W. KLOCKE & F. ORTON.

TOGGLE DRAWING PRESS.

APPLICATION FILED FEB. 17, 1911.

998,969.

Patented July 25, 1911.

11 SHEETS—SHEET 1.

Fig. 1

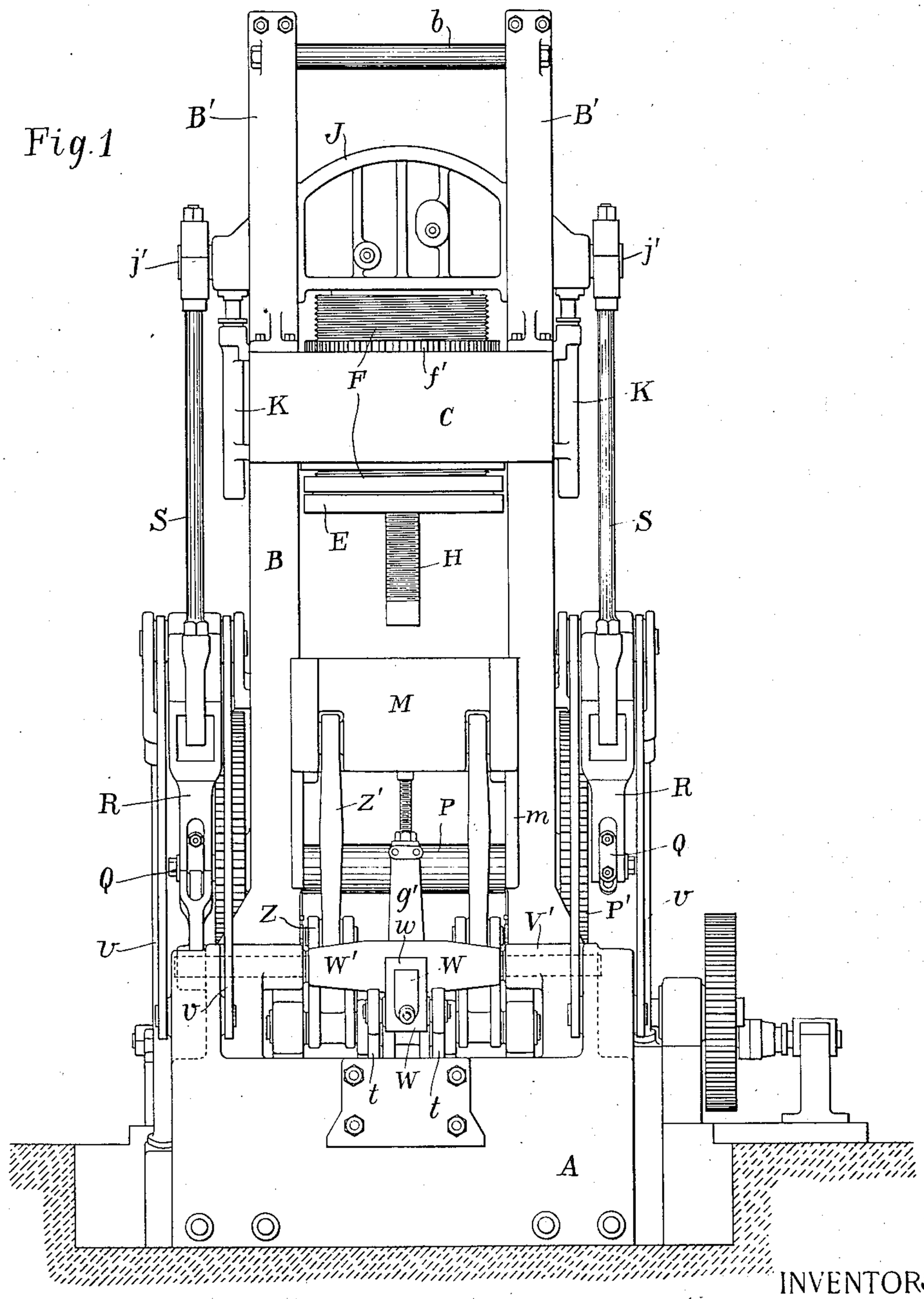

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Fig. 2

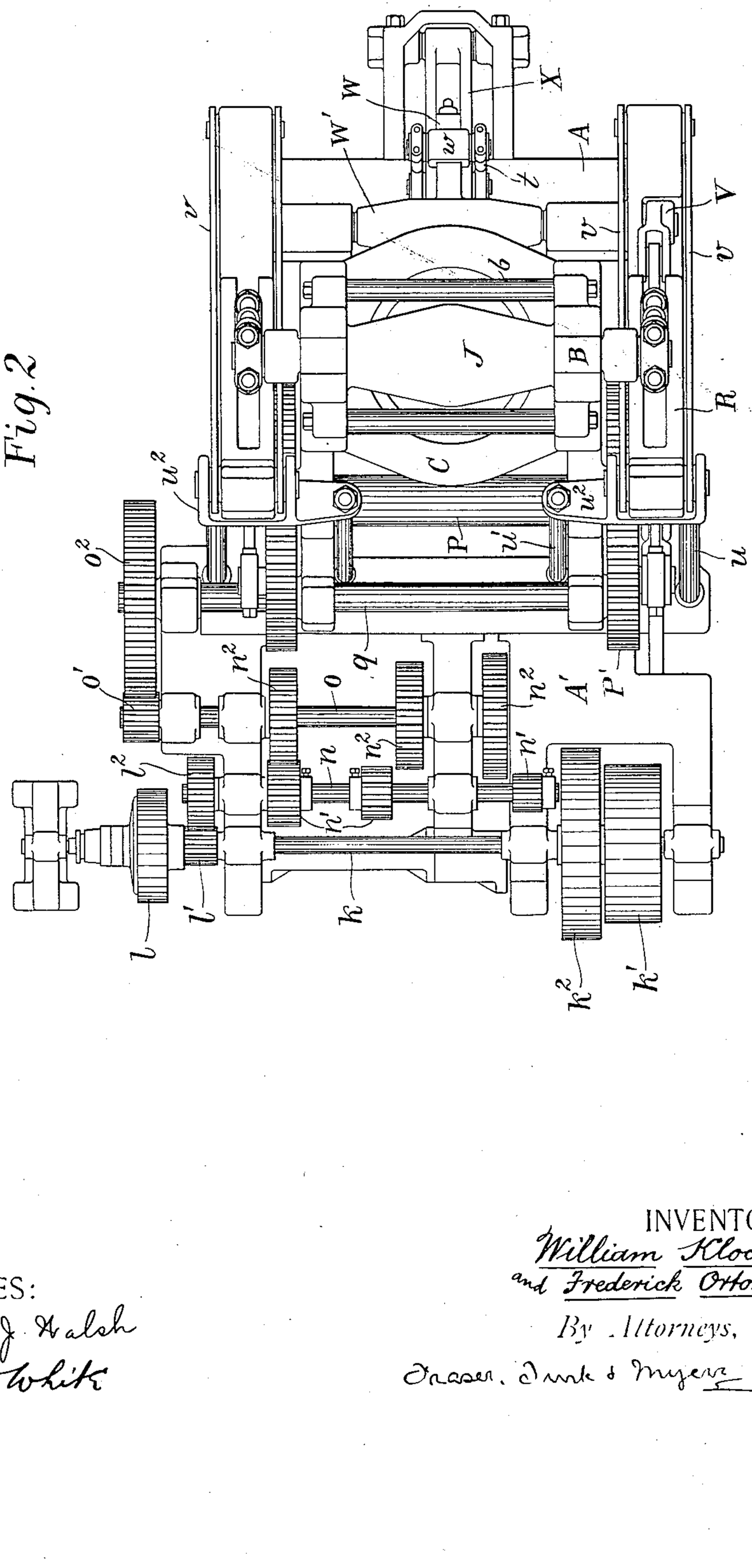

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Fig. 3

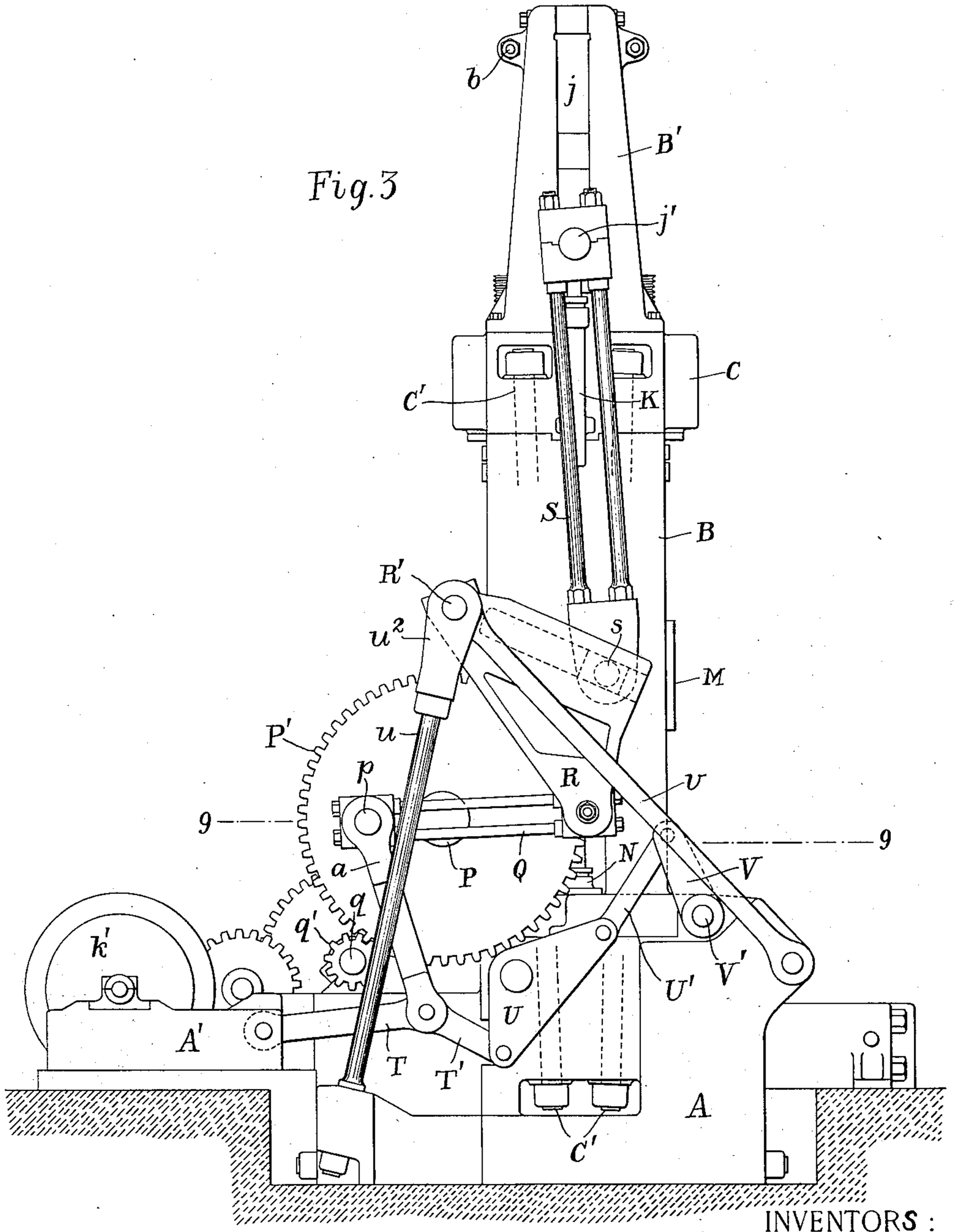

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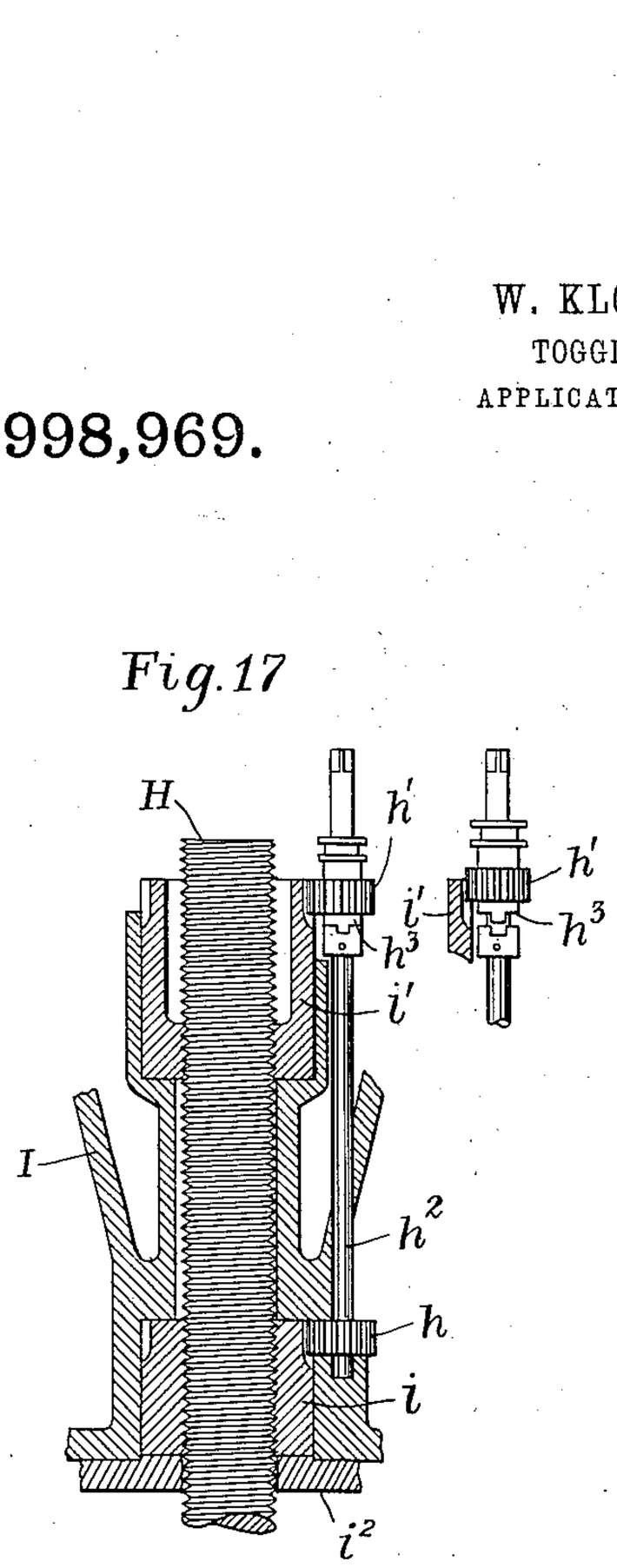
Fig. 17



