(No Model.)

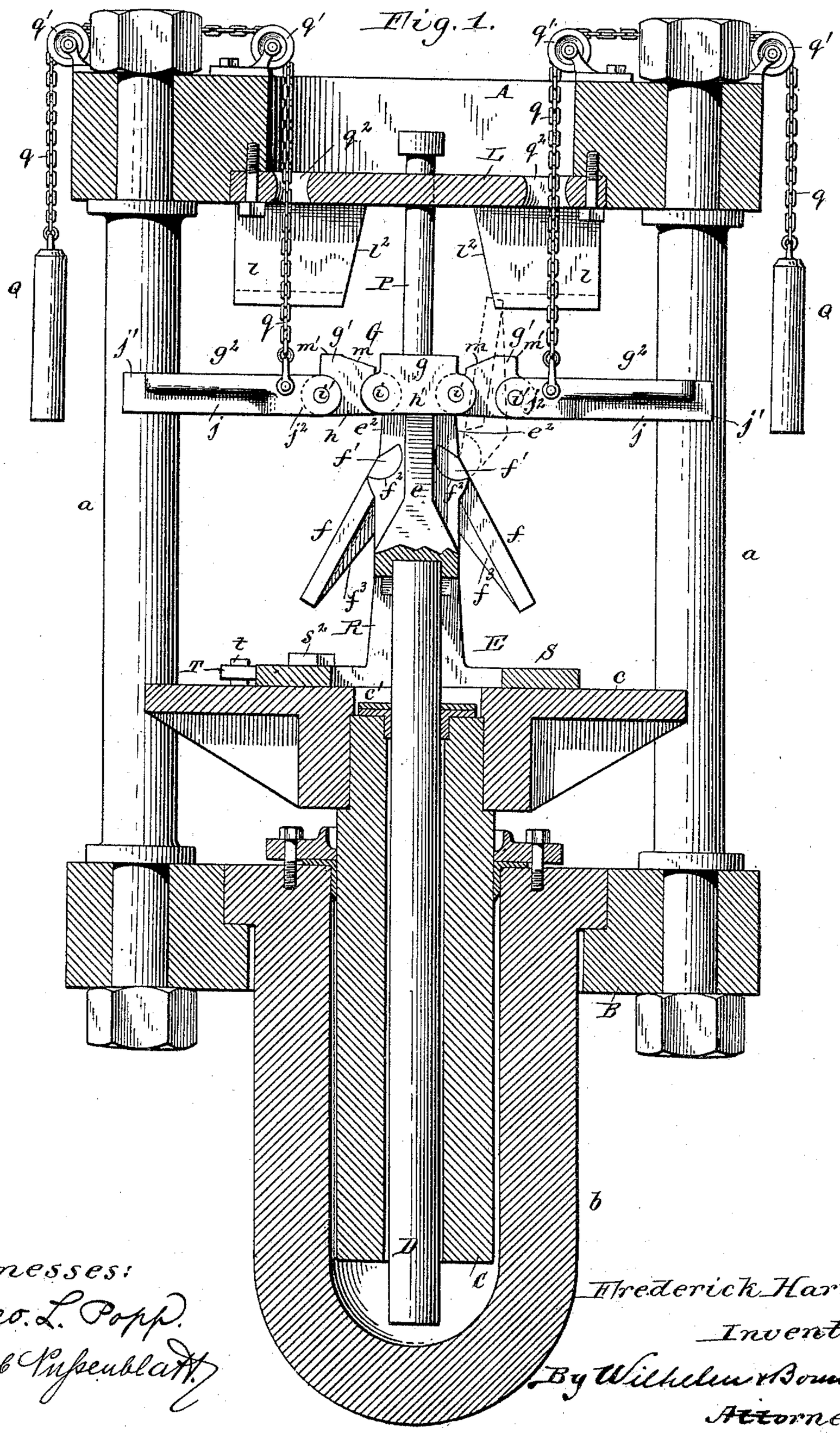
4 Sheets—Sheet 1.

F. HART.

MACHINE FOR BENDING CRANK SHAFTS.

No. 495,631. Patented Apr. 18, 1893.

Fig. 1.



Witnesses:
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Jacob Pfisenblatt.

Frederick Hart,
Inventor.
By Wilhelm & Bonner,
Attorneys.

(No Model.)

4 Sheets—Sheet 2.

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Fig. 2.

