(No Model.)

8 Sheets—Sheet 1.

J. W. OSBORNE.

PRINTING MACHINE.

No. 401,790. Patented Apr. 23, 1889.

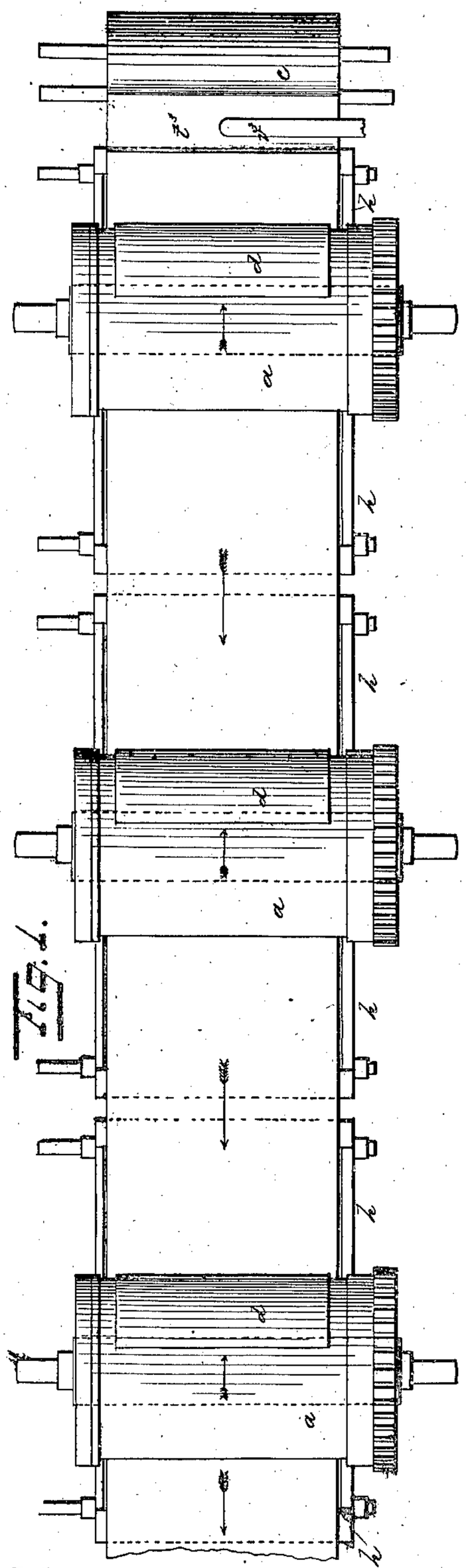

Fig. 1.

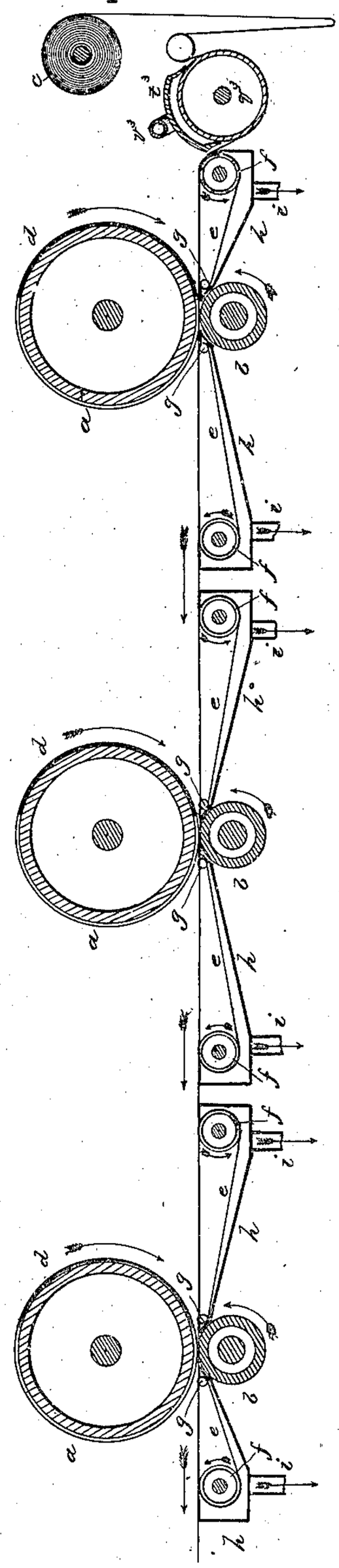

Fig. 2.

Witnesses:
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(No Model.) 8 Sheets—Sheet 2.

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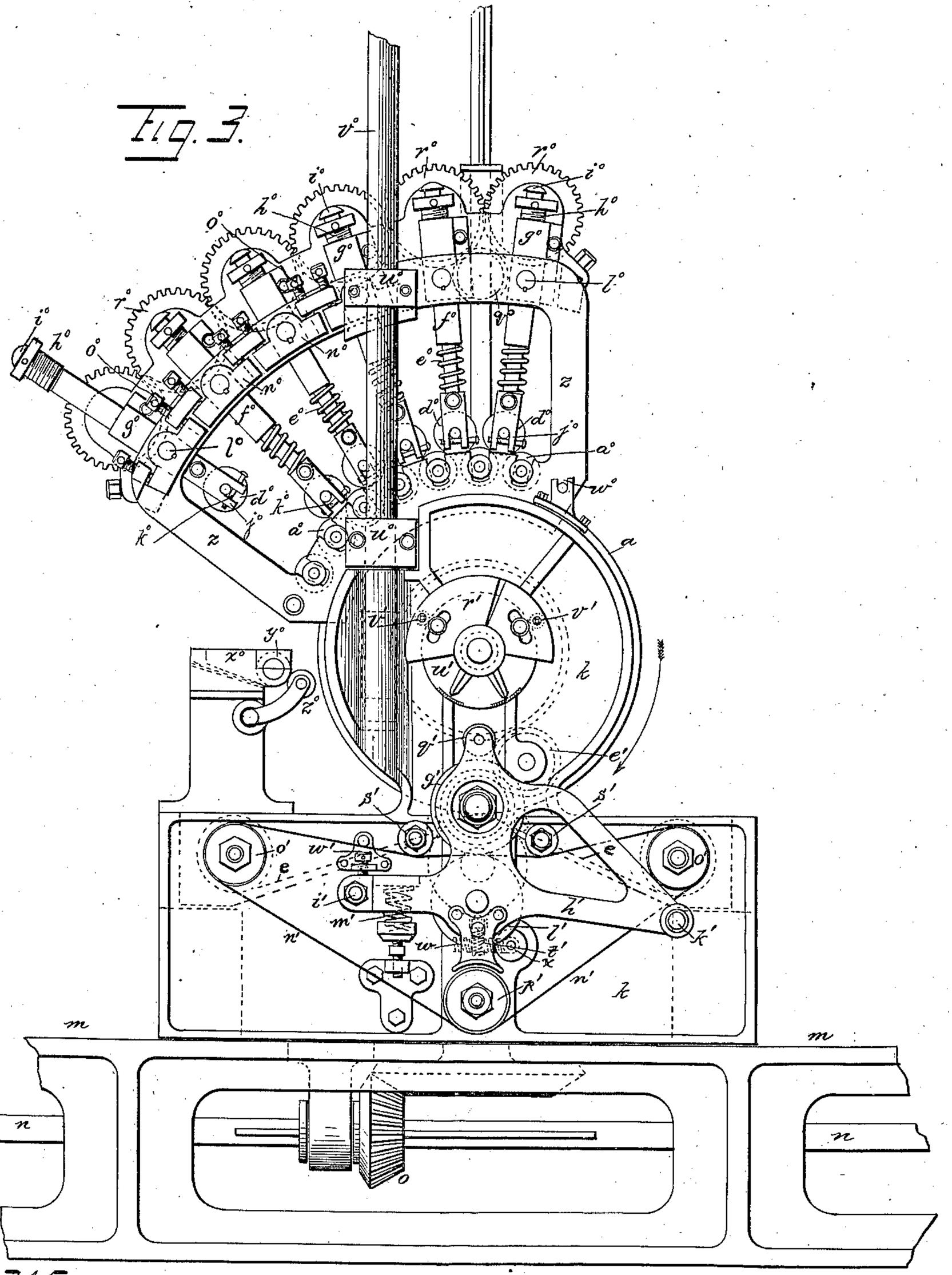
Fig. 3.



Witnesses:
H. C. McArthur,
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Inventor.
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(No Model.) 8 Sheets—Sheet 3.

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No. 401,790. Patented Apr. 23, 1889.

Fig. 4.

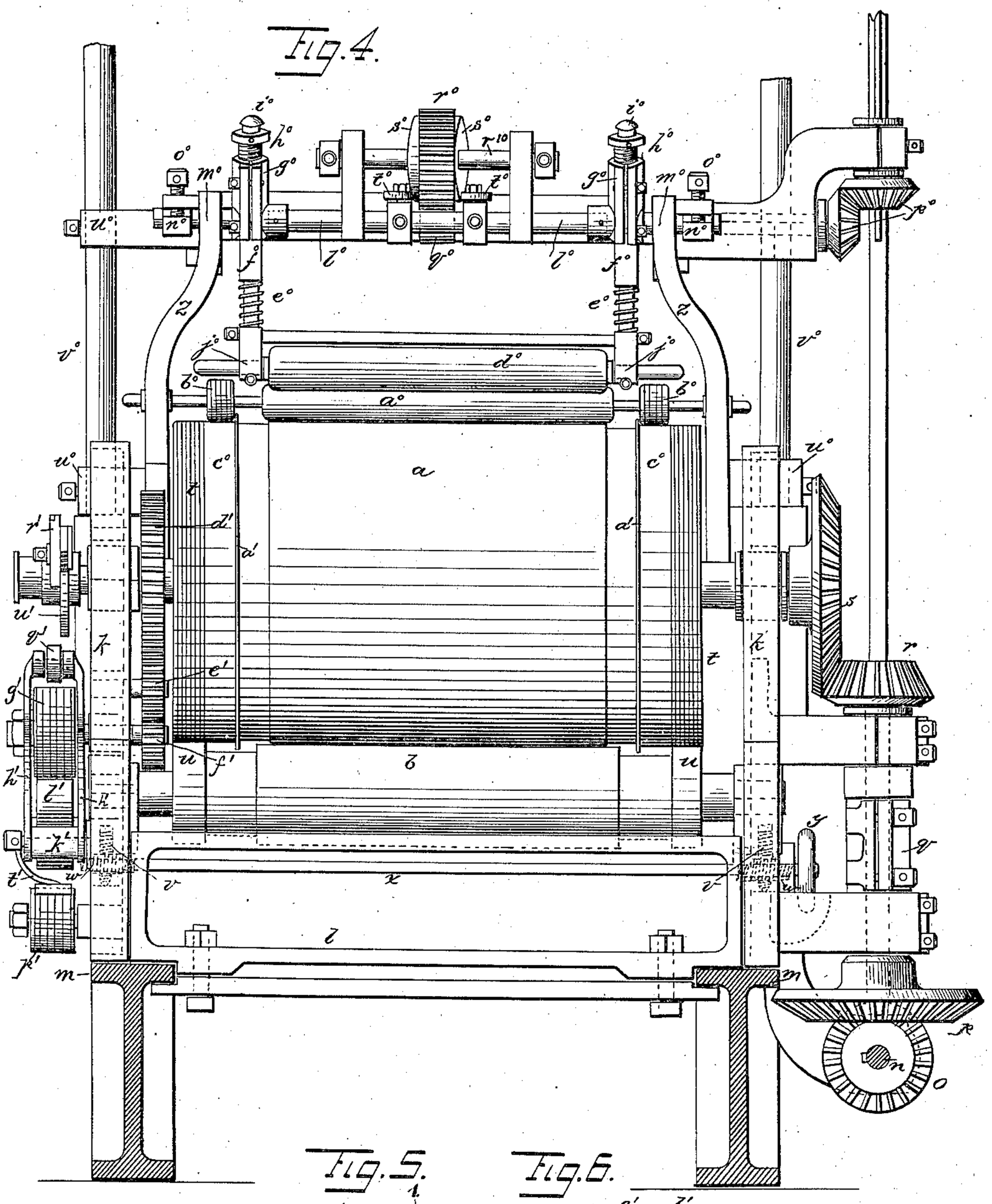


Fig. 5.

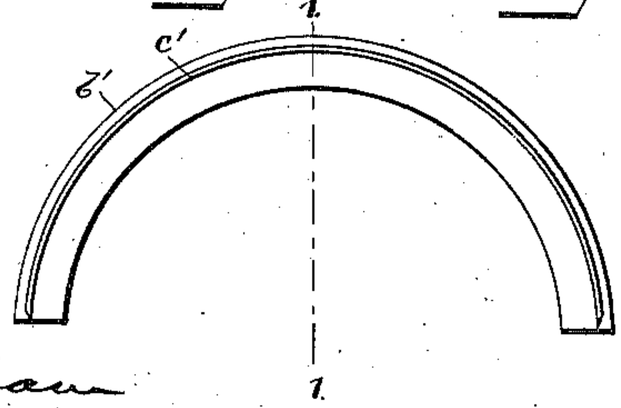
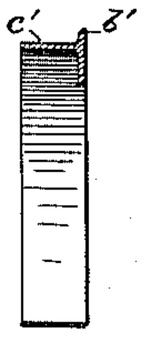


Fig. 6.



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(No Model.) 8 Sheets—Sheet 4

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No. 401,790. Patented Apr. 23, 1889.

Fig. 7.

