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No. 8,991. Patented June 1, 1852.

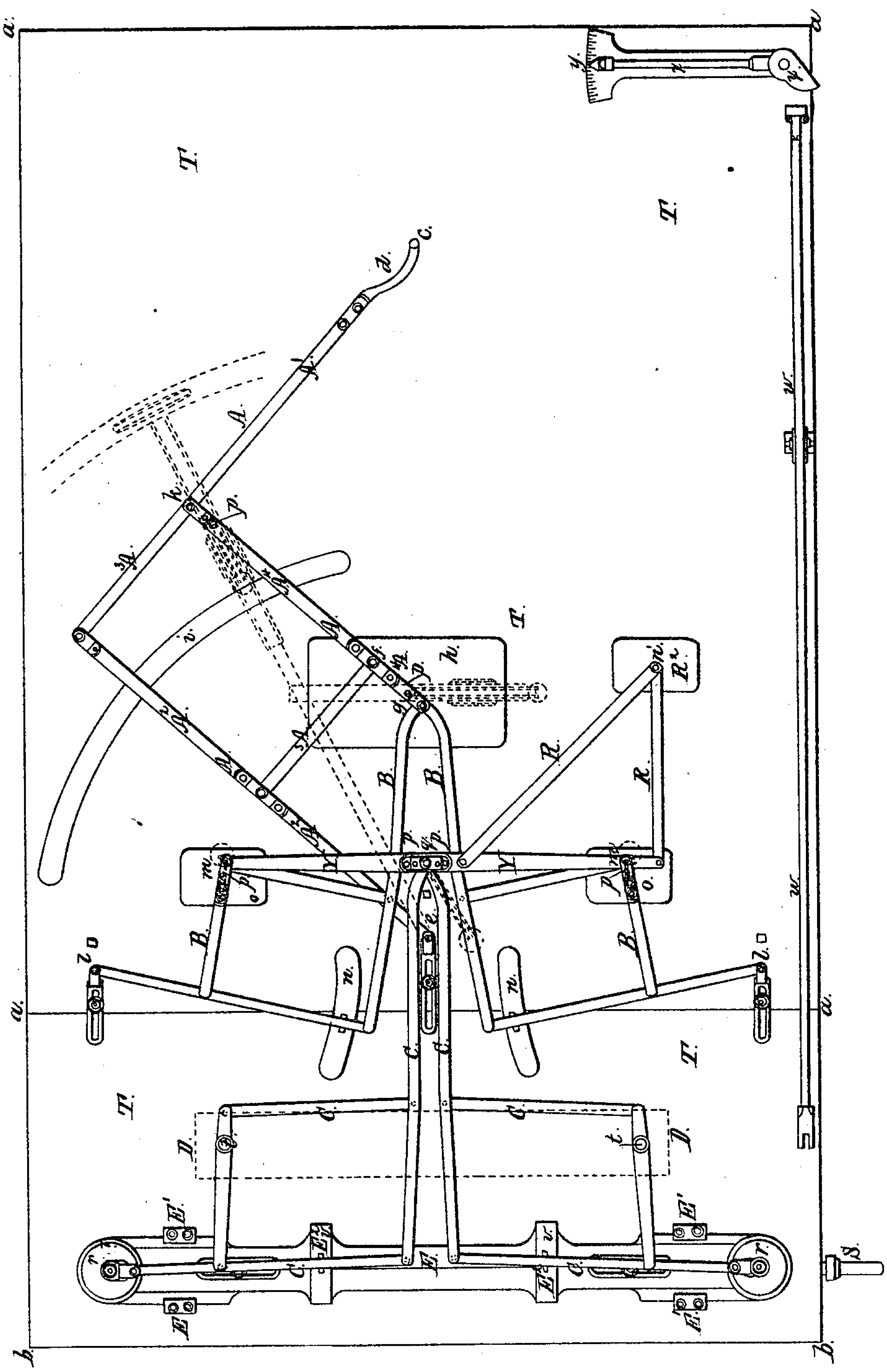

Fig. 1.

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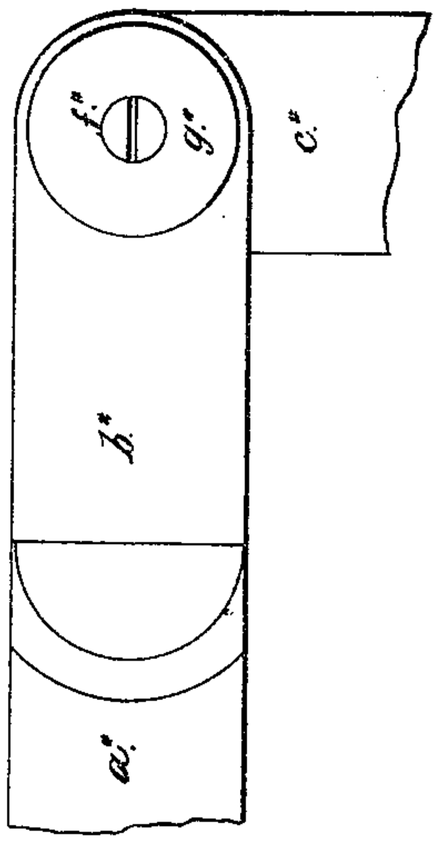
Fig. 3.



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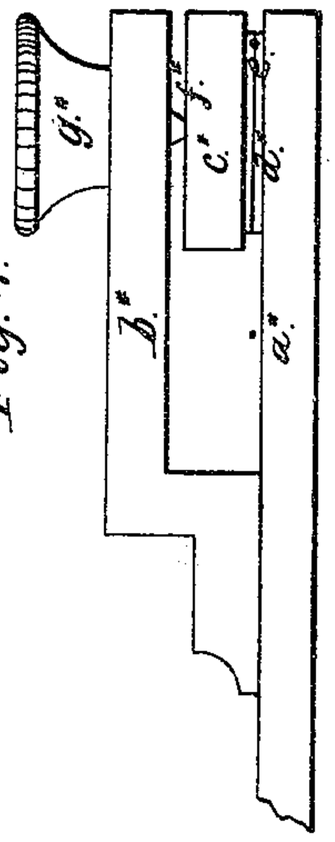
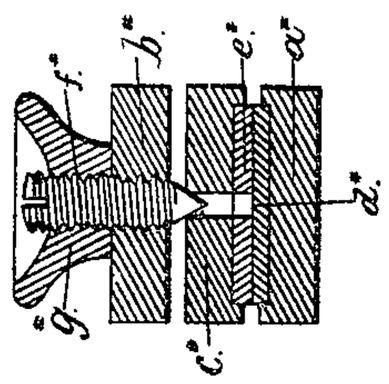


Fig. 5.



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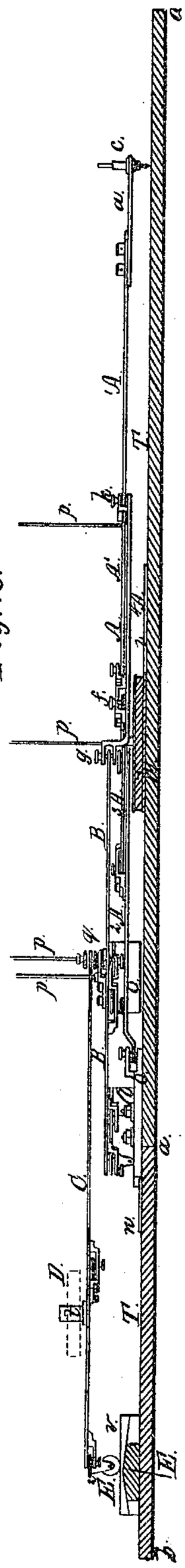

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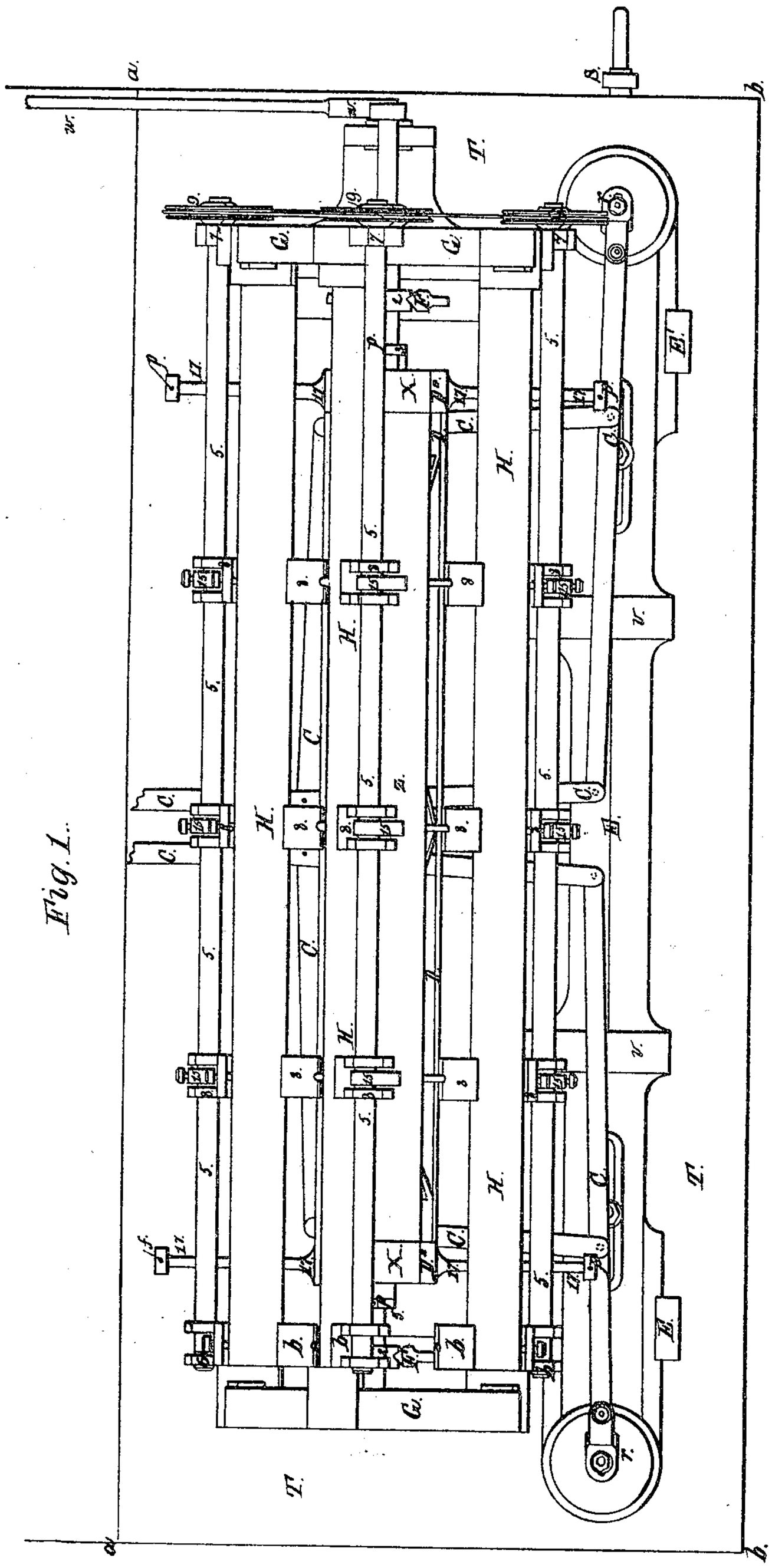

Fig. 1.

