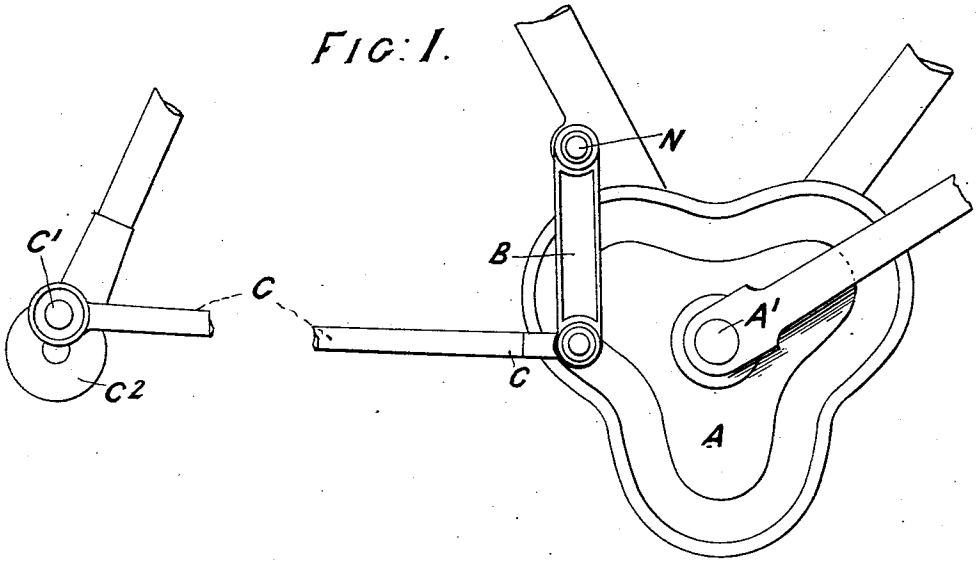
(No Model.) 5 Sheets—Sheet 1.

J. PRICE.

MACHINE FOR MANUFACTURING MULTIPLE THROW CAMS.

No. 564,800. Patented July 28, 1896.

FIG. 1.



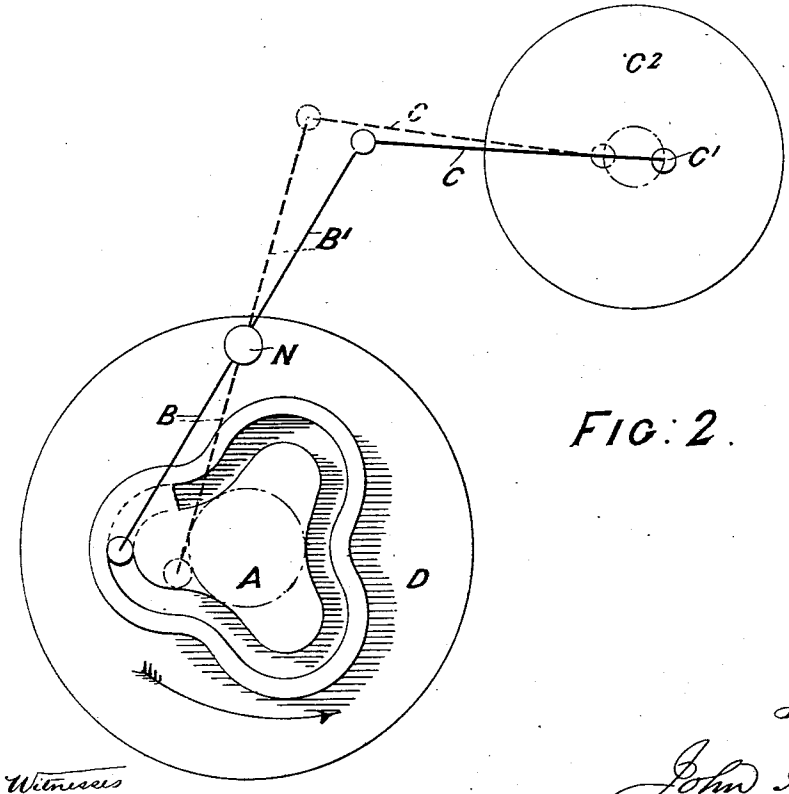


FIG. 2.