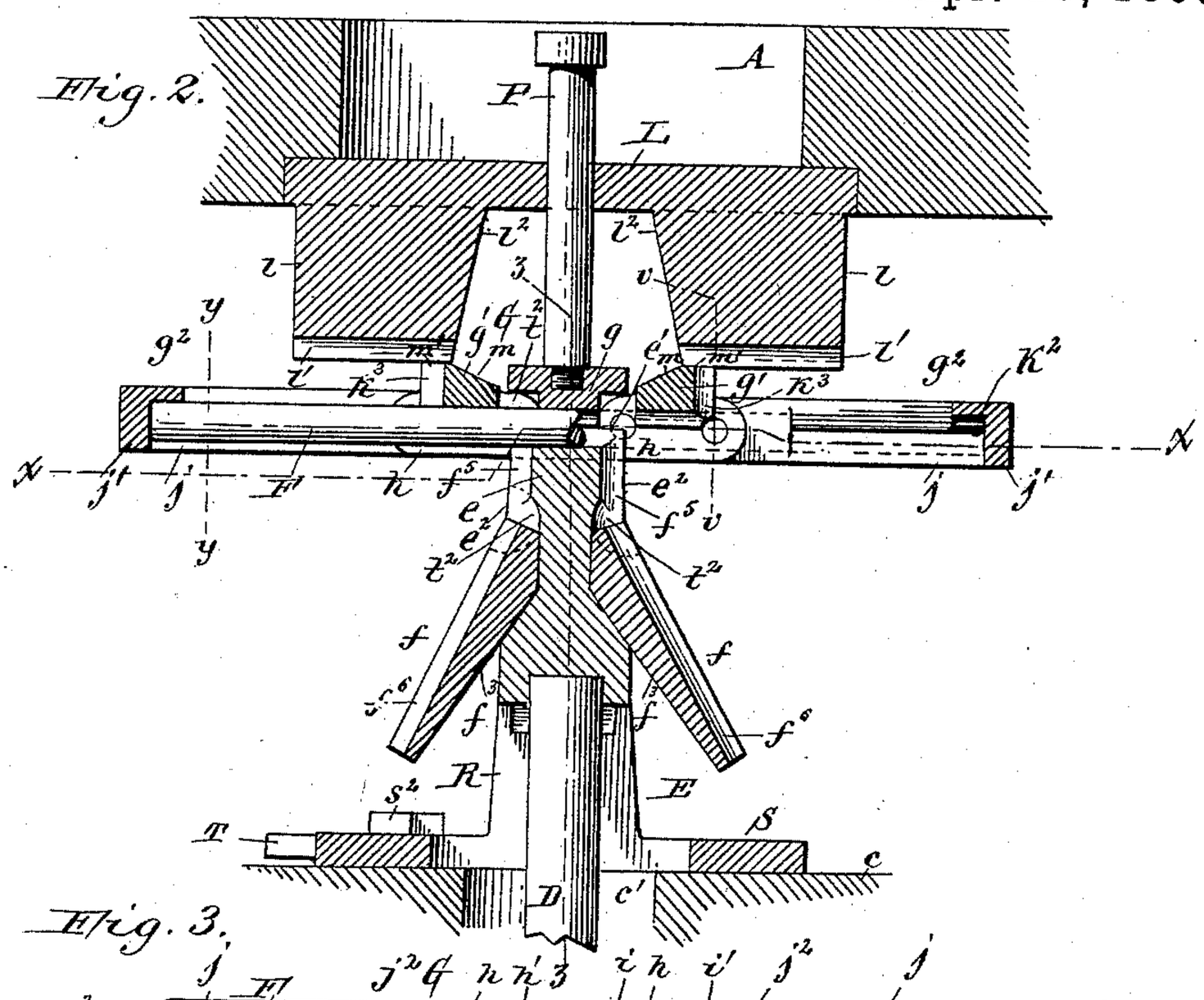


Fig. 3.

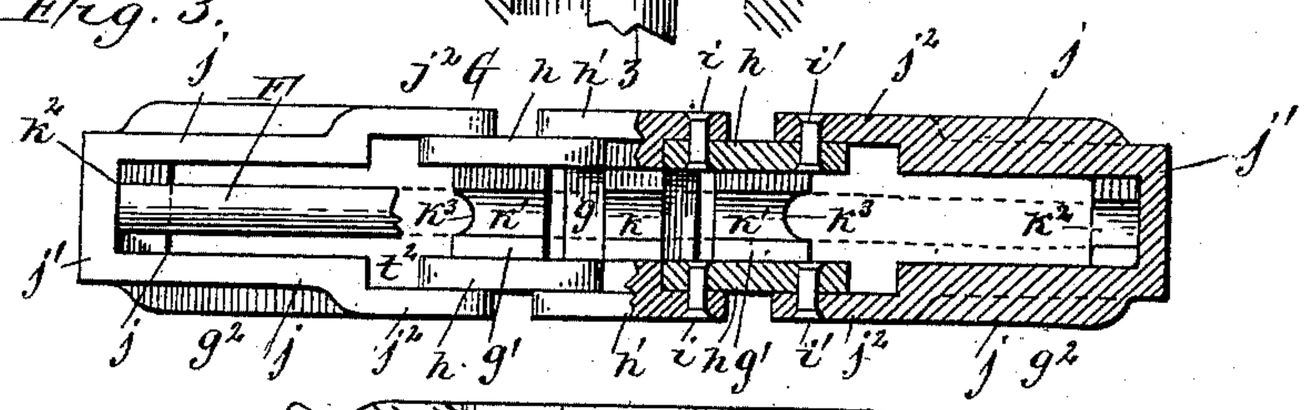


Fig. 4.

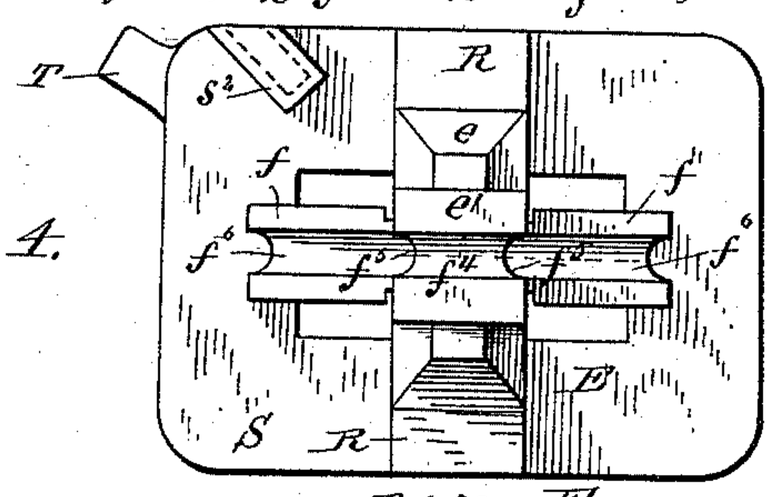


Fig. 5.

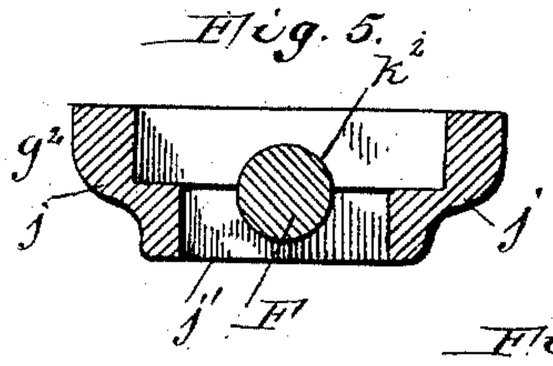


Fig. 6.