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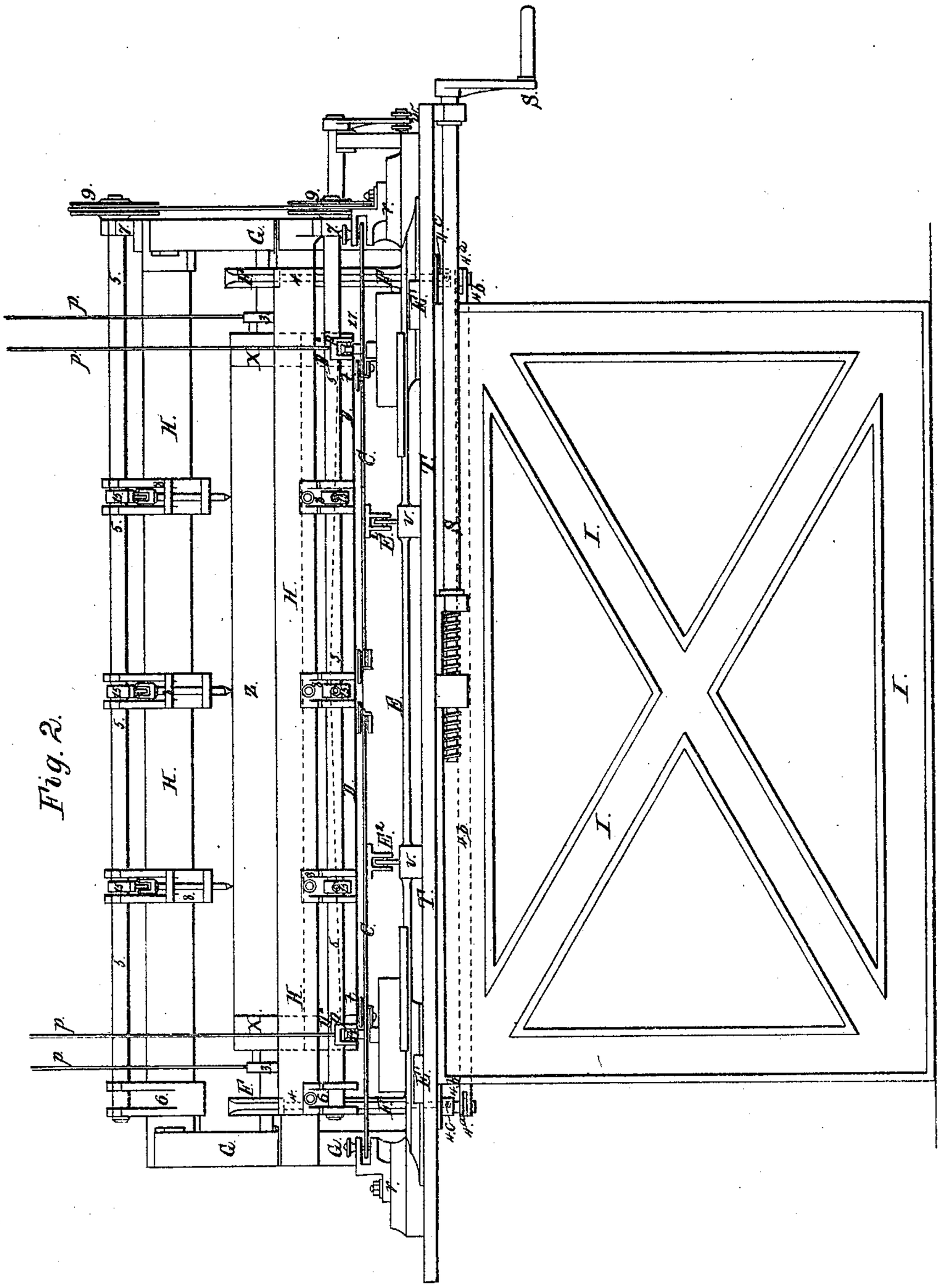

Fig. 2.

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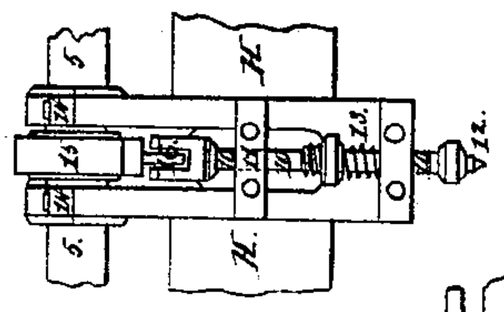
Fig. 5.



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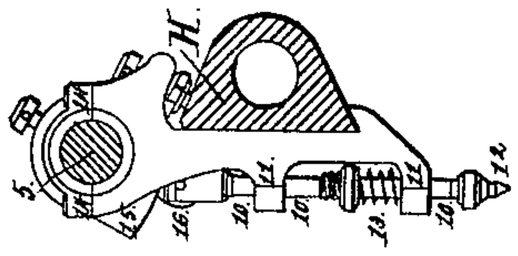

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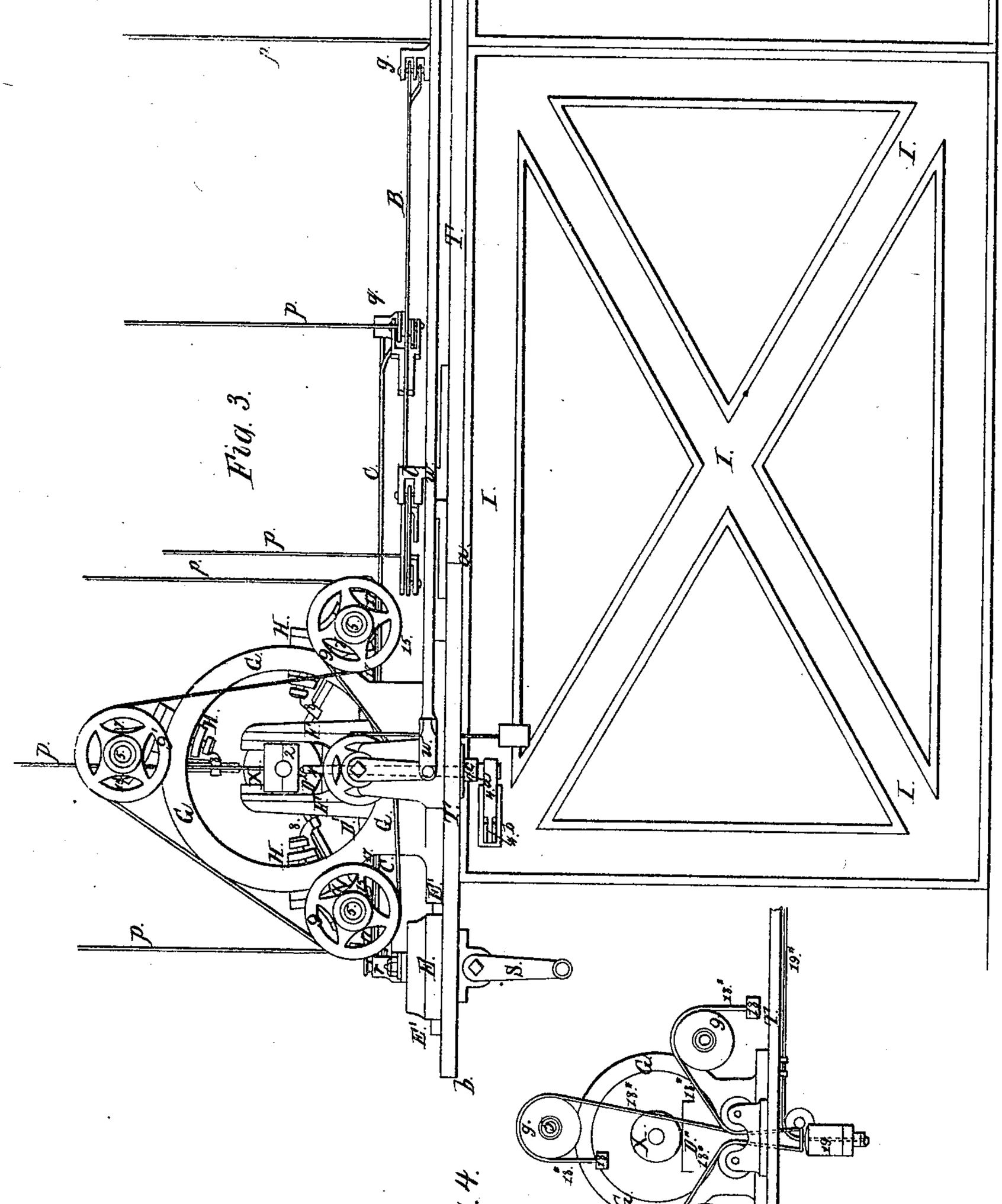

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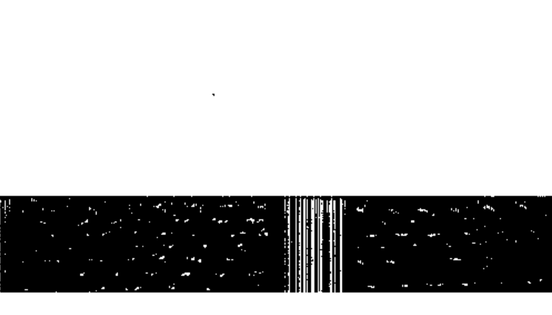

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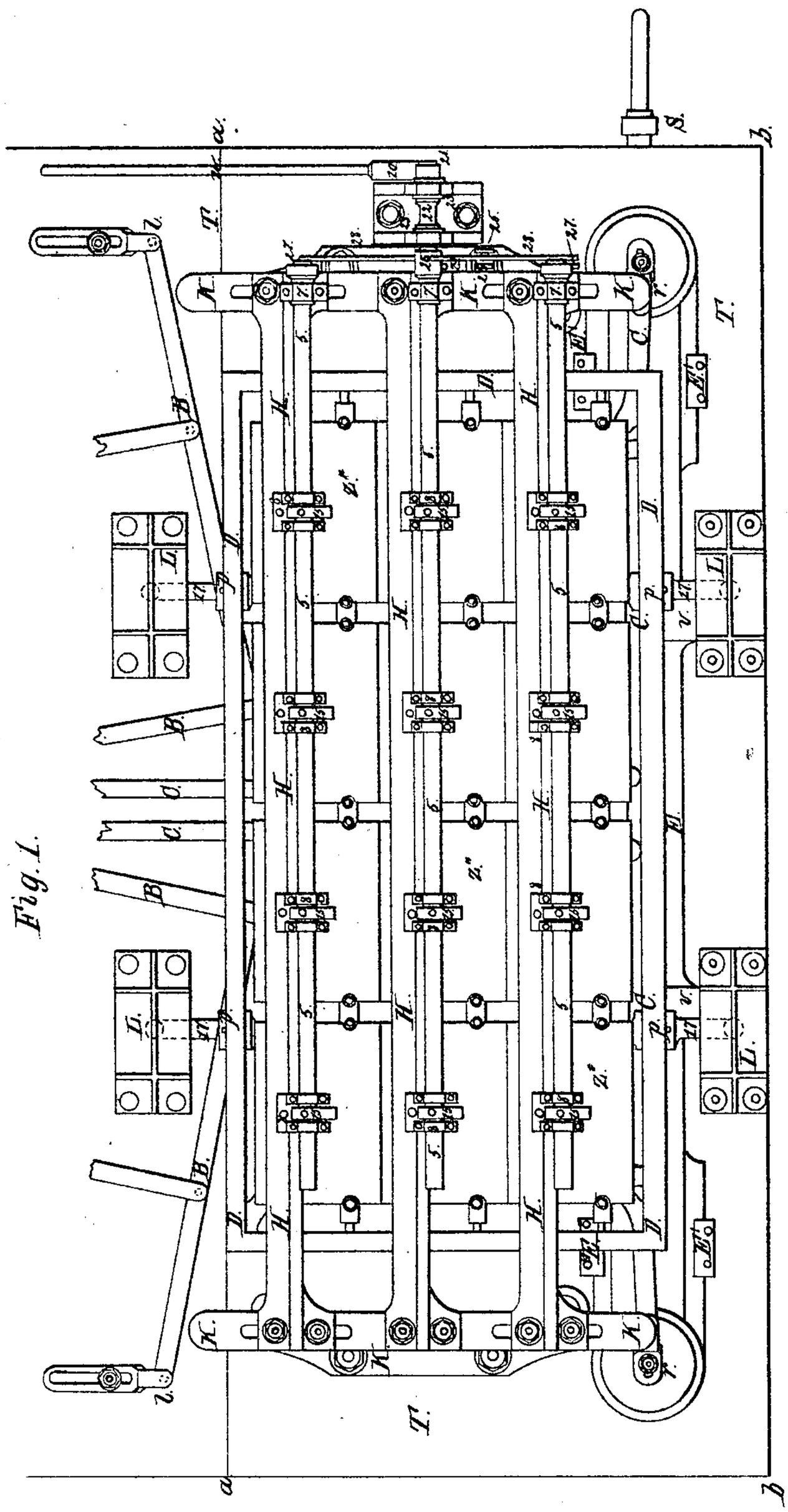

