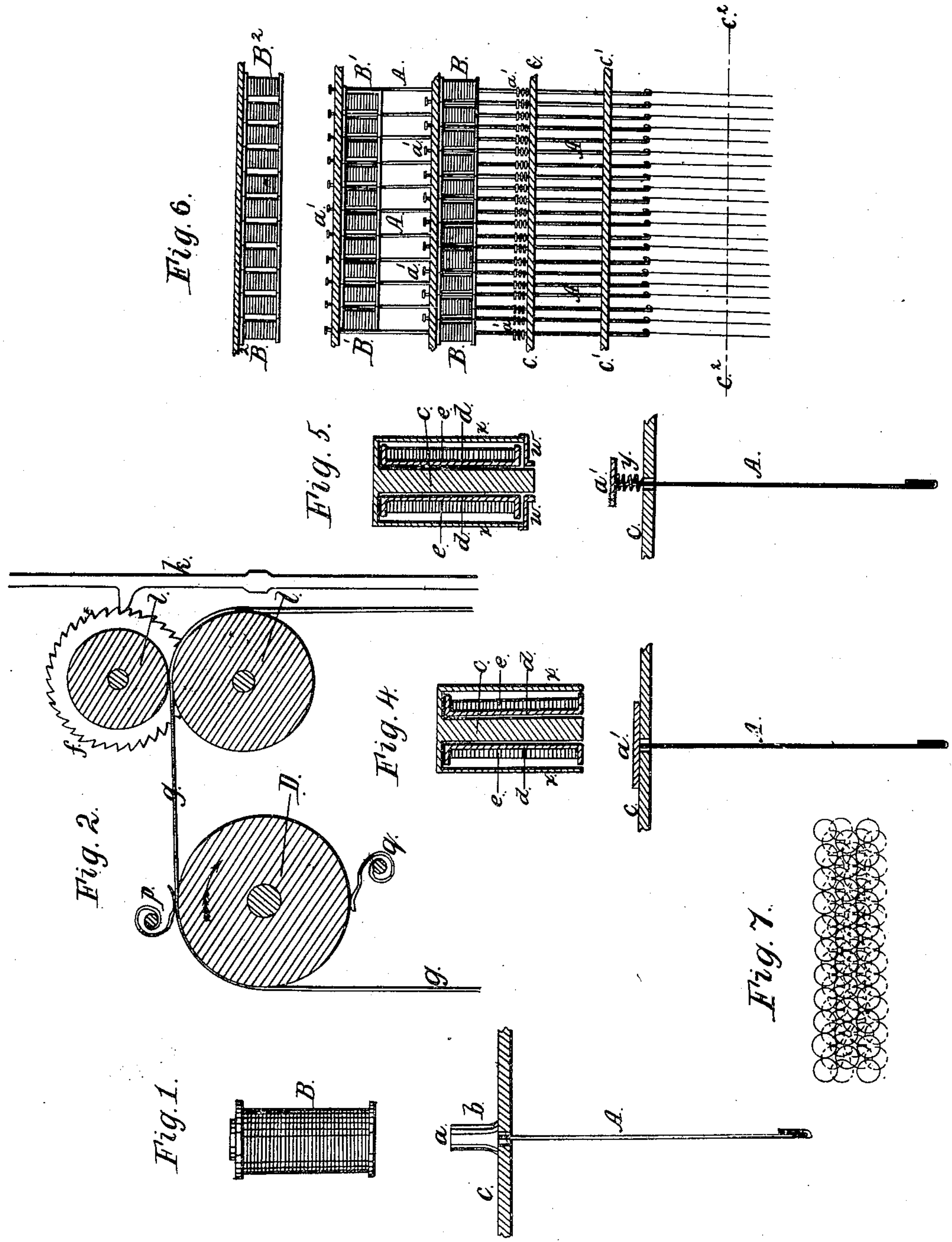
G. BONELLI.

ELECTRICAL LOOM.

No. 12,050.

Patented Dec. 12, 1854.