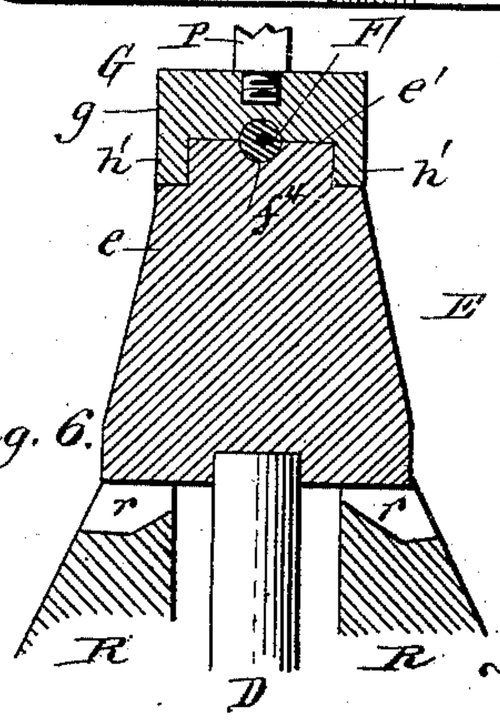
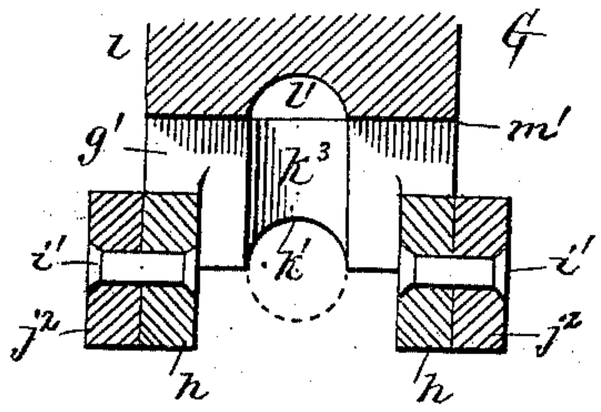


Fig. 7.



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4 Sheets—Sheet 3.

F. HART.

MACHINE FOR BENDING CRANK SHAFTS.

No. 495,631. Patented Apr. 18, 1893.

Fig. 8.

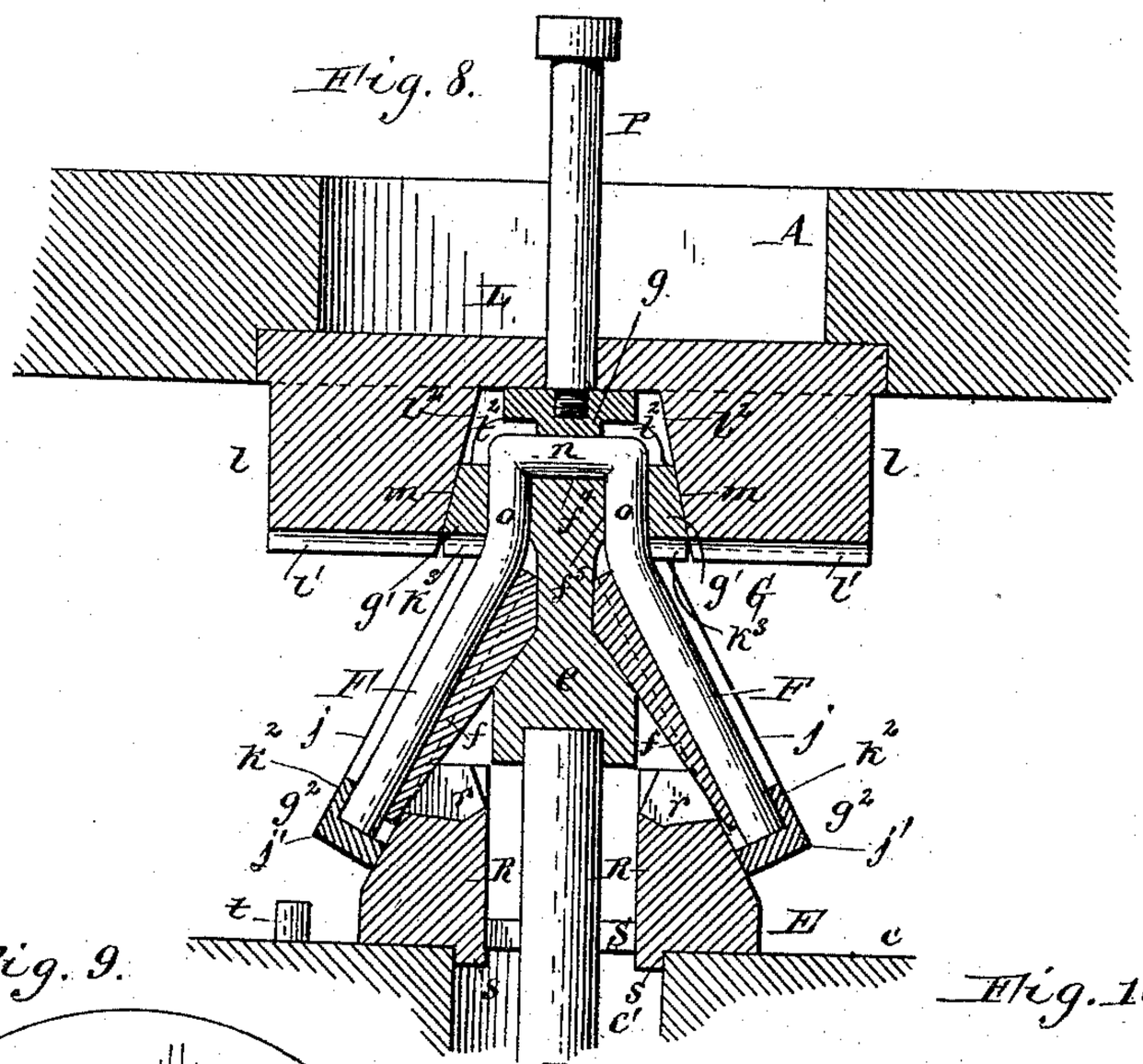
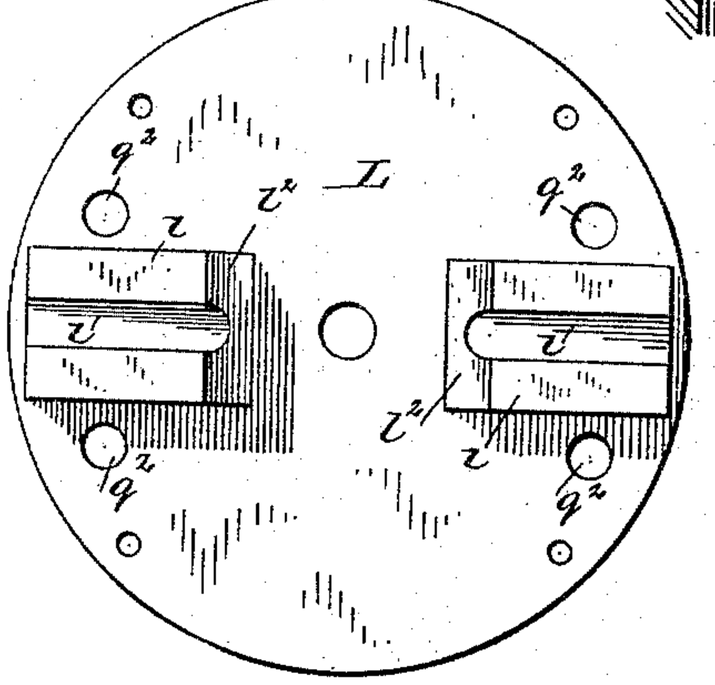