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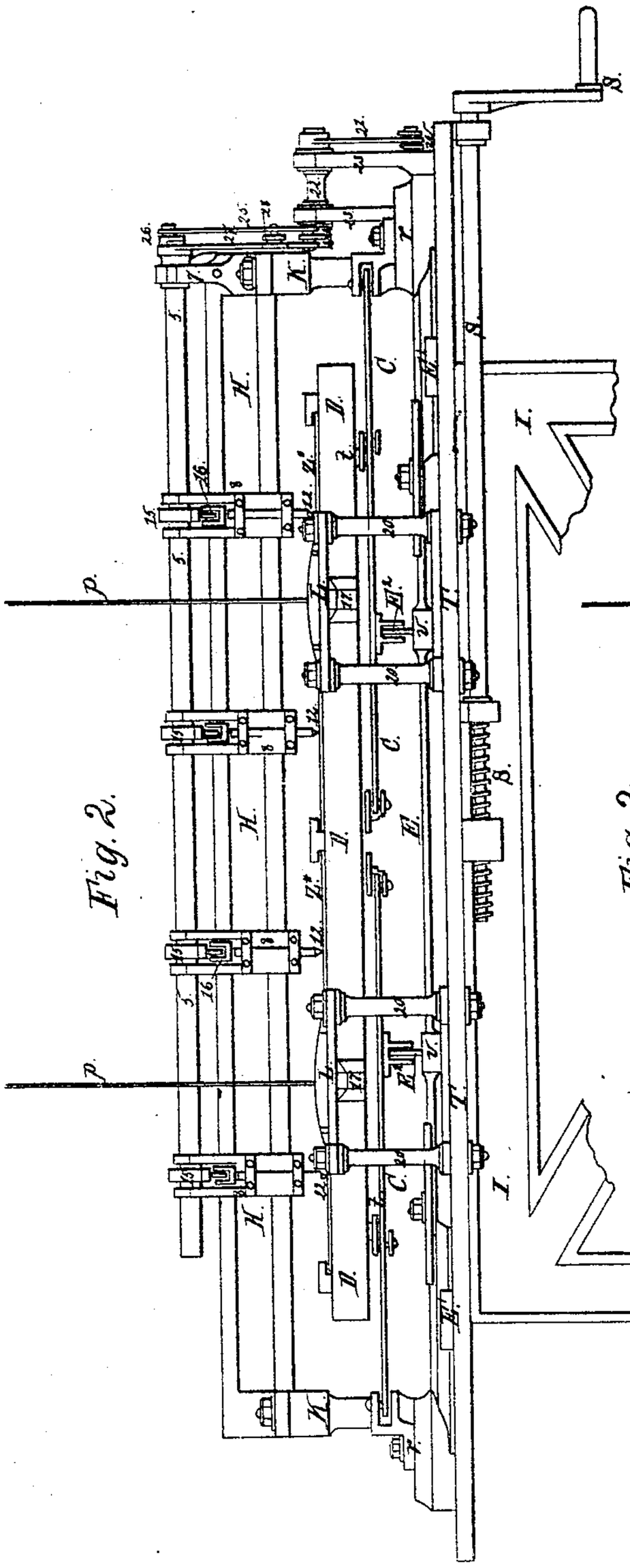
Fig. 2.



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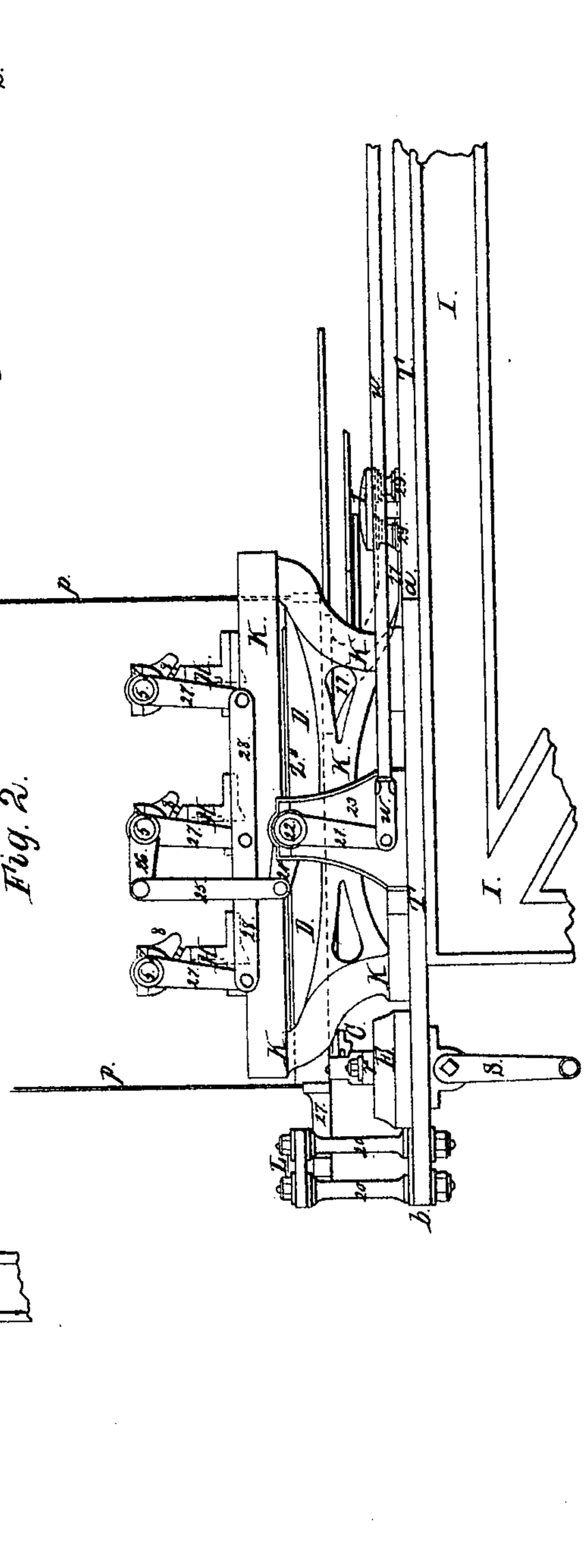

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Fig. 6.

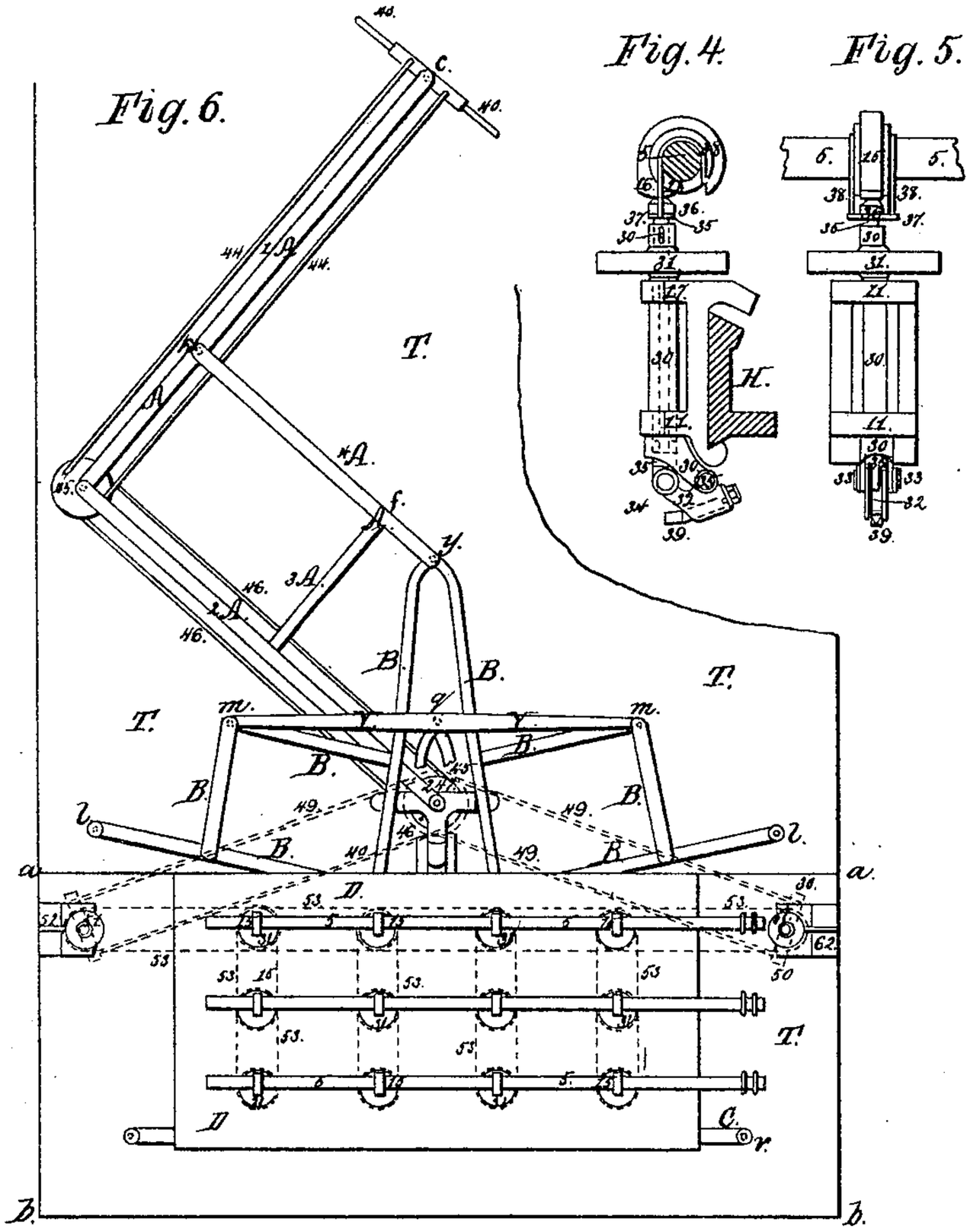

Fig. 4.

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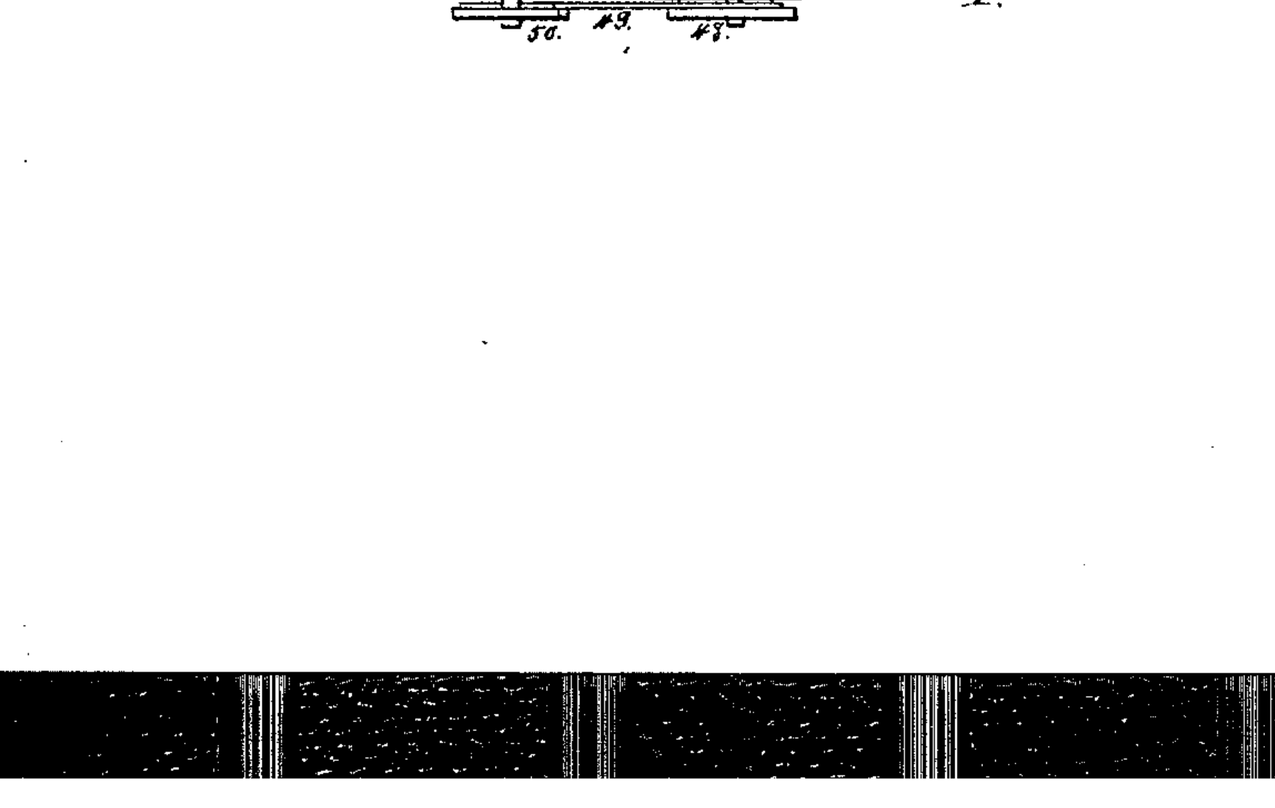