4 Sheets—Sheet 2.

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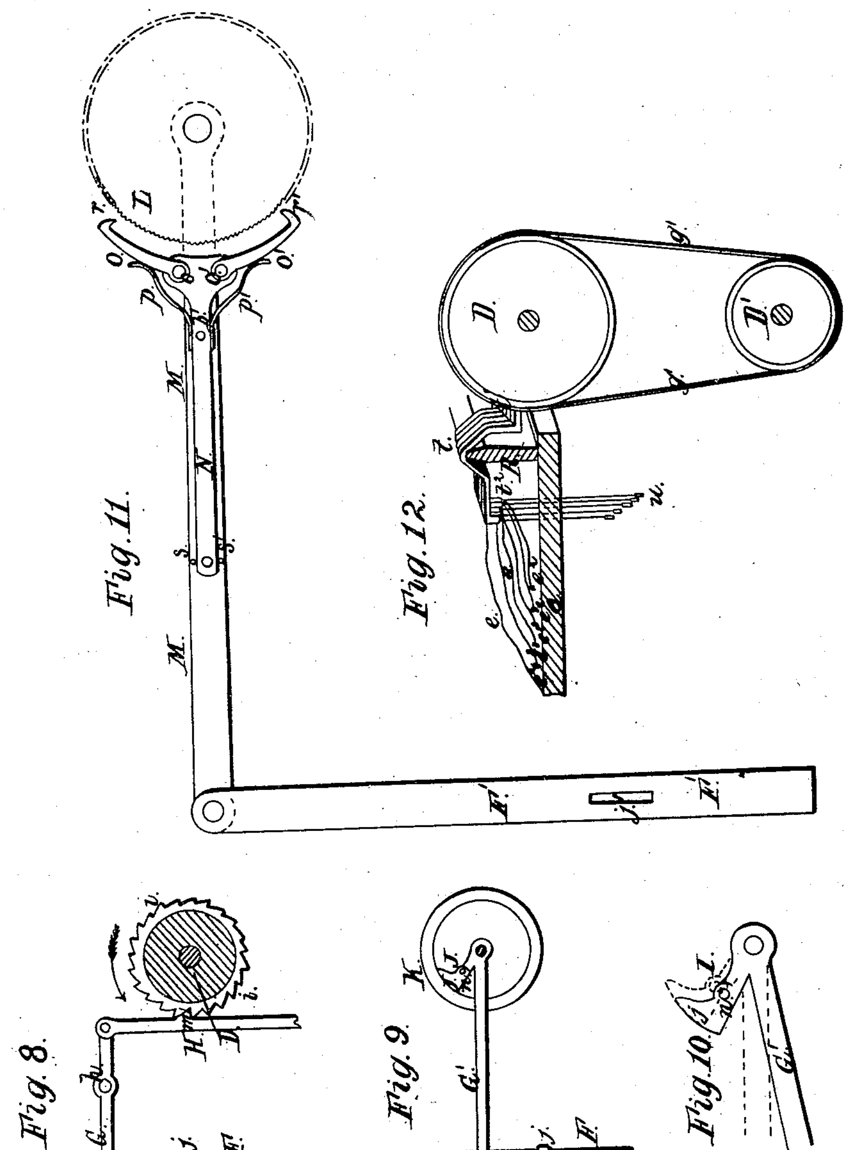

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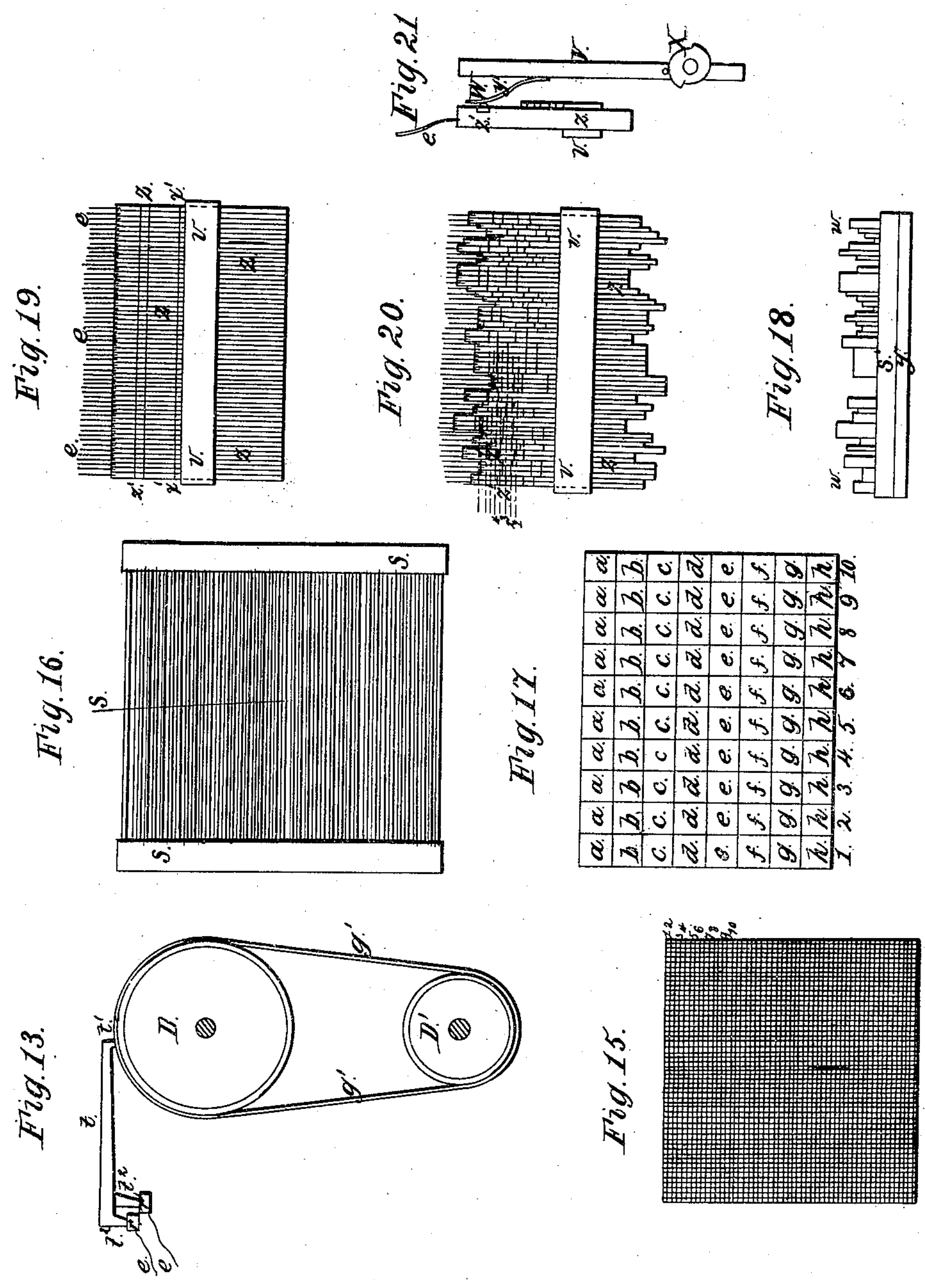

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Fig. 23.

