and the disk cylinder (on which now a corner of the sector for piston 6 is pushed forward) half an escapement-tooth forward—not more, because the upper escapement-arm falls in and stops further movement; secondly, the paper band z is drawn half a letter width forward by the wheel and axis for that purpose.

Fifth, the wheel K moving half a tooth, the tooth a comes to rest on one of the flat teeth of the wheel, and hence.

Sixth, the circuit is closed through L and the tooth a; all the contact-springs, o^1 o^2, &c., being at rest, the current passes the way described in example 6; hence no movement of the armature and no printing.

All the time, then, as long as the piston 6 is kept down, the apparatus continues in the described state; but when it is let go, then the following takes place:

First. The piston 6 is forced up again by its spring.

Second. The spring l, Fig. 2, draws the plate R up in position of rest.

Third. The plate R thereby draws the upper escapement-arm, Fig. 2, out of the teeth on P, and the lower arm y catches into the wheel.

Fourth. The clock-spring meanwhile drives all the movable parts of the apparatus half a step forward.

Fifth. Wheel K is hence also moved half a tooth forward, and the tooth a comes again between two teeth, but without touching.

Sixth. Hence the circuit is broken again.

As just described, the movable parts of the apparatus have made two half-steps forward, and hence the sector and the disk-cylinder also a whole forward step.

On now depressing the knob 1, and letting go again, the same movements and the same circuit are produced as described, without producing any impression on the paper band.

After letting go of the piston 1, the sector of which one corner was pushed forward by depressing piston 6 has gone two steps forward, while the sector of which one corner was pushed forward or upward by depressing piston 1 has gone one step forward. The piston 6 is hence first depressed, then the piston 1, then piston 3, and then piston 2. The first-moved sector has thus now been moved four steps, the second sector three steps, the third sector two steps, and the fourth sector one step.

On writing further—that is, depressing the following keys—the sector-corner raised by piston 1 reaches its spring o^1, touches the ivory point, and raises the spring o^1, so as to bring it out of contact with the point q^1. This interruption of the connection between o^1 and q^1 happens just at the same time that a piston during the writing is depressed. The current must, hence, now go the route described at example 1, and the armature-arm then prints the number 1 on the paper band. Only, after having depressed two more keys, then, during the third down-stroke, the two springs o^3 and o^2 are raised at the same time by their sectors, and the current in the same instant passes the route described at example 3; hence the numbers 3 and 2 are printed at the same time on the paper band, which now contains the three letters 1, 2, and 3. The number 6, the piston of which was first depressed, is still wanting; but by merely depressing a piston, *m*, the spring o^6 is reached and raised by the sector-point pushed forth by at first depressing the piston 6. The current then passes along the route indicated at example 2 of the number 6, is now printed on the paper band in front of the number 1, as desired, giving the number 6132. The writer then strikes the knobs in the order they are to be printed; but the armature-arms print first the number 1, whereupon the disk-cylinder moves two steps forward without printing; then the letters 3 and 2 are printed simultaneously, and then the number 6; but the letters, nevertheless, stand in the right order when printed. With ordinary writing, same as with depression of the pistons of the writing-ball, the order of time of the letters—that is, the order in which they are written—is just the same as the order in which they appear on the paper; but it is not so here, as the order in which the letters appear does not coincide with the order of printing of these letters by the machine, as just described.

For further elucidation of this circumstance we must further remark:

If the arrangement of the piston-points is as follows:

o	*q*	*y*	*u*	*w*	*a*	*e*	*i*	*j*	*c*	*x*	*z*	*h*
1	2	3	4	5	6	7	8	9	10	11	12	13
g	*d*	*b*	*l*	*m*	*n*	*r*	*f*	*v*	*k*	*t*	*p*	*s*
14	15	16	17	18	19	20	21	22	23	24	25	26,

and consequently the piston-point *o* is the first from the left under the writing-ball, *q* the second, and so on, then the types of the armature-arms stand in the same order from right to left, or *o* is the first on the right, Fig. 1, *q* the next, and so on; secondly, because of the diagonal arrangement of the ivory points, the sector-point which is raised by depressing piston *o* has only one step to make, the disk-cylinder making one step forward for each piston-stroke before it lifts its ivory point, causing thereby the simultaneous printing of the letter *o* by the armature-type *o*. (See description of Fig. 9.) The sector-point raised by piston *q* is to make two forward steps before its corresponding ivory point is raised and *q* is printed.

Based upon this we shall now be able to see in which order of time the letters in any word will be printed by the machine. Take the word "Danmark:"

d	*a*	*n*	*m*	*a*	*r*	*k*
1	2	3	4	5	6	7
15	6	19	18	6	20	23
16	8	22	22	11	26	30

The first row shows the order in which the keys are struck, and the order in which they are to appear on the paper band. Each number in this row we indicate by the letter A. The second row shows how many steps the sector-point raised by the particular piston-stroke has to make before it can lift its ivory point, or before the type in question is printed on the paper band. It also shows, as just explained, the place of the type in its row, beginning from the right-hand side. Each number in this row we indicate by the letter B. The third row—the sum of A and B—indicates how many piston-strokes will have to be made before the letter above the number can be printed; or, in other words, the sum indicates the order of time in which the machine prints the letters. It also gives the number of that letter place on the paper band which is under the first type in the row in that moment when the letter in question is printed. Each number in this row we indicate by the letter C. Consequently, $A + B = C$, and $C - B = A$. The letter *a* in Danmark is printed after eight piston-strokes; the second letter *a* is printed after eleven piston-strokes; the letter *d* is printed after sixteen piston-strokes; the letters *n* and *m* (simultaneously) after twenty-two piston-strokes; the letter *r* is printed after twenty-six piston-strokes; the letter *k* is printed after thirty piston-strokes.