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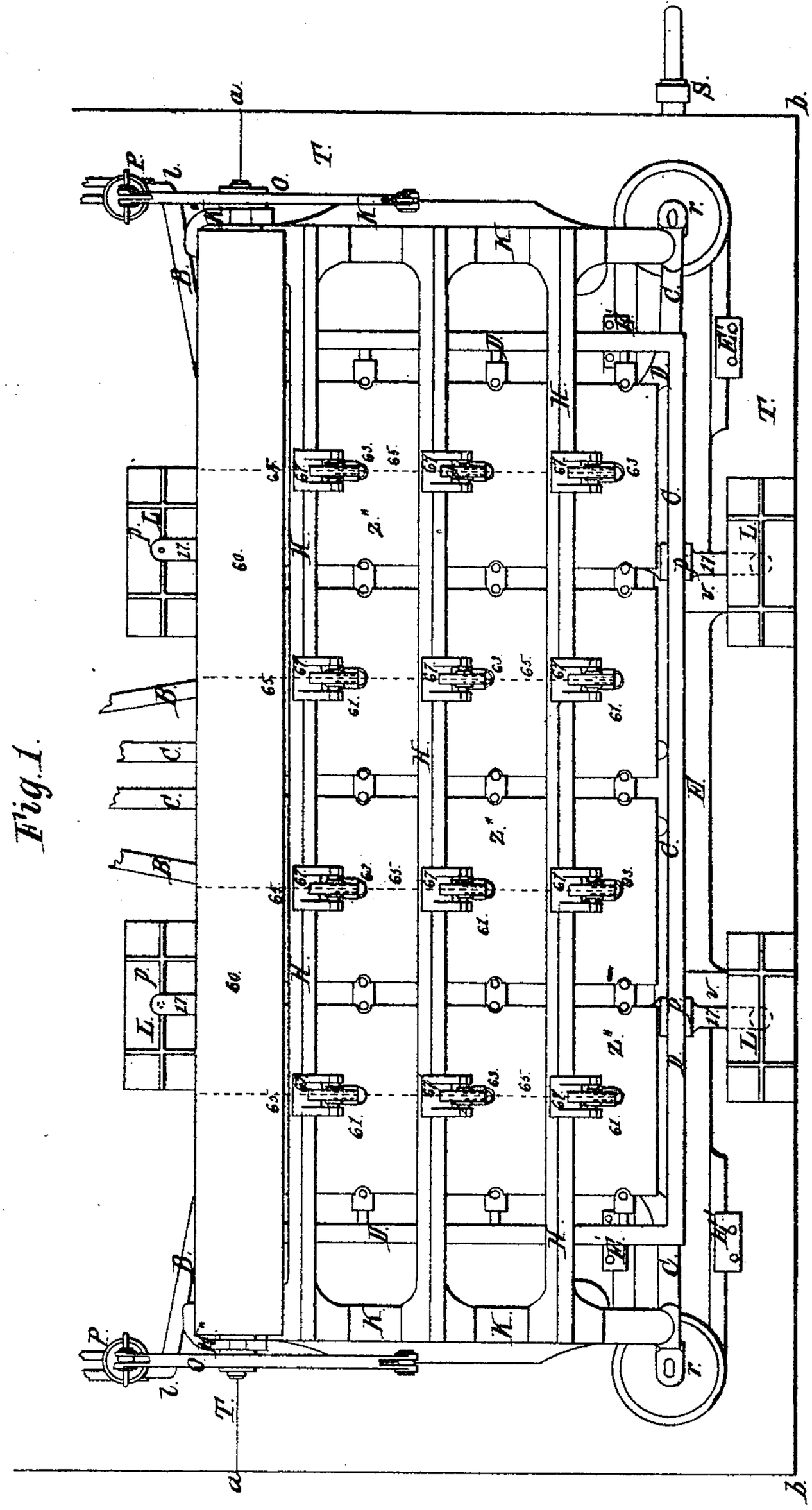
Fig. 1.



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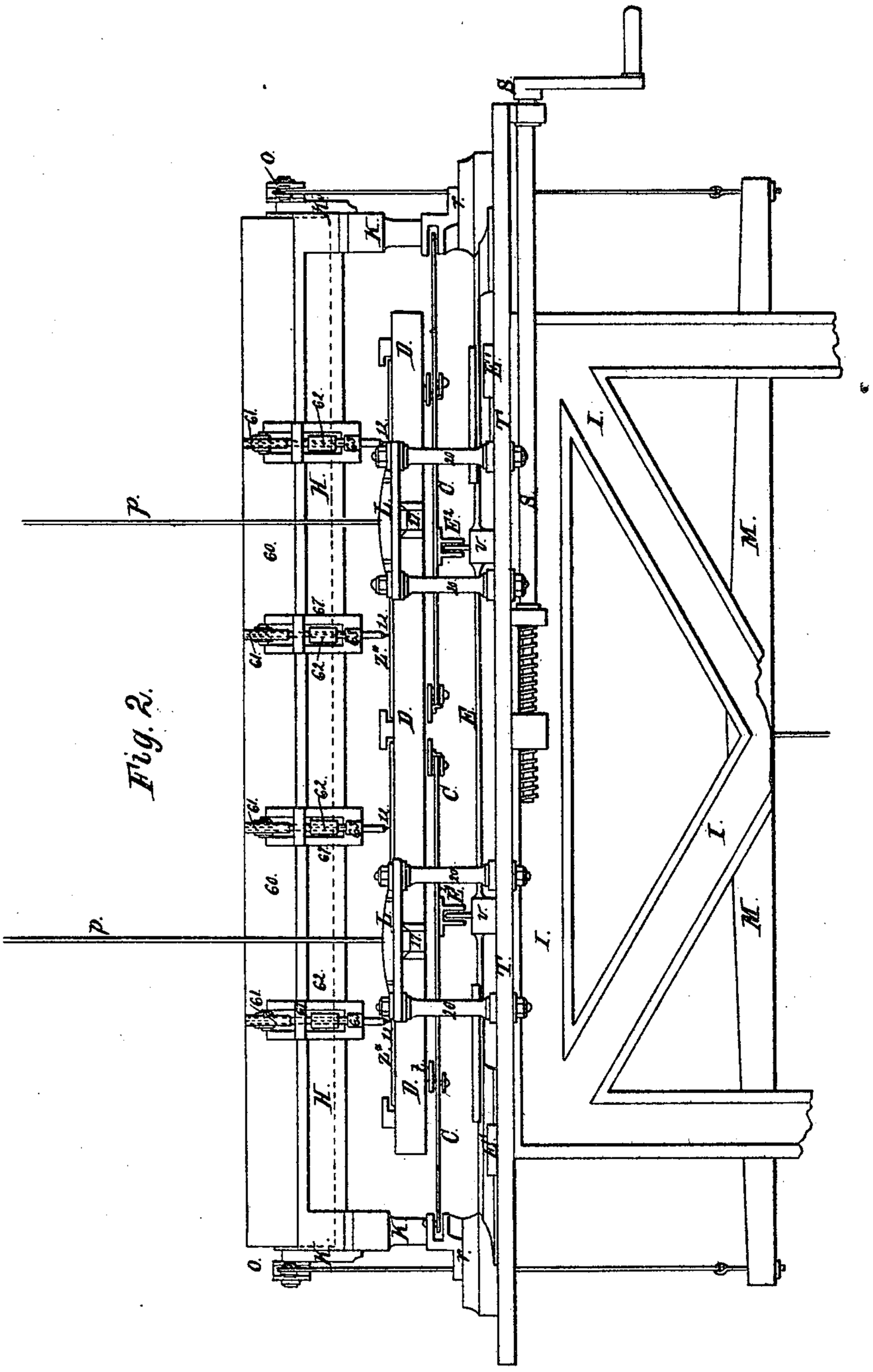

Fig. 2.

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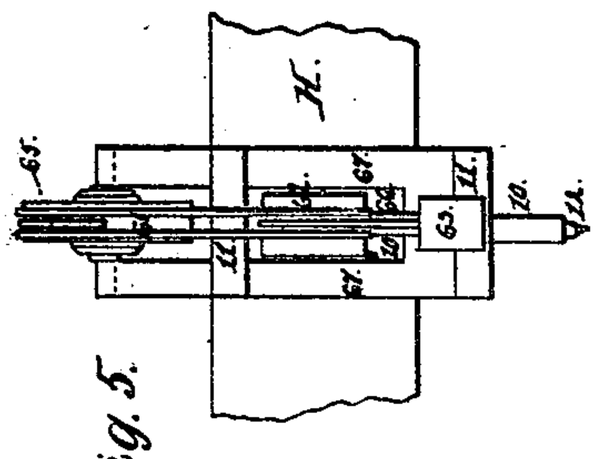

Fig. 5.

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ENGRAVING.

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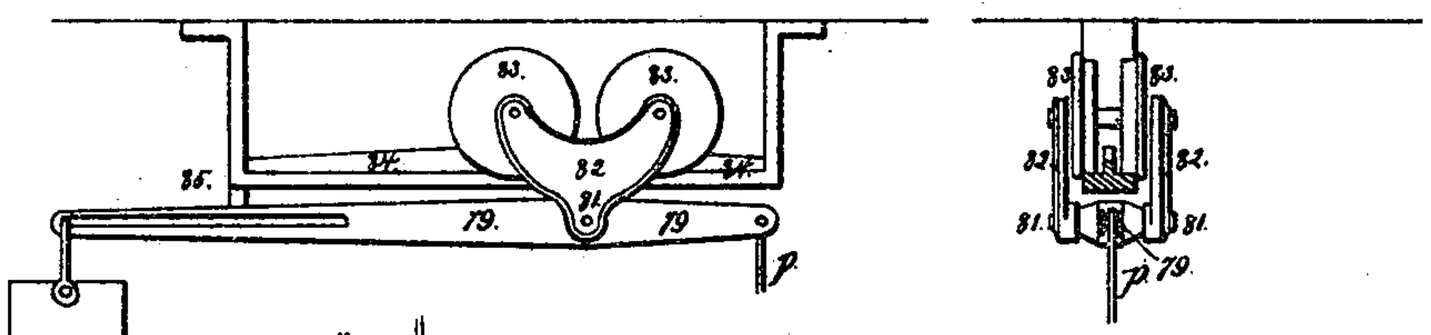
Fig. 6.



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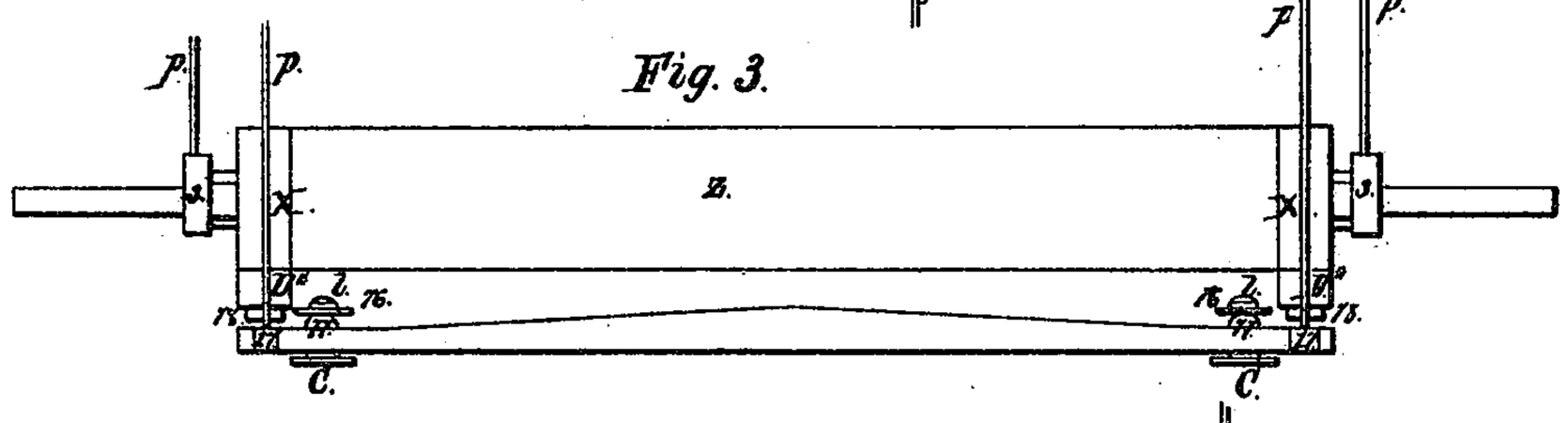