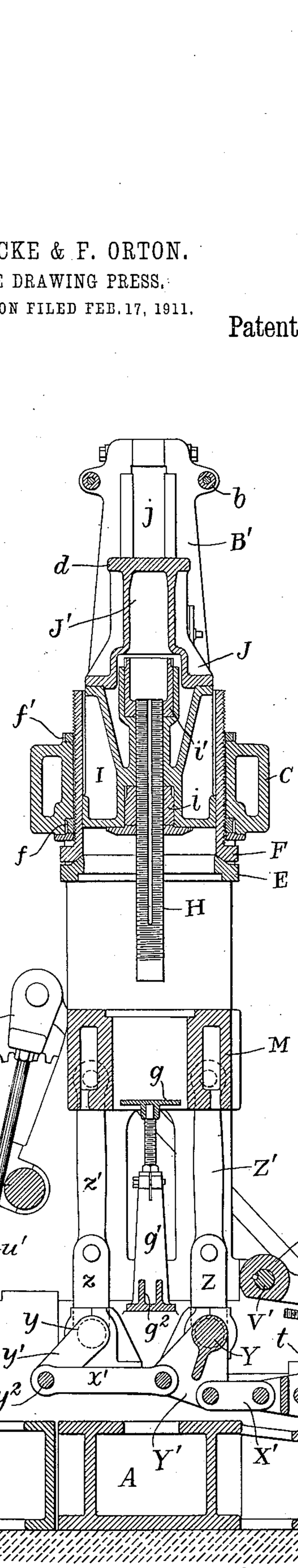
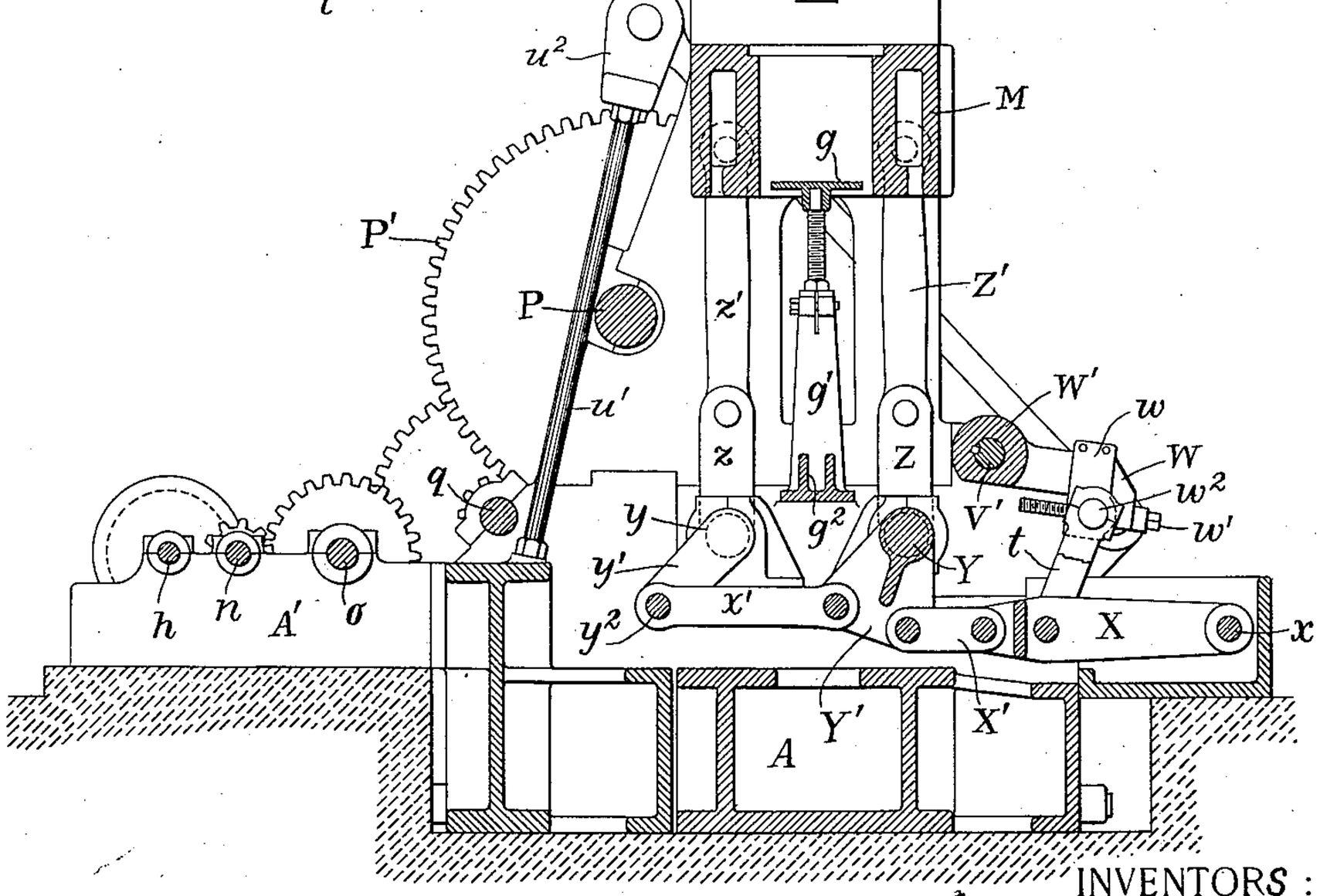


Fig. 4



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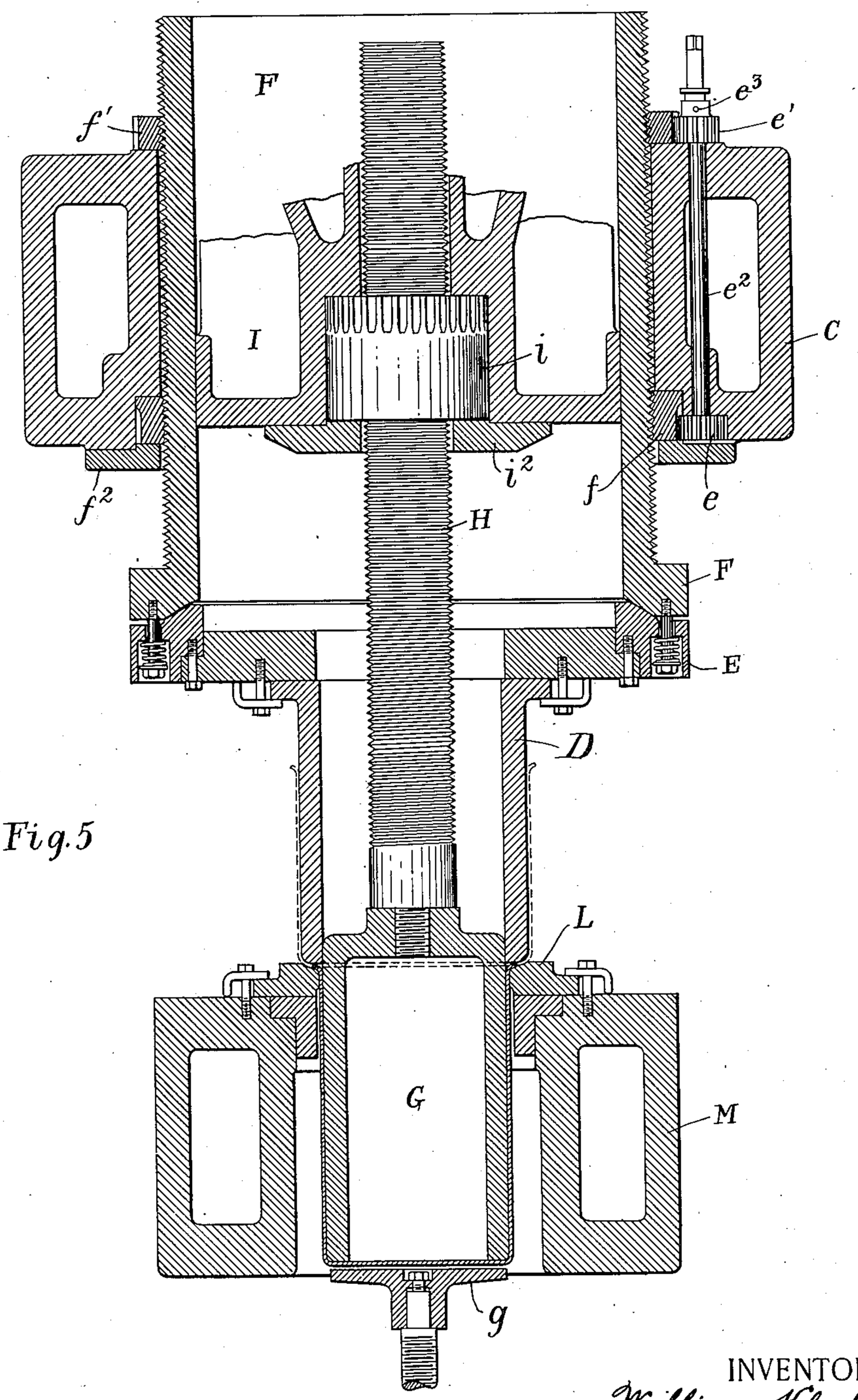

Fig. 5

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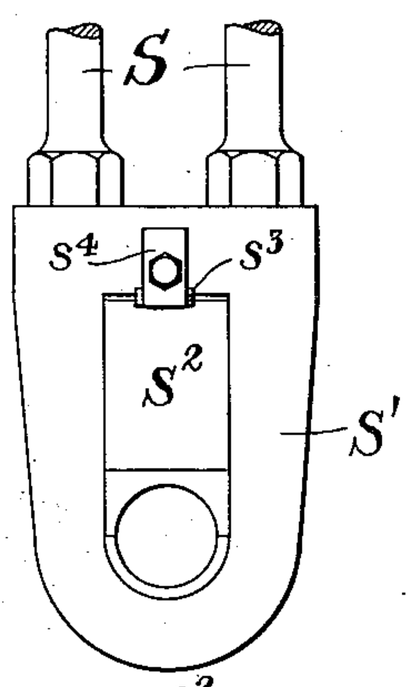