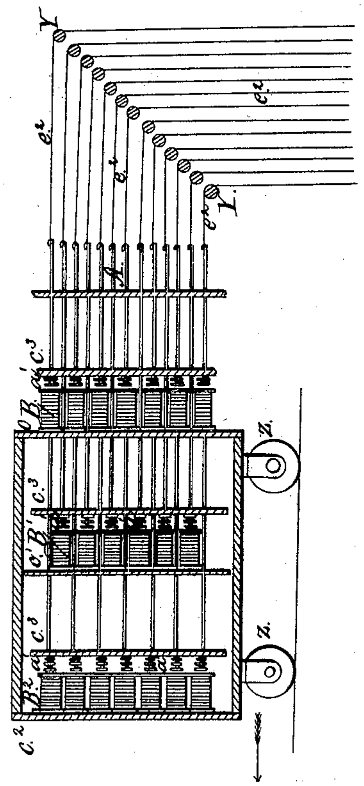


Fig. 24.

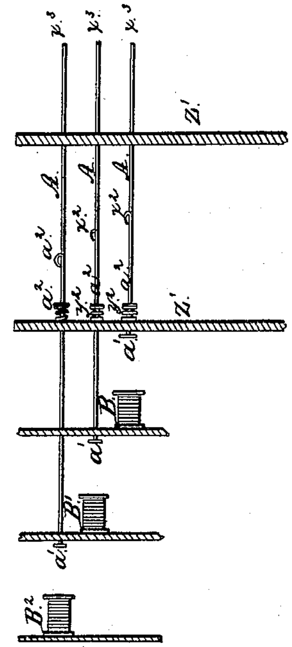
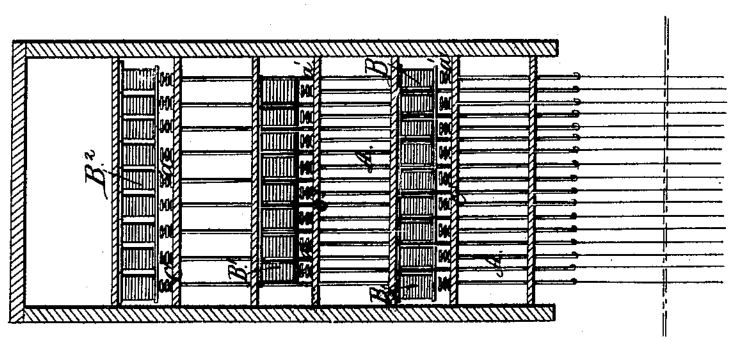


Fig. 22.



UNITED STATES PATENT OFFICE.

GAETAN BONELLI, OF TURIN, SARDINIA.

IMPROVEMENT IN OPERATING LOOMS BY ELECTRICITY.

Specification forming part of Letters Patent No. **12,050**, dated December 12, 1854.

To all whom it may concern:

Be it known that I, GAETAN BONELLI, of Turin, in the Kingdom of Sardinia, have invented certain new and useful Improvements in Looms by the Application of Electricity; and I do hereby declare that the following is a full, clear, and exact description of the principle or character which distinguishes them from all other things before used or known, and of the usual manner of making, modifying, and using the same, reference being had to the accompanying drawings, showing this apparatus.

My invention consists in the application of electricity to looms for weaving fashioned stuffs or patterns, and particularly to those called "draw-looms," looms of the high or low warp, and to the Jacquard machines.

The principal advantages which result from my invention are, first, the suppression of the cards; second, the diminution of labor in actuating the looms; third, the small probability of the loom being put out of order; fourth, great economy and exactness or accuracy.

The weaving of fashioned stuffs distinguishes itself from the weaving of the plain stuffs, because, instead of using simple leaves of healds, every one of which carries the half, third, or fourth part of the warp, the loom is provided with hooks raising a certain number of threads at moments determined by the nature of the design to be reproduced. All the threads of warp which are to be raised simultaneously must be assembled in one series, and it will require the same number of hooks as there are such series.

As in all looms the operations and mechanism are the same for every heald or hook it is only necessary to describe the application of the electro-magnet to one hook.

In the accompanying drawings, Figure 1, A is the hook of a leaf of healds. Its upper extremity, *a*, is of very soft iron and thicker than the lower part. It carries a border or boss, *b*. C is the table, provided with holes through which the hooks A pass, but too small for the border *b*. Exactly over the hook A is an electro-magnet, B. If the table is raised or traversed in a vertical direction, the head of the hook will come in contact with the electro-magnet, and if the table C is lowered, the hook remains hung up to the magnet or descends with the table, according to whether the electrical current circulates or not through the copper wire of the magnet. Thus, if as many electro-magnets have been placed over the table as there are hooks, and an electrical current is made to circulate only through the wires of the electro-magnets corresponding to the hooks which must remain elevated, all the others will come down again; and by varying the passage of the currents at each movement of the table C the hooks, and consequently the threads of warp to be kept in an elevated state for the passage of the shuttle, will be also varied. It is obvious that the arrangement of such looms may be much varied without altering this principle. Thus, for example, instead of moving the table C, the whole row of the magnets may be made to come down; and to effect this they might be provided with a weight or counterpoise, in order to render their moving easier; or the hooks might be brought into motion by means of little levers, or of threads passing over pulleys and provided at their other extremity with weights, which would be supported by means of a movable table, so as to permit only those hooks to come down which would not be attracted by the electro-magnets; or yet by making the magnets to draw or to push horizontally the rods or bars of the Jacquard machine, and by bringing bringing back by means of springs those which would not be attracted by the magnets.