Witnesses
Chas. H. Smith
J. Stair

Inventor
John Price
per L. W. Serrell & Son
Atys

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

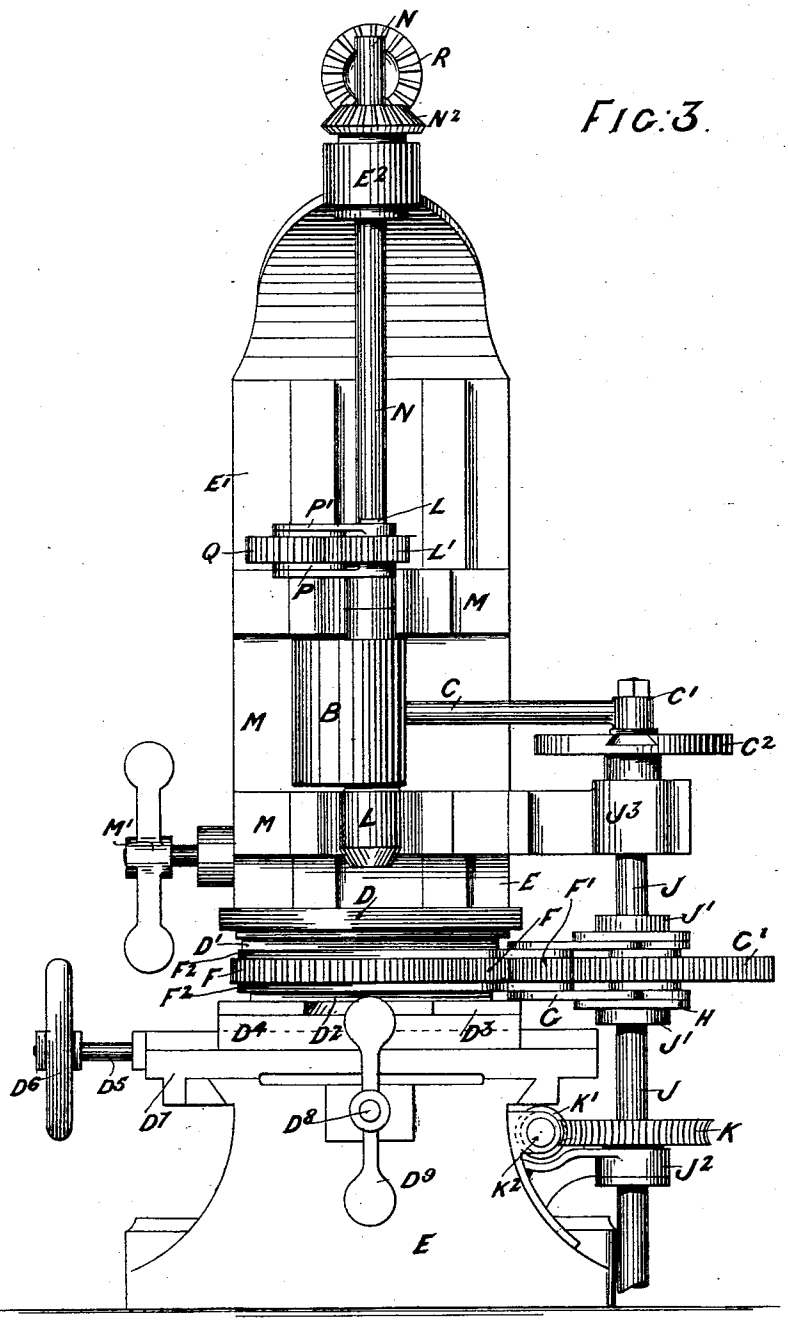
(No Model.) 5 Sheets—Sheet 2.