Fig. 6

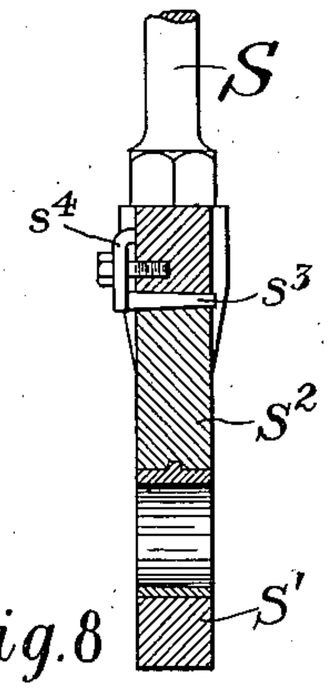


Fig. 8

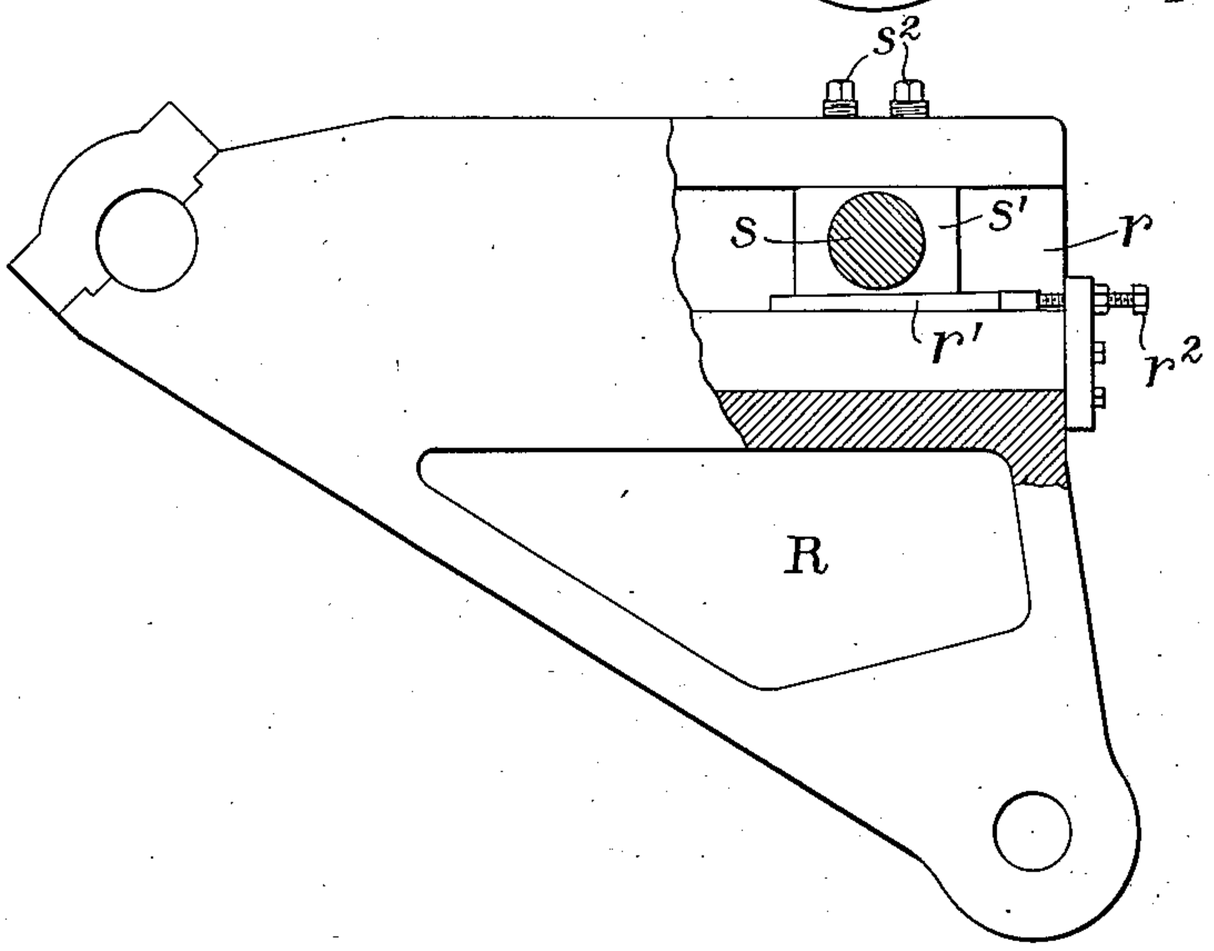
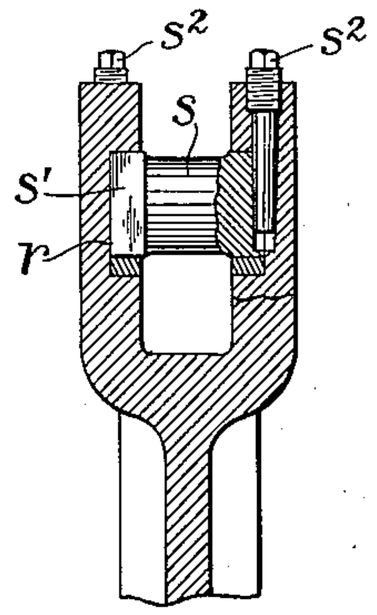
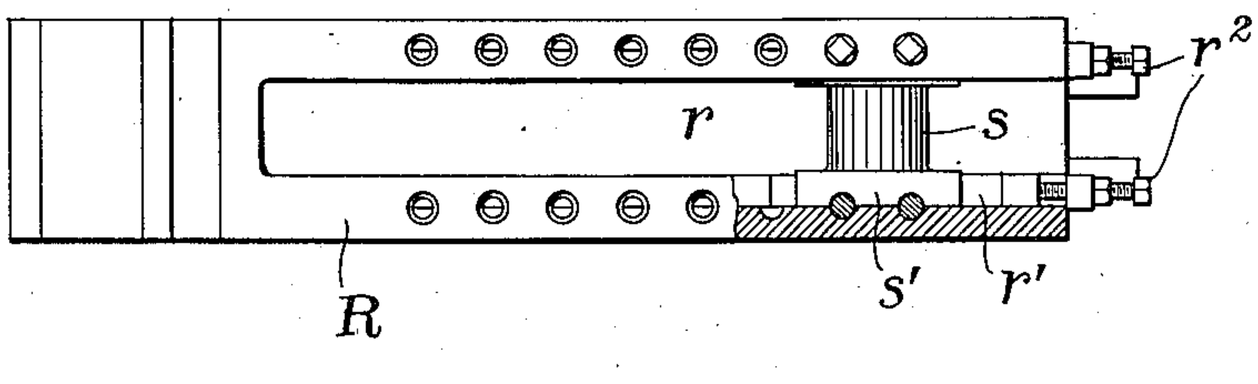


Fig. 7





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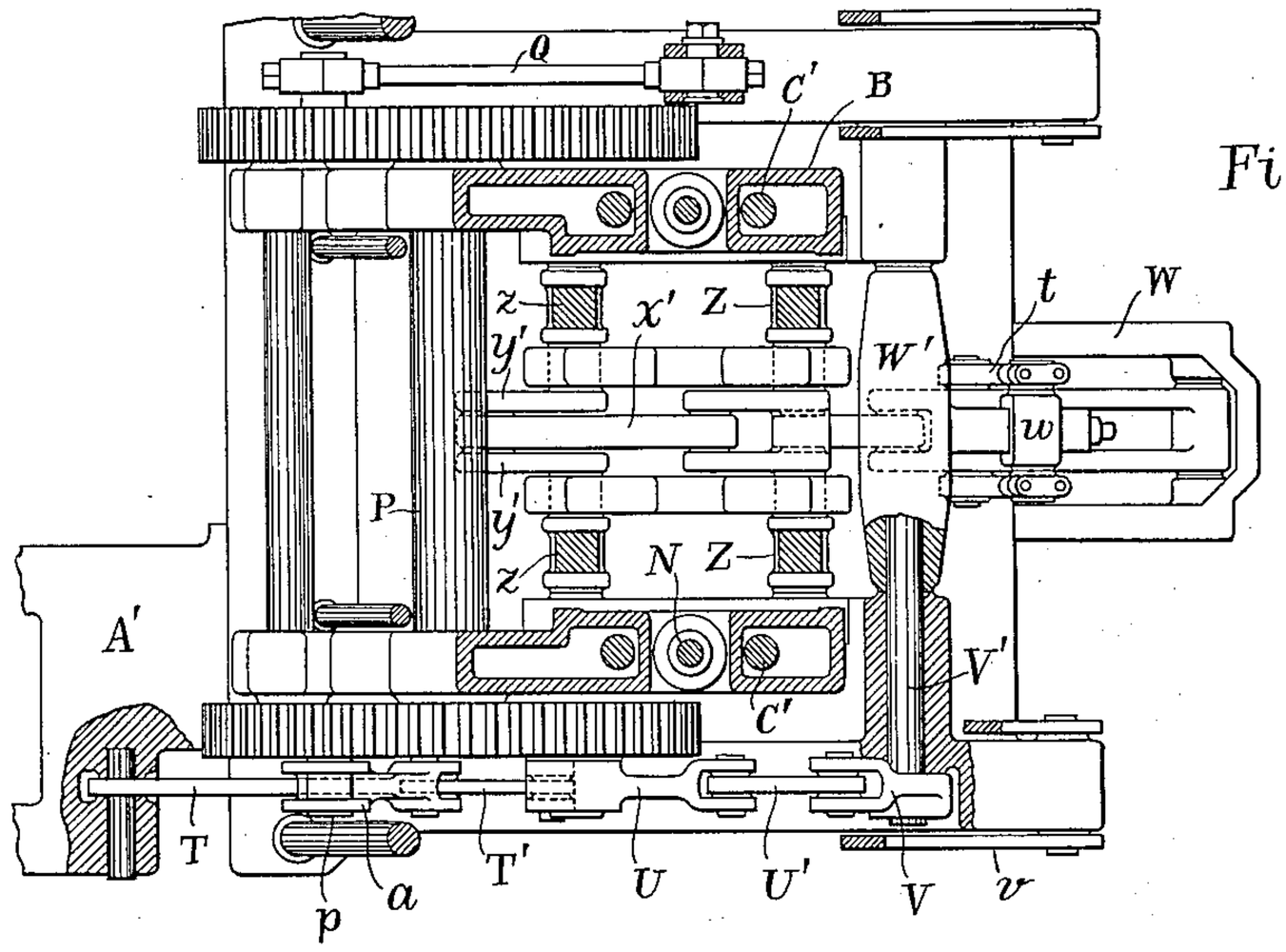