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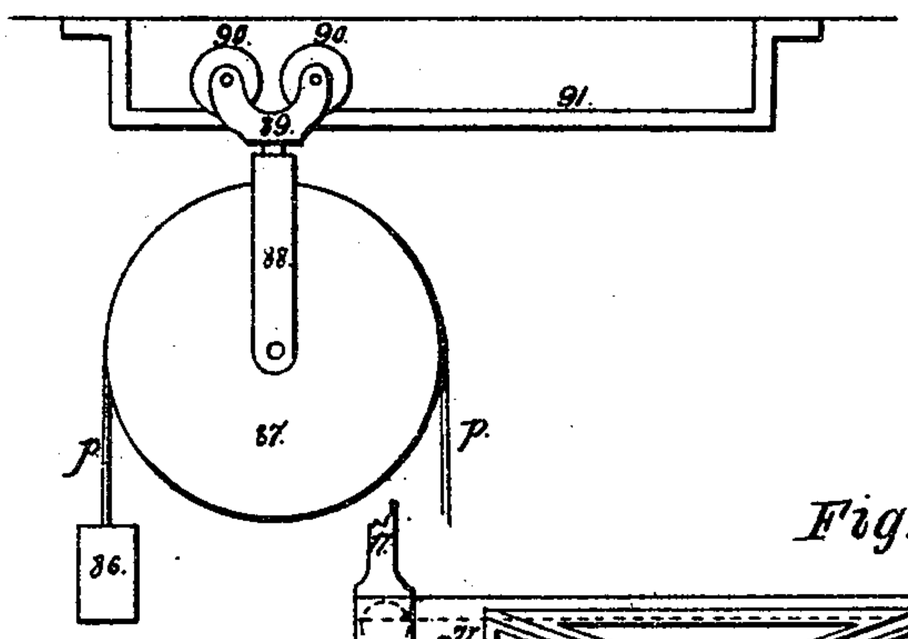

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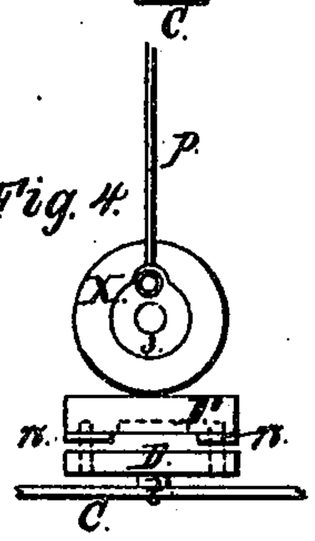

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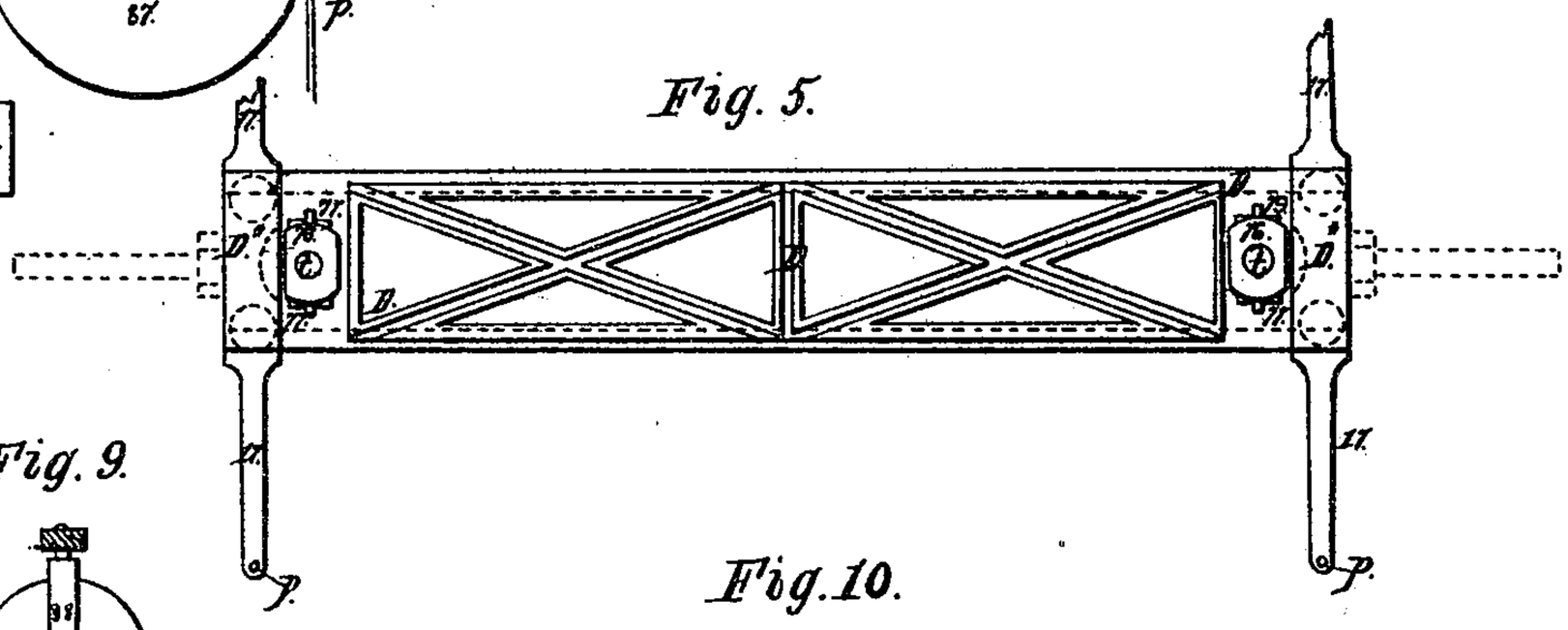

Fig. 9.

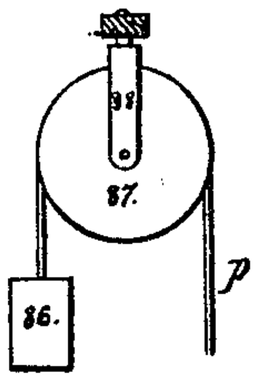

Fig. 10.

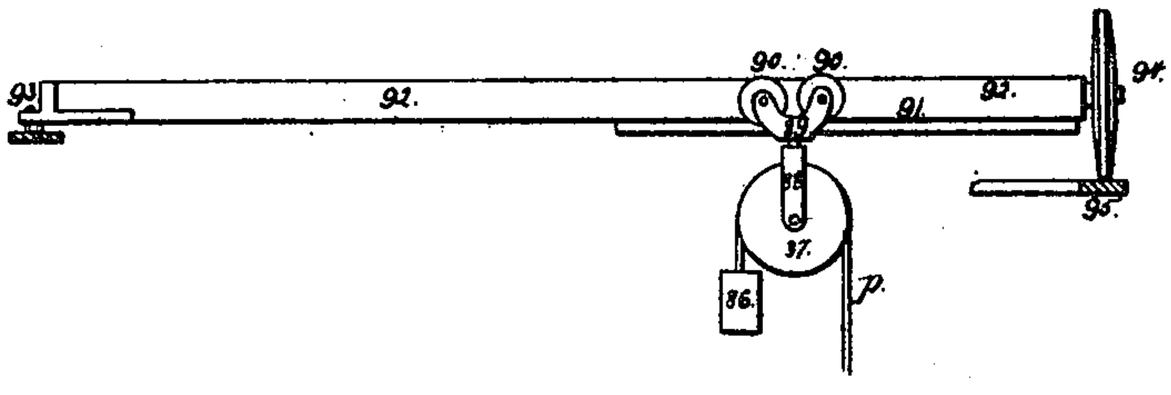

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Fig. 12.

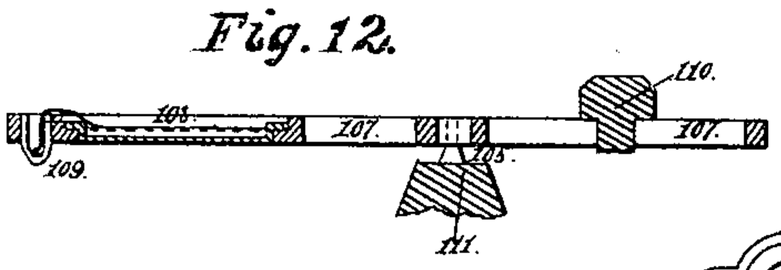


Fig. 11.

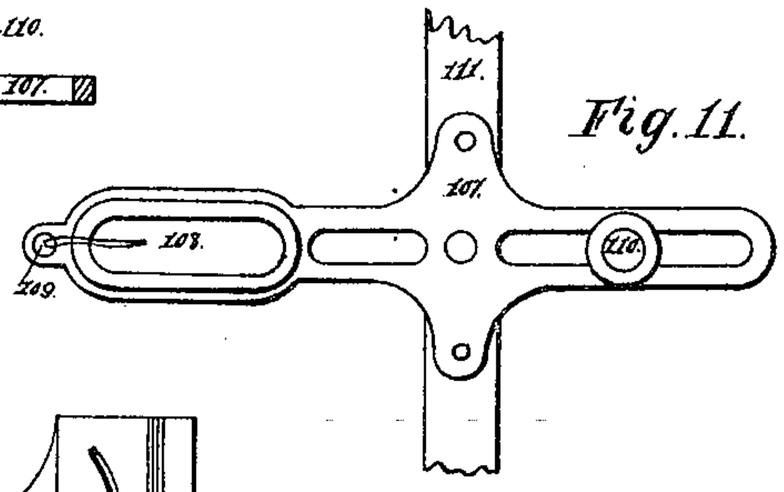


Fig. 15.

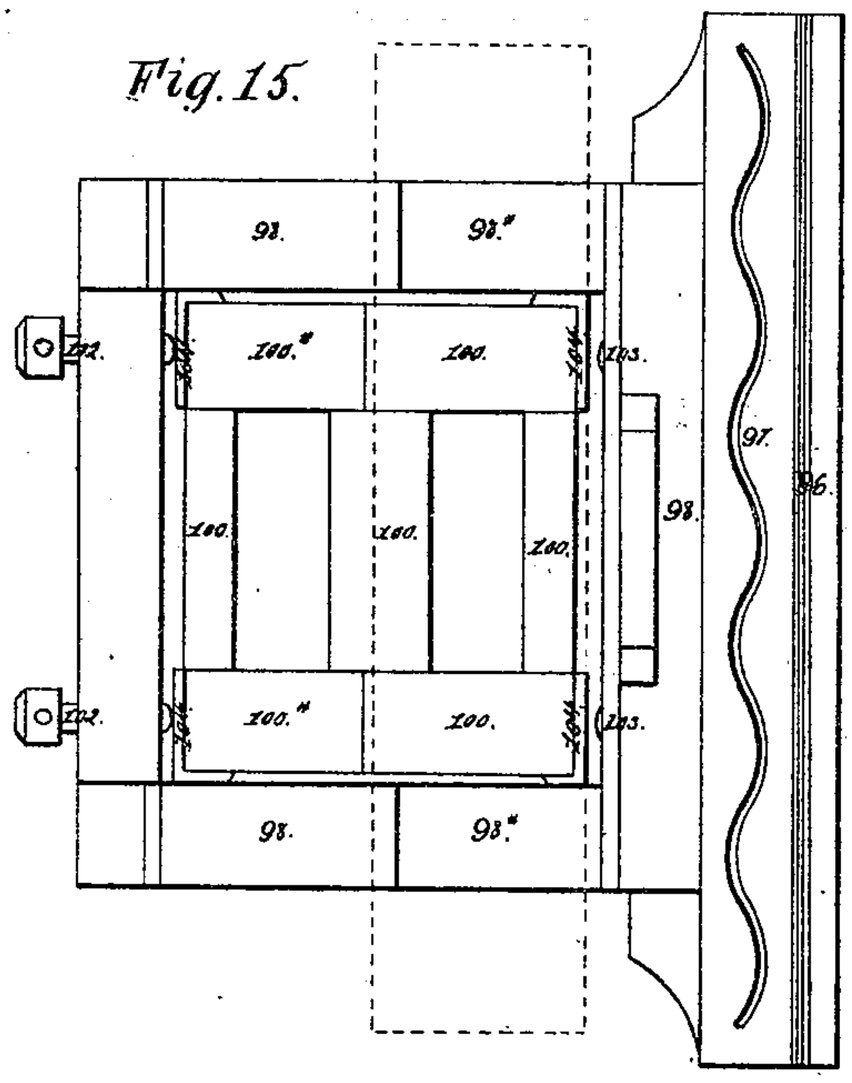


Fig. 16.

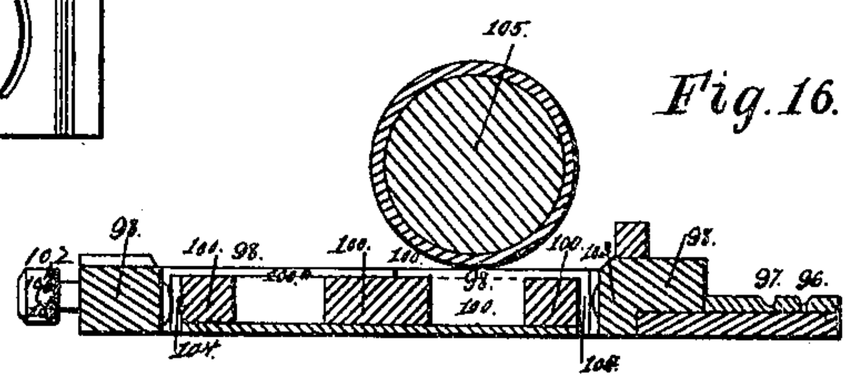


Fig. 14.