J. PRICE.

MACHINE FOR MANUFACTURING MULTIPLE THROW CAMS.

No. 564,800. Patented July 28, 1896.

FIG. 3.



Witnesses
Chas. H. Smith
J. Stair.

Inventor
John Price
by L. W. Serrell & Son
Attys

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

(No Model.) 5 Sheets—Sheet 3.

J. PRICE.

MACHINE FOR MANUFACTURING MULTIPLE THROW CAMS.

No. 564,800. Patented July 28, 1896.

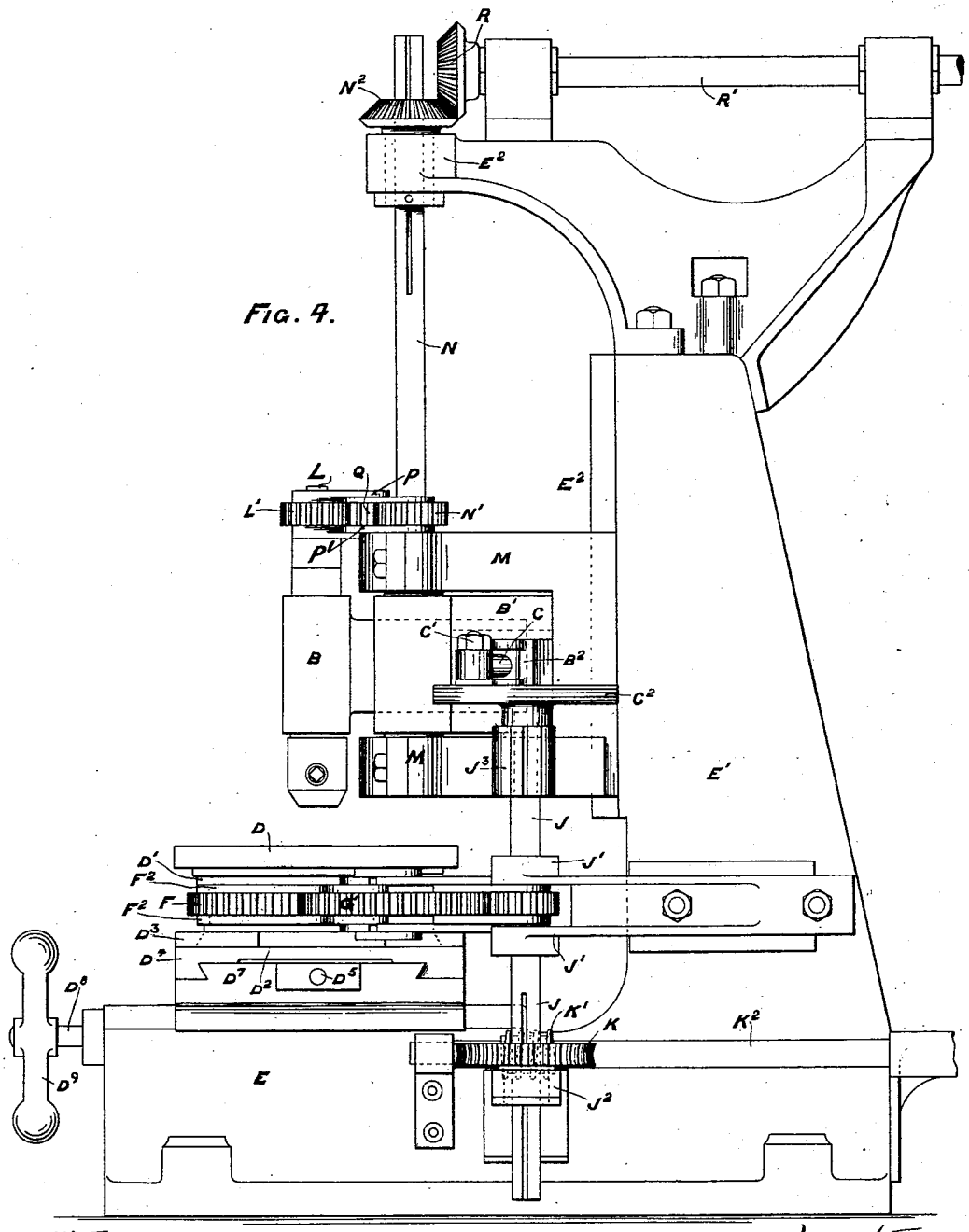


Fig. 4.