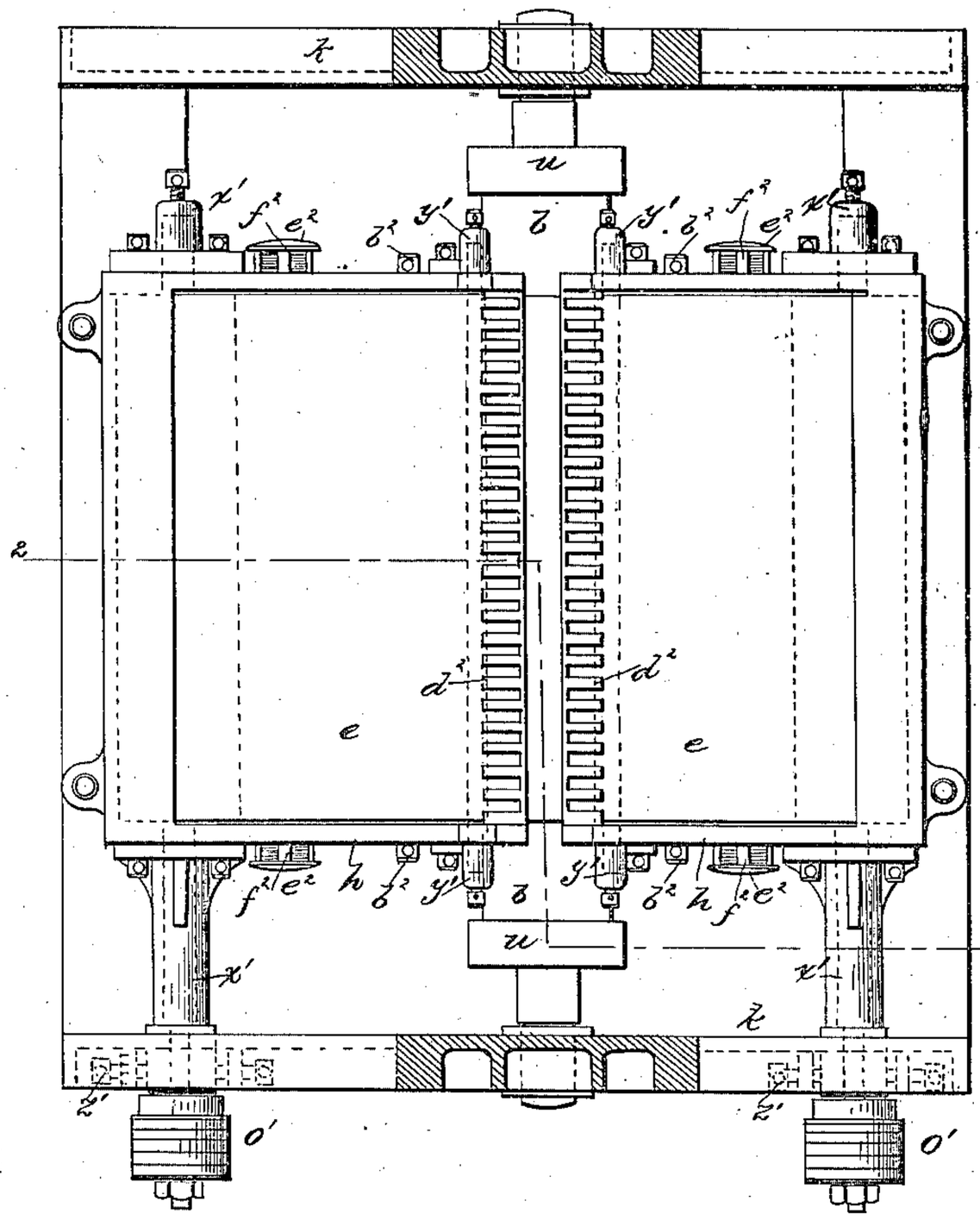

Fig. 9.

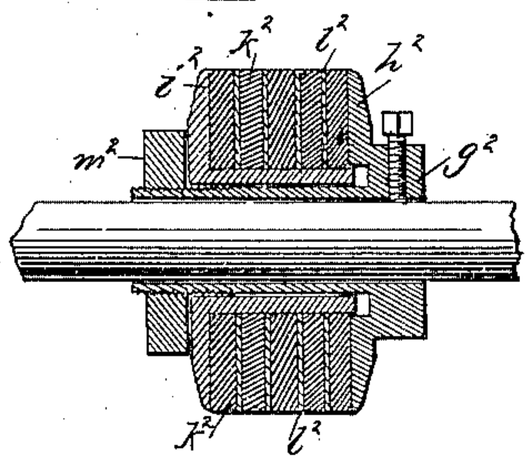

Fig. 10.

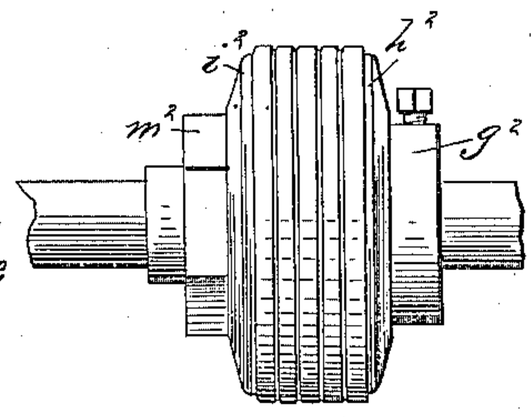

Fig. 8.

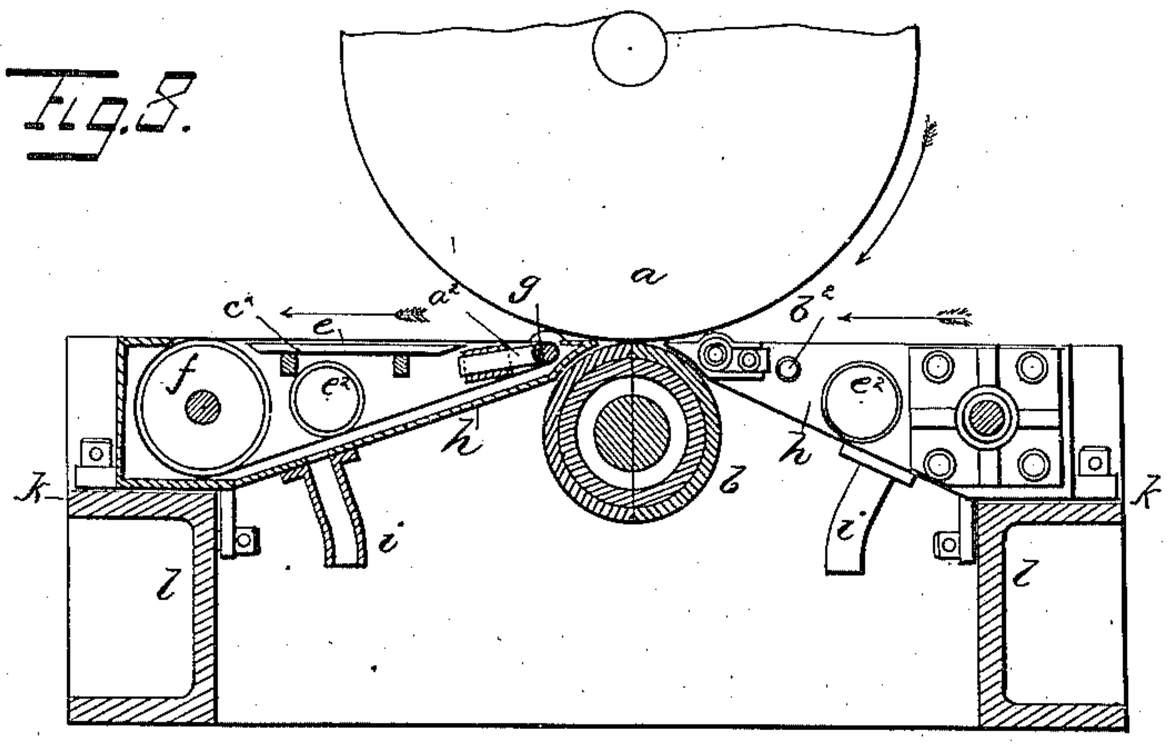

Fig. 11.

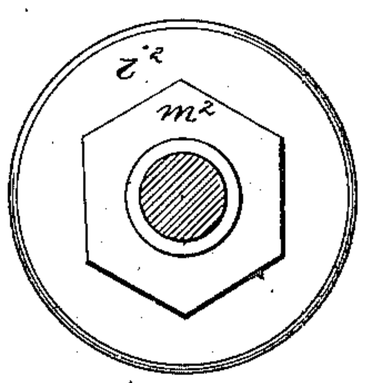

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Fig. 12.

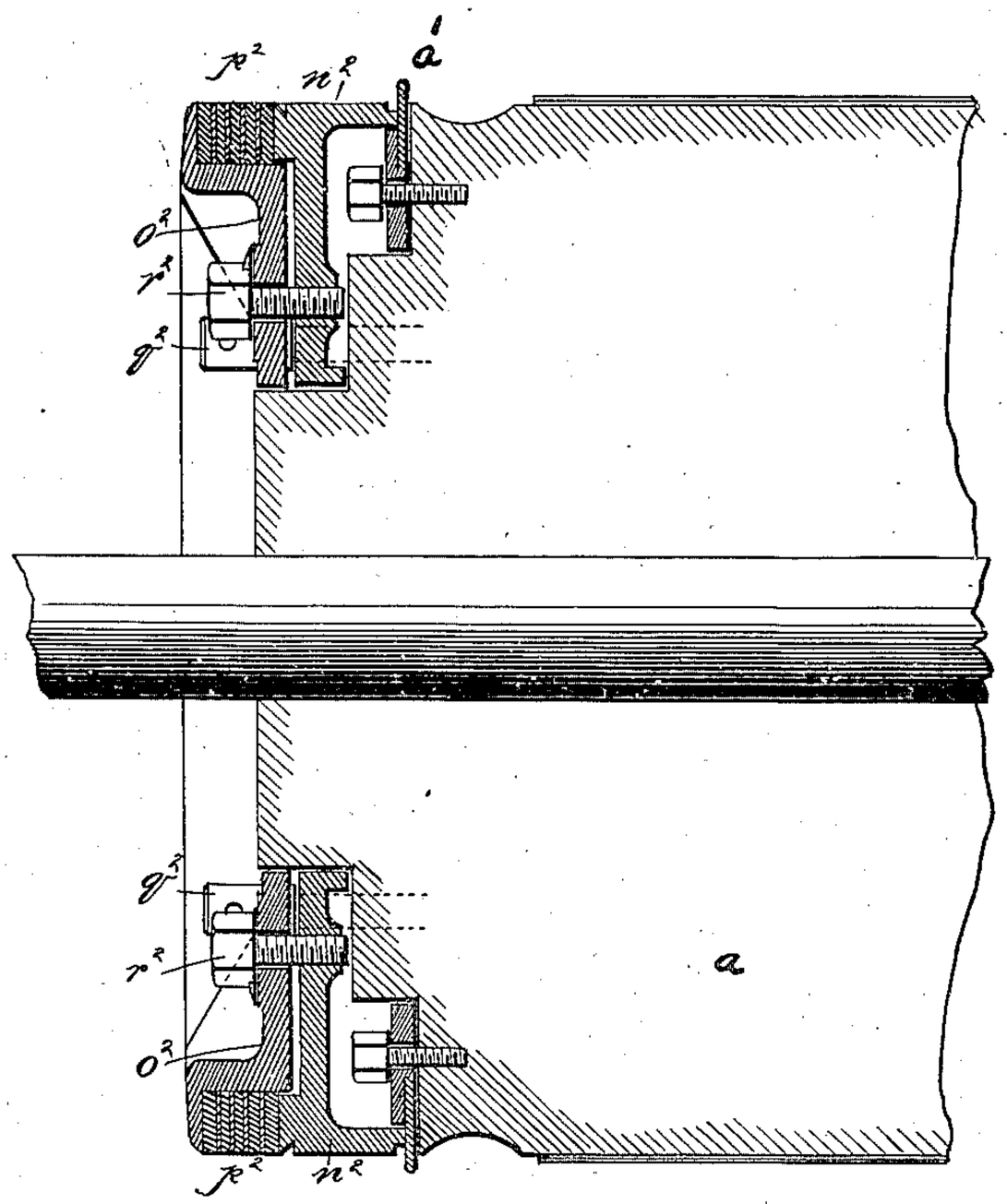
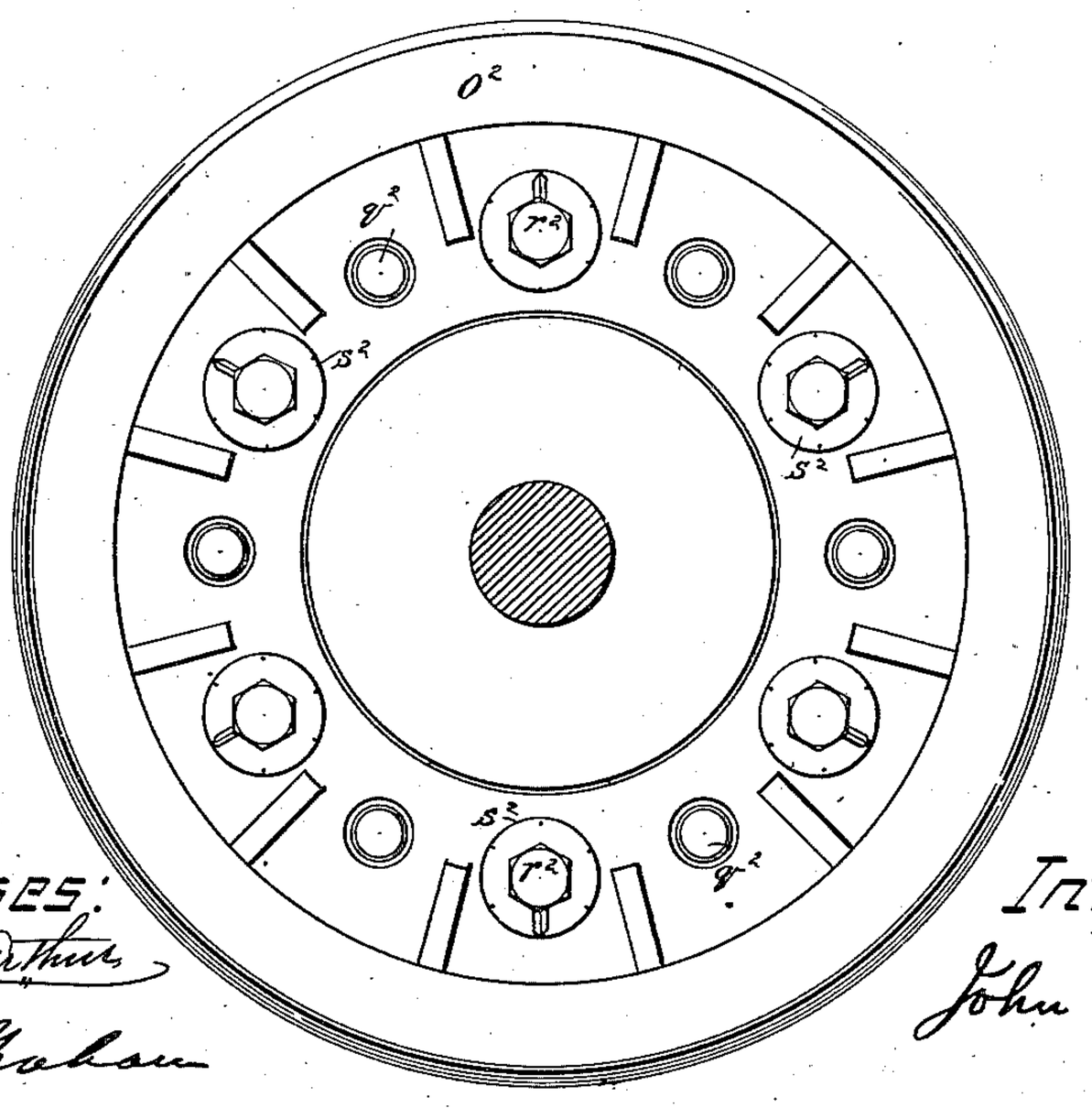