Fig. 9

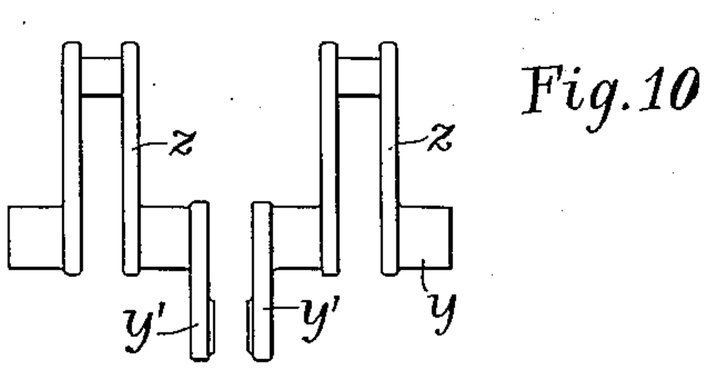

Fig. 10

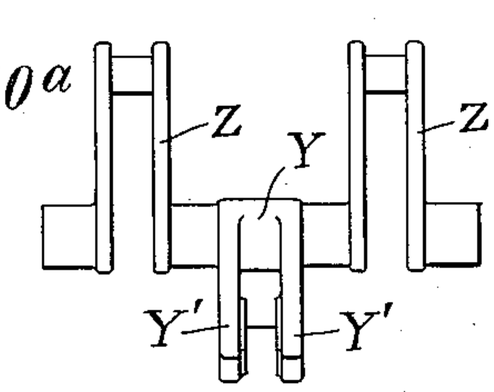

Fig. 10a

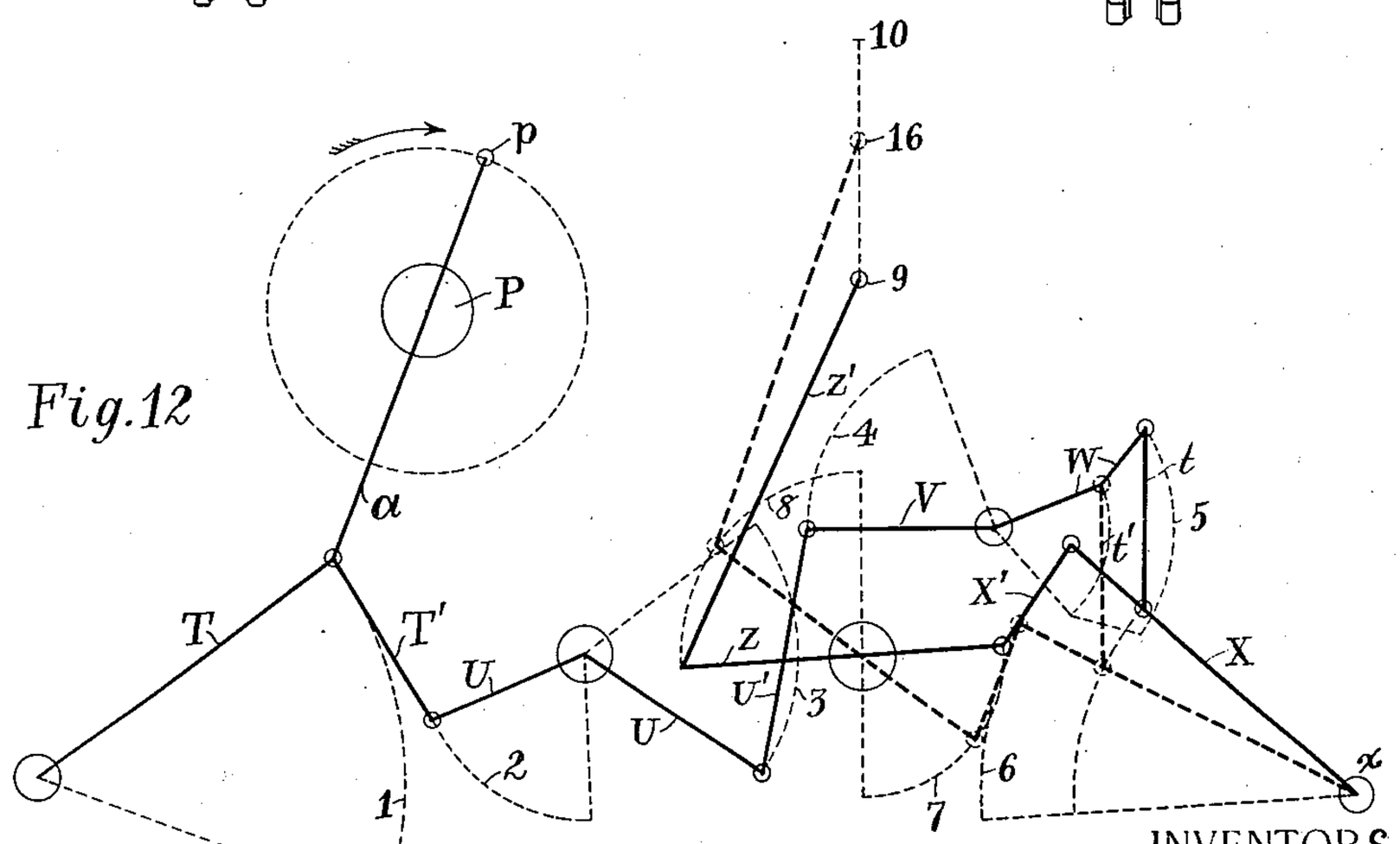

Fig. 12

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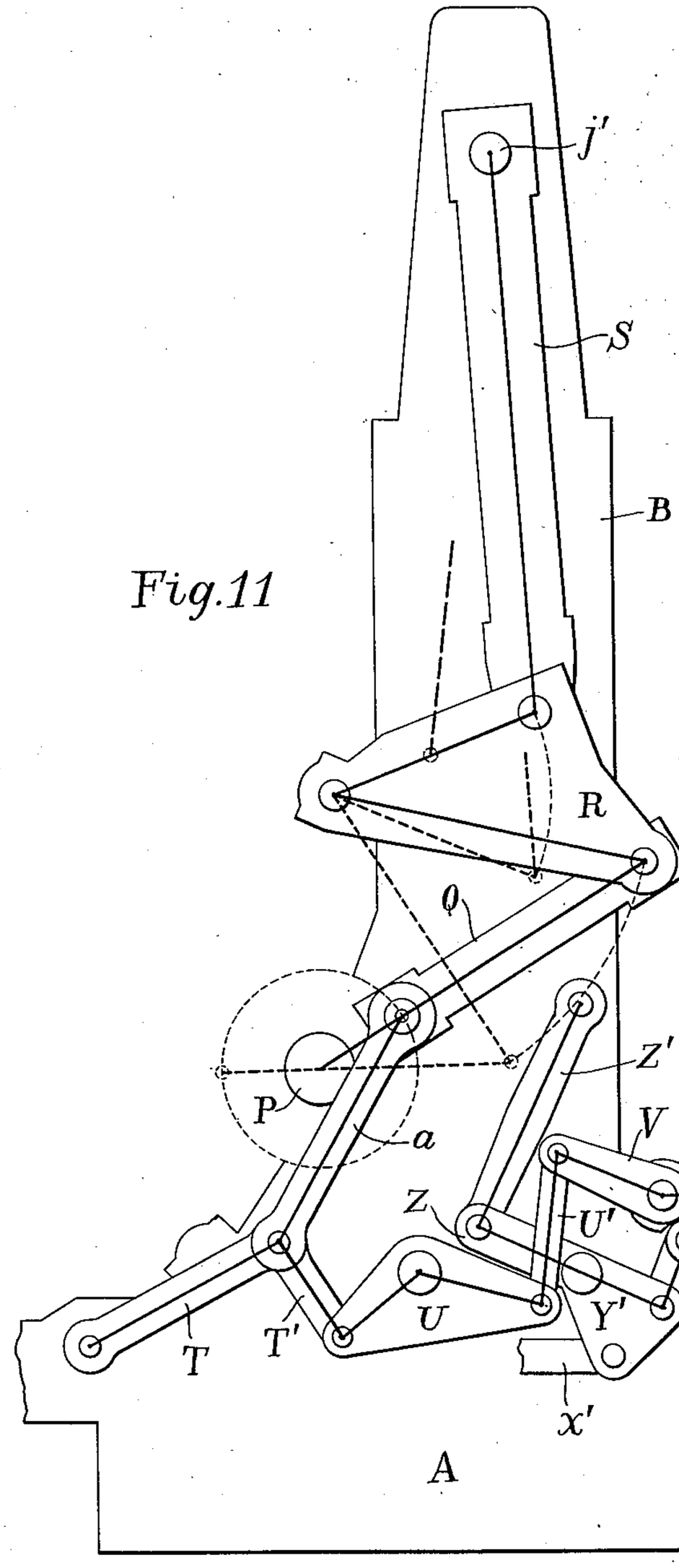
11 SHEETS—SHEET 8.

Fig. 11



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11 SHEETS—SHEET 9.