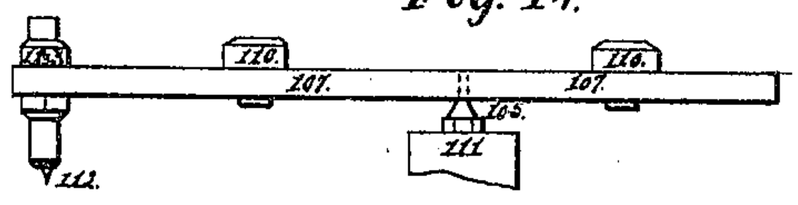
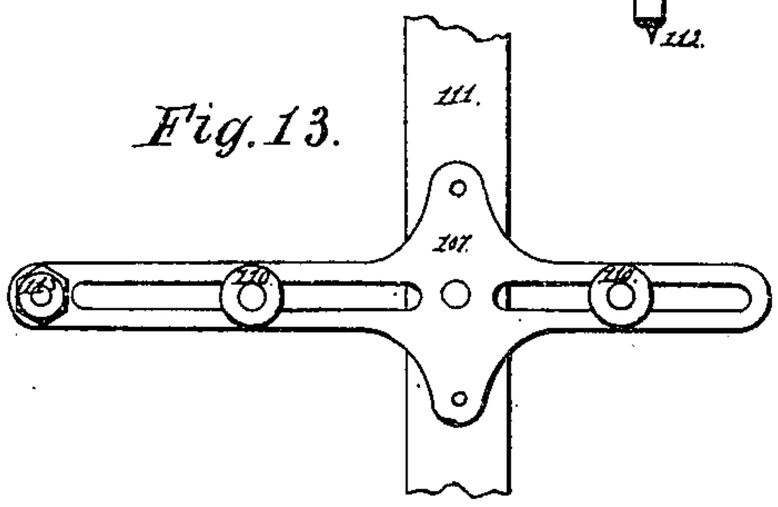


Fig. 13.



UNITED STATES PATENT OFFICE.

ISAAC TAYLOR, OF STAMFORD RIVERS, ENGLAND.

ENGRAVING SURFACES.

Specification of Letters Patent No. 8,991, dated June 1, 1852.

To all whom it may concern:

Be it known that I, ISAAC TAYLOR, gentleman, of Stamford Rivers, in the county of Essex, England, a subject of the Queen of Great Britain, have invented improvements in preparing and engraving surfaces, and also in the construction of cylinders adapted for engraving, and also in machinery for printing and ornamenting surfaces, of which the following is a specification.

The machinery and instruments constituting the first part of my invention include and bring into combined operation three principal elements by means of which advantages are secured in preparing and engraving surfaces that have not belonged to any mode hitherto adopted of employing the well known principle of the hinged rhomboidal frame or pentagraph. These advantages are so substantial and so extensive in their application as to render the machinery under the various modifications of which it is susceptible practically efficient and available for almost every species of work connected with the engraving printing and ornamenting of surfaces and also for effecting upon such surfaces simultaneously many exact repetitions of the same figure, device, or species of work.

The first of the above referred to principal advantages attaching to my invention is that by means of which the highest perfection of work is secured and which is not attainable except by what is in this specification called a high diminution. By the term a high diminution is meant such a ratio or proportion between the tracing point of the instrument and the working point as cannot be usefully, or for any practical purpose obtained by the means of a single rhomboidal frame; for if upon one such frame any such high diminution is attempted as is required for the perfection of work—not merely must the longer arm or bar be of very inconvenient length, but the working point or tool must be carried up so near to the hinge or joint, and both must be so contiguous to the fulcrum as to render the whole inapplicable to important practical purposes. These inconveniences always attach to the use of a single rhomboidal frame when a ratio of diminution is required beyond a twelfth to a fifteenth and this inconvenience becomes a mechanical impossibility when as is often requisite the diminution is carried up as high as from a twenty-fifth to a ninety-sixth degree. No such ratio as this—that is to say beyond a 15th can I believe with practical advantage be obtained or be applied to important purposes except in the mode which my invention brings into operation—in various forms—and this is by placing several rhomboidal frames in a continuous series the first imparting its movement to a second frame or to a pair of such frames and these to a third or to a third pair and so on, if requisite, to a fourth or more. By this means while a power of leverage is placed at command which is sufficient for all ordinary purposes any necessary extent of diminution is easily effected while yet the working point on each of such frames is kept far away from the fulcrum and from the hinging joint. That is to say—on no one of the frames need the working point to be carried farther up toward the hinge or the fulcrum than is required for effecting a diminution of 5 or 6. Thus if the first frame in the series be set at a diminution of $\frac{1}{3}$rd which gives a convenient and extensive range to the tracing point, then the second frame or pair of frames may be at $\frac{1}{5}$th and the third at $\frac{1}{4}$th thus effecting together a diminution of 60 or the successive diminutions may be varied as for instance the first may be to $\frac{1}{4}$th the second to $\frac{1}{6}$th and the third to $\frac{1}{4}$th thus $4\times6\times4=96$ beyond which ratio of diminution I have not found it necessary to go but if desired the diminution may be carried farther.

The great advantage and indeed necessity of effecting a high diminution for securing beauty freedom and perfection of work becomes manifest when it is considered that in whatever mode the lines of any figure or design may be followed by the tracing point; or even if this point be made to move in a metallic groove or against an edge, the movement will be liable to some extent of aberration from its true and exact track and which in relation to the finest description of work and even to some important purposes less fine, would be enough to render the work inadmissable. It should be said that this supposed aberration attaches exclusively to the tracing point, for if the machinery now to be described is constructed with due care no perceptible incorrectness is found to result from the series of frames. But if this incipient and unavoidable aberration may on an average be estimated as equal to the 30th

part of an inch or even if it were not more than the 50th part this error as carried forward to the work at a low diminution, say of 12 would amount to the 360th or the 600th part of an inch, which in fine work would often equal the half or the third of the distance between two adjoining lines and would therefore render such work quite useless. But if the same aberration of the 30th part of an inch be applied to a diminution not higher than 1/45th it will be reduced upon the work to the 1350th part and which may safely be disregarded as an insensible or unappreciable quantity. It is found as a practical rule that the perfection of work is ordinarily directly as the diminution. The practical value of this high diminution appears not merely in relation to that sort of work where an absolute mathematical accuracy is required, but also where absolute freedom of line constitutes the excellence of the work. No method of executing such work at a low diminution is found to give the grace and spirit of an artist's handling to free lines. On the contrary a mechanical stiffness and obtuseness and roundness instead of sharpness attaches to all such work. It is therefore first and chiefly in order to obtain a high diminution—next for having at command a requisite lever power—and lastly for the advantage of space in applying various mechanical adjustments to the working tools, points, gravers, drills or other instruments employed upon metallic or other surfaces that the work performed by machines of the kind presently to be described is effected by a series of rhomboidal frames which propagate the movement given to the first until it reaches the last. Every movement is in continuous fluxion through the entire system of bars and joints. On this construction no one frame is at any time liable to be either stretched out or compressed into an extreme angular position—acute and obtuse, but each performs its office near to that position—namely a rectangular position, which occasions the least possible strain upon the joints, or resistance, or pending upon its fulcrum; all which conditions are more or less important or indispensible in relation to practical purposes, and especially so when the work demands at once mathematical accuracy and force. But to secure this accuracy and this force along with perfect freedom of action and to exempt the tracing point as far as possible from sensible resistance and from any reaction and momentum resulting from a mass of considerable weight, the whole of each principal part of the system of frames is so floated off from its bearings whether these be friction rollers or smooth surfaces as that only such a residue of weight shall be left upon these bearings as is required for securing steadiness of horizontal movement throughout. This floating of the machine is effected by the means of steel-yards, or by swinging arms, pulleys and weights. By these means while the entire leverage of the machine is held at command the residual *vis inertiæ* is reduced almost to an insensible amount.

The complicated structure of the machine instead of giving rise to an encumbered action renders that action so much the more facile and exact.

That which constitutes the second of those principal advantages which my invention secures is the means of bringing a number of working points or tools to operate simultaneously and in perfect unison upon one continuous surface or upon several contiguous surfaces. Each point or tool must at the same moment execute the same work and the work of each must (most often) flow into the work of the points next adjoining. In most cases in which a design or pattern of any kind is to be often repeated upon a surface there must be no visible break or want of perfect continuity of line throughout the whole.

Now for satisfying at once these two conditions namely a multiplied repetition of the same figure or work and a perfect fusion of the work on all its sides with its fellows no construction on the principle of the pentagraph has hitherto been practically successful, or has been found available except to a very limited extent. But the second part of my invention as now to be described meets both these conditions while at the same time it embraces and secures those before mentioned.

These further improvements consist of placing rhomboidal frames in pairs, or as it might be said back to back in contrary positions one to the other and yet so that the two take on to one and the same axis of movement at the extremity of the longer bar. The pair being so adjusted a bar of some kind is carried across from the working point of the one frame to that of the other as seen in the Drawing No. 1, Fig. 1. It is evident that as these frames thus yoked together are exact counterparts the one of the other and as they receive their movement at a common center or axis the bar which connects them will always preserve a parallel position in reference to its own previous position and that therefore every spot upon such a bar, board, frame, or table has the same movement in all directions as every other spot upon its surface. By means of this bar we are no longer confined to the one point upon the diagonal line which is mathematically identical with the tracing point but may take as many points around and between the two diagonal points as the bar or board will offer to our use, and as this may be made indeterminately large, ample scope is afforded as well for the number of points as for the application of mechanical adjust-

ments to them. It is also evident that whether the working points be attached to the connecting bar and the surface to be wrought upon be fixed opposite to them or whether as is most convenient the surface to be wrought upon be attached to the bar while the points are arranged over or beneath it the effect will be the same though in a contrary direction.

Inasmuch as the working points attach to one surface and are fixed in just a position they may easily be so arranged as that the work of each shall flow into that of its neighbor. A machine of this construction covers a large surface with work in the same time that would be required to execute a single compartment of the whole.

I will now call attention to the third of those principal elements which recommend and distinguish my invention from what has heretofore been done where pentagraph apparatus has been employed. For engraving rollers for calico and other printing and for other and analogous purposes it is necessary or highly desirable that by a simultaneous movement any figure or species of work which is placed upon the tracing table and which of course is on a plane surface should be produced by the working points not merely on one breadth of the roller or cylinder from end to end but on all sides of it and as if its rotund surface were spread out upon a flat surface. Heretofore it has been attempted by the means of a pentagraph to move a cylinder so as to be acted on by a row of gravers or instruments and thus to execute a breadth of a cylinder at a time and then to repeat the operation until the circumference had been successively wrought upon. But in this or any similar mode not only does the work occupy a much longer time than in the method about to be described but an insurmountable difficulty presents itself in attempting to effect a perfect continuity of work when the pattern is not an insulated figure but forms a continuous whole. Moreover on any such construction as has heretofore been attempted by means of pentagraphs the working point or tool does not take its bearing upon a cylindrical surface in a true radial direction except at the moment when it is passing over the tangential line. But by means of the construction now to be described each tool and how many soever that may be brought to bear upon any part of a cylinder operates always in the line of the radius of the cylinder and therefore the work it performs is liable to no deflection.

The cylinder the surface of which is to be etched upon engraved inscribed or figured in any manner is first fitted upon a mandrel running through it or in some cases upon separate axes the mandrel on these axes being of sufficient length to meet the requirement of the machine as seen in the Drawing No. 2. The cylinder either upon its own surface or upon surfaces of the same diameter at each end rests with a portion of its weight or with the whole of its weight upon blocks or sleepers attached to the connecting bar or yoke of the working pair of frames as seen in the Drawing No. 5, Figs. 3 and 4 the surfaces of these blocks are jagged roughed or grooved. The superfluous weight of the cylinder if any is separately floated off by steel-yards as one over each end. The cylinder taking this bearing upon the bar is carried with it or if unconfined would be carried in all directions. Laterally or from side to side in the direction of its own axis it is carried in obedience to the movement of the tracing point. But what is wanted is to give it also a rotatory movement and so by the combination of the two movements at right angles to obtain a diagonal or any other required movement. To effect this the axis or mandrel of the cylinder is made to work freely and yet exactly at each end in sockets which themselves are adjusted in the grooves of standards or brackets. When therefore the moving bar takes its direction longitudinally or in any direction not precisely lateral the cylinder receives a corresponding rotatory movement equivalent in peripheral extent to the longitudinal movement of the bar on which it rests. It is therefore manifest that if a fixed point be brought to bear upon the surface of the cylinder or any part of it the line or figure which such a point would have traced upon a plane surface similarly resting on this bar will also and with equal exactness be produced upon this rotund surface. It is also evident that any number of such points which might conveniently be made to apply to the cylinder—above beneath and on either side, and from end to end would all and simultaneously produce the same line or figure thereupon.