Fig. 13.



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No. 401,790. Patented Apr. 23, 1889.

Fig. 4.

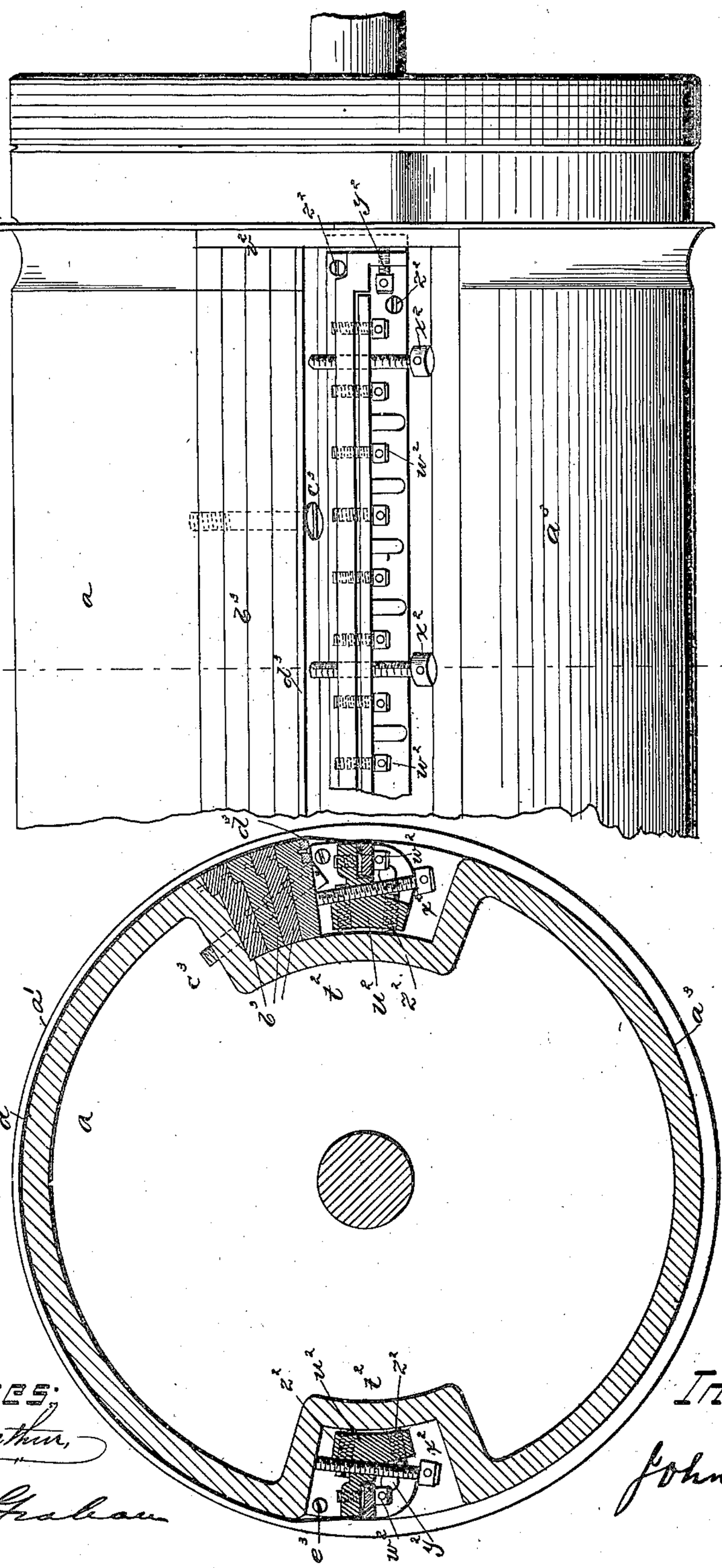

Fig. 5.

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(No Model.) 8 Sheets—Sheet 7.

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PRINTING MACHINE.

No. 401,790. Patented Apr. 23, 1889.

Fig. 18.

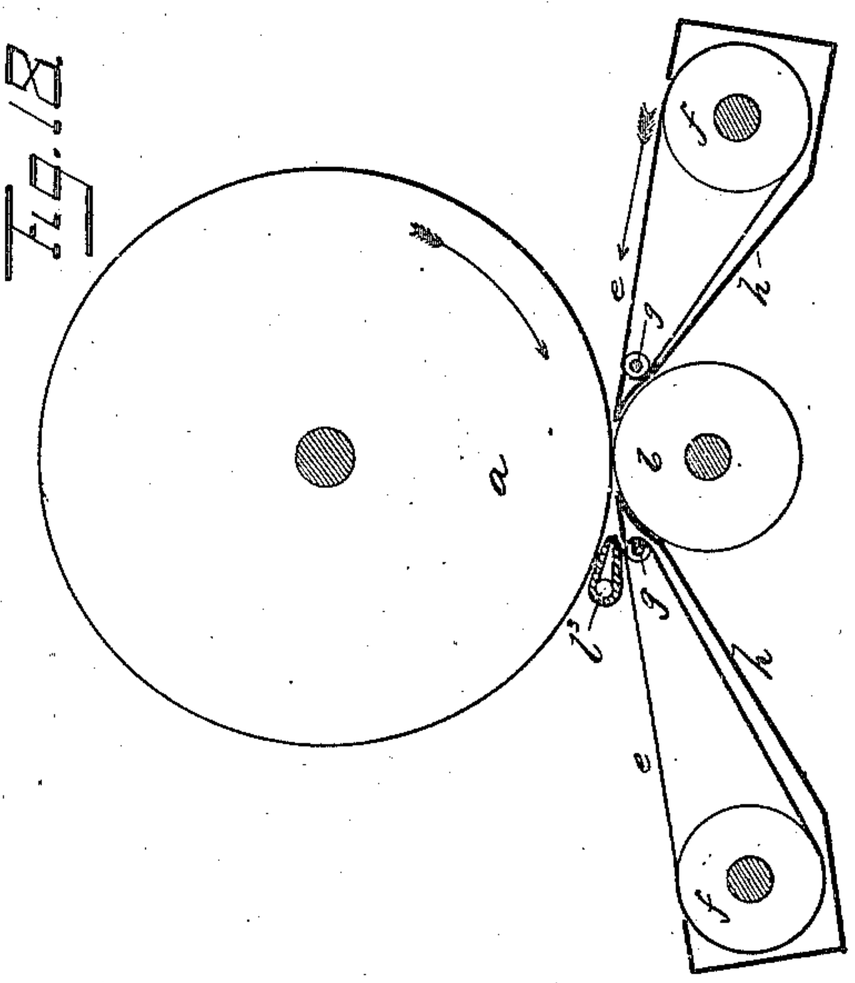


Fig. 19.

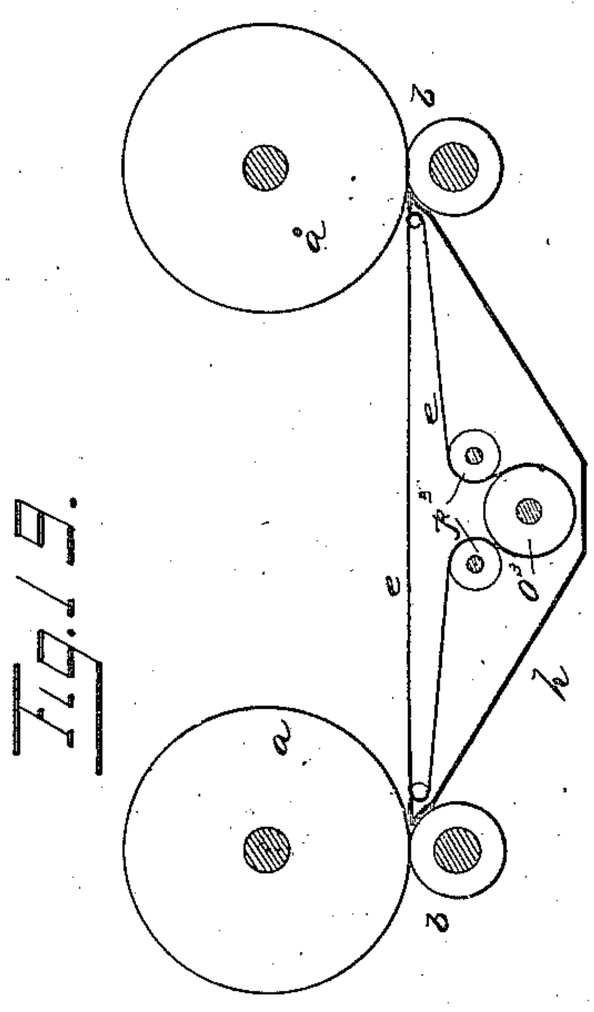


Fig. 16.