The regulating of the passage of the electrical current through the numerous electro-magnets, in order to obtain the raising of the healds according to the design or figure to be reproduced, may be effected in various manners. It will be sufficient to put, for instance, one end of the copper wire surrounding the electro-magnet into continual communication with one pole of an electrical pile, while the other end would be only connected with the other pole by means of a piece of metal, the contact of the wire with this piece being successively established and interrupted by interposition of a sheet of paper provided with holes, exactly upon the same principle as the cards of the Jacquard machine. The contact, and consequently the electrical current, will only take place when holes meet with the wire, and also in those moments the electro-magnets will attract the hook set into close contact with it by the raising of the table C. This disposition will be better understood by means of

Fig. 2. D is a cylinder of metal. The springs *q* placed under it connect this cylinder with one pole of an electrical pile. Other springs, *p*, situated over the said cylinder, communicate each with the end of the wire of one electro-magnet. The other end of these wires, as I already said, communicates with the opposite pole of the same pile. A strip or sheet of paper, *g*, provided with holes, passes over the cylinder D under the springs *p*, and it is drawn by the cylinders *l*, between which it passes, and which act upon it as a flattening-machine (*laminoir*) at each movement of the table C. Every time the table C, Fig. 1, is raised it acts upon a vertical rod, *k*, which it lifts up, and which is provided at its upper extremity with a tooth gearing into the teeth of a ratchet-wheel, *f*, fixed on the shaft of one of the cylinders *l*, and which this movement makes to turn round the length of a tooth. Then, if the table comes down, the rod *k*, being free, comes also down by its own weight by yielding a little backward, and its tooth comes into gear with the next tooth of the ratchet-wheel *f*. Thus at each movement of the table the paper advances a constant quantity, so as to present to the springs *p* a new range of holes.

Although the above description I consider sufficient for practical men, yet it may be useful to mention that in the piles it is desirable to have a quantity of electricity; but it is not necessary to use a great number of piles for each electro-magnet; but it is desirable to have a considerable surface steadiness. The most convenient piles are those made of a large piece of zinc surrounded by a cylinder of coal or reciprocally, the whole being immersed in a saturated solution of sea-salt. Separate piles may be used for each magnet. It is advantageous to make the piles of greater dimensions than those hitherto used.

Wooden troughs may be substituted for the glass or metal vessels, and larger pieces of zinc and more coal than is generally used.

It is not necessary to describe the electro-magnets, as they may vary indefinitely; but that which I have found to make use of the power of the pile, and to occupy a small space, so as to permit the hooks to be disposed at a short distance from one another without using any system of transmission of movement, is that shown on Fig. 4, in which *e* is the wire of copper wound like a bobbin on a brass tube, *d*, in which is placed the cylindrical piece of soft iron *c*, having an outer tube, *x*, connected at the top to the central piece, *c*. The hook A passes through the table C, and is connected with a disk, *a′*, which bears against the cylinder *c* and the tube *x*, and thereby the disk receives the properties of the magnet, and consequently there are two magnets of different polarities which attract one another.

Fig. 5 is similar to Fig. 4, excepting that a disk, W, is secured to the lower end of the tube. This disk has in its center a projecting ring. The disk *a′* on the hook bears against this ring and the end of cylinder *c*. The end of the copper wire passes through a slot in the lower part of the tube *x*, and the disk W supports these ends and the bobbin itself. To prevent the hook remaining attached to the disk a piece of thin paper may be attached to the disk *a′*, and in some instances a helical spring, Y, may be used to advantage.

In order to permit the hooks to be placed nearer together, the electro-magnets must be placed in several planes, disposed one above the other in such a manner that the centers or axes of the upper magnets correspond to the intervals left between the others. Thus, if the magnets are disposed in three planes, B B' B^2, as shown in front elevation in Fig. 6, their centers will be in the positions shown in Fig. 7, in which the bobbins of the lower plane, B, are shown in black lines, those of the second plane, B', in red lines, and at last those of the upper plane, B^2, in blue lines.

The hooks A must be of three different lengths, according to the plane of magnets to which they belong. It will be useful to make the hooks corresponding to the two upper planes of copper or of brass, to prevent them from receiving any influence from the electro-magnets of the lower planes between which they pass.

It is unnecessary to say that the disks *a′* must always be made of soft iron. As to the table C, which carries and raises the hooks, it does not suffer any change, excepting that its holes will be placed much nearer one another. In this manner it will be possible to dispose one thousand, and even twelve hundred, hooks in a space of forty inches in length and of one and one-tenth inch in breadth.

The distance of one of the planes B B' B^2 to the next one must only be sufficient to permit the traversing of the disks *a′*, which is generally two-fifths of an inch.

Instead of raising the hooks to bring them to the electro-magnets, these magnets, in their passive state, may be kept in continual contact with the disks. Then the weaver by pressing upon the treadle would raise the whole magnet, attracting only the required hooks for the production of the pattern.

In order to produce the same work with a less considerable number of piles or weaker piles, and consequently with a less electrical current, (this is particularly important for the electro-magnets of the healds forming the ground of the fabric,) the apparatus may be be disposed in such a manner that instead of supporting the hooks directly with their threads and weights, the magnets have only to act upon battering-rams or similar dispositions, holding the hooks or permitting them to escape. As this may be effected by various means I shall not describe any peculiar disposition of this kind. This effect may be also obtained by keeping the mechanism of Jacquard, and applying to it electro-magnets instead of cards, as I shall explain it by describing the loom.