Fig. 13

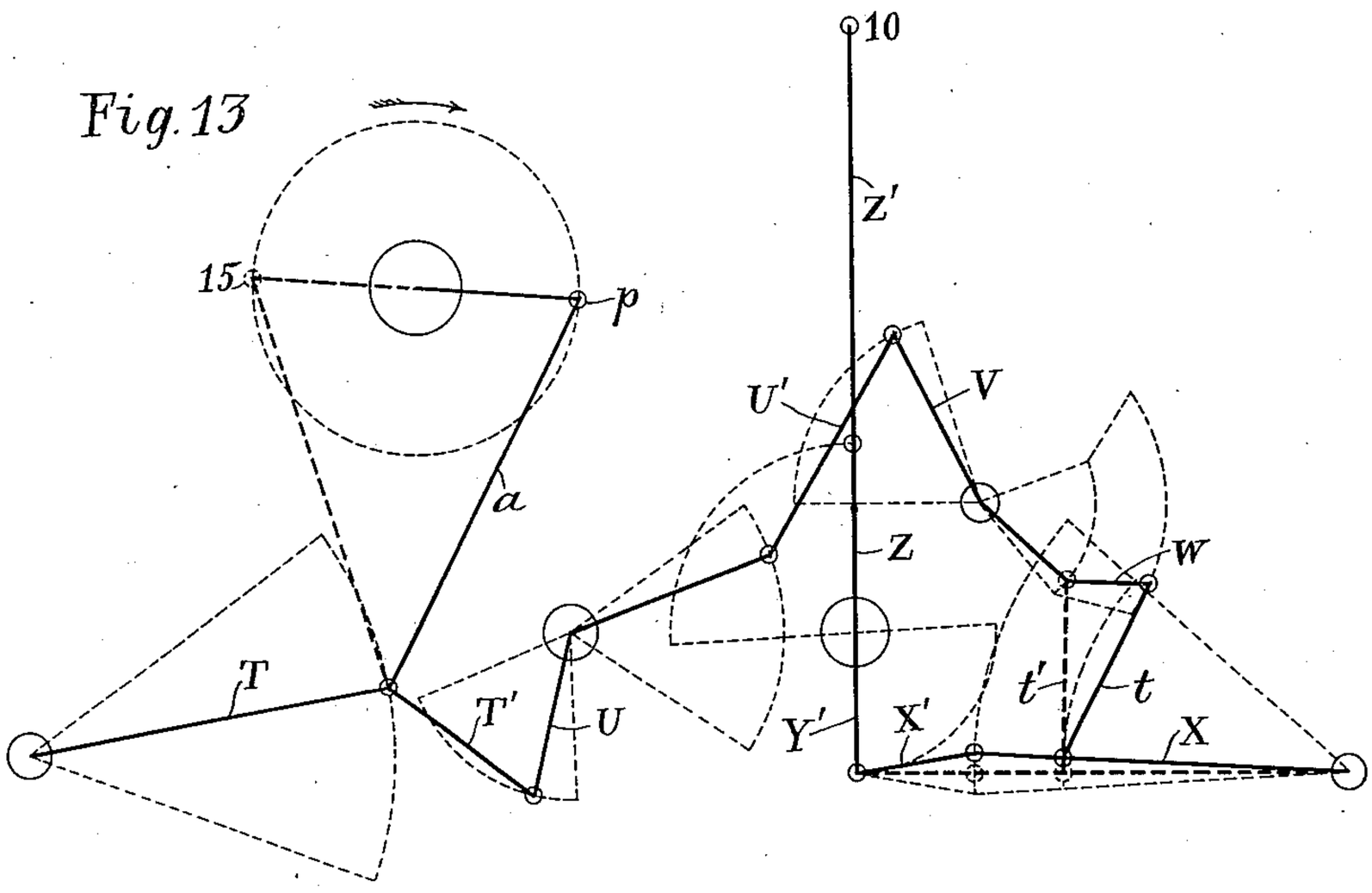

Fig. 14

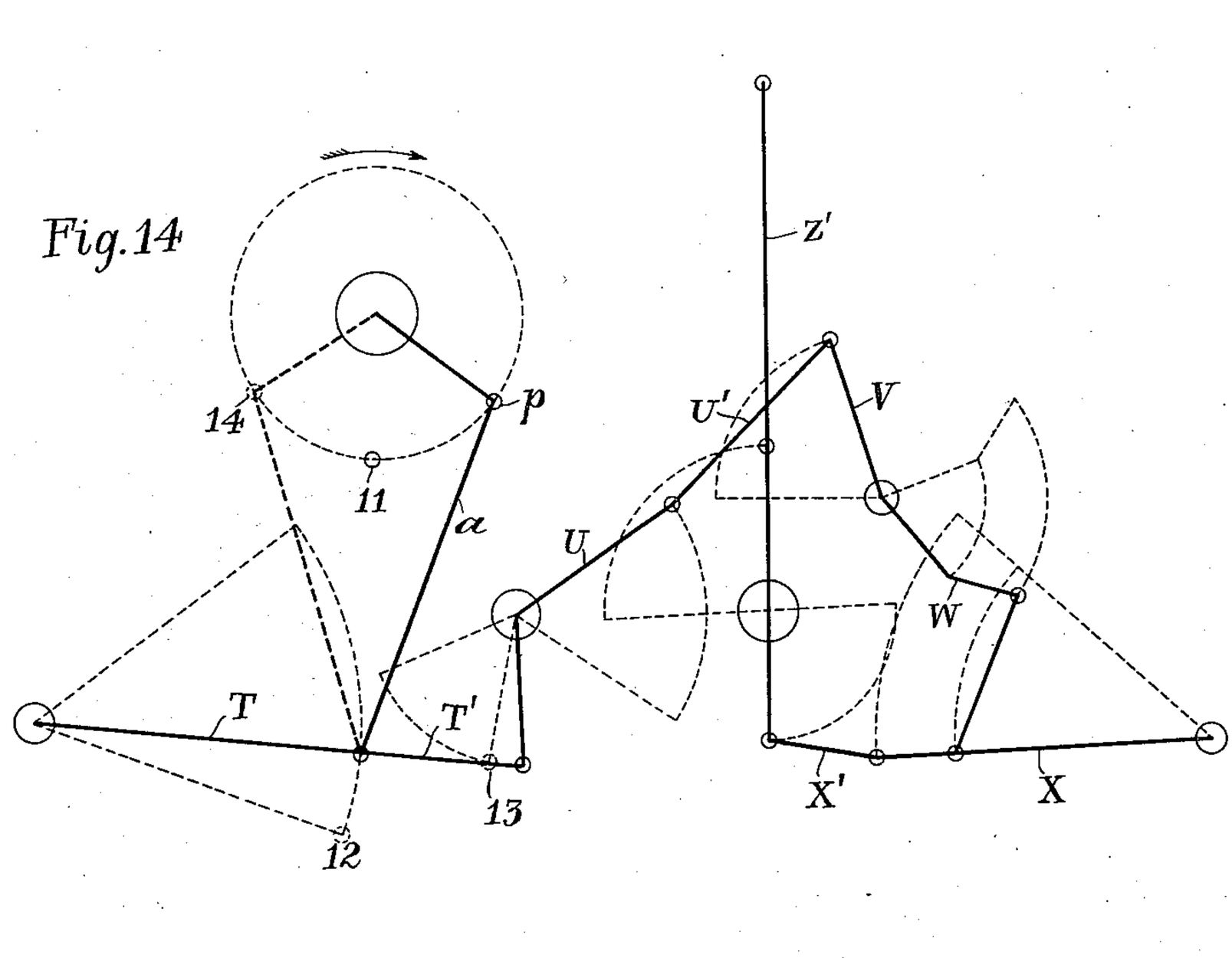

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Fig. 16

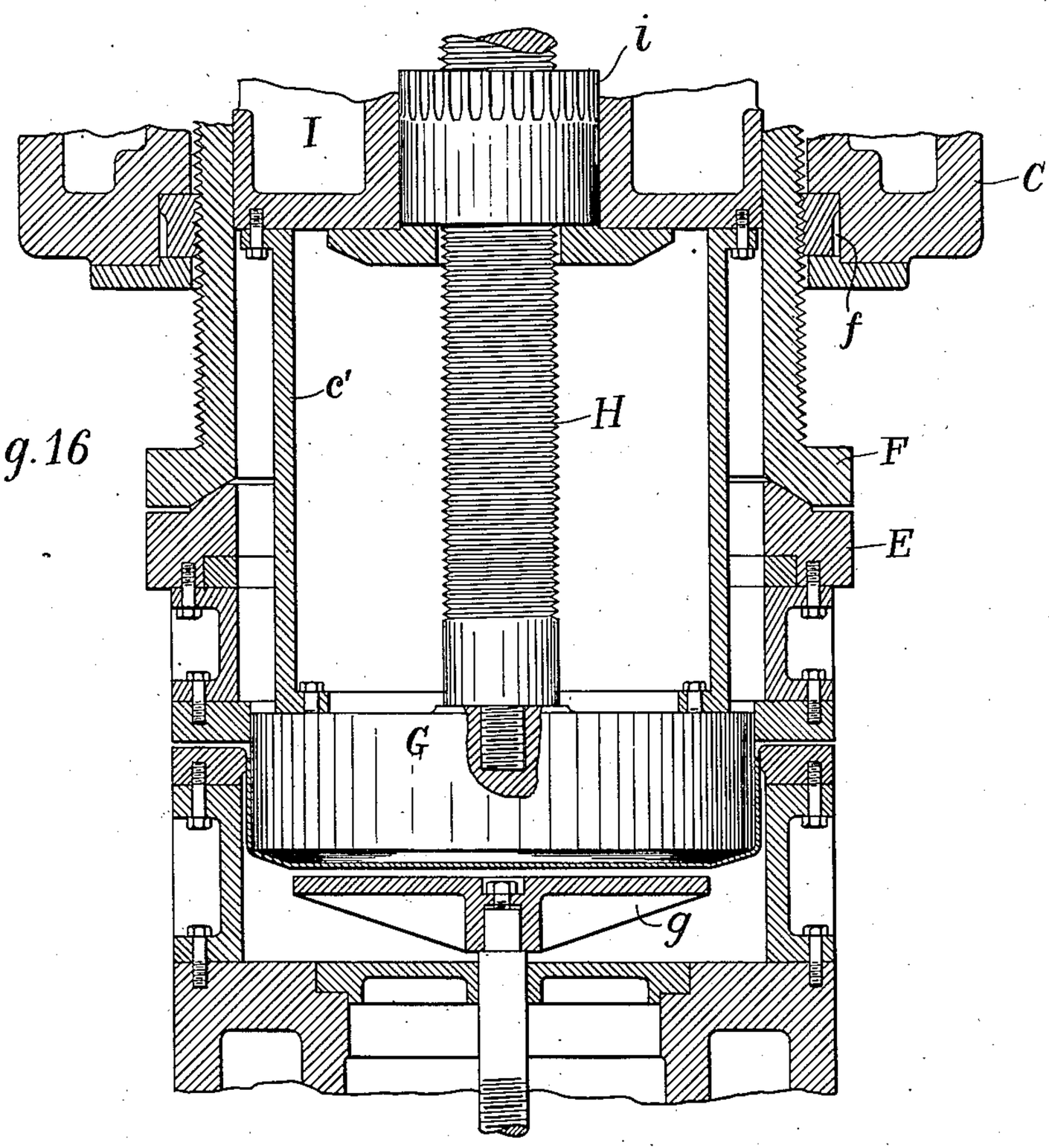

Fig. 15

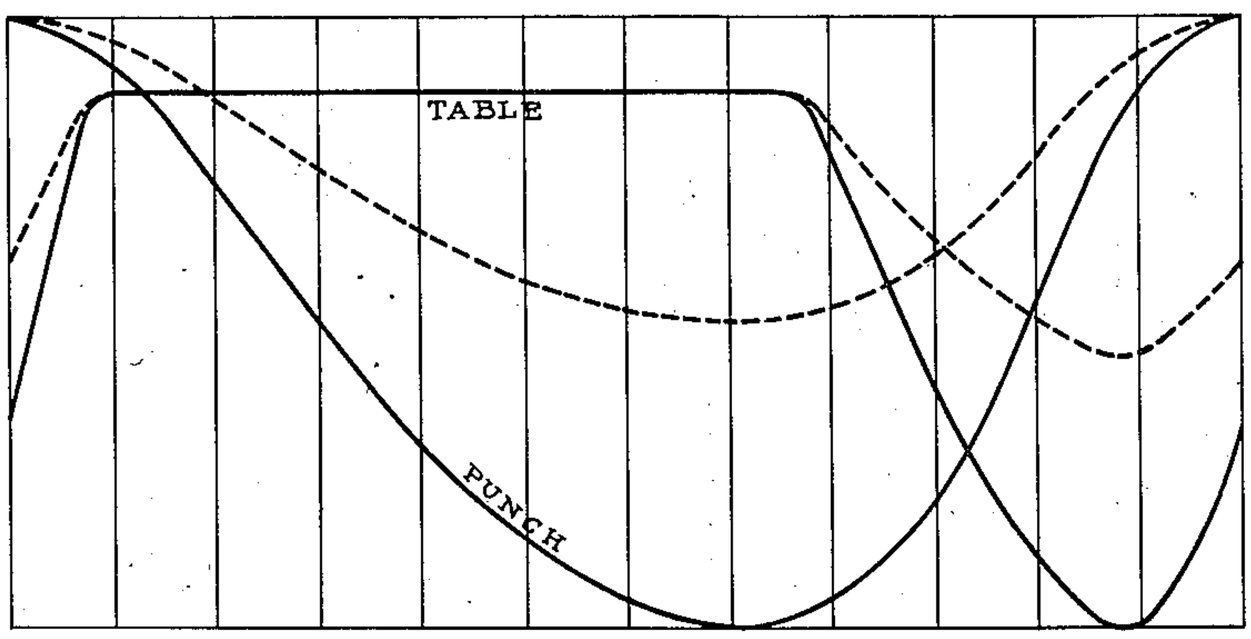

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Fig. 18

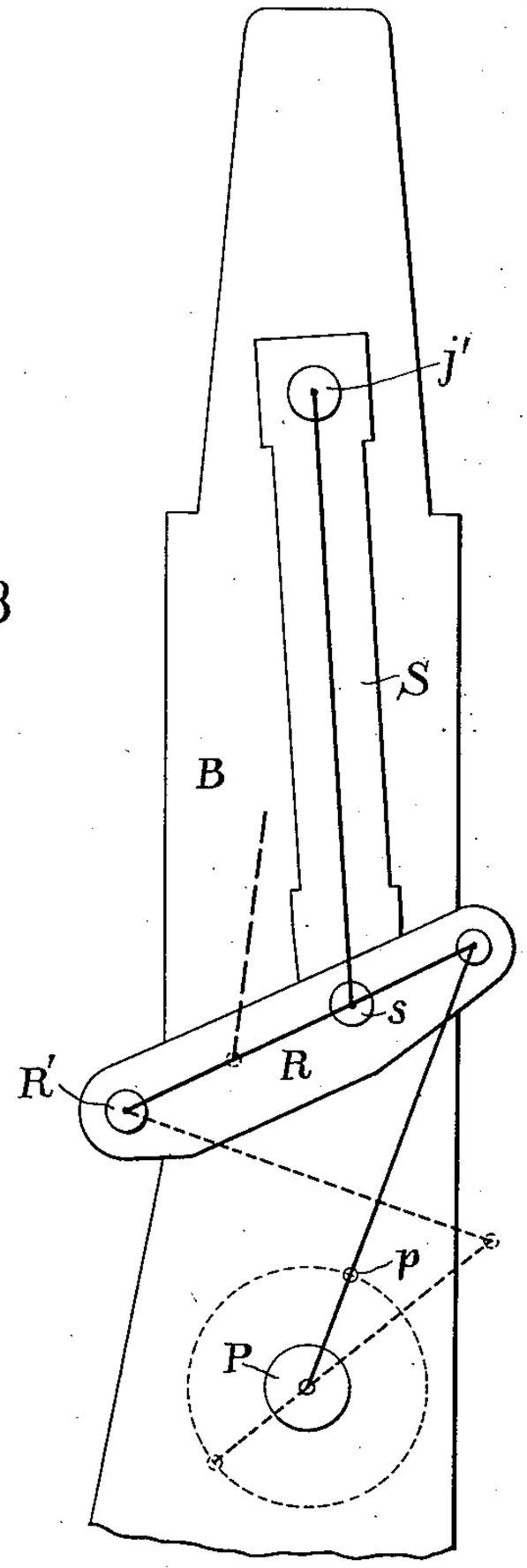
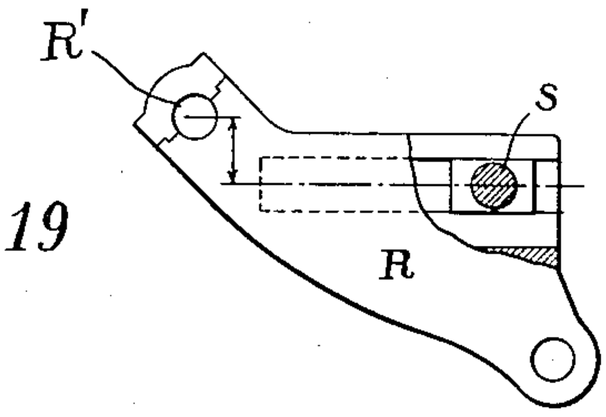


Fig. 19



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UNITED STATES PATENT OFFICE.

WILLIAM KLOCKE AND FREDERICK ORTON, OF NEW YORK, N. Y., ASSIGNORS TO E. W. BLISS COMPANY, OF BROOKLYN, NEW YORK, A CORPORATION OF WEST VIRGINIA.

TOGGLE DRAWING-PRESS.

998,969. Specification of Letters Patent. **Patented July 25, 1911.**

Application filed February 17, 1911. Serial No. 609,192.

To all whom it may concern:

Be it known that we, WILLIAM KLOCKE, residing in the borough of Brooklyn, county of Kings, city and State of New York, and FREDERICK ORTON, residing at Glendale, in the borough and county of Queens, city and State of New York, both citizens of the United States, have jointly invented certain new and useful Improvements in Toggle Drawing-Presses, of which the following is a specification.

This invention is directed to the production of a drawing press having a toggle-operated table, wherein the table and punch shall have each a variable stroke, and the punch a quick-return stroke.

The invention also provides certain other or secondary advantages as will be described.

Although otherwise useful, the invention is chiefly designed for large and heavy presses such as are used for drawing steel cups or shells of large size, say for example of a length approximating three feet and a diameter approximating two feet. For drawing such shells from a flat plate it is necessary to resort to several successive drawing operations. Of these the first is of large diameter and short stroke, the following operations being successively of smaller diameter and longer stroke, until the final operation of maximum stroke and minimum diameter produces the finished cup or shell. As the expense of such heavy presses is considerable, it is desirable to be able to utilize one machine for each of the successive drawing operations required to produce such a shell, as well as for other or analogous operations. These varied uses necessitate a press having a stroke of punch and of blank holding table sufficient for the maximum length of shell to be drawn. They also necessitate that the machine shall have sufficient strength and power to draw shells of the maximum diameter to be produced. As the punch pressures required are roughly in proportion to the diameters of the shells being drawn, and as for any given shell the relative diameters of the shells produced at the first and final drawing operations are approximately as 2 to 1 respectively, it follows that the punch pressure for the first drawing is about double that required for the final drawing. The power required to drive the press at any instant while drawing is proportional to the punch velocity multiplied by the punch pressure. This power is very considerable in large work, and affects the dimensions of the train of gears, with their shafts and bearings, leading back from the crank shaft of the press to and including the motive power apparatus, which is commonly an electric motor. It is sometimes desirable that the power required to drive the press be maintained as nearly constant as possible, whatever may be the work which the press is called upon to perform, in order to avoid providing greater motive power and greater strength of the power-transmitting parts of the press than is sufficient for average requirements. The occurrence of the maximum work is so infrequent that it is undesirable to build presses of this very costly type strong enough to do the heaviest work at the highest speed; hence an important economy is effected by the ability to speed down the press for work exceeding the average power requirements.