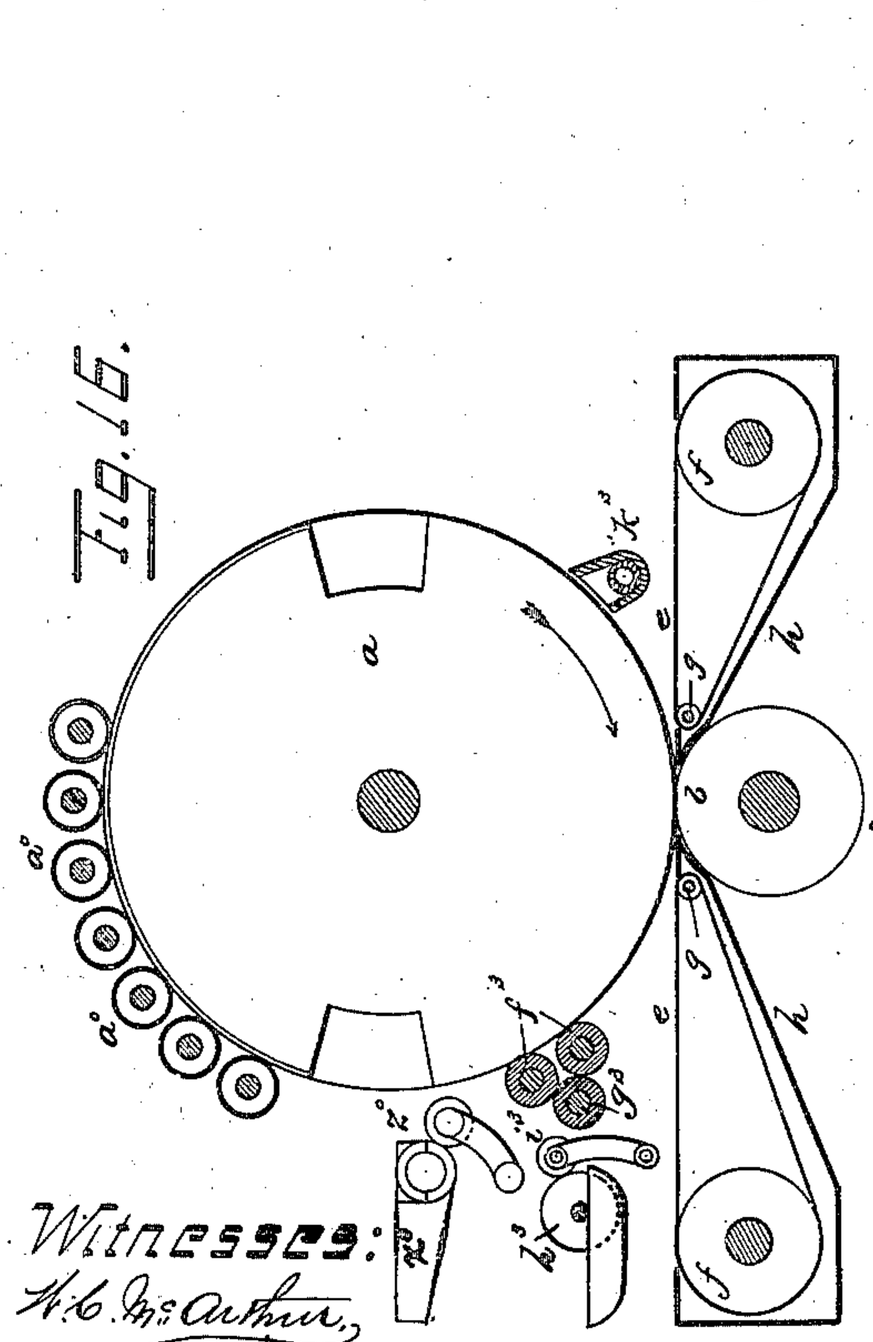
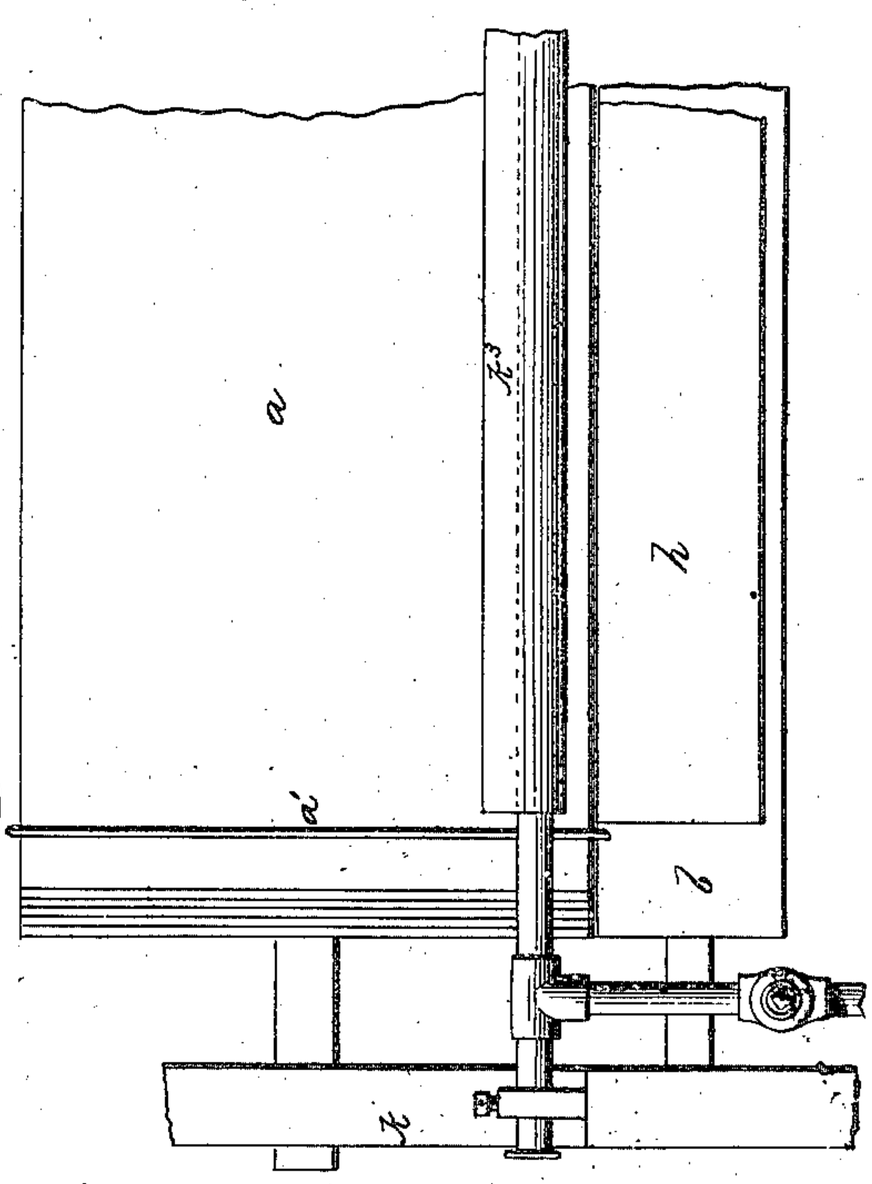


Fig. 17.



Witnesses:
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(No Model.) 8 Sheets—Sheet 8.

J. W. OSBORNE.

PRINTING MACHINE.

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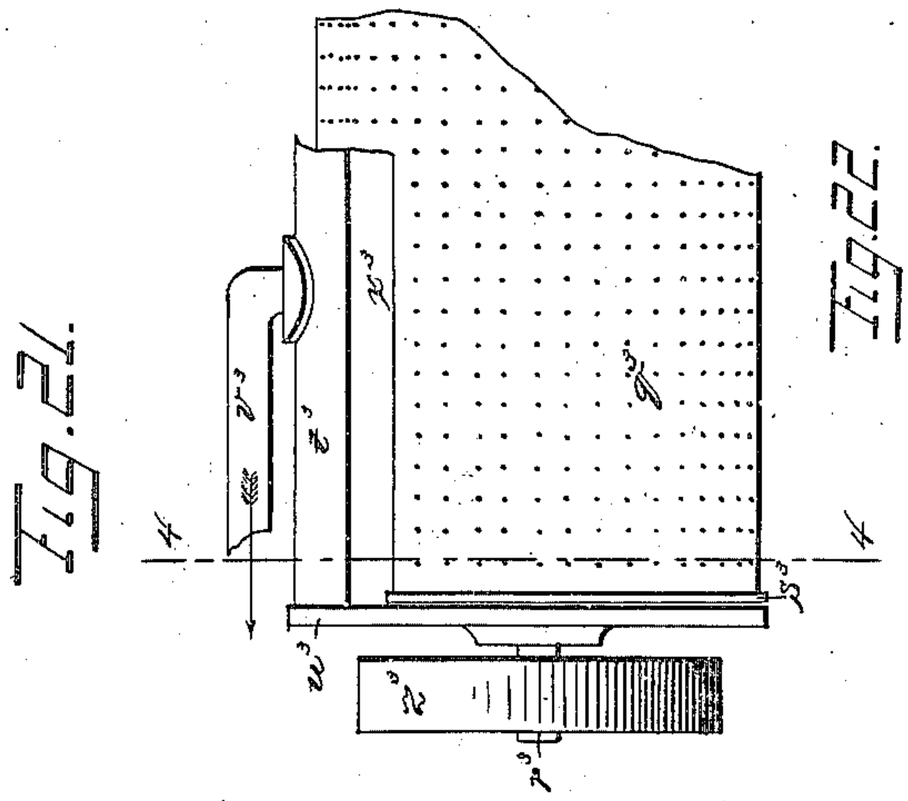

Fig. 21.

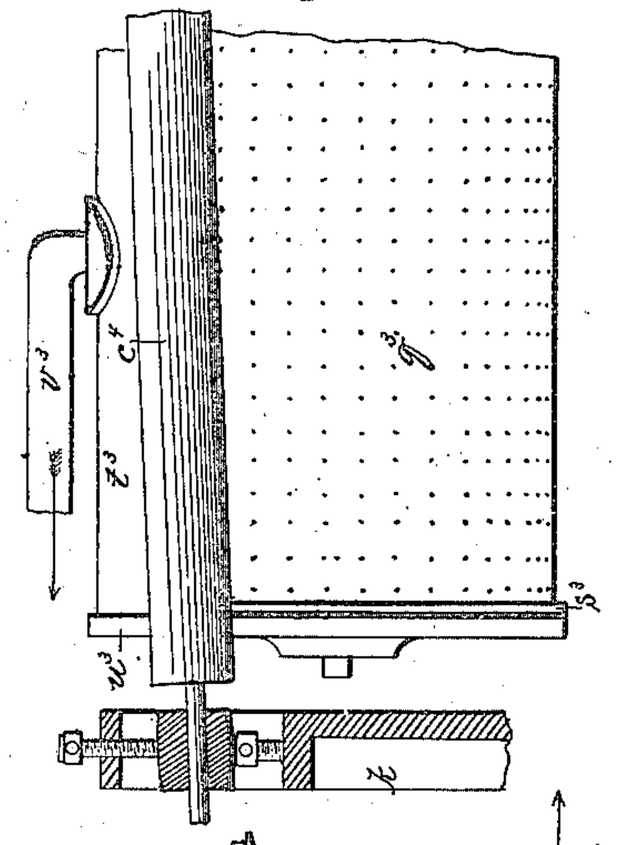

Fig. 22.

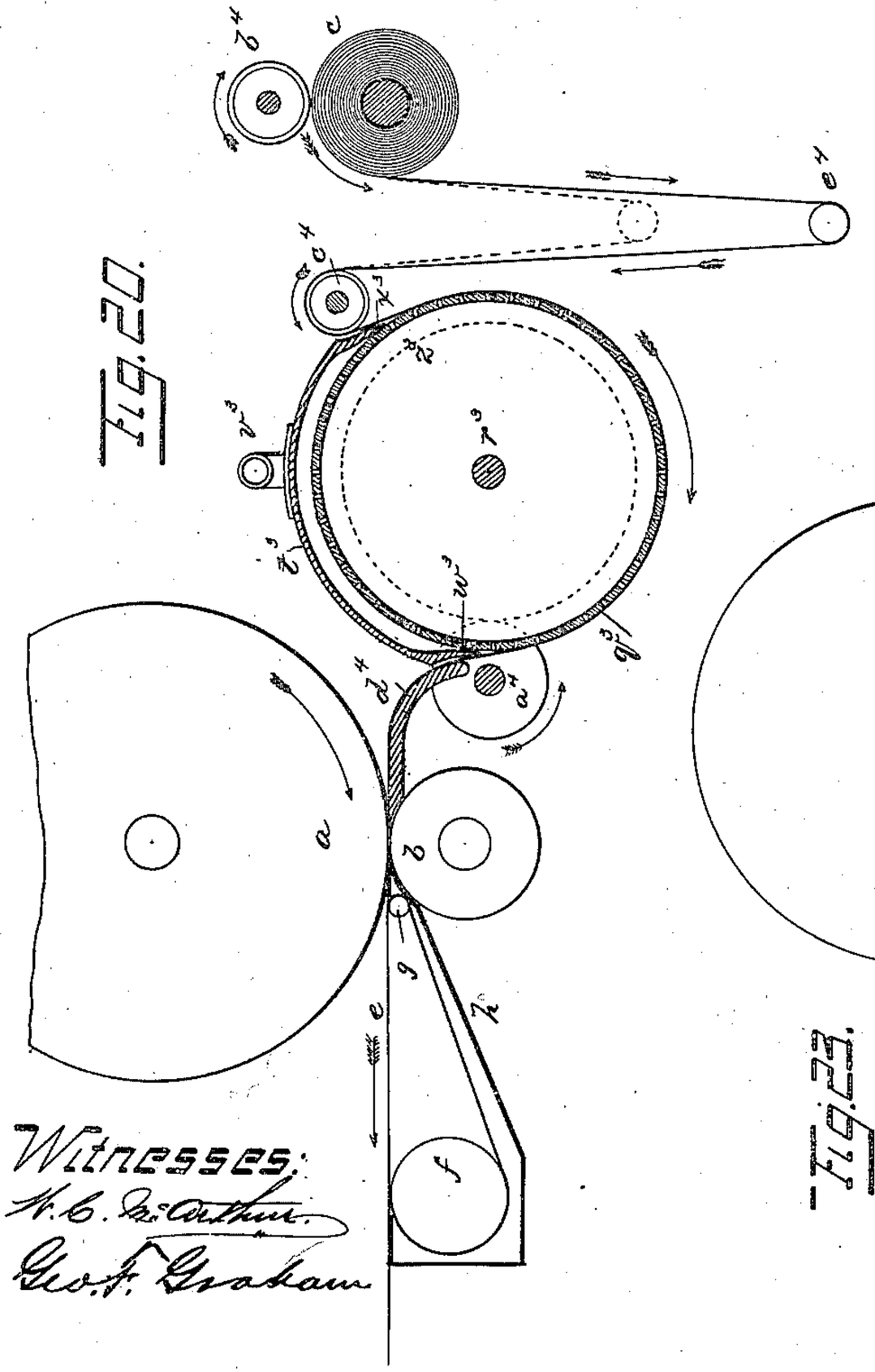

Fig. 20.