As to the mechanism by which the design is reproduced, the piece which carries the design must answer two essential conditions: first, to be made of a material conducting electricity—that is to say, a metallic substance; secondly, to be in continual communication with one of the poles of the pile.

As generally the same pattern or design must be repeated several times in the same piece of stuff or fabric, it will be better to have the movable piece which carries the design of an indefinite length. A plain sheet would evidently be not convenient, since it would be necessary to take the sheet away every time the whole length of the pattern would have been reproduced, and to place it again into its first position, in order to recommence it. I prefer to use a large cylinder or an endless cloth. If a cylinder, it might be of such a diameter as to give a surface of forty inches, and this will permit a pattern of a considerable length to be reproduced in the fabric. If it would be desirable to have a design yet longer, it will be sufficient to take a long sheet of very thin metal, the two ends of which would be united together, and this sheet would work on two cylinders like an endless cloth or a belt. In this case the cylinders might be insulated, and the sheet of metal would be allowed to pass upon a plate of metal, the edges of which would be rounded, and which would be in communication with the pile.

The cylinder and the metallic sheet may be indifferently horizontal or vertical.

As the force of the pile must be sufficient to hold up the greatest number of hooks and healds which may be necessary to be held up simultaneously, and as it can happen for certain designs or patterns, this number to be considerable—for instance, two hundred hooks—and besides, as there may be places in the same pattern where this number will be reduced to ten or twenty, it follows, therefore, that ten or twenty hooks would be held up with the force necessary for two hundred. In consequence of the extra power given to the magnets the hooks might remain hung up after the interruption of the current. In order to obviate this inconvenience, the whole length of the cylinder may be divided into several insulated parts, each of which would communicate with a certain number of separate piles. This system is, however, not quite convenient. The pattern or design is, in this case, divided in several parts, and each pile must always have a sufficient force to hold up almost the whole hooks corresponding to this part of the cylinder.

The best means to have always a sufficient force would be perhaps to divide the piles into four or five series, to unite all the wires of the poles of the same designation to one end of the wires of the electro-magnet, and to connect the other pole of each series separately to a point of metal in contact with a zone of the periphery of the cylinder. In this way one might have four or five points in contact with the cylinder upon the same line parallel with its axis. When the design has been prepared a certain variable breadth of this zone will be covered with varnish. In the places where only a few hooks are to be held up only one or two such points will be in close contact with the metal, and consequently one or two piles will be only in communication with the cylinder and the electro-magnets. Thus it will be sufficient to proportion the uncovered part of the zone corresponding to the piles to the equally uncovered part of the larger zone carrying the design. The piece carrying the design or pattern receives the necessary movement from the table itself, which raises the hooks at each passage of the shuttle. This effect may be obtained in the following manner:

Fig. 8, D is the cylinder to which the movement must be communicated from the table. F is a rod or bar fixed to this table and passing through a hole in the end of one of the arms of a lever, G, oscillating at *h*. This lever carries at its other extremity a piece, H. On the shaft of the cylinders is keyed a ratchet-wheel, *i*. Every time the table C ascends, as soon as the adjustable socket *j* on the rod F meets with the lever G it will act upon it and depress the other extremity of this lever and the piece H. This piece is provided with a tooth, *m*, gearing into the teeth of the ratchet-wheel *i*, and which will make this wheel, and consequently the cylinder D, to advance in the direction of the arrow. The longer arm of the lever G must have a sufficient weight to bring back this whole mechanism. The tooth of the piece H slides upon the inclined part of the teeth of the wheel, and the said wheel remains still. The socket *j* is screwed on the rod F, so as to permit its adjustment.

Fig. 9 shows the mechanism of Dobo as applied to the same object as that above described. This mechanism consists in a bent lever, G′, the shortest arm of which I is provided with an articulation at *n*. The extremity of this arm consists of a piece, J, bearing against the inner periphery of a wheel or pulley, K, keyed on the axle of the cylinder. As often as the longer arm of the bent lever is raised by the socket *j* the articulated arm I, becoming straight, forces the piece J to press against the circumference of the wheel K, which moves round by the adherence. Then, as the action of the socket ceases, the lever falls back by its own weight, and the arm I yields by bending itself. This disposition will be easily understood by means of Fig. 10, in which the bent lever and its articulated arm are shown on a larger scale.

The disposition of Fig. 8 presents the advantage of a great regularity and exactness; but by its application the wheel *i* can only be allowed to advance the length of an exact number of teeth. On the contrary, the disposition of Fig. 9 permits the cylinder D to advance any given quantity.

According to the system which I have adopted for the reproduction of the design or pattern, the cylinder must only advance a very little quantity at each movement of the table C, as for one such movement only a part of the design as thick as one thread of weft will be reproduced. The quantity which the cylinder advances at once must be about one one-hundredth of an inch at its circumference, and for this effect it is better to transmit the motion of the wheel i to the cylinder D by means of toothed wheels, reducing the quantity of movement. The mechanism shown in Figs. 9 and 10 can be, on the contrary, applied directly to the axle of the cylinder by adjusting the socket in a suitable position. Besides the mechanism of Fig. 8 used in combination with toothed wheels is more convenient for combs with two rows of points, and for designs composed of several colors, for which a great exactness is wanted, as it will be seen hereinafter.

It results from what I said that the cylinder D must advance one one-hundredth of an inch at each passage of the shuttle, that a design which would require six thousand two hundred and eighty cards in the Jacquard's machine could be executed on the periphery of a cylinder of one-half meter in diameter.