If a press having an invariable length of stroke were run at a uniform speed for drawing both long and short shells, the stresses in the driving gearing, and the motive power required, would be greatest (at any specified crank position) while drawing a short shell, as the short shell has the largest diameter and requires the greatest punch pressure. The length of the stroke of such a press would be determined by the longest shell to be drawn, which would be in excess of the requirements for drawing a short shell. In a variable stroke press, however, such as our invention provides, the stroke may be reduced for drawing the short shell with corresponding reduction in punch velocity, and increased distances of crank and gear rotation during the drawing period of the punch, resulting in lower stresses and lesser power demand at any instant and permitting of lesser dimensions of gearing, shafts, bearings, etc., and of a lower motive power, and a reduction of space occupied by those portions of the machine and by the motor used to drive the machine, all without reduction of the number of strokes per minute performed. Thus the variable stroke is a means of changing the leverage between the crank shaft and the punch so that the punch may be made to exert a greater pressure through a shorter distance

without increasing stresses in driving gearing, and without demanding increased motive power.

The speed of drawing presses, or number of strokes per minute, is limited by the highest punch velocity that can be used without causing the sheet metal to tear in drawing. In those cases where there is ample drawing power, and when it is desirable to build the power-transmitting parts of the press of sufficient strength, the press may be adaptable for a variety of operations requiring a considerable diversity of power. If a press is to be used for such variety or operations, some requiring less punch stroke than others, it is evident that by shortening the stroke for some of the operations, the rotative speed, or the number of strokes per minute, can be increased in inverse ratio to the reduction of stroke without increase of punch velocity; resulting in a greater average production of shells in a given time than would be possible with a press having an invariable length of stroke. Thus the variable stroke is a means permitting of an increased number of strokes in a given time for operations requiring less than the maximum length of stroke of the press, greatly increasing the productive efficiency of a press that is driven by a variable speed electric motor, or a press receiving power from any transmitting agency that has the function of altering the speed of the driving belt of the press. Furthermore the variable stroke has an added advantage in combination with speed change gearing in the driving gear of the press itself, obviating the necessity of employing either a variable speed motor or any extraneous speed changing devices. The imparting of a variable stroke to the blank holding bed or table also has important advantages. The table stroke when drawing long shells that are to be removed from the press from over the die is necessarily long, to create space for the removal of the shell from over the die, and between the die and the bottom of the punch, or the bottom of the stationary blank holder, when the die has descended and the punch ascended to their stopping positions. If however a long shell be pushed through the die to be removed from the press from underneath the table, then the table stroke need only be as long as necessary to create space for the introduction of the succeeding shell that is to be placed on the die for redrawing, and the length of which will be considerably less than the redrawn shells that are pushed through the die and removed from underneath. The lesser stroke of the table necessary under these conditions is desirable in that it leaves a greater space beneath the bottom of the table when the table is down, which greater space facilitates the removal of the push-through shells. Another reason for shortening the table stroke is that when drawing shells of shallow depth, the die and bolster that are used for drawing such shells will often be of considerable weight, and the press may be speeded up to its maximum rate of reciprocation, and under such conditions it is undesirable to maintain a needless length of stroke for the massive table, large die and bolster, and table counterweight, which by the increased inertia and momentum at the maximum number of strokes would result in unnecessary stress in moving parts and wear of joints.

The feature of imparting to the punch a quick return movement is important in that by reducing the time of the idle or upstroke of the punch, it so extends the relative time of the drawing stroke that the press can be speeded up to a considerably higher number of strokes per minute than a press of the same dimensions devoid of this feature, without causing the maximum drawing velocity of the punch to exceed that of such other press. By this means alone the productive capacity of the press is increased by from 20 to 25 per cent.

Having thus indicated the leading features of our invention and the advantages thereof, we will proceed to describe a drawing press constituting an embodiment of our invention in its preferred form. Such press is shown in the accompanying drawings, wherein,—

Figure 1 is a front elevation of the press; Fig. 2 is a plan thereof; Fig. 3 is a side elevation viewed from the left; Fig. 4 is a vertical mid-section also viewed from the left; Fig. 5 is a vertical section on a larger scale than Fig. 4 showing the punch, blank holder, and their operating parts in the act of drawing a shell; Figs. 6, 7 and 8 show one of the rocking levers through which power is transmitted to the punch slide, being respectively a side elevation partly broken away, a plan, and a front view in vertical section. Figs. 6 and 8 show also the lower end of the rod S. Fig. 9 is a horizontal section in the plane of the line 9—9 in Fig. 3, certain parts being omitted; Figs. 10 and 10^a are plans of two of the shafts in Fig. 9; Fig. 11 is a skeleton view corresponding to Figs. 3 and 4, except that the parts are shown in a different position, the center lines and pivotal connections of the press being indicated by heavy lines and dots by way of a diagrammatic illustration. The position thus shown is approximately the position of rest or starting position of the machine; Figs. 12, 13 and 14 are diagrams showing successive positions of the table operating mechanism; Fig. 15 is a diagram or time chart showing the relative movements of the

punch and table; Fig. 16 is a section corresponding to Fig. 5, but showing a different punch and blank holder; Fig. 17 is a fragmentary vertical section showing the punch plunger adjustment; Fig. 18 is a diagram showing a modification. Fig. 19 shows a modification of Fig. 6.

In the particular construction shown in the drawings, the fixed framework of the machine comprises a massive base or bed A, parallel upright side frame B B, with a cross frame C uniting them above, their extensions B′ B′ above the cross frame being tied together at top by tie rods *b b*. The base A has a rearward extension A′ forming a frame for the speed changing gearing. The blank holder D (Fig. 5) is mounted against the usual equalizing ring E carried at the lower end of a blank holder frame F, which is fixedly and adjustably mounted in the cross frame C. For transmitting the tensile or blank-holding stress between this cross frame C and the base A, the two are connected by pairs of upright rods C′ fitted with heads or nuts.

The punch G (Fig. 5 or 16) is carried upon the punch plunger H, which is vertically adjustable in the lower member I of a sliding cross head J, which is vertically movable in guideways *j j* formed in the extensions B′ B′ of the upright frames B B, a part or all of its weight being carried by hydraulic rams or buffers K K as usual.

The die L (Fig. 5 or 16) is carried by the table or movable bed M which slides on vertical guideways *m m* between the upright frame B B. Part or all of its weight as desired is carried by hydraulic rams or buffers N N as usual, these being located within the side frames B B and base A.

Both the punch and table derive motion from the crank shaft P through cranks, levers, links and connecting rods, as will be described. The shaft P may be driven in any suitable way, preferably through reduction gearing, as will be described. In the construction shown the main shaft P is mounted in bearings in rearward extensions of the side frames B B, being located considerably to the rear of the center line of the press, for reasons hereinafter stated. The shaft P carries on opposite sides cranks *p p* from which both the punch and table are driven. These cranks are conveniently formed as studs fixed in gear-wheels P′ P′ keyed upon opposite ends of the shaft, and through which gear wheels the shaft is driven.

For driving the punch the cranks *p p* connect through rods or links Q Q with rock levers R R on opposite sides of the press, which levers in turn connect through rods or links S S to the pivotal ends *j′ j′* of the cross head J. The connection between the levers R and rods S is made by means of pivot pins *s* which are adjustable toward or from the fulcrum pivots R′ of the levers for the purpose of imparting a variable stroke to the punch. The detail construction for permitting this adjustment may be greatly varied, but in that shown the wrist pin *s* has square heads *s′* which slide in opposite grooves *r* formed in a channel portion of the lever, wedges *r′* being provided for taking up any looseness when driven home by screws r^2. For anchoring the wrist pin against any possibility of displacement, locking keys or dowel-pins s^2 are driven or forced into holes drilled partly in the metal of the lever R and partly in the heads *s′*, additional holes being bored in the lever for each adjustment of the wrist pin. The pins s^2 are preferably tapered screw pins or plugs. To enable the connecting rods S, levers R, and wrist pins *s* to be assembled, the connecting rods are each made with a loop or stirrup S′ at its lower pivotal end (see Fig. 6), having an opening large enough to permit the head *s′* to be passed through it, this opening being filled by a block S^2 tightened by a wedge s^3 driven in above it and held by a screw clamp s^4 (Figs. 6 and 8).

The movements of the table M are imparted from one (or both) of the cranks *p* through a succession of connecting links and toggles coöperating to impart to the table when in its elevated or blank-holding position the prolonged dwell which is necessary for gripping the blank and holding it during the drawing operation. The crank stud *p* as shown connects by a link *a* with a pair of links T T′ constituting a toggle joint, their outer ends being jointed respectively to the fixed frame A′ and to one arm of a rock lever U. To the opposite arm of this lever U is jointed a link U′, this arm and link constituting a second pair of toggles; the opposite end of this link U′ is connected to a crank arm V fixed on a transverse shaft V′ which has bearings in the base frame A, and to which is keyed the prolonged hub W′ of a lever arm W, this arm being adjustable in length to vary the movement of the bed. To this adjustable arm is jointed a link (or preferably a pair of links as shown) *t*, connecting to a lever X, the front end of which is fulcrumed at *x* to the base A, and its rear end is jointed to a link X′, so that X and X′ constitute together a third pair of toggles. The other end of the link X′ is jointed to an arm Y′ (or pair of arms) projecting from a rock shaft Y, which is formed with two arms Z Z projecting from it, each of which is jointed to a toggle link Z′ the opposite end of which link is jointed to the table M. Each arm Z and link Z′ constitute a pair of toggles. In order to support the table firmly four pairs of the toggles Z Z′ are provided, arranged

symmetrically so as to support the table near the four corners thereof, two of these toggles being connected to the shaft Y as described, and the other two (lettered *z z'*) being connected to a parallel rock shaft *y* having an arm *y'* connected by a parallel motion link *x'* with the arm Y', so that the shafts Y and *y* oscillate in unison, causing simultaneous movements of the respective toggles Z Z' and *z z'* for raising and lowering the table M. Thus it is seen that between the crank *p* and the table M there are four successive pairs of toggles, viz: (1) the toggles T T'; (2) the toggles U U'; (3) the toggles X X'; and (4) the toggles Z Z', and their mates. The relative arrangement of these toggles is important for the attainment of the prolonged dwell of the table in the blank holding position. The extent of this dwell and the movement of the bed and of the punch are shown in the diagram or time chart Fig. 15, wherein the heavy full lines show the movements of the table and punch respectively when adjusted for their maximum movements, the heavy dotted lines showing their adjustment to their minimum movements.

As is usual with drawing presses, the press is driven through a clutch by which the main or crank shaft is turned for one complete revolution at each operation and is stopped (either manually or automatically) at the end thereof. This stopping point should ideally be when the punch is fully raised and the table fully depressed, but as these positions cannot practically be realized in exact coincidence, the stopping point may occur at any time after the table is fully or nearly down and before the punch is fully up. It may for example be in the position occupied by the parts as shown in Fig. 11, in which the punch is at top stroke and the table has been elevated but little from its lowermost position. Starting therefore with the position shown in Fig. 11, we will follow the successive movements of the apparatus, taking first the punch movements. In Fig. 11 as stated the punch is at top stroke, and hence the crank *p* is on a radius alined with the center line of the connecting rods Q, that is to say, on its "dead center." The relations of the crank shaft axis, crank radius, fulcrum axis or lever R, and the length of the long arm of this lever, are such with the proportions shown in the drawing that the crank has to move through an arc of 210° (approximately) in order to bring the crank radius again into alinement with the middle line of the connecting rod, or to its opposite dead center corresponding to the lowest position of the punch (this position being shown in dotted lines in Fig. 11). It results therefore that the upstroke or idle movement of the punch is performed in the remaining 150° of the crank's rotation. Thus the down or working stroke of the punch is so prolonged, and the upper idle stroke so accelerated, as to create a difference of 60° in time between them. This relative timing of the parts may be varied by changing the proportions or relative arrangements of the working parts. The table movements are less obvious because of the co-action of the four successive pairs of toggles, whereby a crank movement of approximately 180° is practically extinguished from its effect upon the table, so that the latter has imparted to it during one half rotation of the crank, rapid descending and ascending movements, and during the other half of the crank's rotation is held practically motionless.

The table movements can best be traced through the series of diagrams Figs. 11 to 14 inclusive. For clearness the duplicate toggles *z z'* are omitted from these diagrams. Fig. 12 shows the parts when the table is in its lowermost position, the link *a* being on the upper dead center of the crank, and the toggle link T being (as shown by the arc 1) at the upper end of its stroke. The toggle T T' is consequently buckled, the lever U being at one extremity of its stroke as shown by the arcs 2 and 3. The toggles U U' are also buckled, and the lever formed by arms V W is at one end of its stroke as shown by arcs 4 and 5. Consequently the toggle X X' is buckled, (see arc 6) and so are the toggles Z Z' (see arcs 7, 8) and their mates, so that their pivotal engagement with the table is at the lowest point 9 (the highest point to which the table is to be lifted being located at 10).

In Fig. 13 the crank *p* has turned about 62° or sufficient to bring the toggle arm T nearly to mid-stroke. During this movement the table has been completely lifted. This is due to the angular relation of the successive toggles, as will be seen by comparing Fig. 13 with Fig. 12. The link T' has pushed lever U to nearly the end of its stroke, thereby nearly straightening the toggles U U', bringing the lever V W nearer the end of its stroke than is the lever U, and consequently so nearly straightening the toggle X X' as to swing the arms Y' Z into vertical position, thus straightening the table lifting toggles Z Z' and lifting their pivotal connection with the table to the level 10.