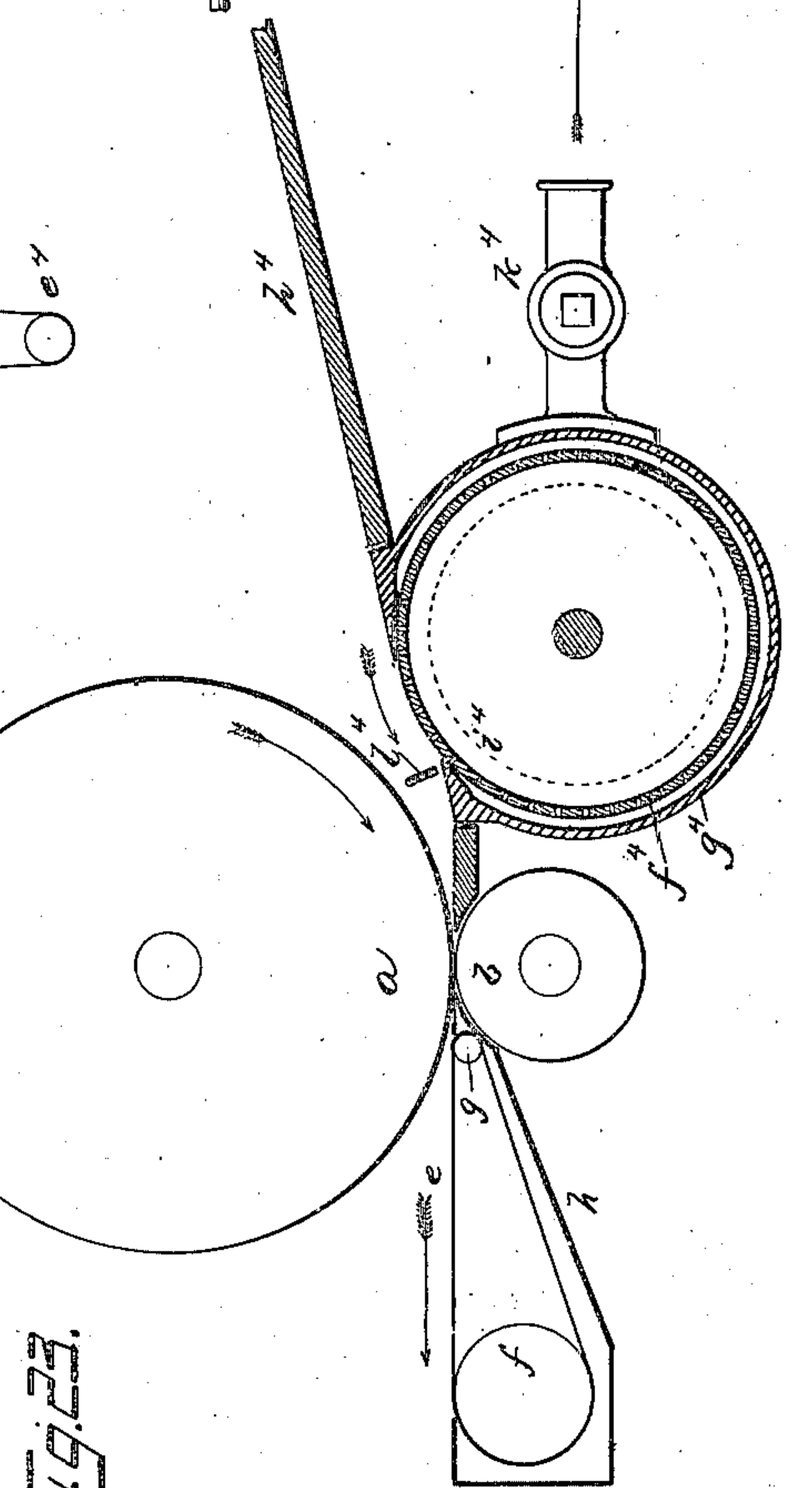

Fig. 23.

Witnesses:
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Geo. F. Graham

Inventor.
John W. Osborne

UNITED STATES PATENT OFFICE.

JOHN W. OSBORNE, OF WASHINGTON, DISTRICT OF COLUMBIA, ASSIGNOR TO WILLIAM H. FORBES, OF BOSTON, MASSACHUSETTS.

PRINTING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 401,790, dated April 23, 1889.

Application filed May 1, 1882. Serial No. 60,065. (No model.)

To all whom it may concern:

Be it known that I, JOHN W. OSBORNE, of Washington, District of Columbia, have invented certain new and useful Improvements in Printing-Machines for Chromographic and other Printing, of which the following is a specification.

My invention relates to rotary printing-machines, and also to those printing-machines in which two or more impressions in different colors are printed in immediate sequence and in register upon one sheet and upon the same side of it for the production of a chromographic design; and it consists in the several combinations of parts hereinafter described and specifically claimed.

Figures 1 and 2 in the drawings accompanying this specification represent in plan and section the principal elements of my invention in a chromatic press for three colors. Fig. 3 is a side elevation, on a larger scale, of one complete pair of form and impression cylinders in such a press, showing important details. Fig. 4 is a front elevation of the same with certain parts omitted. Figs. 5 and 6 show in elevation and cross-section a movable false bearer for form-roller trucks. Fig. 7 is a horizontal section at the line of contact of the two cylinders, Figs. 3 and 4, showing in plan the arrangement of the moving surfaces which hold and feed the paper. Fig. 8 is a vertical section of the foregoing, showing some details of the paper feeding and conducting apparatus. Fig. 9 shows in section an expansible pulley or roller truck used for adjustments of speed. Figs. 10 and 11 are front and side elevations of the same. Fig. 12 is a longitudinal section of part of a form-cylinder, showing the application of rubber friction-gearing for driving the impression-cylinder. Fig. 13 is an end elevation of the same. Fig. 14 shows in plan part of a form-cylinder adapted for zincographic printing on a large scale. Fig. 15 is a cross-section of the same. Fig. 16 shows in general sectional outline the position of the damping apparatus when the press is used for printing in the lithographic manner. Fig. 17 shows in elevation the relative position of one species of damping apparatus and the form-cylinder. Fig. 18 shows a modified position of the surfaces which conduct the paper and supplemental means for removing the sheet from the form-cylinder. Fig. 19 gives in general outline the shape which the paper-feeding surfaces may take when the length of the form is constant. Fig. 20 represents in section and general outline the application of a cylindrical surface for feeding a web to the first pair of printing-cylinders in a chromatic press. Fig. 21 is an elevation of part of the feeding cylindrical surface shown in the preceding figure. Fig. 22 shows in elevation the relative positions of an oblique guide-roller and a cylindrical feeding-surface. Fig. 23 is a sectional view of a cylindrical feeding-surface like the preceding, but adapted for separate sheets.

In Figs. 1 and 2, *a* represents the form-cylinders; *b*, the impression-cylinders, between which a web of paper or other material from the roll *c* is passed. Each pair of cylinders is geared together as shown in Fig. 1, and all are driven at the same speed from a common shaft, which is omitted from the drawings, as is the framing, the inking apparatus, and all details not essential to a proper understanding of the leading features of my invention. The forms *d* cover only a portion of the form-cylinders, the uncovered part being of smaller radius than that of the printing-surface.

In or near the plane of the paper each pair of cylinders is furnished with two endless belts, *e*, one in front—that is to say, at the side toward which the paper is fed—and one behind, where it is delivered. These belts are the full width of the form. Each passes over a large roller, *f*, and a small one, *g*, the latter being placed as near the line of contact of the two cylinders as is convenient, and is made small for that purpose. These rollers are parallel to each other and to the cylinders, and are supported in fixed but adjustable bearings. The belts are made of some material pervious to air—such as cloth, perforated rubber-cloth, perforated paper, or wire-cloth, or in some cases of thin sheet metal provided with numerous holes. Each belt, with its rollers, is inclosed in a case, *h*, which is closed at the sides, bottom, and ends, as shown, but

open above, which open part is filled with tolerable accuracy by the upper portion of the pervious belt just described. The tubes marked *i* connect the case surrounding each belt with an exhaust-fan or similar contrivance, by means of which a partial vacuum can be maintained within all the cases.

To a device constructed substantially in the manner described I apply the term "exhaust-belt," and shall use the same in this specification and in the claims to designate this important feature of the present invention.

A sheet of paper or similar material lying upon an exhaust-belt is (in consequence of the atmospheric pressure on it) held fast and evenly by the same and can be moved as the latter is moved. In Figs. 1 and 2 the web of paper lies solidly upon all the exhaust-belts. Just before the forms *d* reach the impression-cylinders *b* the large rollers *f* are caused to revolve in the direction indicated by the arrows. These give simultaneous motion to the belts, and they carry the paper forward at the proper speed independently of the cylinders. The forms, properly inked, reach the paper while it is in motion, impress themselves upon it, and when they leave the same its motion forward still continues for a short time.

On the distance which is traversed by the paper before and after it is impressed by the form depends the length of the margin or blank space between the impressions. In Figs. 2 and 3 the distance between the lines of contact of the form and impression cylinders is a little more than double the length of the forms, so that two complete impressions from the preceding cylinders are at all times on the exhaust-belts between the cylinders. In Fig. 2 the position shown is approximately that which each form-cylinder has at the moment when the paper starts. After the paper stops it lies over the impression-cylinder, which, while it revolves freely under it, has no tendency to propel it forward, because the depressed surface of the form-cylinder relieves it of any pressure from above. It will thus be seen that in this press the intermittent movements are confined to the lighter parts, which have but little inertia or momentum, while all the heavy and massive machinery revolves continuously. From a purely mechanical point of view such an arrangement offers many practical advantages. The initial feeding mechanism interposed between the roll of paper, *c*, and the first exhaust-belt (shown in these figures) is passed over for the present, but will be fully described later on.

In Figs. 3 and 4 one single pair of cylinders is shown with fuller details. The form-cylinder is marked *a* and the impression-cylinder *b*, as before. The frames *k* on each side contain the bearings for both cylinders, said frames being held together by the struts *l*, and the whole machine as a unit rests and slides upon the long parallel ways *m*, upon which also slide to adjustable positions the other pairs of cylinders of similar construction used in the chromatic series. Motion is communicated to the form-cylinder from the long shaft *n*, running the whole length of the ways *m*, through the intervention of the bevel-wheels *o* and *p*, (the former sliding along the feather on the shaft *n*,) the clutch *q*, and the bevel-wheels *r* and *s*, and in like manner the other form-cylinders in the series are driven from the same shaft. The clutch *q* when freed upon the upright shafts lets the form-cylinder free to turn in its bearings by hand, which is often desirable.

The impression-cylinder *b* may be driven in the usual manner by toothed gearing on it and on the form-cylinder, as indicated in Fig. 1; but in the press shown in Figs. 3 and 4 this is accomplished by frictional rubber gearing *t* in contact with the smooth bearers *u* on the impression-cylinder. This means of driving will be fully described and explained hereinafter. The impression-cylinder has upon its surface a continuous blanket of rubber or some one of the usual substitutes for it, which is wider than the widest form used. The bearings in which the axle of the impression cylinder revolves slide up and down in the side frames, *k*. They rest upon large screws, which enter them below, (indicated by dotted lines at *v*.) The lower extremity of each screw is stepped upon a horizontal bearing, and each is provided with a worm-wheel, *w*, which is rotated by worms on the rod *x*, communicating with the hand-wheel *y*. By turning this wheel the impression-cylinder is raised or lowered, so as to throw it in or out of gear with the form-cylinder, or to increase or decrease the pressure upon the form.

The form-cylinder in the press here shown is intended to receive the form upon not more than one-half its perimeter, while the other half is depressed and used as an ink-table. This arrangement I believe to be the best and most convenient; but the form may cover more than half the cylinder, in which case the ink-table will occupy less than half. Nor is it necessary that the uncovered part of the same should be used as an ink-table, other means of carrying the ink to the form-rollers and helping its distribution being practicable and well understood.

When the form is typographic, the stereotyped or electrotyped plates are attached to the cylindrical surface either directly or upon movable form-blocks in any of the ways practiced by practical printers. When the printing is to be executed in the lithographic manner, and zinc or collographic plates are employed, the construction of the face of the form-cylinder is modified in a way which will be specially shown and described hereinafter.

For typographic printing the usual bearers may be used on both cylinders to prevent excessive localization of the pressure on certain parts of the form; but in Figs. 3 and 4 these are not shown, because their application and

position are well understood, and because the rubber friction-gearing may be made to take their place when applied to both ends of the form-cylinders, as in Figs. 3 and 4.

The frames *z*, connected by struts and rods across the press, carry the inking-rollers and their riders. In Fig. 4, to avoid confusion, only the first rider from the front of the press and the second roller are shown with their connections. The form-rollers (marked a^0) are in movable bearings, which slide radially to and from the axis of the form-cylinder to a slight extent and carry on their spindles the roller-trucks b^0, Fig. 4. These trucks are expansible rubber rollers or pulleys of peculiar construction, to be more fully described and explained hereinafter. Their expansible character renders it possible to adjust their diameter exactly to that of the roller, and to secure a surface speed of the latter which shall be identical with that of the form over which the rollers pass. These form-roller trucks are driven by friction from the form-cylinder, the bearers for them, c^0, Fig. 4, being depressed for part of their surface in such a way as to allow them at the proper part of a revolution to drop upon the ink-table and receive a fresh supply of ink. The riders d^0 rest upon the rollers, and are caused to rotate by contact with them. Each end of the rider-spindle is carried by a fork, j^0, which forms the termination of a round steel bar encircled by a strong spiral spring, e^0. The round steel bar passes through the sleeve f^0, the split clutch g^0, and the nut h^0, and terminates above in the cap i^0, which is screwed upon or into the end of the bar to form a stop.

The sleeve f^0 fits the split clutch exactly, and its outside diameter is the same or a little greater than that of the spring e^0. When the rider is in position upon the two form-rollers and the sleeve f^0 is pressed down upon the spring e^0 and the hollow nut h^0 entered into the thread cut in the split clutch g^0, the rider exerts the minimum pressure required of it upon the rollers under it, while the forked bar is still at liberty to rise and fall within the sleeve, so as enable the rider to accommodate itself to the movements of the rollers. By screwing down the nut h^0 this pressure can be increased and adjusted within desirable limits. When this is accomplished, the split clutch g^0 is clamped fast. For the purpose of lifting the riders so as to dispense with some of them, or to gain access to the rollers, the screw-pin k^0 closes the fork below the spindle. Then by lifting the riders radially, the clutch *g* having been loosened, the sleeve f^0 and spring e^0 will both slide through the clutch g^0; and when the latter is again clamped upon the sleeve the cap i^0 will prevent the return of the bar, and the roller will remain suspended. In Fig. 3 one of the riders is shown in its elevated position. It is proper here to state that the specific devices herein described for effecting this purpose, though I believe them to be new, are not claimed in this specification, as they are jointly the work of myself and another person; but their description could not be dispensed with for reasons which will be readily seen.