Fig. 9.

Fig. 10.



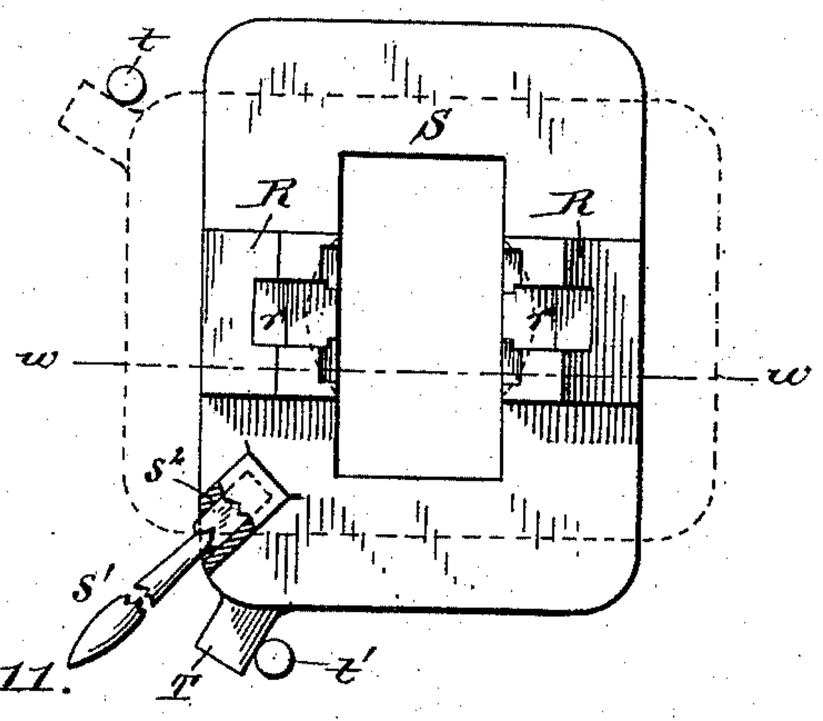
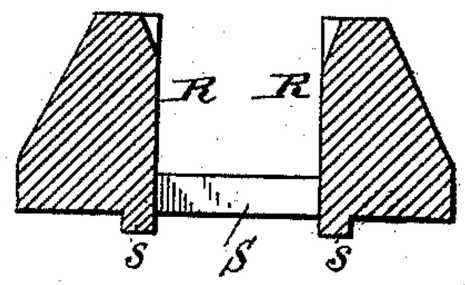


Fig. 11.



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(No Model.) 4 Sheets—Sheet 4.

F. HART.

MACHINE FOR BENDING CRANK SHAFTS.

No. 495,631. Patented Apr. 18, 1893.

Fig. 12.