It will be better to have in each loom a second mechanism similar to one or the other of those shown in Figs. 8 and 9, but disposed in such a manner as to make the cylinder D to move round in the opposite direction and at the same speed. If woven fabrics ought to be unwoven, it will be sufficient to set the table C in communication with this supplementary mechanism and at each stroke to withdraw the weft. For this effect the rod F must be removed from the table C, to which another rod will be fixed, acting upon the inverting mechanism.

Fig. 11 shows a very simple disposition, by means of which both the forward and backward movements will be obtained with one mechanism.

L is a toothed wheel, which may be keyed on the axle of the cylinder, in which the teeth must be very fine in order to reduce the movement of the cylinder to one pick of the fabric. A lever, M, is attached to the same axle, and another shorter lever, N, oscillates on a stud, h', fixed to the lever M. To the extremity of the lever N are attached two bent arms, O O′, which can oscillate on fixed centers $o\ o'$. These bent arms are provided at their extremity with an inclined tooth, $r\ r'$. The other end of the lever N is secured by a pin which may be stuck into either one or the other of the two holes $s\ s'$. Springs P hold the arms O O′. To the opposite end of the greater lever, M, is attached a rod, F′, carrying a tooth or socket, j', which acts upon the table C at each of its movements. If the pin of the lever N sticks in the upper hole, s, of the lever M, the tooth r will gear into the teeth of the wheel L. At each oscillation of the lever M the tooth r drives the wheel in a certain direction, and in its back motion this tooth slides upon those of the wheel, in consequence of its obliquity and of the flexibility of the spring P. The contrary effect will be produced if the pin of the lever N is engaged into the hole s', in which case the tooth r' comes to gear with the wheel.

After having described the communication of one pole of the pile with the cylinder or other piece carrying the design or pattern I have now to explain the manner in which the electric current is brought to the bobbins of the electro-magnets to which an attractive power is to be imparted independently of the others.

One extremity of the wire of each of the bobbins communicates constantly with the pole of the pile or piles opposite to that in connection with the cylinder. The other end of the wire of these bobbins is connected to an insulated point in contact with the cylinder. All these points must be generally disposed in the same line and very near to one another to prevent a too considerable length to be given to the said cylinder, and in order that the points can follow all the contours of the design.

Fig. 12 shows a very simple manner of disposing the points so that each of them occupies in thickness a space of only one twenty-fifth of an inch. D is the movable cylinder carrying the design, or over which passes a sheet of metal, g', surrounding it, and which is tightened by another roller, D′. On a horizontal table, Q, is fixed a vertical piece or board, R, the upper edge of which is made of ivory or of very hard wood, and is cut so as to form an acute angle. On this edge are disposed, astride, small blades t, of copper or of brass, bent to an angle more obtuse than that of the edge of the piece R, so as to be able to swing freely upon it. The rounded end t' of these blades is in contact with the cylinder D. The same blades are ended at their other extremity by the tail t^2, bent down and of five different lengths, and they must be disposed in such a manner that these tails form a species of gradation, five and five. This difference of length has for its object to permit the wires e of the electro-magnets to be attached by welding them to these tails without the proximity of the blades being prevented by the thickness of these wires. To the tails t^2 are attached, by means of threads of silk of various lengths, hanging weights u, the effect of which is to keep the extremity t' of the blades in constant contact with the cylinder D. Instead of using such weights, the tails of the blades t might be kept horizontal and exactly in the same plane, and a bar of lead would be laid upon them, by taking care to place a strip of india-rubber between the said bar and the blades, in order to equalize the pression and at the same time to insulate the blades of copper from this piece of lead.

The wires e from the blades t may be directly connected with the electro-magnets, or attached to screws e^2 fixed on the table Q, and to which the wires of the electro-magnets would be connected. (In order to prevent the frequent passage of the electrical current from oxidating the points t', and diminish their power of conduction, it will be well to weld small pieces of platina to their extremity.) By means of this disposition it will be easy to remove a blade of this range or comb, in order to repair or to examine it, and then to put it again to its place. Each of these blades is covered on one face with a strip of paper or varnish, in order to insulate it from its neighbor.

It will be sufficient for a loom of twelve hundred hooks to use a comb (or range of blades) and a cylinder, D, of forty and one-half inches in length. In consequence of its movement this cylinder will present at each passage of the shuttle a new line to the points t'. If this length of forty and one-half inches would be found yet too considerable, it might be reduced to the half or to the third part of it by disposing the blades t on two or three ranges, touching the cylinder on two or three different lines. In this case the disposition of the design must be altered, as it will be hereinafter explained. One could also adopt the disposition of the blades t shown at Fig. 13. The points t' of these blades are always in contact with the cylinder D. As to the tails t^2, as the blades t are made of two different lengths they are situated in two ranges, and each of them bears upon a piece of metal, r r', one twenty-fifth of an inch thick. As these pieces r r' are in two ranges each of them is separated from its neighbors in the same range by a space of one twenty-fifth of an inch, in which a blade of wood, of ivory, or of any other insulating material will be disposed, the object of which is at the same time to guide the metal blades in their movements. To the pieces r r' are attached the wires e of the electro-magnets. The necessary pressure may be obtained in the same manner as in Fig. 12, either by means of weights suspended to the blades, or of a single weight laid upon them.

I shall hereinafter describe another system of comb especially applicable to patterns of several colors.

By the disposition which has been described there is a continuous communication between all the bobbins or magnets and both the poles of the pile. Consequently all the magnets will receive a magnetic attractive power, so that all the hooks and healds would remain in a raised state if the pile were sufficiently powerful.