The adjustment of the rider so that it shall take, when clamped, the proper position between the rollers and not press unduly on one of them is accomplished as follows: The two clutches g^0 belonging to a rider are fast upon the ends of the round horizontal shaft l^0, and the prolongations of the clutches in the line of the shaft l^0 have bearings m^0 in the roller-frame *z*, in which they are capable of both a lateral and a rotary motion. Outside the bearings the ends of these prolongations have keyed upon them the pieces n^0. The set-screws o^0, one at each end of each piece, passing through lugs upon the frame *z*, butt against the upper surface of the pieces n^0, and by adjusting these screws the position of the rider is under perfect control and its pressure equalizable on the two rollers it lies upon.

In Fig. 3 the pieces n^0 are not all shown, nor are the butting-screws o^0 upon them. This is done to exhibit details in Fig. 3; but the corresponding omission is not made in Fig. 4.

The ink-distribution in this press is effected chiefly by vibrating the riders. To accomplish this the upright shaft that drives the form-cylinder is prolonged upward, and by means of the miter-wheels p^0 the pinion q^0 is driven. This pinion meshes into one of the train of spur-wheels marked r^0, which drives all the rest. The cam-surfaces on the sides of these wheels (shown at s^0, Fig. 4) vibrate the horizontal shafts l^0 from side to side through the intervention of the anti-friction rollers t^0, bolted to the same. By releasing the set-screw which holds any one of these anti-friction rollers upon the shaft l^0 and against the cam-surface s^0 on the spur-wheel, the lateral vibration of the rider to which it belongs is stopped for the time being without affecting any of the others.

The roller-frame *z*, as a whole, with the rollers, riders, and vibrating gear connected with it, rests upon the flat edge of the side frame or cheek, *k*. Its proper position relatively to the form-cylinder is determined and maintained by means of the sliding bearings and caps at u^0 on the upright guide-posts v^0 and by the notch and pin at w^0. The posts v^0 are socketed into a projection on the side of the cheek-piece *k*, and they extend perpendicularly upward for some distance above the press, and may be connected at top. They act as guides for the roller-frame *z*, for by attaching a suitable hoisting apparatus above the press to convenient beams or other supports, and connecting the roller-frame to it by means of wire cords, belts, or chains, it can be lifted high above the form-cylinder, whereby the latter will become completely exposed and accessible for the adjustment of the stereo-

type or zincographic form upon it, and for other purposes, after which the rollers and riders as a whole can be at once lowered to their proper position without any disturbance of the inking apparatus or its adjustments. The facilities which this construction offers render it easy in the usual way to lift the rollers promptly off the form, whenever the press stops, by means of a cam or toggle.

The ink-fountain is represented at x^0, y^0 being the fountain-roller, and z^0 the carrying-roller oscillating between the same and the ink-table on the form-cylinder in the usual manner. The movements of this part of the machine may be accomplished by well-known mechanism familiar to all press-builders, which need not be described herein.

In getting up the ink on the rollers in this press it is desirable to run the same on the ink-table without letting them fall upon the form as it passes under them. This is accomplished by the use of a segment or false bearer, the construction of which is shown in elevation and section in Figs. 5 and 6. On the form-cylinder a, Fig. 4, the ribs or flanges a' project slightly from the face of the cylinder. These are inserted to some depth in the body of the cylinder and each is made in two parts, one being a little more than the semicircle and the other a little less. The former is fast, while the latter can be removed at pleasure. When it is desired to keep the rollers a^0 off the form, the smaller piece at each end of the cylinder (corresponding in position to that of the form) is removed and the segment b' made fast in its place by suitable screws. The false bearers c' then rest upon the true bearers c^0 under them at both ends of the form, and the roller-trucks ride up upon them, whereby the form-rollers escape the form, while they still run upon the ink-table, and the ink can be gotten up without detriment to the printing-surface.

The attaching of the false bearer to a piece similar in size and shape to the replaceable part of the rib, as here described, is a convenient way of making it fast in position; but this piece is not an essential part of the device, for the same may be attached in other ways—as, for instance, by screwing it directly down upon the true bearer, or by substituting for part of the true bearer a thicker segment, which would raise the form-rollers to the extent required to keep them off the form when that change is desired.

In Figs. 3 and 4 a very important part of my invention is shown—namely, the means I prefer for starting and stopping the large driving-rollers of the exhaust-belts, though it will be obvious to all machinists that there are other ways by which the same results may be reached. The power for this purpose is taken from the form-cylinder shaft. The spur-wheel d', fast on that shaft, gears into the intermediate e', which runs free upon a stud in the side frame, by means of which the wheel f' is driven. This wheel is on the inner end of a short shaft, which passes in a bearing through the side framing, k, and carries on its outer end an expansible rubber pulley, g', with a broad flat face, the construction of which will be hereinafter more fully described. All these parts revolve continuously while the press is in action.

The arm h' consists of two parallel frames, of the shape shown in Fig. 3, bolted together at i' and swinging on the fixed stud at k'. This arm carries a broad flat-faced pulley, l', which revolves freely in bearings in the arm h'. The stiff spring m' forces the arm h' strongly upward at all times, bringing the free pulley l' against the expansible rubber pulley g' with considerable force. Between the two the broad endless belt n' (not shown in Fig. 4) is strained. I prefer a metallic belt for this purpose; but one of any description which will not stretch appreciably will work well. The belt passes over the expansible rubber pulleys o' and under the idler p', which may also be made expansible with advantage. The rubber expansible pulleys o' are on the spindles of the large exhaust-belt rollers f, (shown in Fig. 2,) and the object in view is the starting and stopping of them at proper times relatively to the position of the form on the form-cylinder. It will be seen that the two sides of the arm h', while they do not come in contact with the driving rubber pulley g', converge above it and carry between them a small anti-friction roller, q'. The cam r', fast on a prolongation of the form-cylinder shaft, in revolving comes in contact with roller q', and, being of the proper radius, it depresses the arm h', overcoming in doing so the force of the spring m'. The depression of the arm causes the free pulley l' to drop from the driving rubber pulley g', and the metallic belt n between them instantly springs away from the latter under the influence of the small deflecting-pulleys s'. The pulleys s' bear the belt n slightly away from the face of the rubber pulley g' when the belt is not held up to said pulley g' by the free pulley l'. Under these circumstances the belt n' is no longer driven, and will remain motionless till the cam r' again allows the spring m' to act so as to hold the belt up against the rubber driving-pulley g', thereby starting the exhaust-belts forward.

The exhaust-belt case, which in Fig. 4 would appear in front of the cylinders, is removed to allow the construction of other parts to be better seen and understood. The momentum of the metallic belt, the exhaust-belts, and their rollers is very little; but to make more definite the moment of stopping a brake may be applied either directly to the metallic belt or to one of the rollers over which it passes.

In Figs. 3 and 4 the brake is shown at t'. It consists of a curved plate of metal over the idler p', bolted to the arm h'. As the cam r' comes round and depresses the arm the brake t' is brought into contact with the rubber face of p' and stops it, thereby also stopping the

metallic belt. The cam r' consists of two leaves sliding on the plate u' behind them and partly on each other. The position of the leaves is adjusted by turning two small pinions behind them, one attached to each leaf, by means of a suitable key in the holes v'. The teeth of these pinions engage with similar teeth cut on the edge of the plate u'. Each leaf of the cam is, moreover, provided with a pointer, which traverses a divided arc to facilitate the making of definite changes. The relative diameters of the several wheels and pulleys in the intermittent mechanism I have invented, and which has been just described, are such that the surface speed of the exhaust-belts shall be exactly that of the face of the form upon the form-cylinder; but however accurately this may be calculated it is desirable, for many reasons, that adjustability within a narrow range should be provided for. This is done by the employment of the expansible rubber pulleys o' and g'. By altering the diameter of the latter in the manner to be yet described both exhaust-belts will be affected alike, and may be driven faster or slower. By modifying the diameter of either one of the pulleys o' only that exhaust-belt will be affected.

The entire train of mechanism above described for feeding the paper forward intermittingly I term the "paper-feed mechanism" or "intermittent feeder."

It is often desirable to run the cylinders in this press without feeding the paper forward—that is, without allowing the exhaust-belts to move. This is done by depressing the screw in the lug at w', whereby the arm h' is permanently held down against the spring and the metallic belt never reaches the driving-pulley g'.

In Fig. 7 the two exhaust-belts e (indicated by dotted lines in Fig. 3) are shown in plan, a horizontal section of the side framing of the press being made at the line of contact of the form and impression cylinders. In Fig. 8 the same is shown in section on the line 2 2, whereby the end of one of the exhaust-belt cases appears in elevation. In both figures certain parts are omitted which are not now to be considered. In these drawings, using the same letters of reference as before for parts already referred to, b is the impression-cylinder; e, the exhaust-belts; h, the cases, and i the tubes through which the air is withdrawn from the cases.

The bearings for roller-spindles are outside the cases and are adjustable. Those for the large rollers are marked x' and for the small y'. Screws which hold the bearings x' steadily to the frame after adjustment are shown with dotted lines at z'. Their function is to resist the strain of the driving-belt on the pulleys o'. When the exhaust-belts are wide, a bearing at the middle of the smaller roller is desirable to prevent it yielding. This is shown at a^2 inserted in a bar which crosses the case. These bars are held and adjusted by the tap-bolts marked $b.^2$ The atmospheric pressure on the square inch necessary to hold a sheet of paper fast to a moving surface is very slight; but in the aggregate, when the exhaust-belt has a large superficial area, it becomes a load for which provision may be desirable. Such provision may be made in one of two ways—viz., either by making the belt sufficiently strong to sustain all the pressure it will have to carry and allowing it to sag within the case, the paper then following the flat curve formed by the upper side of the belt, or by placing supports made fast to the sides of the case under the upper part of the belt, over which it remains flat, said supports finally carrying all the weight caused by the difference of pressure within and without the case. Supports of this kind may consist of rollers at suitable distances, placed so that the upper part of the belt lies upon them; or a smooth perforated plate of metal may be used; or a number of thin parallel slats of any suitable material, separated by washers and bolted together, so as to form a flat surface pervious to the air, will be found well adapted for the object in view. In Fig. 8 such a support is shown at c^2. In most cases it will be found desirable to prolong the small end of the exhaust-belt case beyond the small roller, so as to cause it to extend as closely as may be toward the line of contact of the two cylinders. The upper surface of this extension, or "nose-piece," as it may be called, is open, or only covered in part by a number of supporting-tongues, as shown at d^2 in Fig. 7. These tongues are especially desirable when separate sheets of paper instead of a continuous web are fed to such a press, to prevent the edge of the sheet being sucked into the short space between the small roller and the end of the case. When a web is fed to the press, the paper will generally be strong enough to cover the open space without detriment.

In feeding, delivering, or conducting paper by means of an exhaust-belt it is desirable in most cases to hold the paper on the moving surface by an atmospheric pressure which is just enough for the purpose, but not excessive. To accomplish this under varying circumstances with a constant exhausting force, either the dimensions of the tube through which the air is removed from the case must be subject to modification and adjustment, or the rarefaction of the air in the latter must be controlled by the more or less free admission of air from without. I prefer the latter mode of obtaining a uniform exhaust, because the changes can be more gradually made and depend less upon the uniformity of the exhausting force. I effect this object by placing the large adjustable valves e^2 at any convenient place upon the exhaust-belt case. The facilities for the abstraction of air being at all times greater than required, the exhaust within the case can be reduced to the desired degree by opening the valve e^2 and the amount of the change indicated by a

pressure-gage in the usual manner. The necessity for an adjustment of this kind will be apparent when it is remembered that different widths of paper, &c., have to pass through the press, and that those which do not cover the whole surface of the pervious belt permit of the ingress of air through the latter to a greater or less extent, the effect of which must be counteracted by closing e^2 until the proper exhaust is restored. These valves are constructed in the simplest manner. They consist of hollow cylindrical cups with a thread on the outside, screwing into the side of the case. A number of long slots, f^2, Fig. 7, are cut through the cylindrical part, and as the cups are screwed out the exposed openings become larger, whereby more air is admitted. These valves, being removable, also give access to the inside of the exhaust-belt cases without the disturbance of any adjustments, which is occasionally desirable. Each of the exhaust-belt cases, as shown in Figs. 7 and 8, is bolted to the horizontal strut l in such a way as to admit of adjustment as a whole, so as to bring the direction of their movements into the same line—that is, into one which is at right angles to the line of contact of the cylinders. The plane in which these belts move is also subject to some adjustment, the screws and other provisions for which are omitted to avoid confusion.