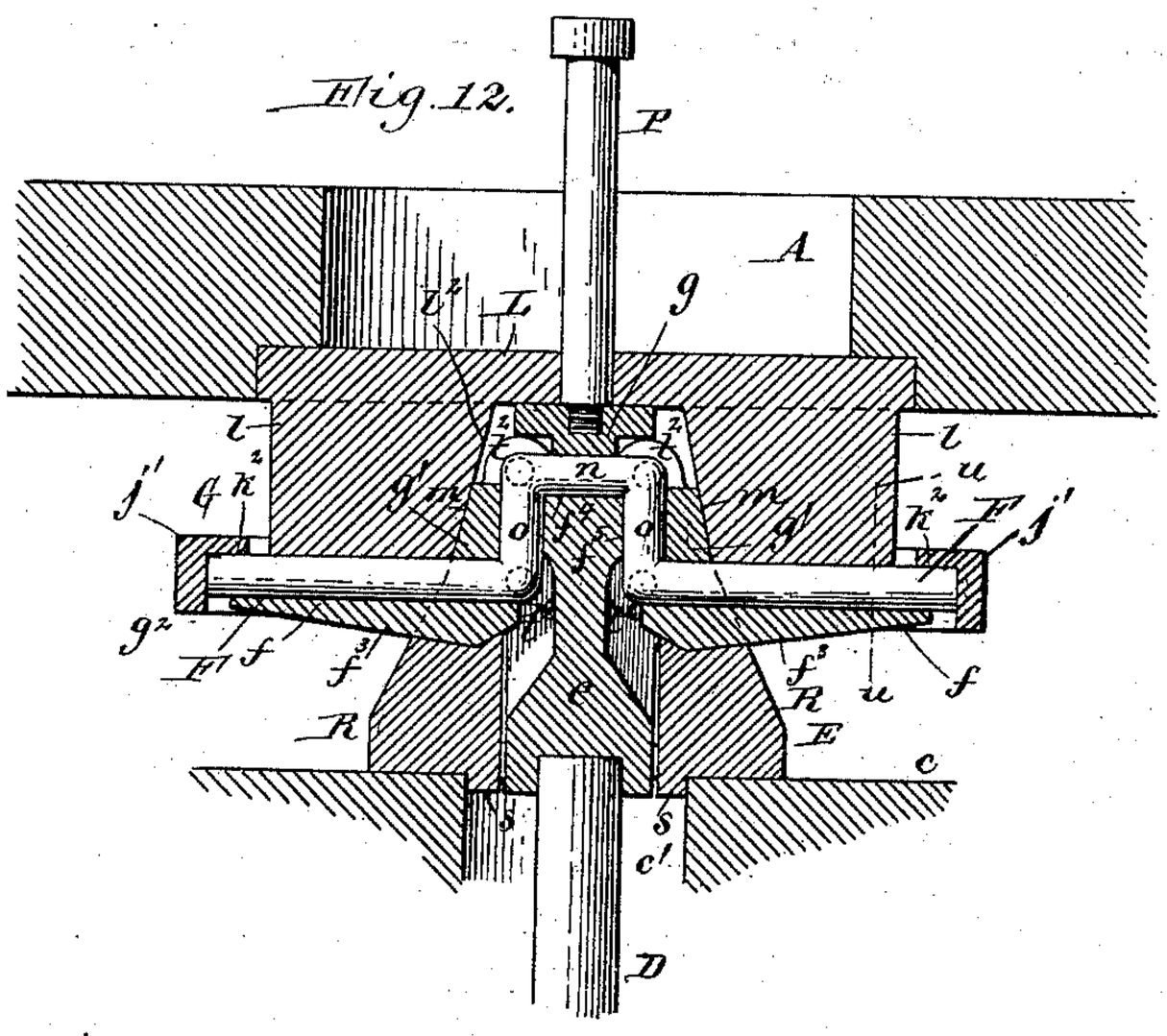


Fig. 13.

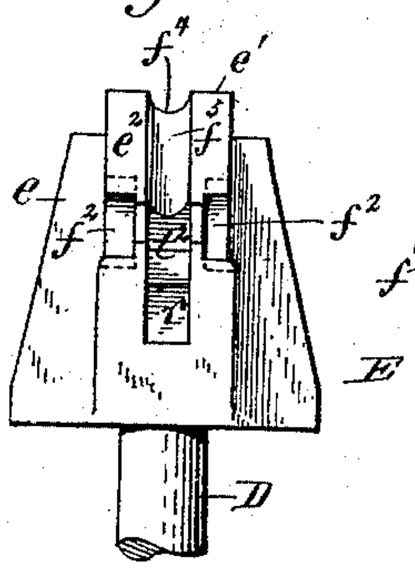


Fig. 14.

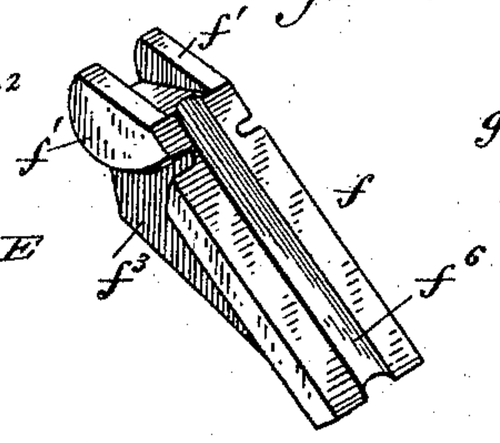


Fig. 15.

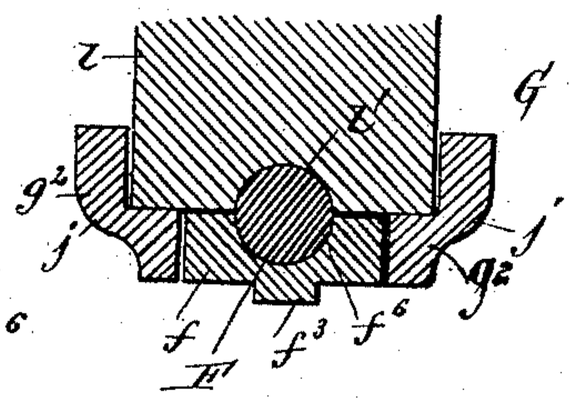
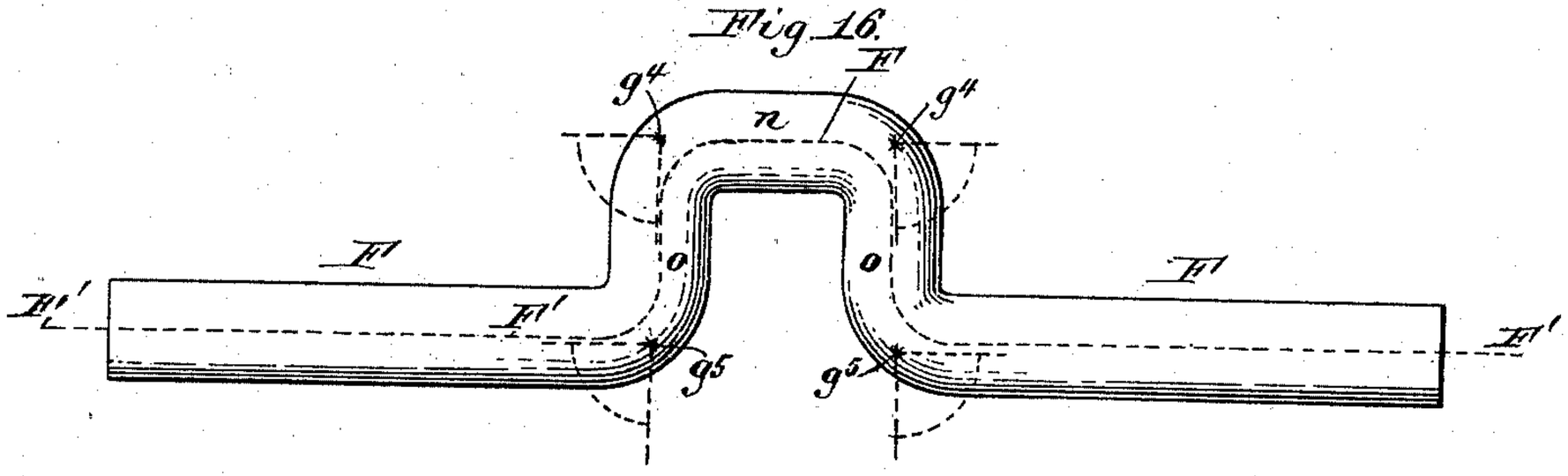