As now described, the order the letters stand on the paper band must be the desired one, though the order of printing them is not coinciding with it. We will, however, explain a little further. As each piston-stroke carries the paper band one letter space forward, and supposing the piston *d* be depressed, the first letter space must be under the first type to the right, and hence the type *d*, the fifteenth in the type row, when printed by the sixteenth piston-stroke, (that is, when letter space 16 on the paper band is under the first type to the right,) prints its letter on the first letter space on the paper band; or, in general, it may be expressed as follows: C−B=A—that is, 16−15=1, just as the question about the order of time is answered by the formula A+B=C. A indicates the order of space; C, the order of time. The order of space is decided in the same way; hence, *d*, first space; *a*, second space; *n*, third space; *m*, fourth space, and so on. As the piston-knobs are so arranged as to be convenient for all ten fingers, and their stroke is only one and one-half millimeter, or less, a great speed for writing is attained, (ten to twelve letters per second,) and as the movement of the types during printing is uniform to all, and very short, the writing becomes very fine and even.

The diagonal connection between both sets of pistons may be produced differently to the manner here set forth. The writing-keys may, for instance, be made to perforate or indent a paper band having a progressive motion, (instead of the rotary motion of the disk-cylinder,) the indents or holes acting mechanically, or by electric conduction to the diagonally-arranged points of junction between the two sets of pistons; or the writing-keys (instead of each of their points acting upon a sector, which is moved forward, fixed on the disk-cylinder, as set forth) may, through an escapement, let loose a weighty body, say a small lead ball, from a vessel—the said body then, by a series of escapements, which are all moved by each stroke of the keys, being made to fall step by step down onto a type-piston, which then prints the required letter or number; and in this case the electrical apparatus is dispensed with, since the weight of the falling body supplies the action of the armature-arms attracted by their respective magnets.

By arranging each armature-arm 2*a* so that its movement will cause a type to fall out of a type-container into a conduit, receiving a motion similar to the paper band, the apparatus may serve as a printer's type-composing machine; or the writing-ball pistons (instead of each of their points acting upon a sector, which is moved forward, fixed on the disk-cylinder, as set forth) may, through an escapement, let loose a weighty body, say a small lead ball, from a vessel—the said body then, by a series of escapements, which are all moved by each stroke of the key in the writing-ball, being made to fall step by step onto an escapement, which frees a type from a type-container, such type falling into a conduit moving under the type-reservoirs, and having a motion similar to the paper band under the type-pistons, thus serving also as a type-composing machine; and in this case, as in the modified writing apparatus above described, the electrical apparatus is dispensed with.

With slight alterations the apparatus can be so arranged as to write or print on a sheet of paper wound round a cylinder, or upon a sheet of paper lying upon a flat surface or table, instead of the paper band Z, as here employed. The keys may also be arranged like the keys of a piano, instead of the arrangement here shown and described. Nor is there any limit for the number of pistons, and hence the application of the apparatus will be very wide, and not only for office-work and short-hand, but also as a printer's type-composing machine and telegraphic apparatus.

The following are the novel features in this apparatus: the set of writing-ball pistons or keys, and the set of armature-arm types; the combination of these two sets by diagonal contacts; all the contact-pieces, the shield, the disks, the sectors, the disk-cylinder, the contact-wheel, and its relation to the contact-tooth *a*; and, lastly, the whole arrangement of the electrical circuit.

What we claim as new in and with this apparatus, which we call the "Takygraph," is as follows:

1. The writing-ball U and keys K *p*, having their points of contact arranged in a straight or diagonal line over the cylinder *e*, as set forth, in combination with the disk-cylinder *e*, sectors *f*, the shield T, provided with a series of contact-pieces, arranged either in a straight or diagonal line, to correspond with the points of contact of the keys K *p*, substantially as specified, the escapement R, spindle O, contact-wheel K, tooth *a*, electro-magnets 2*q*, armatures 2*d*, armature type-arms 2*a*, and a clock-work, substantially as and for the purposes set forth.

2. The writing-ball U and keys K *p*, arranged as described, the disk-cylinder *e*, sectors *f*, the shield T, having a series of contact-pieces arranged thereon, substantially as set forth, and a clock-work, when used as a separate apparatus, and at any distance from and in combination with the electro-magnets 2*q*, armatures 2*d*, armature type-arms 2*a*, an escapement regulated by electro-magnetism, and a clock-work, as another and separate apparatus, the two being connected together by a series of wires of the same number as the keys K*p*, and such wires being joined in a cable, when the two apparatus may be used as an electric printing-telegraph, substantially as set forth.

3. The disk-cylinder *e* and sectors *f*, in combination with the drum S, substantially as and for the purposes specified.

4. The writing-ball U, keys K *p*, disk-cylinder *e*, sectors *f*, escapement R, and a clock-

work, in combination with the pinion I, rollers 2j 2k 2l 2m, having a carbonized paper band wound around them, the armature type-arms 2a, and a moving surface, such as a paper band, Z, substantially as and for the purposes set forth.

5. The writing-ball U, keys K p, disk-cylinder e, escapement R, and a clock-work, in combination with the spindle O, pinions t and s t, spindle V, carrying milled-edge wheel x, and the paper band or other moving surface Z, substantially as and for the purposes described.

6. The rollers 2p, in combination with the paper band Z, substantially as and for the purposes set forth.

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