Witnesses
Chas. H. Smith
J. Stair.

Inventor
John Price
per L. W. Serrell & Son
Attys

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

(No Model.) 5 Sheets—Sheet 4.

J. PRICE.

MACHINE FOR MANUFACTURING MULTIPLE THROW CAMS.

No. 564,800. Patented July 28, 1896.

Fig. 6.

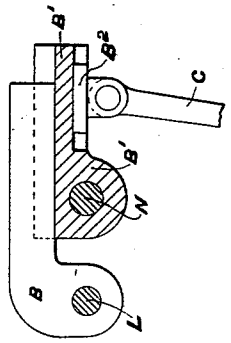
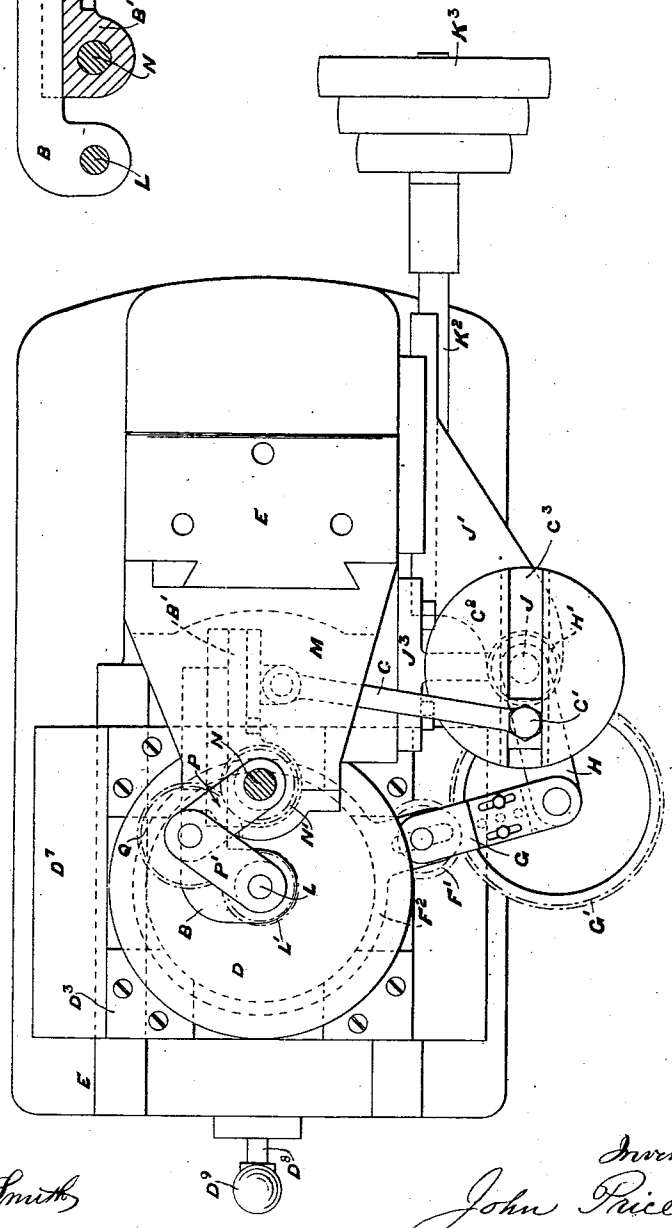


Fig. 5.