Fig. 16.



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UNITED STATES PATENT OFFICE.

FREDERICK HART, OF POUGHKEEPSIE, ASSIGNOR TO D. H. BURRELL & CO., OF LITTLE FALLS, NEW YORK.

MACHINE FOR BENDING CRANK-SHAFTS.

SPECIFICATION forming part of Letters Patent No. 495,631, dated April 18, 1893.

Application filed May 29, 1891. Serial No. 394,543. (No model.)

To all whom it may concern:

Be it known that I, FREDERICK HART, a subject of the Queen of Great Britain, residing at Poughkeepsie, in the county of Dutchess and State of New York, have invented a new and useful Improvement in Machines for Bending Crank-Shafts, of which the following is a specification.

This invention relates to a machine for bending crank shafts and other bars or rods requiring short bends and has the object to bend such shafts, rods or bars readily and without stretching the metal or reducing the cross sections at the bends.

In the accompanying drawings consisting of four sheets:—Figure 1 is a sectional elevation of my improved machine for forming crank shafts. Fig. 2 is a sectional elevation of the upper portion of the machine showing the shaft and dies in position preparatory to effecting the preliminary bending of the shaft. Fig. 3 is a horizontal section of the upper die, in line *x*—*x*, Fig. 2, looking upward. Fig. 4 is a top plan view of the lower die and connecting parts. Figs. 5, 6 and 7 are vertical transverse sections in lines *y*—*y*, *z*—*z* and *v*—*v*, Fig. 2, respectively. Fig. 8 is a sectional elevation of the upper portion of the machine showing the position of the dies after the preliminary bending of the crank has been effected. Fig. 9 is a bottom plan view of the stationary portion of the upper die. Fig. 10 is a top plan view of the ram heads and supporting plate whereby the lower die is actuated. Fig. 11 is a transverse sectional elevation of the ram heads in line *w*—*w*, Fig. 10. Fig. 12 is a sectional elevation of the upper portion of the machine showing the position of the dies when the bending of the crank on the shaft is completed. Fig. 13, is a side elevation of the central section of the lower die. Fig. 14 is a perspective view of one of the pivoted sections of the lower die. Fig. 15 is a vertical transverse section in line *u*—*u*, Fig. 12, showing the relation of the upper and lower dies with reference to the shaft during the final operation. Fig. 16 is an elevation of a crank shaft illustrating the manner of bending the same so as to swage and strengthen the metal at the bending points instead of stretching and weakening the metal.

Like letters of reference refer to like parts in the several figures.

A B represent the horizontal head and foot blocks respectively, of a hydraulic press, connected by vertical posts *a a*.

b represents the hydraulic cylinder, and C the outer ram arranged in this cylinder and provided at its upper end with a horizontal platen *c*.

D represents an inner ram arranged to move vertically in the outer ram, both rams being actuated by the same water pressure in the hydraulic cylinder in the usual manner for operating hydraulic presses containing double rams.

E represents the lower die attached to the upper end of the inner ram and adapted to move vertically therewith. This lower die is composed of a central holding section *e* and two bending arms or members *f f* pivoted to opposite sides of the central section *e*. Each of the arms *f* is pivoted to the central section of the lower die by means of two segmental ears *f′ f′* which engage in correspondingly shaped recesses f^2 f^2 formed in opposite sides of the central section. The ears of the arms *f f* are placed in engagement with the recesses in the central section by raising the arms into the position indicated in dotted lines in Fig. 1, and then lowering the same, as shown in full lines. During the operation of the machine these die arms *f f* are never raised to the position in which the ears *f′ f′* are introduced into the recesses f^2 f^2 and consequently cannot become disengaged from the body *e*. A very simple pivotal connection is thus established between the central section and the arms of the lower die. The downward movement of each die arm *f f* is limited by a longitudinally tapering rib f^3 which engages in a similarly shaped recess formed in the central section *e* of the lower die, adjacent to each die arm. The upper horizontal face *e′* and the vertical sides e^2 of the central section *e* of the lower die are provided with semi-circular grooves or channels f^4 f^5, respectively, which correspond to the shape of the lower side of the shaft F on which it is desired to form a crank.

f^6 represents grooves or channels formed in the outer side of each lower die arm *f* similar

to those formed in the central die section. The grooves in the central section and in the arms of the lower die connect with each other so as to form a bed or support for the lower side of the shaft F when arranged in line.