In order to make some only of the hooks to be kept in an elevated state, it will be sufficient to put any insulating matter between the cylinder D and the points corresponding to the magnets of the other hooks. The electrical current will be then interrupted for these last magnets, while it will continue to take place in the first. Thus to make the design or pattern it will be sufficient to cover with an insulating material the portion of the cylinder D, or of the sheet of metal corresponding to those points, the hooks of which are not to be raised. It is obvious that this may be obtained by various means. Thus, for instance, a sheet of paper provided with holes, or cut out or pinked and pasted on the cylinder, or the sheet of metal may be used, or a woven fabric with open meshes, such as gauze, percale, &c., on which the pattern would be executed by means of a conducting material, such as silver or gold or plumbago, &c. The stuff so prepared would be laid on the cylinder D. Everywhere the points t' meet with the insulated portion of the design the electrical current will be broken, while if the said points meet with the metallic substance of which the design is made this current will be closed. The system which I consider as the best consists in covering certain parts of the surface of the cylinder D or of the sheet metal with a lay of non-conducting varnish. This varnish must be of such a matter that it cannot grease the points t' sliding upon it. The varnish of copal has given me a very good result.

Where the weft or woof is of one color the execution of the design will be very simple, as no translation or any preparatory operation is wanted. It will be sufficient to draw the design with a brush and varnish on the surface of the cylinder D itself, or of the sheet of metal, so as to leave uncovered only the places corresponding to those where the weft is to be seen in the fabric. The cylinder might be also covered with a general lay of varnish, which could be scratched at some places so as to uncover the metal, or the design might be put on the cylinder with aqua fortis. The design executed in such manner will be of the same breadth as the space occupied by the points of the comb, and it must extend over the length of the periphery of the cylinder, or all the length of the sheet of metal. This design, by the revolution of the cylinder, will pass many times under the points or teeth of the comb until the piece of fabric is terminated.

The designs executed in such a manner as just described will be exactly reproduced in the fabric, and to some extent may be varied by varying the quantity which the cylinder moves at each passage of the throttle. Lengthened or shortened patterns will be thus obtained in a regular proportion, and the same design may be used to produce two or three pieces of fabric, each of which would have a different aspect.

With the kind of design which I have just described the teeth of the comb must be all in one range. This system might be inconvenient in this way, that the threads of weft are not sufficiently bound, and consequently by the least friction the fabrics would easily unravel and be quite spoiled. In order to prevent this, a supplementary regular crossing of warp-threads may be added in the loom, so as to secure or bind the weft, and this will also increase the beauty of the fabric. This addition consists only, as it is well known, of a series of two to twelve movements imparted to some healds, and which will be regularly repeated in the same order.

In the greatest number of looms now in use such supplementary warp-threads are generally governed by means of a little supplementary Jacquard's machine brought into motion by an especial treadle. As this mechanism requires not more than twelve small cards one might continue to make use of it in electrical looms, and principally in such looms to which it is already applied. It is, however, obvious that a little mechanism may be used, consisting in a cylinder and a comb similar to those of the principal design or pattern, but acting upon greater and more powerful magnets.

When the sort of fabric requires the weft to be of several colors, so that for the same passage the shuttle must be changed five or six times, then the surface of the cylinder D or of the sheet g' must also be drawn with squares formed by lines distant from each other in one direction of the same width as the points of the comb, and in the other of the width the cylinder D moves at each passage of the shuttle.

The design may be executed in the ordinary manner in the places where the weft is of one and the same color, while in the others the squares corresponding to the respective colors, which are not to be seen, must be covered with varnish. Thus, for instance, in Fig. 15 the design will be made as commonly over the lines 1 2 3 4, as the weft must be of one color in the part of the piece of fabric corresponding to these lines; but the lines 5, 6, 7, 8, 9, and 10, corresponding to the parts of the piece of fabric, in which the weft must be of several colors, must be covered with varnish according to the arrangement of the colors. This means will be very convenient in making pieces of fabric in which only some portions of their lengths are of several colors, as is often the case; but for such fabrics in which seven or eight colors are reproduced and vary indefinitely, as in shawls, the proceeding of covering with varnish the different lines corresponding to each color might be found too long and inconvenient, particularly if this proceeding be compared with the simple and economical one which I described for the manufacture of fabrics in which the weft is of only one color.

In order to render the manufacturing of shawls almost as simple, I have contrived the following disposition, which is entirely new, and which will give a means to facilitate the operation of the reading (*lisage*) even with the common Jacquard machine. This disposition could be applied, if necessary, to the cylinder D or to the sheet of metal of Fig. 12; but I prefer to make use of a grate, S, Fig. 16, formed with bars or blades distant from each other of one millimeter, or nearly so. One must have, besides, a great number of small pieces of wood or of metal of rectangular form and similar to the letters or types used by printers; but these pieces must be of different lengths or heights, according to the number of colors. Their thickness will be one twenty-fifth of an inch, so as to permit them to be put exactly between the bars of the grate S; but the breadth of such pieces must vary from one to ten millimeters, or thereabout. These types will be distributed in a sort of box divided by partitions similar to those in use by printers, as seen in Fig. 17. All the pieces of the same length will be placed into the compartment *a*. The pieces of the first range, or a', will be one millimeter in breadth; those of the second range, or a^2, will be two millimeters in breadth, &c.; and the arrangement will be the same for the pieces *b c d*, &c., each length of type corresponding to one color. For composing the design or pattern these pieces will be used exactly in the same manner as letters or types, while the grate S will be used as a composing-stick. The head of such pieces or types must be a little thicker than their body, so that they cannot fall through the grate between its bars or blades, but that they remain hung to it. When the design or pattern has been composed or set a board or sheet will be laid upon the head of all the types, the surface of which board is as large as the whole grate, so that this said grate may be reversed or turned up without the types being able to fall off. Then there will be on the other side of the grate a series of types more or less long, more or less broad, as shown in Fig. 18, in which S is the grate, T the board keeping the types in their places, and *w* the unequal surfaces resulting from the disposition of the types, according to the order of the colors.