The friction-gearing and expansible pulleys to which reference has been made in the foregoing are constructed on a uniform principle. Fig. 9 is a section on a large scale of one of the form-roller trucks b^0 before expansion. Fig. 10 shows the same in front elevation after expansion, and Fig. 11 is a side elevation of the foregoing. Substantially the very same construction is used for the pulleys o' and the driving-pulley g', the differences being only those of size. In these figures, g^2 is the stock or body of the pulley, provided with the flange h^2. Sliding on the body is a sleeve, which carries the flange i^2. On the sleeve and embraced by the flanges h^2 and i^2 a cylindrical ring of vulcanized rubber is placed, or a number of such rings k^2, separated by thin metallic plates l^2, as shown in Fig. 9. In whichever way the rubber is applied it is firmly held when the pulley is being made by screwing up the nut m^2, and the face is then ground off flush with the circular flanges. Then when the pulley is in place, by screwing up the nut m^2 still more, so as to approach the flanges, the pressure on the rubber will cause it to extend radially and equally from the axle in all directions, whereby the diameter of the pulley will be increased, and a subsequent relaxation of the screw will diminish the diameter so obtained, the working diameter of the pulley at any time (within small limits) depending on the position of the nut. When a solid ring of rubber is used, the face of the same after expansion assumes a flattened convex form very suitable for carrying a belt, whereas with thinner rings of rubber and annular metallic plates between them, as l^2, the face remains flat for all practical purposes, and such a pulley should be used whenever the maximum of driving capacity is required, as in the case of the pulley g', Figs. 3 and 4. When so constructed, each ring of rubber expands radially independently of the others, and as the pressure is equal on all that expansion is equal and the face of the pulley remains virtually flat. When a stratified pulley of this sort is being made, a definite curve, starting from the flanges, can be given to the face (including the plates l^2) when it is being ground off, which curve will be afterward maintained without change during expansion or contraction. Such a face (usually convex to a very slight extent) is useful for expansible pulleys over which a belt passes to help the latter to maintain its central position. In whichever way the rubber is applied the fact that it is thoroughly supported and held at the sides and does not (until expanded) extend beyond them gives great solidity and perfection of form to the same when in use, and the whole forms a truck or pulley possessed of much driving-power and adjustable with great accuracy within moderate limits.

Figs. 12 and 13 show in longitudinal section and end elevation, on a much smaller scale than Figs. 9, 10, and 11, the application of expansible rubber friction-gearing to the form-cylinder, by means of which the impression-cylinder is driven. This construction is essentially the same as that just described. The cylinder a carries upon its end an attachment consisting of the annular plate n^2, the cylindrical part of which (as a matter of convenience) forms the bearer for the form-roller trucks, while its side reacts against the rubber. Between it and the annular plate o^2 the rubber rings and their plates are held, resting upon the cylindrical part of the latter, the whole stratification being marked p^2. The bolts q^2, the long heads of which pass freely through plate o^2, hold this structure as a whole to the cylinder on suitable shoulders provided for that purpose without affecting the movements of plate o^2. The stratified ring of rubber at p^2 is ground off flush with the face of the form on the cylinder, in which condition it barely touches the bearers on the impression-cylinder. To make it take a grip on the same for driving purposes, it is necessary to expand it slightly—an operation which is effected by screwing up the bolts r^2, whereby the two plates n^2 and o^2 are approached and the diameter of the rubber increased until the requisite friction is obtained. To insure a perfectly-uniform expansion all round, it is essential that each of the bolts r^2 be turned to the same extent. This is provided for by attaching to the head of each a small pointer, which traverses a circle, s^2, with numbered divisions, over an equal number of which each pointer is made to pass in screwing up.

The use of pulleys of the kind described for

giving or receiving power in press machinery insures not only the advantages due to the remarkable grip taken by the rubber and to its equal expansion under proper conditions, but also the absence of all noise and rattle wherever it can be made to take the place of ordinary gearing.

In describing my invention no special reference has yet been made to the nature of the form from which the impressions are printed. When relief-plates constitute the printing-surface, they are given the requisite curve and attached to the cylinder or to form-blocks fitted to the cylinder in ways which are well known and understood, and which need not be fully described in this specification; but when the press is used to print from zinc plates in the zincographic manner, or from flexible collographic plates on their metal base, peculiar appliances and modifications of the form-cylinder are required.

Fig. 14 shows in plan part of a form-cylinder adapted for zinc, and Fig. 15 is a cross-section of the same on the line 3 3, which is the middle line of the press. The several transfers for printing purposes are made to the sheet of zinc when flat in an ordinary hand-press, and the sheets so prepared are then bent round the part of the cylinder made to receive them, as represented by the black line in Fig. 15, the same being omitted in Fig. 14 to avoid confusion. To accomplish this operation properly, the body of the cylinder inside the truck-bearers c^0 is made with two depressions or "gaps," one at each of the opposite sides, the bottoms of which at t^2 are concentric with the cylinder-surface. Within each gap a straining-bar, u^2, is placed. These bars run the whole length of the gaps and extend into a rabbet under the segments at v^2, as shown by the dotted lines in Fig. 14. The bolts w^2 close the nippers at the upper part of these bars, in which the turned-over edge of the zinc is caught and clamped tight. This being accomplished, the long bolts x^2, which pass through the bars, are screwed up until, by forcing the bar back, an equal and sufficient strain is put upon the zinc, making it lie flat and solid upon the cylindrical surface. The position of the design upon the zinc will now be approximately correct, and for some purposes sufficiently so, if the transferring and straining have been carefully done; but some adjustment, slight in amount, though very important, will in most cases be necessary to bring the design into perfect register with the corresponding designs on the other cylinders. To move the zinc round upon the cylinder either forward or backward, it is only necessary to slack the screws x^2 in one bar and tighten them in the other. To adjust by sliding the zinc in either direction across the cylinder, the bolts y^2 are used, the long screws x^2 being first turned back a little to diminish friction. These horizontal bolts pass through lugs on the ends of the bars and butt against the segments v^2, throwing the bar and with it the zinc to the right or left, as required. To adjust the diagonals of the design, leaving its center unaffected, the long bolts x^2 at the ends of the straining-bars are used, but alternately, one being tightened and the other slackened in each bar. In doing this it is desirable to free the ends of the bars in the rabbets to a very slight extent, which is accomplished by raising the screws z^2, the ends of which rest on the floor of the gap, whereby the ends of the straining-bar drop from the segments v^2, and it is freed sufficiently to permit of the diagonal adjustment. The screws y^2 and z^2, which aid in giving the lateral and rotary adjustments with precision, may generally be dispensed with when a press of this kind is used (as it often will be) to print one color only, for then the position of the design upon the web or sheet has no reference to any other design, as is the case when the press is used chromatically and slight inaccuracies in the position it should occupy are not perceptible.

It will be seen that the position of the nippers in the straining-bar is such that the zinc slopes upward from it to the rounded edge of the gap, so that when the inking-rollers come from the ink-table a^3 they do not strike an abrupt edge.

To enable a form-cylinder for zinc printing to receive and hold zinc sheets of different lengths suitable to the designs upon them, one or both of the gaps described may be made larger than is required for the movements of the straining-bar. Part of the gap (or gaps) so enlarged is then filled in the manner shown by the pieces b^3, to accommodate the largest form which can be printed on the cylinder—shown in Figs. 14 and 15, which provide for five different lengths of zinc. These pieces are flush with the general surface of the cylinder, and are held in place by the bolts c^3. To suit a smaller form than that shown, one or more of the pieces b^3 is removed, the lip-piece d^3 is screwed into the last which remains, and the straining-bar pushed up to receive the turned-over edge of the zinc, as before, after the return of the bolts c^3. The lip-piece d^3 is necessary to provide a rounded edge, over which the zinc is drawn. In Figs. 14 and 15 the pieces b^3 are shown as of equal size and all in place together when a form of maximum length is on the cylinder; but the changes in length of the supporting-surface may also be effected by making the movable pieces of different sizes and using only one at a time. When this method is adopted, each piece is given a rounded edge where the zinc passes over it, and the lip-piece d^3 is used only upon the edge of the gap when the smallest form goes upon the cylinder, and all the pieces are dispensed with.

The projecting rib or flange a' has been already referred to in describing Figs. 4, 5, and 6. The countersunk heads of the screws which hold the movable part of the same in Fig. 15 are shown at e^3. This rib has another function beside that already explained in connec-

tion with the false bearer, to which reference will be made when speaking of surfaces which print in the lithographic manner.

Fig. 16 shows in outline the relative position of the damping apparatus (required when zinc or a collographic surface is on the cylinder) to the main features of the press already described. In this drawing, (the cylinders, rollers, &c., being lettered as before,) f^3 represents the ordinary damping-rollers made of absorbent material, and g^3 their rider. h^3 is the roller of the water-fountain, and i^3 the carrying-roller vibrating between h^3 and g^3, all of which is well known and understood, and of which no further explanation is required than to state that the rollers f^3 are on spindles, which have bearings in brackets bolted to the side framing.

Each spindle is provided with trucks, which may be of the expansible kind herein described, adjusted to the diameter of its roller and bearing against the same rubber friction-gearing on the form-cylinder which drives the impression-cylinder. In this way the rollers are driven at the proper surface speed, and while they come upon the form at the right time—that is to say, just before the latter passes under the inking-rollers—they escape the ink-table a^3, Figs. 14 and 15, which is depressed, as shown and described. The rider g^3 has bearings in the same brackets, and is held against the damping-rollers by spring-pressure in a way familiar to all press-machinists. This method of damping, which (excepting the expansible rubber-trucks) is that in common use for lithographic presses, may be replaced by other methods without affecting the character of my invention.

In printing from zinc in a chromatic press; when a fresh impression from one form is brought into contact with the non-printing parts of that form which next follows it in the series, an offset upon those parts will take place and the work will suffer unless a second or final damping is applied to such form after inking it. In United States Patent No. 305,169, of September 16, 1884, an invention for thus protecting the form against offset is fully set forth and claimed, and need not be further described in this specification than to show the way in which such second damping admits of application in the press which forms the subject-matter of the present invention. For this purpose damping-rollers similar to those employed for the first damping may be used; but other methods are preferable because the necessary apparatus occupies less room where free space is desirable, and because the very small quantity of water necessary can be applied more exactly and efficiently. One such method consists in blowing on the surface to be damped an atmosphere of air charged with water at a somewhat elevated temperature, whereby a film of dew is condensed upon the printing-surface. In Figs. 16 and 17 the outlet for such saturated air is shown at k^3. This consists simply of a perforated tube embraced by a suitable shield or envelope open toward the cylinder, from which the saturated air issues periodically as the form passes it. The movements of a cock or valve between the supply of such air and the exit-tube k^3, actuated by a rod from a cam in a manner well understood, determine the duration of the flow of saturated air, while the amount of water which the cold form condenses and precipitates as dew depends upon the relative temperature at which the saturation was effected and the quantity of air conveyed to the exit-tube k^3.

Damping apparatus of any kind in the position occupied by k^3 is not required on the first pair of cylinders in a chromatic press of the character herein described, because there can be no offset, and therefore Fig. 16 represents in this regard a second or subsequent pair in the series. The projecting rib a' referred to in the foregoing and shown in Figs. 14 and 15 is of importance when methods of damping analogous to that just described are employed either for the first or for the second damping. In such cases the water is carried to the printing-surface by means of a gentle current of air, and the flange or rib a' (see Fig. 17) prevents the lateral extension of such a current, thereby hindering the deposition of water where it is not wanted.

In feeding, delivering, and conducting paper by means of moving surfaces pervious to air, the accurate accomplishment of which is an important part of the present invention, I avail myself, as circumstances demand, of certain modifications, which I now proceed to explain. Hitherto in this specification the upper moving surfaces of the exhaust-belts have been shown as lying in the plane of the lines of contact of the several pairs of cylinders which make up the chromatic series, the paper as a consequence lying in the same plane. This is not an essential consideration, and may be departed from with advantage in certain cases. Fig. 18 shows in general outline the relative positions of the exhaust-belts for a single pair when the paper does not maintain the same plane throughout. The paper under these circumstances does not pass tangentially between the cylinders, but follows the curve of the impression-cylinder for a short distance where it crosses the same. When the exhaust-belts come to rest after the form has passed, the impression-cylinder can still revolve freely below the paper, which is firmly held before and behind, because it is unaffected by any pressure forcing it into intimate contact with the blanket. When the ink used in printing is very tenacious and adhesive, the inclined position of the exhaust-belts tends to facilitate the stripping of the paper from the form, and accordingly in carrying out my invention provision is made for adjusting the exhaust-belt cases, so as to give them a downward inclination from the line of contact, though to avoid confusion such adjustment is not shown in the figures,

as already stated. It is evident that when this is done a web of paper will not lie flat between two pairs of cylinders, but will follow the inclined belts and pass horizontally over the short intervening space.

In certain kinds of printing—as, for instance, when impressions consisting of large masses of solid color are taken from relief-blocks—I supplement the atmospheric pressure which holds the paper down and facilitates the separation of the sheet from the form by blowing from a slit or a number of perforations in a tube crossing the press, as at l^3, a current of air under pressure above the paper and between it and the form toward the line of contact. By this device the greatest pressure on the paper is localized where the greatest tendency to lift the same exists, and the necessity for increasing the power of the exhaust generally within the case is obviated.

In certain exceptional conditions presses printing two or more colors are required, in which a form of constant length is used exclusively. When this is the case, a single exhaust-belt may be adapted to carry the paper from one form to another in the manner shown in Fig. 19. One large driving-roller, o^3, gives motion to the belt, and the idlers p^3 may be added to increase its grip upon said roller; but whenever the length of the form, added to that of the margins, is a variable quantity, the construction of the conducting surface or surfaces between two pairs of cylinders must be such as to admit of adjusting the position of each pair upon the long ways m, so that the distance between the lines of contact shall be equal to that length or to some multiple of that length.