G represents the upper movable die which is composed essentially of a central holding section g, two intermediate bending sections $g' g'$, and two end holding sections $g^2 g^2$. Each of the intermediate sections $g' g'$, is provided on opposite sides with lugs $h h$ arranged with their inner ends between lugs $h' h'$ formed on opposite sides of the central section of the upper die and pivoted thereto by means of pins $i i$. Each of the end sections of the upper die is composed of two side bars $j j$ connected at their outer ends by a cross bar j', which latter bears against the end of the shaft. The outer ends of the lugs $h h$ of the intermediate sections are arranged between lugs $j^2 j^2$ formed on the inner ends of the side bars of the end sections and pivotally connected therewith by pins $i' i'$. The central section g of the upper die is provided in its lower face with a horizontal semicircular groove or channel k corresponding in shape to the upper side of the shaft which is to be bent. The intermediate sections are provided with grooves $k' k'$ similar to that in the central section of the upper die and the end sections $g^2 g^2$ are provided with similar short grooves $k^2 k^2$ in their end cross bars. The several upper die sections and their grooves $k k' k^2$ are adapted to engage over the upper side of the shaft preparatory to commencing the bending operation, as clearly represented in Fig. 2, a portion of the shaft F being broken away to expose the upper die.

k^3 represents a semi-circular groove or channel formed on the outer side of each of the intermediate upper die sections, which outer side stands vertically when the parts are in the position indicated in Fig. 2. These grooves k^3 are in line and at right angles to the grooves k' in the lower side of the intermediate die sections and are adapted to bear upon the upper side of the shaft during the final operation of bending the shaft as shown in Figs. 8 and 12.

L represents a supporting plate secured to the under side of the head block A.

$l l$ represent two stationary dies which are formed on the lower side of said plate and provided on their lower sides with semi-circular grooves $l' l'$, as represented in Fig. 9. These stationary dies are adapted to engage against the upper side of the shaft between the side bars of the end die sections and assist in holding the end portions of the shaft during the last operation of bending. The inner sides $l^2 l^2$ of the stationary dies converge upwardly and are adapted to engage with the inclined sides $m m$ of the intermediate sections, as the latter swing downwardly and pass upwardly between the stationary dies in forming the crank n and arms $o o$ on the shaft F, as shown in Fig. 8.

P represents a vertical rod secured to the upper side of the central upper die section. This rod passes upwardly through an opening in the supporting plate L whereby the upper die is guided in its vertical movements.

Q represents balancing weights secured to the end sections of the movable upper die by means of chains q, which pass over pulleys q' q' and through openings $q^2 q^2$ in the supporting plate L. The pulleys $q' q'$ are attached to the head block of the press or some other suitable support. The weights Q serve to balance the upper sectional die and render it more convenient in manipulating the parts of the machine when adjusting the upper die to the shaft.

R R represent two ram heads formed on a base plate S resting on the platen c. These ram heads are adapted to bear at first underneath the central section of the lower die and subsequently against the lower side of the pivoted arms of the lower die in order to raise the same in completing the bending of the shaft, as represented in Figs. 8 and 12. The ram heads are inclined on their outer sides to correspond to the angle of the lower sides of the lower die arms when in a resting position, as shown in Fig. 8. The tapering ribs f^3 of the lower die arms engage in correspondingly shaped recesses $r r$ formed on the upper sides of the ram heads whereby the lower die heads are held against lateral movement in being raised by the ram heads.

$s s$ represent two lugs formed on the under side of the base plate S and engaging against the inner side of a circular opening c' formed in the platen c. The lugs $s s$ enable the base plate and ram heads to be rotated concentric with the press cylinder.

In the position of the parts shown in Figs. 1, 2, 4 and 6, the ram heads bear against the lower side of the central section of the lower die, whereby the initial upward movement of the outer ram is utilized to raise the lower central die section in addition to the inner ram. When the inner ram and central section of the lower die mounted thereon have completed their upward movement the base plate and ram heads are revolved a quarter turn by means of a handle s' the end of which is placed in a socket s^2 formed on the base plate, as represented in Fig. 10. This brings the ram heads underneath the lower die arms and raises the same during the subsequent upward movement of the outer ram in completing the bending operation.

T represents a laterally projecting lug formed on the base plate and adapted to engage against stops $t t'$, formed on the platen, and limit the rotation of the base plate and ram heads in both directions.

The operation of bending a crank on a shaft is as follows: The straight heated shaft is placed with its wrist portion upon the horizontal face of the central section of the lower articulated die, which section forms the lower holding die. The upper articulated die is