It should be noted that although it is usually the most advantageous to plant the cylinder upon the bar and to attach the working points to a fixed frame as shown in the drawing yet the same effect would be produced in a contrary direction if the cylinder were stationary while the working points should be attached to a cylindrical coop planted upon the moving bars. The first named plan as shown in the Drawing No. II, being the most convenient, a strong hoop is fixed to the table directly opposite each end of the cylinder, and these hoops give support and attachment to one, two, three, or more, bars and rods, as may be required by the work, and upon each of these bars carriages are attached furnished with points graving tools drills or whatever instrument may be best adapted to the par-

ticular description of work that is to be done. By means of the adjustment shown in the Drawings No. 1 and 2 these points which when the machine is left to itself always stand off from the surface of the cylinder are made at the pleasure of the person working the machine to take on to it and to descend into it the requisite depth.

If for the sake of the beauty and perfection of the work it is done at a high diminution then instead of attempting to give the cylinder such an extent of movement upon its bearings as would be adequate to the execution of the entire figure at once a shift of the cylinder is effected according to a dial and index or by any similar means. At the same time the fulcrums of the pair of frames and which rest upon a bar working between guides are moved laterally to a corresponding extent.

The machine should be placed in a horizontal position upon a slab of slate or a planed iron table and this slate or table taking its bearings upon frames or trussels firmly bolted together and fastened upon a solid floor. If in any case the whole of a pattern or figure as prepared for the machine is of greater dimensions than can be brought at once within the range of the tracing point it is placed in portions upon the table in accordance with registration lines and intersections.

In preparing any pattern or design for the machine various means are adopted at once for securing accuracy of work and for saving time. If the work consists of constantly recurring forms or figures as in the instance of the letters of the alphabet or of musical or other marks of notation then it is found advantageous to execute such forms, figures or signs in metal by cutting, casting or stamping them, and as many of each as may conveniently be disposed upon the tracing table. When a design or pattern is of a more diversified kind it is first enlarged by means of an adjustment of rhomboidal frames similar to that already described but working from the small to the large. The enlarged outline thus obtained is perfected and filled up by hand according to the taste of the artist. When the entire surface of the design is required to be filled with work, as in landscape and other pictorial subjects, the following method is used. The several descriptions of work required are etched in large upon thin sheets of zinc. These etchings are corroded with muriatic or other acid to such a depth as to pierce the plate, except at certain nodes left for the purpose of connecting and holding the whole together. A great variety of such pattern plates being provided each is put down where required upon the paper and a rubber being applied, charged with any black powder such as black lead dust or fine oxid of manganese the pattern is transferred to the paper. Adjoining patterns require some few strokes with the pencil to connect them and to supply any interstices. By this means as variously modified to meet the variety of work large surfaces of those kinds which when executed by hand are the most laborious and costly may be prepared and effected by unskilled persons under the direction of an artist with great ease and rapidity. A large proportion of work upon metallic plates or cylinders is effected in the following manners. The plate or cylinder having been covered with an asphaltum ground in the manner usual with engravers is placed on its bearings in the machine and the work, as laid down upon the tracing table is passed over by the person who guides the tracing point and who according to the indications thereupon gives the tools or points a greater or less extent of action so that these shall be a due proportion between the lighter and the deeper work although none of it may be of the requisite depth. In some cases it is found to be best to pass over the deeper work a second or a third time. The plate or cylinder is then removed from the machine, care being taken so to mark the registrations as that it may readily be returned to its place without deranging the relationship of the work to the tracing point. The plate or cylinder is then immersed in dilute nitrous acid, or other acid according as the metal may require for just so long a time as suffices to remove the bur thrown up by the tool and at the same time to deepen the work; but not so long as would render the work coarse as to the edges of the lines. The first ground is then removed in the usual mode and if the work is of the most delicate kind, the requisite effect is produced in the modes called rebiting as practiced by engravers without recurrence to the machine. But in all those varieties of work that are the most usual as adapted to calico printing and analogous purposes and where a greater depth may be required the plate or cylinder is recovered with a second ground which must entirely cover the surface and fill in the work already effected, it is then returned to its place in the machine with due care and so much of the work as is required to be deepened is passed over anew, the point or tool entering its original track and laying bare the bottom of the stroke which the sides are protected by the ground and bur thrown out in this second operation. When this is completed the plate or cylinder may be immersed anew in the dilute acid for a time long enough to produce the greatest depth that is ordinarily required.

The readiness and celerity with which any species of work or decoration may be

effected upon surfaces by means of the system of machinery herein described renders it available for an almost endless variety of purposes in adaptation to each of which some obvious modification of its parts is required. Some of the most material or most useful of these may be described.

If a large plane surface or a cylinder be covered with paper of any sort or thickness required, over this may be placed a thin, undersized paper the inner surface of which, or the inner surface in contact with the paper first named is coated more or less thickly with any pigment mixed with an unctuous medium such as white wax and oil, or lard, or linseed oil alone or for other purposes honey or soap may be used. Instead of the cutting points or tools employed when metallic surfaces are to be wrought upon the same carriage or carriages adapted to the purpose are furnished with points somewhat obtuse, and more or less so according to the nature of the work: these points acting upon the exterior of the upper and transfer paper transfer to the other paper the color it is charged with, the effect produced being nearly the same as that of a pencil or crayon, when one color has thus been produced a similar paper charged with another color takes its place and so on until the effect of a finished crayon drawing has been printed or produced. The machinery thus becoming printing or ornamenting machinery. In this mode many repetitions of a drawing may be produced or printed at one time and by planting one frame carrying each its set of points a double or treble set may be in like manner produced.

For the decoration of paper such as paper hangings and other surfaces as also for the adding those colors that are ordinarily produced upon them by the means of what is called block printing, the following method is applicable. In place of the blunted points above mentioned and of the carriages already described a swing carriage is used as represented in the drawing at the extremity of which is a small conical tube loosely filled with a roll of soft leather or sponge, near to this tube is a cistern holding a small quantity of the color required and which is to be in such a state of solution as the particular work may require whether more or less limpid or thickened. From the cistern to the head of the tube there is a communication either by a groove or pipe or by a thread or two of worsted. When this swing carriage falls, to impart its color to the surface beneath, the fluid passes forward also, but returns or ceases to flow when the carriage tilts upward. The requisite number of these carriages being planted upon cross bars over the surface to be figured or printed the machine operates in its usual manner the small aperture of each tube conveying its contents at a regulated rate to the surface whether of paper or other material.

Having thus generally stated the nature of my invention, I will now proceed to explain more in detail the mechanical detail by which I have carried the same into practice; at the same time I would remark that I do not confine myself to the details herein given so long as the peculiar character of my invention or any part thereof be retained.

Description of the drawings—No. 1.—Figure 1. Plan of the rhomboidal frames, or floating part of the machine. Five frames disposed and linked together in the manner here shown suffice for most purposes to which the machine is applicable, for some kinds of work three frames are enough and other kinds may require six or more. These frames occupy the surface of a slab or table T, T, T, perfectly true on the upper surface and placed horizontally and which rests upon the iron trussels as seen in the Drawing No. 2. The forepart *a*, *a*, *a*, *a*, is a slab of slate the hinder from *a*, to *b*, is planed iron. A, A, A, is the first rhomboidal frame *c*, is the tracing point, *e*, the fulcrum which by screw bolt and slot is adjustable in all directions. The curve at *d*, is for the convenience of the hand, *i*, a curved bar or rail on which the bar, 2^A, takes a support upon a wheel or friction roller. The prolonged bar, 4^A, takes a support under the triple joint, *g*, upon the platform, *h*. The superfluous weight of this frame is floated off by cords or chains or they may be rods at, *p*, *p*, carried up to as great a height as the room will admit and which pass over pulleys, indicated by the dotted lines and as hereafter described. The prolonged end of this frame at, *g*, is upon the diagonal line from, *c* to *c*, where the fulcrum determines its movements and this point, *g*, being at a third of the diagonal distance the diminution there effected is of course three. At this point, *g*, the tracing frame is jointed on to the two combined arms of the yoked frames, B, B. The manner in which these three arms or bars take on to the same center of movements is best seen in the elevation figure Q. The two frames, B, B, are exact counterparts of each other, their respective fulcrums are at, *l*, *l*, where as with the frame A, at, *e*, they are adjustable by bolt and slot. They take their bearings on the platforms, *n*, *n*, and, *o*, *o*, and their superfluous weight is floated off at, *p*, *p*, in the same manner as is the tracing frame A. What would be the working points of these frames is at, *m*, *m*, where the bar or yoke Y joints on. Every part of this connecting bar will always move in the same direction as do the points at, *m*, *m*, and the bar can never be in any position not parallel with its position at any other time. The bars, R, R, forming a triangle

give support to an index or tracing point at R^1, which takes effect in any required manner upon the registration tablet R^2, although mathematically any spot taken at pleasure upon the bar *y*, would answer the same purpose yet for the sake of securing a mechanical equipoise the central spot *q* is chosen whereat to joint on the combined arms of the frames, C, C, which (in like manner as, B, B, receive their movement from A) receive their motion from the bar or yoke Y, common to, B, B. Thus it is that every movement given to the tracer *c* is conveyed through it to, B, B, and from these by the bar Y, to, C, C, which at the axes or pivots, *t*, *t*, receive a connecting bar indicated by the dotted lines. The floating of this pair of frames with all to which they give motion is better shown in another drawing. The fulcrums of this pair of frames at *r*, *r*, are upon a broad bar or slider E novable laterally upon the table by means of a screw and winch, S, as seen in Drawings 2, 3, and 4. And the sliding bar is controlled by the guide plates E′. The frames, C, C, take support on friction rollers E^2, upon the raised projections, *v*, *v*, of the bar E. The bar, yoke or table shown by dotted lines D, and which joints upon, C, C, at, *t*, *t*, is called the working bar inasmuch as it is to this that the plate or the cylinder to be wrought upon is attached or (in some cases) the tools fixed by which the work is effected. *w* is a rod or lever by means of which as elsewhere shown the points or tools are made to take effect. The extent of movement allowed it at any time is regulated according to a scale Y, by the lever *x*, and volute *z*. Fig. 2 is an elevation of this system of frames taken through the central line of the whole at, *q*. This elevation shows that by adjustment of the joints and a swan neck at, *g*, there is but a small perpendicular difference between the hand at, *d*, and the working bar at the pivots, *t*, *t*, this avoidance of angular strain is of much importance as related to the mechanical perfection of a machine in which a delicate movement is propagated through a great number of joints. Figs. 3, 4 and 5, show the structure of the joints employed throughout the frames, 3 the plan, 4 the elevation and 5, a section through the center. *a**, the body of a bar to be jointed, *c**, the bar to be connected with it, *b**, a swan neck piece in which works the screw *f**, *g**, a lock nut this pin has a finely turned conical end which takes its bearing in a hole drilled through the bar *c**, *e** a circular facet or disk of steel let into *c**, which plays upon a similar disk, *d** let into, *a**. These facets being true surfaces are held always in perfect contact and in position by the conical point of, *f**, a degree of elasticity in the piece *b** keeps this joint firm with the least friction and it is capable of more exact adjustment than any other kind of hinge or joint with which I am acquainted.