Witnesses
Chas. H. Smith
J. Staib.

Inventor
John Price
per
L. W. Serrell & Son
Attys

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

(No Model.) 5 Sheets—Sheet 5.

J. PRICE.

MACHINE FOR MANUFACTURING MULTIPLE THROW CAMS.

No. 564,800. Patented July 28, 1896.

FIG: 1A

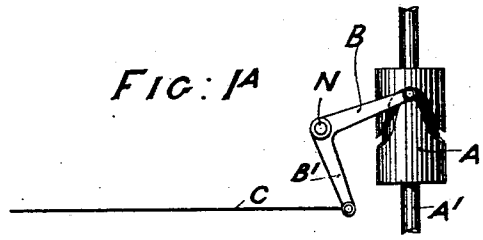


FIG: 7.

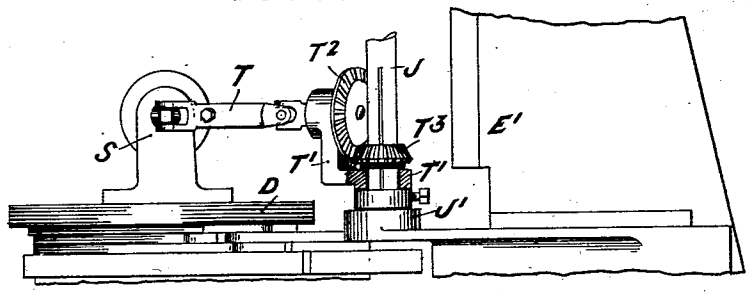
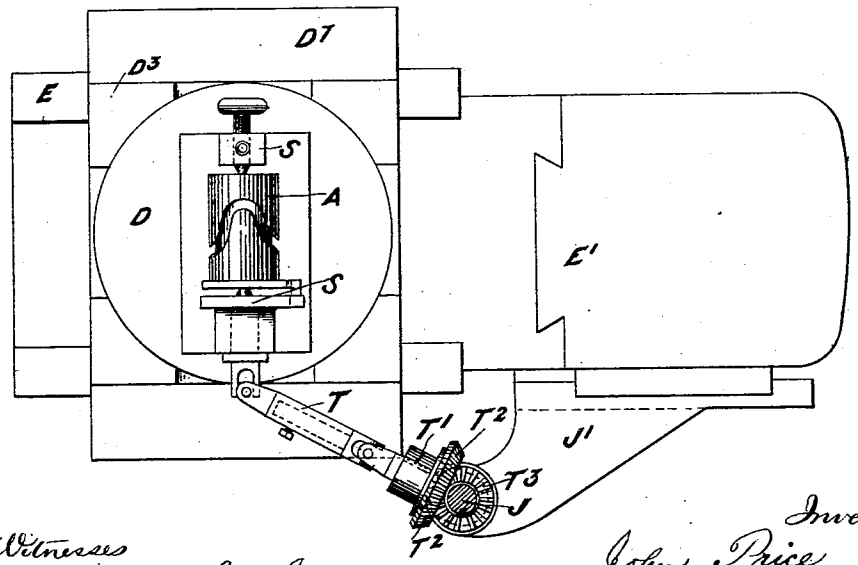


FIG: 8



Witnesses
Chas. H. Smith
J. Stair

Inventor
John Price
per
L. W. Serrell & Son
Attys

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

JOHN PRICE, OF LONDON, ENGLAND, ASSIGNOR OF FOUR-FIFTHS TO DICK EDWARDS RADCLYFFE, ALFRED HENRY SMITH, THOMAS HANN, AND WILLIAM BROMLEY, OF SAME PLACE.

MACHINE FOR MANUFACTURING MULTIPLE-THROW CAMS.

SPECIFICATION forming part of Letters Patent No. 564,800, dated July 28, 1896.

Application filed April 6, 1896. Serial No. 586,320. (No model.)