drawn down by hand with its sections or members extended so that the semi-circular grooves k k' k^2 of its members will fit snugly against the upper side of the shaft and the end bars j' will fit snugly against both ends of the shafts, as shown in Figs. 1 and 2. The ram heads being arranged underneath the central section of the lower die, as represented in Fig. 6, both the inner and outer rams are raised simultaneously, and unite in carrying the movable dies and shaft upward until the outer ends m' m' of the intermediate or upper bending dies g' g' strike the inner ends of the stationary dies l l, as shown in Fig. 2. The continued upward movement of the rams carries the upper and lower holding dies g e upwardly between the two stationary dies until the upper holding die bears against the underside of the supporting plate L, as shown in Fig. 8. As the upper and lower holding dies are carried up between the stationary dies, the latter resist the further vertical movement of the upper bending dies and force their outer ends downwardly and inwardly. This downward and inward movement of the upper bending dies permits these parts to move upwardly between the stationary dies together with the holding dies. The upper bending dies in passing between the stationary dies engage with their inclined sides m m against the inclined inner sides l^2 l^2 of the stationary dies whereby the upper bending dies are wedged inwardly and caused to bend a portion of each end of the shaft downwardly at right angles or nearly so to its former position, whereby the crank arms o o are bent at both ends of the wrist portion n, as represented in Fig. 8. When the upper bending dies are forced downwardly and inwardly, the ends of the shaft and the end sections of the upper die are carried downwardly and inwardly until the lower side of the shaft rests in the semi-circular grooves in the outer sides of the pivoted arms of the lower die. In this position the end sections of the upper die inclose the lower die arms and the pivots of both are brought axially in line with each other, as shown in Fig. 8. When the parts are in this position the pressure on the rams is relieved so as to permit the ram heads on the base plate to be removed from underneath the lower holding die and rotated a quarter turn so as to bring them underneath the pivoted arms of the lower die. Pressure being again applied the inner ram will hold the holding dies firmly in place and the ram heads supported on the outer ram will raise the lower die arms, the ends of the shaft seated therein and the end sections of the upper die until the shaft engages snugly in the recesses formed in the stationary and pivoted dies, as represented in Fig. 12. The pivots of the lower die arms and the pivots of the end sections of the upper die being axially in line, these parts swing concentrically upward when acted upon by the ram heads, which render these parts practically a solid die and holds the ends of the shaft against lateral movement during the final bending operation. The open end sections of the upper die inclose the lower portion of the stationary dies in being carried upwardly with the ends of the shaft, as shown in Fig. 15, whereby the ends of the shaft are held firmly in place while the final pressure is applied to the ends of the shaft. This final operation bends the line portions of the shaft at right angles to the crank arms o o or parallel with the wrist n which completes the bending of the crank shaft. The completed crank shaft can be removed by lowering the lower die. Those portions of the sectional dies which would lie adjacent to the outer corners of the angles of the bent shaft are cut away, as shown at t^2 t^2, so as to allow a free outward movement of the metal in bending the angles which retains the metal in its original round shape so as to form full and solid corners. This is particularly desirable in short bends, as the pressure of the die is brought to bear on the shaft directly adjacent to the pivot of the die which enables an abrupt and short bend to be made, thereby avoiding flattening of the corners which tends to lengthen the shaft and weaken the crank. In order to upset or compact the crank shaft at the bending points and prevent decrease in thickness or strength, the pivots of the lower die arms and of the upper die sections are placed eccentrically with reference to the center line of the shaft or the central or neutral axis of the metal when the shaft is not round in construction. These eccentric pivots of the movable dies are preferably located at each bend diagonally outside of the center line or the axis of the metal of the finished crank shaft, as indicated in Fig. 16. In this figure F′ represents the center line of the shaft g^4 the pivotal points of the intermediate dies, and g^5 the pivotal points of the lower die arms and of the end sections of the upper dies. The pivoted dies describe a quadrant in bending the portions of the shaft at right angles to their former position and the portions of metal adjacent to the corners are upset or swaged. The closing of the dies shortens the center line of the shaft by reason of the eccentric arrangement of the pivots and as the metal flows easiest at the bends, where its particles are already in motion by reason of the bending, the displaced metal is principally driven into the bends where it serves to absolutely prevent drawing on the outside of the bend and so maintain the original thickness and strength of the shaft or increases the same. When the bend is comparatively long the pivotal centers of the die sections may be arranged in the center line of the shaft, bar or rod or in the axis of the metal thereof and the stretching or lengthening of the shaft and the reduction of its cross section at the bend or bends will be prevented as the ends of the shaft are securely held against spreading by the die sections.

I claim as my invention—

1. The combination with the upper and lower holding dies adapted to bear respectively against the upper and lower sides of the wrist, of the upper bending dies pivoted at the sides of the upper holding die, means whereby these pivoted dies are swung toward the sides of the lower holding die, thereby bending the crank arms against the sides of the lower holding die, lower bending dies pivoted at the sides of the lower holding die below the top thereof, and means whereby the lower bending dies are swung upwardly into line with each other, substantially as set forth.

2. The combination with the upper and lower holding dies adapted to bear respectively against the upper and lower sides of the wrist, of the upper bending dies pivoted at both sides of the upper holding die, means whereby these pivoted dies are swung toward the sides of the lower holding die, holding sections which are pivoted to the upper bending dies and which hold the ends of the shaft, lower bending dies pivoted at the sides of the lower holding die below the top thereof, and means whereby the lower bending dies are swung into line, substantially as set forth.

3. The combination with the upper stationary dies, of an upper and lower holding die movable toward and from said stationary dies, upper bending dies pivoted at the sides of the upper holding die and adapted to enter between the upper stationary dies, whereby said bending dies are swung toward the sides of the lower holding die, and lower bending dies pivoted at the sides of the lower holding die below the top thereof, substantially as set forth.

4. The combination with an upper and a lower holding die, a pair of bending dies pivoted to opposite sides of the upper holding die and adapted to bear on the upper side of the shaft, and a pair of bending dies pivoted to opposite sides of the lower holding die and adapted to bear against the under side of the shaft, of two stationary dies engaging with the upper pivoted bending dies, and two rams engaging with the lower pivoted dies whereby the pivoted dies are actuated, substantially as set forth.

5. The combination with the upper and lower holding dies, bending dies pivoted respectively to the upper and lower holding dies, and holding dies pivoted to the outer ends of the upper bending dies, of stationary dies engaging against the upper bending dies whereby the shaft is bent downwardly at opposite ends of the wrist portion to form the crank arms, and rams engaging against the lower bending dies whereby the shaft is bent upwardly to form the line portions, substantially as set forth.

6. The combination with the upper and lower articulated dies, of a plate provided with stationary dies adapted to bear against the upper articulated die, a rod secured to said upper die and passing through an opening in said plate, and a ram supporting the lower die, whereby both upper and lower dies are guided vertically, substantially as set forth.

7. The combination with the upper articulated die and a lower die having a central section supported on the inner ram and die arms pivotally secured to opposite sides of the central section, of an outer ram and two ram heads capable of rotation on the outer ram to engage alternately underneath the central section and the arms of the lower die, substantially as set forth.

8. The combination with the upper sectional die and a lower die having a central section and die arms pivotally secured thereto, of an outer ram having a circular opening at its upper end, a base plate provided with two ram heads and having depending lugs engaging in said opening, a lug formed on said base plate, and stops on said ram, whereby the base plate can be moved horizontally to bring the ram heads alternately in engagement with the central section and the arms of the lower die, substantially as set forth.

9. The combination with the upper sectional die and a lower die section having segmental recesses, of die arms having segmental ears engaging in said recesses, whereby a pivotal connection is formed between the said die section and the die arms, substantially as set forth.

Witness my hand this 23d day of May, 1891.

FREDERICK HART.

Witnesses:

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WILLIAM J. KENNEDY.