Drawing No. 2.—Fig. 1, is a plan of that part of the machine for engraving cylinders which is superposed upon the system of frames or floating part shown in Drawing No. 1. Fig. 2, an elevation of the same as seen in the rear of the table T, T. Fig. 3, an elevation of the left hand end of the same. The shade of color shows the upper part of the cylinder Z or roller with its mandrel and cylindrical ends X, X, of the same diameter. C, C, the bars of the working pair of frames. E, the platform which gives support to the fulcrums of this pair at, *r*, *r*, and which is movable laterally by the winch and screw, *s*, *s*—*t*, *t*, the pivots of, C, C, upon which is jointed a bar or table, D, D, at either end of which is a block or sleeper D, whereupon the cylinder Z takes its bearing either upon its ends, X, X, or upon its own surface. F, F, standards or brackets—one at each end of the cylinder in the upright groove of which (in bushes 2) the spindle end of the mandrel works freely and with an exact fitting. (3) (3) the collars and, *p*, *p*, suspending wires by which the superfluous weight of the cylinder is floated off by steel yards aloft. 4, 4, are props each of which at its lower end has an arm, 4^a, attached to it and these arms are connected together by means of the rod 4^b, so that each prop 4, may have like movement given to it. The props 4, 4, have screws formed on part of their length by which they are supported in the nuts 4^c, with a capability of raising the cylinder Z from its bearings when the cylinder is required to make a partial revolution. G G fixed circular frames bolted to the table beyond the standards. These circular frames give support and attachment to bars in whatever position as to the cylinder the working points may require them to be placed. Three such bars, H, H, H are here shown. To each bar is appended a rod or spindle (5) (5) (5) supported at one extremity by the cariage (6) and at the other in a socket (7). The bar and spindle give support wherever wanted to the carriages (8) (8) (8) one of which is shown on a larger scale in figures (5) and (6). These spindles (5) (5) (5) receive a partial rotatory movement by wheels or pulleys (9) (9) (9) as shown in this drawing connected by a chain placed centrically and taking on to the wheels placed around its periphery all these are simultaneously put in action by a treadle. In Figs. 5 and 6 is shown the manner in which the rotatory movement of the spindle brings the points or tools to bear upon the cylinder. (10); (10), a stock working in the journals (11), (11). (12) the point or tool inserted in the stock (10). This stock is kept off from the work by the

spiral spring (13). (14) cheeks taking their hold on either side of the spindles. (15) is a volute cam bolted on to the spindle and which when it receives a limited movement acts upon the friction roller (16), thus depressing the stock and so bringing the tool to bear upon the surface of the cylinder. The side elevation, Fig. 6, shows the mode in which the carriage takes its hold of the transverse bar, H, and is adjustable upon it. (17) are bars or arms from the table D, by the aid of which this table with what it supports is floated off from its bearings by the suspension wires, *p*, *p*. Fig. 4, is a modification of part of the machine showing another method of raising and depressing the points or tools. (18) (18) are weights suspended by the cords or straps 18# and acting by means of the pulleys (9) (9) upon the spindle or cam axes 5 and thereby pressing the points or tools upon the surface of the cylinder. (19) is a weight suspended to the other extremities of the cords (18#) and so acting as to raise the weights (18) (18) and permit the points or tools to be removed from the surface of the cylinder. By means of a treadle acting upon the cord (19#) the weight (19) is raised and the wieghts (18), (18). are allowed to act as before.

Drawing No. 3.—When flat surfaces are to be wrought upon whether as one plate or as many—instead of the coop with its apparatus as shown in the Drawing No. 2, there is substituted the adjustment shown in Fig. 1, the plan Fig. 2, the elevation in the rear, and Fig. 3, the side elevation. The parts of the rhomboidal frames which are seen in this drawing are indicated by the same letters by which they have been before referred to. The colored parts, Z, Z, Z, are twelve flat plates upon which the same figures or work of any kind is to be effected. These plates are held to their places by small clamps taking on to the edge of each plate and the whole is securely bolted upon the barred frame or table, D, which table is carried by the pivots, *t*, *t*, upon, C, C, in the manner before described in reference to Drawing No. 1. L, L, L, L, are ribbed tablets attached to pillars (20) (20) (20) (20) which are bolted on to the table T. These tablets on their under surfaces receive the ends of the bars or arms (17) (17) 17) (17) which have a movement upon them by which means the table D, with its plate or plates takes its bearings upward, so that when the tools or points are at work upon the plates the pressure and friction upon the bearings is diminished instead of being increased as it would if the bearing were downward. K, K, K, K, a strong frame or stool extending beyond the range of the frames, C, C, and which gives support to the bars, H, H, H, and spindles (5) (5) (5) with their carriages (8) (8) (8). These spindles upon which the volute cams are fixed receive their partial rotation by means of the compound levers moved by the rod, *w*. This movement is carried on from (21) to (24) (25) (26) (27) (27) (27), and thus affect the three spindles simultaneously—(23) a standard giving support to the axis (22). The carriages and tools are the same as those shown in the preceding drawing. Figs. 4, and 5, exhibit the structure of a graving apparatus which in executing its work—that is to say in cutting out and driving the metal before it moves on its axis of motion in conformity with the direction of the line its cutter is plowing. Fig. 4, a side elevation and Fig. 5 a front elevation of the same. H the bar which carries the graving apparatus, and (5) the spindle as before described. (11) (11) the body of the carriage with its journals in which the stock (30) rotates (31) a wheel receiving a partial rotatory movement from a rod or band passing upon its periphery. Upon this stock is jointed at (33) and (34) the body (32) which holds in oblique position the rhomboidal graving tool or cutter (39). The stock (30) is tubular and within it the stock (35) rises and falls by the alternate action of the cords (38) and the volute cam (15). The cutting extremity of the graving tool is so placed as to be always precisely beneath the center of motion the difference of centering between (33) and (34) gives it a forward motion—clearing the bur when it rises from its work. Fig. 6 shows the manner in which these graving tools receive their rotatory movement in conformity with the direction of the line they cut. It is a plan of the whole machine combining the part shown in No. 1, and in Fig. 1 on this drawing. To the tracing point or axis, *c*, is attached a handle (40) which is held by both hands so as to give a more steady and determinate movement to the arm IA. This handle (40) gives action to the rods (44) (44) and these again to the wheel (45) which revolves upon the same center as the joint (45) gives action in like manner to (46) (46) and these to the wheel (47). This wheel revolves upon an axis concentric with the fulcrum joint *e*. The axis of this wheel passes down below the table T, in the manner shown in Fig. 7. The wheel (48) on the same axis as (47) gives movement right and left to the rods (49) (49) (49) (49), which attach to and move the cross bars (50) (50). Fig. 7, shows an elevation of Fig. 6. From the wheels (51) on either side acting in combination movement is conveyed by endless bands (53) (53) to the several tool wheels (31) shown at large in Figs. 4 and 5. In this instance the fulcrum of A, is of the shape shown so as to afford a firm support on the table T, over the circular aperture at

(47). In working a machine on this construction the bar (40) is to be kept nearly in a right angular position to the line which the tracer is following.

Drawing No. 4.—Shows similar views to those contained in the Drawing No. 3. Fig. 1, a plan. Fig. 2, elevation in the rear and Fig. 3, an elevation of the end. This adjustment is for working upon flat surfaces but adapted to those instances in which the work is best done by weight upon the tool rather than by the absolute action of the volute cam. Fig. 3, the lever, *o*, *o*, is counterpoised by the weight P, which, when the machine is at rest, brings the roller (60) in its own direction and by the cord (65) attached to each of the wheels (61) (61) (61) elevates the lever piece (62) (62) (62) which working against the pins (64) (64) (Fig. 4) raises the stock (10) with its tool (12) from the surface of the plate. When the machine is put in movement the treadle N by its rod reverses the action of the lever *o*, *o*, lifting the weight P, and thus allowing the weights (63) (63) (63) to act upon the lever (62) and so to bring the stock and tool down upon the plate with such an amount of weight as the work requires.

Drawing No. 5.—Figs. 3 and 4 show in longitudinal and transverse elevations the cylinder or roller Z, taking its bearings at X, X, upon the blocks or sleepers, D#, D#, which are roughened on the upper surface in order to the better taking hold of the cylinder. These views show also the mode of its suspension by wires, *p*, *p*, (3) (3) collars within which the axis of the mandrel works, *p*, *p*, wires of suspension passing up to the steelyard or beam (79) in Figs. 6, and 7. This beam revolving at (81) is held in equipoise by the weight (80) adjustable in the slot according to a scale. (82) (82) checks taking on to the wheels (83) (83) which run upon rails in (84) and thus allow the cylinder beneath a requisite extent of movement in the line of its axis. *t*, *t*, the pivots of movement in the bar table D, D. (76) a collar taking a bearing upon the friction wheels, (77) (77) so as to give freedom of movement to the frames, C, C, instead of counterpoises. Fig. 4, (78) (78) are screws by means of which the blocks or sleepers D# D# are adjusted and brought to an exact bearing beneath the ends, X, X. Fig. 5, is a plan of the frame or table D, D. D#, D# the blocks or sleepers sustaining the ends X X of the cylinder. (76) (76) collars resting and revolving upon the friction wheels (77) (77) as shown in Fig. 3,—the arms (17) are the means of suspending the bars or table D. Fig. 8, shows the mode of floating off the superfluous weight of the frames where some extent of movement in every direction is required by that part of the rhomboidal frame to which it attaches. The cord, *p*, of the weight (86) passes over the pulley (87) which pulley is suspended by the cheeks (88) upon the swivel joint (89) which allows the pulley to revolve freely. The whole also runs by the wheels and carriage (90) (90) upon the trams (91). Fig. 9 shows the mode of floating off where a run upon the rail is not required, but where a swivel movement is sufficient. Fig. 10 shows the mode of counterpoise or floating off which is applied to the longer arm of the tracing frame A, Drawing No. 1. In this case a wide range of movement is provided for. The parts (86) (87) (88) (89) (90) (91) are similar to those shown in Fig. 8, but the whole is attached to a long lever (92), with its pivot at (93), (94) is a wheel running upon a curved rail (95) as indicated by the dotted lines in Drawing No. 1. Figs. 11 and 12 are plan and section of what is called a swing carriage applicable to surfaces when some fluid color is to be imparted to them. The body (107) rests and revolves upon conical points (106) taking into holes of small bore and thus resting upon the cross piece or bar (111). (108) is a flat cistern containing the fluid pigment (109) a conical tube with a small aperture at its lower apex. The communication from the cistern to the tube is effected by a thread of worsted or other similar substance having a capillary structure (110) (110) weights adjustable in slots for regulating the pressure of the tube upon the surface it is to act upon. This swing carriage rises or falls in obedience to the foot by means of the treadle in the usual mode and as otherwise shown in these drawings. Figs. 13 and 14 are plan and section of a similar swing carriage furnished with a point (112) instead of the tube and cistern above described. The other parts are similar to the corresponding parts in Figs. 11 and 12. This carriage is applicable either where a point—whether diamond or steel—is to be employed upon a surface with extreme delicacy as in the etching of fine works or where (as for the purpose above described) a tracing is to be effected upon a surface of paper by means of an interposed transfer paper. Figs. 15, and 16, are plan and section of a ruling machine of a novel construction by means of which when applied to the tracing point on the tracing table parallel lines either straight or waved may be effected. (96) and (97) are grooves, the one straight and the other waved in a metallic plate attached to the fore part of the board or frame (98) (98) within which is placed the frame (100) (100) moving freely within the frame (98) and having an extent of movement forward and backward limited at pleasure by the screws (102), (102) against the polished knobs (103) (103). The bearings upon the side of these two frames are so adjusted as

that the loaded cylinder (105) in passing to and fro shall alternately rest upon the outer and the inner frame and shall insensibly transfer its weight from the one to the other, the upper surfaces of the frames (98), (100) being recessed at the parts (98ˣ) (100ˣ), so that when the roller is resting upon one frame the other shall be at liberty to slide or move freely the distance to which it is adjusted by the set screws (102). The wrist and fingers of the left hand easily effect these movements and give perfect direction to the tracing point with great rapidity of execution.

The same contrivance made up upon a larger scale and with the requisite adjustments is available as a ruling machine for executing skies and other similar parts of plates in the mode usually practised by engravers.

What I claim as my invention and desire to secure by Letters Patent is—

1. In the first place the connecting of rhomboidal frames or pentagraphs in series so as that the one which first receives a movement from the hand or other moving power conveys its movement to a second and this again if required to a third and so on as far as the nature of the work to be done may need a high diminution to be carried.

2. In the second place I claim as my invention the placing rhomboidal frames or pentagraphs in pairs so connecting each pair by a rod or bar at the working joint of each as that a true geometric point of movement is presented upon every point or spot of such rod or bar, whether the said rod or bar be made to communicate motion to the cutting, or other tools, which act upon a fixed surface; or whether it be made to communicate motion to the surface itself either plane or cylindrical, while the tools are fixed. These tools which may be of any number convenient to apply or required by the work may be diamond or steel points, gravers, punches, drills, pencils, pens or tubes for conveying colors.

3. In the third place I claim as my invention the conveying the movement of the above mentioned rod or bar connecting two pentagraphs to a cylinder or roller in such manner as that when points or tools of any required kind are applied to the surface of the same and in whatsoever direction, whether vertically or on the sides horizontally or beneath, each point or tool brought into contact with the cylinder produces thereupon the same figure or mark of whatever kind which it would produce if operating upon a plane surface.

4. In the fourth place I claim as my invention the construction of a frame called in my specification a ruling board which by transferring the weight of a loaded cylinder alternately from the sides or bearers of an external and internal frame allows each frame in its turn to move backward or forward a distance regulated by screws or other similar means. In this manner and by the application of a carriage or traversing point to one of these frames lines may be ruled or engraved with perfect accuracy as to their distance one from the other.

ISAAC TAYLOR.

Witnesses:
JOSEPH MARQUETTE,
WILLIAM EWING.