Fig. 19 shows a comb by means of which each color will be culled from the others and represented by an especial line without necessitating any translating or reading (*lisage.*). This comb is formed of vertical rods *z*, assembled and fitted loosely in a sort of frame or tong, U. Each of such rods carries a tooth or socket, preventing them from descending below a certain height in the piece U. They are entirely covered with varnish, excepting a little space, z', which is situated equally high in each rod. To their upper extremity are connected the wires *e* of the electro-magnets. As long as the teeth or sockets x' rest on the piece U all the spaces z' will be situated in one straight line; but, on the contrary, if by allowing the lower end of such rods to come into contact with the uneven surface formed by the numerous types *w* of Fig. 18 the rods *z* are raised to an equal number of different heights as there are lengths of the pieces *w*, the spaces *z* will draw themselves up in several lines, 1 2 3, &c., each of which corresponds to a different color. Thus, if one has a blade communicating with one of the poles of the pile, and if this blade be successively brought into close contact with the lines $1z'$ $2z'$, &c., it will only transmit the attractive power to the teeth, where it will meet with the uncovered metal, so as to lift the hooks corresponding to the various colors, respectively. Thus it will be sufficient, in weaving the fabric, to lower the comb upon the first line of the grate S, then to bring to the line 1*z′* the blade communicating with one pole of the pile, after this to act upon the treadle, and to throw the shuttle with the red weft, then to bring the blade to the line 2*z′*, to act upon the treadle and to pass the shuttle with the black weft, and so further for each color. Then the comb will be lifted up again, the grate is made to advance one step, the comb is lowered again upon the second line or range of the grate, and the movements of the blade will be repeated.

The advancing of the grate at each raising of the comb *z* will be produced by means of a mechanism similar to those of Figs. 8, 9, 10, and 11. The motion of the blade will be obtained by means of a mechanism which the weaver will actuate by hand or by a treadle. This mechanism may simply consist of a vertical rod which would be caused to ascend or descend gradually and then draw back rapidly. Thus the disposition of Fig. 21 might be adopted, in which V is the vertical rod carrying the blade W, kept in contact with the rods *z* of the comb by one or more springs, *y′*. A cam or eccentric, X, by revolving lifts up the rod V and then lets it fall back. A ratchet-wheel, conveniently disposed, allows the eccentric X to push the rod V the distance between two lines 1*z′* and 2*z′*, &c., Fig. 20, at each movement of another rod actuated by hand or by means of a treadle.

It will be easily understood that the disposition of Figs. 18 and 19 might be kept by using, instead of the combs *z*, rods into which holes would be made at a certain height, so as to obtain, by means of a mechanism analagous to that of Jacquard, either the movement of the cutters used to pierce the cards of a Jacquard's machine or the pushing of the horizontal rods and of the hooks without cards or electricity.

The loom.—The disposition of the lower part of the loom remains quite the same as in the common looms generally in use, only the upper part of it—that is to say, the mechanism contrived by Jacquard—will be changed from the table near which the warp-threads are attached to the healds. The hooks will occupy the whole breadth of the loom, and the electro-magnets will be applied directly to the hooks. The obliquity of the threads is also avoided, which obliquity renders them more difficult to be raised, and exposes them to the danger of being easily broken. This disposition will be understood by means of Fig. 6, showing such an arrangement as seen from the anterior part of the loom. C^2 is the table, near which the warp-threads are attached to the healds; C′, the table guiding the hooks, and C the movable table which raises the said hooks. B, B′, and B^2 are the three ranges of electro-magnets.

By moving the electro-magnets instead of the hooks and healds (as already explained) the disposition of Fig. 6 would be replaced by that of Fig. 22, in which the ranges of electro-magnets B B′ B^2 are allowed to descend and to ascend, carrying up the disks *a′*, which rest by means of helical springs on fixed tables C^3.

As the electro-magnets might be found too heavy they could be disposed horizontally on a carriage, as shown at Fig. 23, in which e^2 are threads which pass over pulleys Y, and are attached to the hooks A. To the extremity of these hooks are secured disks *a*, bearing, as in Fig. 22, by means of springs against three fixed boards, C^3. Three other boards or tables, C C′ C^2, belonging to a carriage moving on wheels Z, carry the electro-magnets.

The carriage is made to advance, so as to put the electro-magnets in contact with the disks *a′*, then by bringing back the carriage the electro-magnets would drag the required disks and the corresponding hooks.

Having now described my invention and the manner in which the same is to be performed and used, I desire to have it well understood that I do not confine myself in the exact details of the above description and drawings; but

What I claim as my invention is—

1. The application of electricity or of electro-magnets to power-looms, in order to raise or to keep in an elevated state the hooks and healds in the required order to form the design or pattern of fashioned stuffs, such as shawls, carpets, ribbons, &c., as hereinbefore described.

2. The various means of making such designs on metallic surfaces by means of an insulating material, and the use for this purpose of varnish, of weavings or paper painted or colored with metallic substances, of paper cut out or pinked or pierced.

GAETANO CAV. BONELLI.