In Fig. 14 the crank *p* has advanced about 33° farther or to the point where the toggles T T' are straightened, thereby bringing the levers U, and V W to their extreme position, almost straightening the toggles U U' and carrying the toggles X X' past their straight line position to a flexure approximately equal but opposite to that in Fig. 13. This movement momentarily elongates the toggles X X' and then shortens

them again to their former length, but this variation imparts so little angular movement to the toggles Z Z′ and their mates that the difference in the length of these toggles is so slight as not to appreciably affect the bite of the blank holding surfaces upon the blank or shell being drawn. During the further movement of the crank p to the point 11 in Fig. 14, the toggle arm T is carried to the extremity of its movement at point 12, thereby shortening the toggles T T′, and drawing the connection of the latter with lever U back to the point 13; the lever U thus is rocked back to the position it had in Fig. 13, and all the following parts then reoccupy the positions shown in that figure. This movement again rocks the toggles X X′ past their alined position, thus lengthening and again shortening them to so minute an extent as not to affect appreciably the toggles Z Z′, which remain essentially alined. The further movement of the crank from point 11 to point 14 (Fig. 14) re-alines the toggles T T′ and brings all the succeeding parts back to the position shown in Fig. 14. This again throws the toggles X X′ from one side of their alined position to the other, but with the same negligible effect upon the toggles Z Z′. The further movement of the crank p from point 14 to the point 15, Fig. 13, (see dotted lines) restores the toggles T T′ and all the succeeding appartus to the positions shown in Fig. 13. With this movement again the toggles X X′ rock across from one side of their alined position to the other, with the same negligible effect upon the toggles Z Z′. The crank pin p in passing beyond the point 15 in Fig. 13 further buckles the toggles T T′ until the position shown in Fig. 12 is again reached, and during this interval (a movement of about 100°) the table is lowered to its first position.

To vary the working stroke of the punch it is only necessary to vary the effective length of the shorter arm of the lever R by shifting the joint between this lever and connecting rod S toward or from the fulcrum point R′. This is accomplished by removing the keys s^2, slacking the wedges r', sliding the wrist pin blocks in the grooves r to the required position, and reinserting the tapered keys and retightening the wedges. This adjustment must be made with exact equality for both levers R R, in order that both ends of the cross head J shall be moved the same distance during the revolution of the crank.

The lever R is shown as so shaped that this adjustment is made on a radius which is horizontal at about mid-stroke. It follows from this arrangement that the shortening of the punch stroke by adjusting the joint toward R′ occurs equally on both sides of mid-stroke. The invention is not limited to this feature, as the construction might be such that the adjustment would not alter the upper, or lower, or any other desired portion of the punch or punch-slide. If the change of punch-stroke alters the elevation of the punch, it is easy to effect a compensating readjustment of the height of the punch plunger.

To vary the movement of the table, it is only necessary to adjust the effective length of the lever arm W. For this purpose a slide w is arranged to move along this arm, and a screw w' is provided for adjusting it in or out along the arm. The link t (whether constructed as a single link with a bifurcated upper end forming two ears, or preferably as two parallel links) pivotally engages studs w^2 projecting to opposite sides from the slide w. These studs are on an axis considerably beneath the middle line of the arm W, so that the axis is adjustable in a direction tangential to the axis of the shaft V′, the purpose being to insure that the adjustment of the table shall not affect its elevated or blank-holding position. Hence the line of this adjustment is approximately a level line when the table is elevated, being shown exactly level in the position of Fig. 13. Considerable variance is permissible in the exact angle of this line of adjustment, provided the adjustment does not carry the toggles X X′ outside (or materially so) of the degree of deflection (substantially that indicated in Figs. 13 and 14), which keeps the table-operating toggles Z Z′ vertically alined. Hence the effective length of the arm W may be adjusted to vary proportionally the rise and fall of the table without affecting the uppermost position of the table, and hence without affecting the grip upon the blank exerted between the blank holding surfaces. The extreme adjustment is that indicated by the dotted line t' in Fig. 13, and by the heavy dotted lines in Fig. 12, this adjustment diminishing the descent of the table to the extent shown by the latter lines, so that the lowest point instead of being at 9 is at 16 in this figure. The modification of the path of movement of the table is shown by the heavy dotted line in the diagram Fig. 15.

The blank holder, die and punch, will of course have any proportions necessitated by the work being done, and will be supported either directly upon their respective supports or through any required intermediate spacing pieces or bolsters, as is the well understood practice. As the table rises to an invariable height, the space between it and the equalizing ring or swivel plate E must be sufficient to receive the die and blank holder for the longest shell to be drawn; for shorter shells the space may be filled or nearly so by interposing spacing pieces, or bolsters, as shown in Fig. 16, which shows

the drawing of a shell of maximum diameter and minimum length from a flat blank. Such use of spacing bolsters avoids the necessity for excessive adjustment of the blank-holder frame F for each different new die and blank-holder. The punch plunger H requires to be adjusted vertically to accommodate the different lengths of punch to be used, and with reference to the lowermost position of the punch, at the end of each draw. Figs. 5 and 16 show two adjustments for punches of widely varying lengths.

For adjusting the blank-holder equalizing-ring to different heights, the blank-holder frame F is made vertically adjustable, preferably by externally threading it and providing it with screwthreaded clamping rings or nuts f beneath and f' above. By turning these rings the frame or cylinder F may be propelled up or down, being held from rotation in any suitable manner. When adjusted to the desired height, either of the rings is rotated sufficiently to clamp the frame F fast, thus serving as a lock nut. The rings f f' may be turned in any convenient way, as for example by the means shown in Fig. 5, comprising pinions e e' meshing with the respective rings, mounted on a single shaft e^2 which may be turned by a key or crank. To enable one screw ring to be turned independent of the other for clamping and unclamping the frame F, one of these pinions must be separable from its shaft, as for example the pinion e', which is shown as fastened by a removable pin, cotter or set-screw e^3 so that on disconnecting this it may be independently rotated. The vertical adjustments of the punch plunger H may be made in similar manner. This plunger is a screwthreaded shaft passing freely through the bore of the lower member I of the punch-carrying cross-head, being splined thereto to prevent rotation. Adjusting nuts i and i' engage the plunger and turn in recesses formed in the member I. These nuts also may be turned in any suitable manner, and because of their inaccessibility it is necessary to provide special mechanism for turning them. A suitable mechanism is that shown in Fig. 17, wherein the nuts and gear teeth are engaged respectively by pinions h h' on a vertical shaft h^2 which is carried by the members I J of the punch slide, and which shaft may be turned by a crank or gearing in any convenient way. One of the pinions h or h' must be detachably connected so that one of the nuts may be turned independently of the other for unclamping the plunger H before adjustment and reclamping it fast after adjustment, for which purpose any suitable clutch h^3 may be provided. In order that the lower nuts f and i may carry the weight of the parts engaged by them, they are held in place by flanges or rings f^2 and i^2 respectively, these rings being fastened in place to inclose the respective nuts.

The punch plunger H is made as short as possible consistent with the range of vertical adjustment necessary, and to carry it with the unmost possible firmness, it is supported as described in the extension member I, and therefore considerably beneath the cross head proper J. This extension I makes a sliding fit with the bored interior of the blank-holder frame F, whereby it is accurately guided and the punch firmly centered. When the punch plunger has to be adjusted to a considerable downward projection from the member I, it may be further supported by introducing temporarily a strut or brace piece, this being especially desirable when the punch is of large diameter. In Fig. 16 a vertically depending strut or reinforce shell c', has been introduced, projecting beneath the member I and engaging the top of the punch, so as to steady a punch of large diameter against any tipping tendency due to the excessive pressure on one side, or any lateral dragging effect due to an uneven grip upon the blank, or other cause.

The cross head J is preferably of arch form as shown, to best transmit the downward pull of the rods S S against the upward resistance or reaction of the central punch plunger H. This arched form permits of forming within it a central chamber J' (Fig. 4) of sufficient height to permit the extreme upward adjustment of the punch plunger without necessitating that it pass up through the top of the cross head, so that the upper flange d of the cross-head is kept imperforate and of maximum strength. The central thrust or reaction of the plunger is transmitted to the cross-head through the extension member I, which has a coned body portion whereby the thrust is transmitted outwardly and distributed to the cross-head, thereby enabling the latter to be made of considerably less weight than would be required if the same punch pressure were applied to it at its middle as heretofore.

For removing the drawn shells by lifting them out upwardly, it is common to use a stationary knock-out which as the table descends stops the shell and holds it so that it is pushed out of the die by the descent of the table. This knock-out is shown at g (Figs. 4 and 5) and consists of a plate held on a vertically adjustable column g' supported on a cross bar g^2 which at its ends is detachably connected to the side frames. When it is desired to remove the drawn shell from beneath the table, it is necessary to detach and take out the knock-out.

The press may be driven in any suitable way, but preferably it is provided with a variable speed gear between the crank shaft and the source of power. This is best shown

in Fig. 2, where k is the driving shaft to which power is applied in any suitable way, as for example by a belt on a pulley k', a fly-wheel k^2 being preferably applied and the power transmitted through a clutch l of any suitable type, its driving member being fixed to the shaft k, and its driven member sleeved thereon with a pinion l' driving a gear l^2 on a secondary shaft n, which in turn drives a third shaft o, which in turn through pinion o' and gear o^2 drives a fourth shaft q, which has pinions q' meshing with the two gear wheels P′ on the main or crank shaft P. The speed change gears are shown as introduced between the shafts n and o, the former carrying any suitable number (three being shown) of pinions n', and the latter a corresponding number of gear n^2, the respective pinions and gears being in different speed ratios, and either the pinions or gears being adjustable along the shaft in order to bring one or other of them into mesh according to the speed desired, this being in itself a common and well known arrangement of speed changing gear. The speed ratio may be so varied as to impart to the punch the maximum permissible speed with a uniform speed of the motor, or it may be varied to avoid excessive driving torque with heavy loads, or to operate the press at the maximum speed within the power of the motor.

The swinging lever R is preferably not pivoted to the upright frame of the press, for the reason that the stresses upon its pivot during the drawing movement of the punch are exerted in an obliquely upward and backward direction, the angle varying during the punch stroke and having, especially in the earlier part of the movement, sufficient of a rearward component to exert an undesirable bending stress against the upright frames, such as might spring the upright frames enough to throw the blank-holder out of line. For carrying this stress, we provide a special frame or frames consisting of posts or struts u u' and tie bars v v which converge at the fulcrum studs R′ and diverge to fixed connections with the heavy base A. The posts u u' for each lever are arranged on opposite sides of the gear wheel P′ and are connected by a stirrup plate u^2 bridging the gear wheel and having upwardly projecting ears coinciding with the terminal ears of the links v v and embracking the fulcrum stud R′. The ties v are arranged in pairs so as to balance the stress, and the lever R works between them.

The crank shaft P is preferably located as shown to the rear of the center of the press, for several reasons. This location facilitates the essential arrangement of the crank axis relatively to the long arm of the lever R, whereby the quick return stroke of the punch is secured. It also removes the shaft P from beneath the table where its presence would prevent the removal of pressed-through shells from beneath, as is sometimes desirable. Its rearward location also brings its bearings to the exterior of the frame, where the shaft, bearings, cranks and gearing are readily accessible for inspection, adjustment and repair.

The interposition of the levers R for communicating motion from the cranks to the punch cross head, accomplishes a triple purpose:—(1) by the described co-relation between the crank and the arc described by the long arm of the lever, the quick return stroke of the punch is attained as already described; (2) the levers provide for the adjustment of the punch stroke, as already described; (3) the levers enable the crank shaft to be located at the rear of the machine, thus attaining the advantages stated.

It is desirable to make the rear toggle shaft y in two sections, as best shown in Fig. 10, each section having its own bearings, and each formed integrally with one of the crank arms y' and one of the toggle arms z. The two shaft sections are united by a crank pin y^2 (Fig. 4) forming the joint between the arms y' and link x'. This construction facilitates the assembling of these parts.

The arrangement of the table-operating parts partly inside or between the arms and partly outside, is advantageous. The outside arrangement of the toggles T T′ and connecting rod a and their relation to the crank circle, permit the table-operating mechanism to take motion from the crank pin p on this side of the press, so that the same crank pin serves both for the punch motion and the table motion, and avoids the necessity of cranking the shaft P. While it is necessary to duplicate the punch-operating mechanism so as to carry the stresses symmetrically on opposite sides of the frame, this is not necessary with the table-operating mechanism, except for the toggles directly supporting the table, which are placed between the upright frames as usual. A certain amount of spring is admissable and even desirable in the first toggles T T′ and U U′, any spring in these or in the arm V and shaft V′ having no effect to impair the symmetry of the forces which lift and sustain the table, since the final toggles receive their motion from the middle of the shaft V′, where it is preferably stiffened by the prolonged and heavy hub W′. It results that between this hub W′ and the table the transmission is nearly rigid, while between this hub and the source of motion at the crank pin p a relatively considerable elasticity is permitted.