When paper in the form of a web is fed to a press such as that herein described, it is of much importance that the direction communicated to the same before it enters the first pair of cylinders should be accurately established, and is the true direction to be afterward maintained throughout its course. For this purpose an exhaust-belt of considerable length may be successfully used; but I prefer to employ (with or without an exhaust-belt in advance of the first pair of cylinders) a perforated cylindrical surface revolving within and partly inclosed by a hollow case from which the air is drawn by a fan. This apparatus, which I shall refer to as an "exhaust-roller" in this specification and in the claims, is an important part of my invention. It is closely allied in principle to th exhaust-belt, though possessed of definite advantages of its own. In Fig. 20 the exhaust-roller q^3 is shown in section and in relation to other parts of the mechanism. Fig. 21 is a front elevation of part of the exhaust-roller alone. The roller q^3 consists of a hollow cylinder of thin metal—usually brass—having a true surface pierced with many perforations. This roller has solid ends, which are fast to the spindle r^3. One of the ends projects slightly, forming a flange, as seen at s^3, and as a matter of convenience the other end may be similarly constructed. The hollow case t^3 partly surrounds the roller, (for the present purpose about one-third,) and is adjustable on its supports (not shown in the figure) in every direction. It is provided also with solid ends w^3, which carry the bearings for the spindle r^3. The tube v^3 is attached to any convenient part of the case, and through it the air is drawn from the latter. When the exposed part of such a perforated roller is covered by a sheet or web of paper, or other material more or less impervious to air, the exhaust within the case extends to the roller itself, the air therein being withdrawn outward through the holes, and the sheet is held firmly on the surface in consequence of the atmospheric pressure thereon. If the roller is then revolved, the paper will be carried forward in the direction of rotation and at precisely the surface speed of the roller.

The edges of the case, which are parallel to its axis, are made stiff and rigid, and are inclined toward the surface of the roller at w^3 and x^3. They terminate in thin smooth knife-like edges, which lie close to said surface without touching it, and are so formed to admit of passing the paper to the roller and from it in the direction of a tangent, or nearly so, the edge w^3 especially, which meets the paper as it leaves the roller, acting as a stripper to lift and disengage it from the perforated surface. The exhaust-roller, when situated as shown in Fig. 20, for the purpose of guiding and controlling the entrance of a web of paper into a press, may be conveniently driven by putting a friction-pulley, z^3, (indicated in position by a dotted circle in Fig. 20,) on the shaft r^3 and in contact with the same a driving-pulley, the position of which is indicated at a^4, Fig. 20. One of these should be an adjustable rubber pulley, preferably the smaller one.

The pulley a^4 is inside the side framing of the press, and is on a shaft passing through the frame and carrying outside one of the pulleys o', Fig. 3, over which passes the metallic belt n'. In this way the exhaust-roller q^3 takes the place of the first exhaust-belt in the series, and its periodic movements are controlled by the cam r', Figs. 3 and 4. The paper is taken periodically by the exhaust-roller from the roll c, but not directly. By means of the roller b^4, (resting upon c and following it down as its size diminishes,) which is driven at a uniform speed, the paper is unwound with sufficient rapidity to feed the press. The power for this purpose may be taken from the main shaft or any other suitable source. The exhaust-roller takes from the slack paper at the proper times and in the quantities required to suit the length of the form and margins; but the paper in passing to the exhaust-roller q^3 first passes over the roller c^4, which revolves freely in adjustable bearings. By inclining this roller very slightly one edge of the paper is per-

sistently carried to the side of the flange s^3, and, as the atmospheric pressure holds the paper where it is placed till disengaged and the said flange s^2 is in the true line which the edge of the paper should follow, the presentation of the web will be always correctly made.

Fig. 22 shows in front elevation the inclined position (greatly exaggerated) of the guide-roller c^4 in relation to the exhaust-roller, with means for the adjustment of the same. In this figure, according as the roller c^4 is inclined the paper will be fed to the flange s^3, as shown, or to a similar flange at the other end of the exhaust-roller. As shown in Fig. 20, the paper after it is stripped from the exhaust-roller follows the curved table d^4 to the contact-line of the first pair of cylinders; but, if it is desired, an exhaust-belt may be substituted for the table, as in Figs. 1 and 2, under which circumstances, however, the outer end of the case should only rise to half the height of the larger roller, f, so that the web may reach it at a tangent from the stripping-edge w^8, and then bend over said roller f to the horizontal position. When, as in Figs. 1 and 2, an exhaust-belt is interposed between the exhaust-roller and the first form-cylinder, the driving-roller f may be perforated, as shown, whereby the adhesion of the paper due to the exhaust in the case h is extended to the belt as it passes over the roller f, which would not be the case if the latter had a solid face.

The exhaust-roller offers many advantages when used to perform the function here required of it. These are its true cylindrical surface, the true direction given by the flange s^3, and the possibility of varying the intensity of the exhaust to suit paper of various qualities without modifying or interfering with other adjustments. It is also possible and desirable to subject the web of paper from the moment it leaves the stripping-edge w^8 to a continuous and equable tension. This is important for obvious reasons. It is accomplished by diminishing the size of the pulley a^4, (if that be the rubber pulley,) or enlarging that of the belt-pulley o' on the same shaft outside the frame, so as to make the surface speed of the exhaust-roller q^3 a very little slower than that of the series of exhaust-belts in the press. It will be seen that by doing this the paper has to stretch or slip upon the face of the exhaust-roller, and that the strain thus put upon it is a differential result entirely under control.

The apparatus here described may also be used for the same purpose in another way which is frequently convenient—namely, when heavy paper is fed in the form of web. This consists in allowing the pull of the paper itself to drive the exhaust-roller, (the metallic belt n', Fig. 3, then playing no part,) for which purpose the pulleys z^3 and a^4 are thrown out of contact by diminishing the size of one of them sufficiently. In this case a friction-brake controlled by an adjustable spring or weight is allowed to act upon the spindle of the exhaust-roller in a manner well understood, whereby the same is restrained and its rotation retarded. Finally, the same apparatus can be used to retard and direct the paper in a third way, which consists in clamping the roller q^3 fast in its bearings and allowing the paper to slip over its whole surface. In this case the retardation and strain upon the paper depends, essentially, upon the intensity of the exhaust, which should be slight if the exposed part of the perforated surface is large. In the three different ways of using the exhaust-roller and its appurtenances the guide-roller c^4 plays the same part, placing the edge of the paper always in the true line, which is in the plane of the flange s^3. This is accomplished by virtue of its inclined position, which urges the web as it passes onward feebly but persistently to one side until stopped by the flange, beyond which it cannot go. To regulate the pressure upon the guide-roller c^4, the slack of the paper may be weighted with a light free roller, e^4, which rises to about the position indicated by the dotted lines when the paper for one impression has been taken, from which it then sinks until a forward movement of the web again takes place; but this roller, though sometimes useful, is not an essential part of my invention.

Single sheets may be fed to a press of this description by the use of an exhaust-roller, as shown in Fig. 23. In this drawing, f^4 represents the perforated roller similar to that shown in Figs. 20 and 21, except that a flange (as s^3 in said figures) is not required. The case g^4, from which the air is withdrawn, covers the greater part of the roller, leaving exposed a portion of the surface, which forms a continuation of the feed-board h^4, on which the paper which is to be printed is placed. An expansible pulley on the spindle of the exhaust-roller (the position and approximate size of which are indicated by the dotted circle i^4) is driven outside the side framing of the press by the belt n', Fig. 3, whereby the exhaust-roller f^4 is started and stopped at the proper times and driven at the same surface speed as the form-cylinders, exhaust-belts, &c. The roller-case g^4 is exhausted through a tube attached at any convenient place; but its connection with the exhaust-fan is not continuous, as in Figs. 20, 21, and 22, the periods of diminished pressure within the case being controlled by a valve or cock, k^4, which is moved when required by a cam-rod acting on a suitable lever. The sheets are fed by hand from the feed-board (provided with the usual guide) against the stop l^4. This is a little beyond the stripping-edge of the case and a very little above it. When the edge of the sheet touches the stop, its stiffness prevents it falling completely on the stripping-edge; but the moment the cock k^4 is opened it is sucked down flat upon the same and upon the exposed part of the roller f^4. This takes place while the latter is at rest, after which

the exhaust-roller begins to revolve and carries the edge of the paper under the stop l^4 and between the form and impression cylinders, so that it may meet the form at the proper time. When the form has passed, the exhaust-roller comes to rest and the cock is closed. Another sheet is laid on, and the above order of movements takes place again. When single sheets are fed in this way, the cam r', Figs. 3 and 4, is set so that the distance from the stop l^4 to the contact-line of the first pair is added to the margin allowed at the head of the sheet, as if it were margin, and the distance between the pairs on the long ways m, Figs. 3 and 4, is also spaced accordingly. The exhaust in this case when so small a part of the roller f^4 is used should be strong to overcome by the proportionate adherence of the paper the resistance offered by the stripping-edge of the case. The specific devices in this mechanism for feeding sheets I do not claim herein.

In the drawings which form part of this specification, the pairs of cylinders required for the several colors which are to be printed appear as placed upon the same horizontal surface; but such arrangement may be departed from without altering the character of my invention. The general direction which the paper takes, for instance, may be perpendicular instead of horizontal, or its general direction may undergo changes at different places, as would be the case if the different lines of contact lay in a curve. Nor is it necessary when the several pairs are in the same horizontal plane that the form-cylinder should be above and the impression-cylinder below, for this state of things may be reversed if the exhaust-belts and their cases are also inverted, so as to carry the paper with its printed side downward, and although in the preceding description the production of a partial vacuum on one side of a sheet or web is referred to as giving that difference of air-pressure which causes the adhesion of the same to a moving surface below it, yet a similar difference may be caused and a similar adhesion produced by blowing the air forcibly down upon one side, while the other suffers no such increase of air-pressure. It is, moreover, obvious that the method of printing herein described is applicable to a single pair of cylinders when impressions in one color only are required, and that web or sheets can be fed to such a press.

As a printed web (either from such a single pair or from a whole chromatic series) leaves the press, it may be separated into sheets at once by cutting apparatus which is well known; or it may be conducted away and dried as a whole. For such guidance of the printed web the employment of exhaust-belts and exhaust-rollers will be found as efficient as are the same devices in the press. By their means the paper is held and handled entirely by its unprinted side, and can be carried at a definite speed in every direction without injury to the freshly-printed surface.

Having thus described my invention and the manner in which the same is practiced, what I claim, and desire to secure by Letters Patent, is as follows:

1. The combination, substantially as described, with a case having an open side for the feeding-belt and provided with air-exhausting mechanism, of rollers and an endless flexible pervious belt mounted on said rollers.

2. The combination, substantially as described, of the endless pervious belt and its rollers with the case provided at one end with the supporting-tongues and with air-exhausting mechanism.

3. The combination, substantially as described, of a pervious surface or support, means for moving said surface, and means for applying atmospheric pressure to the same, with the case having its projecting end provided with supporting-tongues.

4. The combination, substantially as described, with an intermittent feeder, of two or more pairs of form and impression cylinders having their several printing surfaces or forms located to print simultaneously, and means for continuously revolving said cylinders.

5. The combination, substantially as described, with two or more pairs of form and impression cylinders having their several printing surfaces or forms located to print simultaneously, and means for continuously revolving said cylinders, of intermittent feeders located, respectively, in front of the first pair and between the pairs of cylinders.

6. The combination, substantially as described, of the perforated revolving feed-roller, as q^8, provided with flange s^8 and stationary case, as t^8, partially inclosing said roller and provided with air-exhausting mechanism, with the inclined adjustable guide-roller, as c^4.

7. The combination, substantially as described, of the perforated revolving feed-roller, as q^8, provided with flange s^8 and stationary case, as t^8, partially inclosing said roller, and provided with air-exhausting mechanism, with the inclined guide-roller, as c^4.

8. In a printing-machine, the combination, substantially as described, of the driving-pulley g', connected by gearing with the form-cylinder shaft, the free pulley l' in the arm h', held against the pulley g' by the spring m', the belt n', passing between the two and over the pulleys o' on the exhaust-belt rollers, and the depressing-cam r' on the form-cylinder shaft, substantially as and for the purpose described.

9. In a printing-press, the wheels, as r^0, geared together and provided with cam-surfaces s^0, in combination with the vibrating shaft l^0, carrying the anti-friction rollers t^0, the forked bars j^0, and the form-roller riders, substantially as and for the purpose described.

10. In a printing-press, the vibrating shaft l^0, in combination with the pieces n^0, keyed thereon, the screws o^0, the forked bars j^0, and the form-roller riders, substantially as and for the purpose described.

11. In a printing-press, the roller-frame z, carrying the form-rollers, their riders, and devices for vibrating the same, and provided with sliding bearings u^0, in combination with the guide-posts v^0, substantially as and for the purpose described.

12. In a printing-press, the false bearer c', in combination with the form-cylinder and the form-roller trucks, substantially as and for the purpose described.

13. In a printing-press having one or more form-cylinders adapted for the reception of flexible forms, the straining-bars u^2, provided with nippers, in combination with the segments v^2 and the straining-screws x^2, substantially as and for the purpose described.

14. In a printing-machine having one or more cylinders adapted for the reception of flexible forms, the straining-bars u^2, provided with nippers, in combination with the segments v^2, the straining-screws x^2, the adjusting-screws y^2, and the releasing-screws z^2, substantially as and for the purpose described.

15. In a printing-press, the combination, substantially as described, of a form-cylinder adapted to carry flexible forms with the movable pieces b^3 and the interchangeable lip-piece d^3, as set forth.

16. In a printing-press, a form-cylinder adapted for flexible forms, in combination with a straining-bar provided with clamps and adjustable in all directions, and mechanism, substantially as described, for adjusting the straining-bar in all directions on the cylinder.

17. In a printing-press, a form-cylinder having gaps in its surface, as described, a straining-bar adjustable in all directions in each gap, a flexible form, and mechanism, substantially as described, by which the straining-bar may be adjusted in all directions in the gap, all combined substantially as described.

18. In a printing-press having a form-cylinder adapted for printing in the lithographic manner, the projecting rib a', in combination with the form and with apparatus for damping the same, substantially as and for the purpose set forth.

J. W. OSBORNE.

Witnesses:
GEO. F. GRAHAM,
L. C. YOUNG.