It is within our invention to locate the crank shaft P in other positions than shown, for example directly beneath the center of the press, as indicated in the diagram Fig. 18. This involves a rearrangement of the

levers R whereby their respective arms are brought more nearly into line, the pivotal connection *s* with the rods S being substantially intermediate of the fulcrum R′, and the joint engaging the connecting rods Q. The essential relation between the circle described by the crank center and the arc described by the long arm of the lever, whereby the quick return stroke of the punch is secured, is thus unchanged.

The adjustment of the effective length of the lever R need not necessarily be along a radial line, and for some purposes it may be preferable to make it along a tangential line, as shown for example in Fig. 19. The tangent may be such that the lower position of the punch-carrying slide may be unaffected by the adjustment of the punch stroke.

The particular press illustrated is designed to sustain a blank-holding pressure amounting to six hundred tons and a drawing or punch pressure of six hundred tons, making a total die-pressure carried by the table, of twelve hundred tons. These figures are given only as illustrative, as the invention is adapted to a wide range of sizes and pressures.

It must not be inferred from the particularity of detail with which we have described the preferred embodiment of our invention, that we are by any means to be limited thereto, since our invention is susceptible of a wide degree of modification within the skill of the engineer or constructor, and with reference to the particular work the machine is in any instance designed to perform. The features of our invention which are believed to be novel are defined in the claims terminating this specification.

We claim as our invention:—

1. In a drawing press, the combination with a reciprocating slide for carrying the punch, a reciprocating blank-holding table, and driving mechanism for said slide and table, of adjusting means for varying the stroke of said punch-carrying slide and of said table.

2. In a drawing press, the combination with a reciprocating slide for carrying the punch, and driving mechanism for said slide, of adjusting means for varying the stroke of said slide.

3. In a toggle drawing press, the combination with the reciprocating blank-holding table and driving mechanism therefor, of adjusting means for varying the stroke of said table.

4. In a toggle drawing press, the combination with a reciprocating slide for carrying the punch, of positive driving mechanism for said slide adapted to reciprocate the slide more rapidly on its return or idle stroke than on its working stroke.

5. In a drawing press, the combination with a reciprocating slide for carrying the punch, a reciprocating blank-holding table, and driving mechanism for said slide and table, of adjusting means for varying the stroke of said punch-carrying slide and of said table, and speed varying mechanism whereby when the drawing speed is changed by a punch stroke adjustment it may be compensated for by a speed adjustment to restore or partially restore the normal drawing speed.

6. In a drawing press, the combination with a reciprocating slide for carrying the punch, and driving mechanism for said slide, of adjusting means for varying the stroke of said slide, and speed varying mechanism whereby when the drawing speed is changed by a punch stroke adjustment it may be compensated for by a speed adjustment to restore or partially restore the normal drawing speed.

7. In a drawing press, the combination with a reciprocating slide for carrying the punch, and driving mechanism for said slide, of adjusting means for varying the stroke of said slide comprising a lever and means for varying the effective length thereof.

8. In a drawing press, the combination with a reciprocating slide for carrying the punch, and driving mechanism for said slide, of adjusting means for varying the stroke of said slide comprising a lever, a driving crank for rocking said lever, and a connection between said lever and slide, with means for varying the effective length of said lever.

9. In a drawing press, the combination with a reciprocating slide for carrying the punch, and driving mechanism for said slide, of adjusting means for varying the stroke of said slide comprising a lever, a driving crank for rocking said lever, and a connection between said lever and slide, with means for varying the effective length of said lever by adjusting the distance of such connection from the fulcrum of the lever.

10. In a drawing press, the combination with a reciprocating slide for carrying the punch, and driving mechanism for said slide, of adjusting means for varying the stroke of said slide comprising a lever and means for varying the effective length thereof consisting of a pivotal stud and means for adjusting the same to varying distances from the fulcrum of the lever.

11. In a drawing press, the combination with a reciprocating slide for carrying the punch, and driving mechanism for said slide, of adjusting means for varying the stroke of said slide comprising a lever and means for varying the effective length thereof, said lever formed with a slideway, a piv-

otal stud adjustable in said slideway, and means for fastening said stud in position after adjustment.

12. In a drawing press, the combination with a reciprocating slide for carrying the punch, and driving mechanism for said slide, of adjusting means for varying the stroke of said slide comprising a lever formed with a slideway, a pivotal stud adjustable in said slideway, and a key for fastening said stud after adjustment.

13. In a drawing press, the combination with a reciprocating slide for carrying the punch, and driving mechanism for said slide, of adjusting means for varying the stroke of said slide comprising a lever formed with a slideway, a pivotal stud adjustable in said slideway, and a wedge for tightening said stud in said slideway after adjustment.

14. In a drawing press, the combination with a reciprocating slide for carrying the punch, and driving mechanism for said slide, of adjusting means for varying the stroke of said slide, comprising a lever, a connecting rod, and a pivotal stud uniting them, said stud adjustable toward or from the fulcrum of the lever and having an enlarged head, and a connecting rod formed with a stirrup having an enlarged opening to admit such head, and a filling piece for closing said opening.

15. In a drawing press, the combination with a reciprocating slide for carrying the punch, of driving mechanism for said slide comprising a crank and connecting rod, the crank arranged to operate at a greater mechanical advantage during the working stroke of the punch and at a lesser advantage during the idle or return stroke thereof.

16. In a drawing press, the combination with a reciprocating slide for carrying the punch, of driving mechanism for said slide comprising a crank, a lever oscillated thereby, and a connecting rod connected to said lever relatively arranged to operate at maximum mechanical advantage during the working stroke of the punch, and at minimum advantage during the idle stroke thereof, whereby the punch is given a relatively rapid return movement.

17. In a toggle drawing press, the combination with the reciprocating blank-holding table and driving mechanism therefor, of adjusting means for varying the retractile stroke of said table without affecting its blank-holding position.

18. In a toggle drawing press, the combination with the reciprocating blank-holding table, of driving mechanism therefor comprising a lever arm through which motion is communicated to the table-operating toggles, and means for adjusting the effective length of said lever arm to vary the stroke of the table.

19. In a toggle drawing press, the combination with the reciprocating blank-holding table, of driving mechanism therefor comprising a lever arm through which motion is communicated to the table-operating toggles, and means for adjusting the effective length of said lever arm to vary the stroke of the table, such adjustment being in such direction as not to alter the effective position of said toggles when straightened, whereby the blank-holding position of the table is not varied.

20. In a toggle drawing press, the combination with the reciprocating blank-holding table, of driving mechanism therefor comprising a crank, toggles connected to said crank to be buckled thereby during one semi-revolution and vibrated thereby to opposite sides of their alined position during the second semi-revolution, a second pair of toggles vibrated by the first with a diminished amplitude of movement during such second semi-revolution, a third pair of toggles vibrated from the second, and the final or table-operating toggles vibrated from such third toggles, said parts operatively related to essentially eliminate the motion of said final toggles and hold the table stationary during approximately said second semi-revolution, thereby insuring a blank holding dwell approximating 180 degrees of the rotation of said crank.

21. In a toggle drawing press, the combination with parallel side frames and a reciprocating blank-holding table moving between said frames, of driving mechanism therefor comprising a crank, successive toggles interposed between said crank and table, the primary toggles and their connection with said crank arranged outside said frames, the final or table-operating toggles arranged between said frames, and a rock shaft extending partly outside and partly between said frames for communicating motion between said outside toggles and said final or inside toggles.

22. In a toggle drawing press, the combination with parallel side frames and a reciprocating blank-holding table moving between said frames, of driving mechanism therefor comprising a crank, successive toggles interposed between said crank and table, the primary toggles and their connection with said crank arranged outside said frames, the final or table-operating toggles arranged between said frames, a rock shaft extending between said frames receiving motion from said primary toggles and having a lever arm with means for adjusting its effective length, and a connection from said arm to said final or inside toggles.

23. In a toggle drawing press, the combination with the reciprocating blank-holding table, of table-operating toggles therefor arranged in pairs, those of one pair con-

nected to an integral rock shaft, and those of the other pair connected to a parallel rock shaft divided into two sections, a crank pin uniting said sections, and a parallel link communicating motion between said shafts, engaging said crank pin on the divided shaft and a corresponding crank pin on the integral shaft, and driving mechanism for operating said toggles.

24. In a toggle drawing press, the combination with a reciprocating slide for carrying the punch, a reciprocating blank-holding table, a driving shaft having cranks, connections between said cranks and the punch-carrying slide, toggles for operating the blank-holding table, and a connection between one of said cranks and said toggles.

25. In a toggle drawing press, the combination with a reciprocating slide for carrying the punch, and parallel side frames, of a main shaft having cranks, and connections therefrom to said slide, said shaft located out of line with and exterior to said side frames.

26. In a drawing press, the combination with parallel side frames, a reciprocating slide for carrying the punch, and a reciprocating blank-holding table moving between said frames, of an operating shaft for driving said slide and table located to one side of said frames.

27. In a drawing press, the combination with parallel side frames, a reciprocating slide for carrying the punch, and a reciprocating blank holding table moving between said frames, of an operating shaft for driving said slide and table, mounted transversely of and to the rear of said side frames.

28. In a drawing press, the combination with parallel side frames, a reciprocating slide for carrying the punch, and a reciprocating blank holding table moving between said frames, of an operating shaft for driving said slide and table, mounted transversely of the side frames and in rear of the path of movement of the table.

29. In a drawing press, the combination with parallel side frames, a reciprocating slide for carrying the punch, an operating shaft, and connections between said shaft and slide comprising a rock lever, of a bearing frame for said rock lever distinct from said side frames.

30. In a drawing press, the combination with a base and upright parallel side frames, of a reciprocating slide for carrying the punch, an operating shaft, connections between said shaft and slide comprising a rock lever, and an independent frame for receiving the fulcrum thrust of said lever, connected to said base and independent of said side frames.

31. In a drawing press, the combination with a base and upright parallel side frames, of a reciprocating slide for carrying the punch, an operating shaft, connections between said shaft and slide comprising a rock lever, and an independent frame for receiving the fulcrum thrust of said lever, comprising a bearing stirrup for the fulcrum stud, posts connecting it with the base, and tension stays connecting it with said base.

32. In a drawing press, the combination with parallel side frames, a punch-carrying slide, a punch-plunger adjustable in said slide, a punch carried on said plunger, and a reinforce attached to the slide for steadying the punch.

33. In a drawing press, the combination with parallel side frames, of a reciprocating cross head sliding therein, an extension piece carried by said cross head, and an adjustable punch plunger carried in said extension piece.

34. In a drawing press, the combination with parallel side frames, of a reciprocating cross head sliding therein, having a closed top member and a deep central recess within said cross head beneath said member, and a punch plunger projecting beneath and fastened to said cross head, longitudinally adjustable with relation thereto and adapted when adjusted upwardly to enter said recess.

35. In a drawing press, the combination with parallel side frames, of a reciprocating cross-head sliding therein, a slide carried beneath said cross-head, a punch plunger adjustably connected to said slide, and adjusting means for propelling said plunger up or down in said slide.

36. In a drawing press, the combination with parallel side frames, of a punch-carrying slide, a screwthreaded punch plunger carried by said slide, an adjusting nut for said plunger seated in said slide, and means for turning said nut to adjust the height of said plunger relatively to said slide.

37. In a drawing press, the combination of parallel side frames, a punch-carrying slide, a threaded punch plunger adjustably connected to said slide, an adjusting nut carried by said slide and engaging threads of said plunger, a clamping nut therefor, and adjustable means for turning said nuts either simultaneously to adjust said plunger or dissimultaneously to clamp the same fast.

38. In a drawing press, a stationary framework, an adjustable blank-holder frame carried thereby, and a reciprocating punch-carrying slide comprising a cross head, and an extension thereof entering and guided by said blank holding frame.

39. In a drawing press, a fixed framework, a tubular blank-holding frame, and a reciprocating punch-carrying slide comprising a cross head overlying said blank holding frame, and a cylindrical extension therefrom entering and guided by said blank holding frame.

40. In a drawing press, parallel side frames and a reciprocating punch-carrying slide comprising a cross-head, an adjustable punch plunger, and an intervening extension piece in which said plunger is seated and which communicates the thrust thereof to said cross head.

41. In a drawing press, parallel side frames and a reciprocating punch-carrying slide comprising a cross-head, an adjustable punch plunger, and an intervening extension piece having a seat for said plunger, with an adjusting nut socketed therein, and said extension piece formed as a conical shell expanding outwardly to its junction with said cross head to transmit and distribute the thrust symmetrically thereto.

42. In a drawing press, a framework comprising a transverse frame, combined with a blank-holder frame adjustably seated therein and externally threaded, an internally threaded ring for adjusting said frame, and a similar ring for clamping said frame, and an adjusting means engaging said rings and adapted to rotate them either simultaneously to adjust said frame or dissimultaneously to clamp it fast.

In witness whereof, we have hereunto signed our names in the presence of two subscribing witnesses.

WILLIAM KLOCKE.
FREDERICK ORTON.

Witnesses:
F. C. FLADD,
G. L. JOHNSEN.