To all whom it may concern:

Be it known that I, JOHN PRICE, mechanical engineer, a subject of the Queen of Great Britain, residing at Upper Kennington Lane, London, England, have invented a certain new and useful Machine for the Manufacture of Multiple-Throw Cams, of which the following is a specification.

In the drawings, Figure 1 is an elevation of the cam and connections. Fig. 2 is a diagram illustrating the manner in which the shape of the cam is laid out. Fig. 3 is a front elevation of the cam-forming machine. Fig. 4 is an elevation at the right-hand side. Fig. 5 is a plan view. Fig. 6 is a partial sectional plan of the compound lever. Fig. 7 is a partial side elevation of the work-table and shaft, and Fig. 8 is a plan of the same, and Fig. 1^A illustrates a bent arm and cam.

The object of this invention is to provide a machine for the mechanical manufacture (without the employment of a model or templet) of plate or cylindrical cams capable of imparting a number of equal throws at each revolution, and whereby the curved paths so produced are automatically formed and are of symmetrically-perfect character. Such cams, when mounted to be rotated, are advantageously employed for transmitting motion and communicating an increased speed to other parts of machinery, such as, for example, transmitting motion from a driving-axle to a wheel or shaft to be driven.

These cams are particularly advantageous for use in the driving-gear of velocipedes, as is illustrated by diagram Fig. 1 of the accompanying drawings, where A is one of these multiple-throw cams of "plate" variety, keyed on a driving-shaft A'. B is a swinging arm pivoted at one end N to the framework and provided at its lower end with a bowl entering the cam-groove. At the bowl end of the arm B is jointed a connecting-rod C to drive a crank C' on disk C^2. Such cam-grooves may obviously be formed, in some cases, upon the curved surface of a cylinder, as, for example, is shown by the diagram Fig. 1^A, where A is the cam on a driving-shaft A'. A bell-crank lever is pivoted at N, one arm, B, having a bowl operated by the cam, while the other arm, B', is jointed to the connecting-rod.

The machine hereinafter described is capable of being caused to cut multiple-throw cam-grooves upon such a flat surface as at Fig. 1 or a cylindrical surface as at Fig. 1^A.

In order that the system of action of the machine for the manufacture of such cams, and as hereinafter fully described, may be readily understood, I will first describe what I may call the "elements" of the mechanism I employ according to my invention.

In order to produce a plate-cam, say, of three-throw character, the plate A from which the cam is to be formed is fixed to and carried by a revolving table D, as is indicated by a diagram view, Fig. 2. Above the table D is a two-armed lever B B', capable of being rocked on a center N, by a connecting-rod C and a crank-disk C^2, the outer end of the lever-arm B carrying a cutter or rotary milling-tool to act upon and cut the cam. The various parts are so relatively operated that while the table D is revolved once the tool-arm B is rocked toward the center of the cam three times and is rocked to the outer extent of the cam-groove three times, and a three-throw cam is thereby formed. When cylindrical cams are to be cut, the table D is held stationary, while the cylinder to be cut is mounted thereon between centers and is revolved at the same rate as the table D would be revolved if cutting a flat cam.

In the machine hereinafter fully described the number of throws of the cam to be produced can be varied, while the throws of the said cam can also be made to suit any throw of the driven crank at C^2, Fig. 1, or any length of swinging arm B, Fig. 1.

The rotary table D, onto which the plate to be cut is fixed, is fitted with a lower extension or neck D', and has a coned base D^2, held by bearing-pieces D^3 to a laterally-sliding bed D^4, capable of being slid transversely by screw-shaft D^5 and hand-wheel D^6, Fig. 3. The upper bed D^4 is carried on transverse guides on a lower longitudinally-adjustable bed D^7, capable of being operated by screw-shaft D^8 and hand-wheel D^9. The bed D^7 is carried on longitudinal guides formed on the

frame E of the machine. By this construction the table D is capable of being rotated, while it may be adjusted into any desired position, both transversely and longitudinally, upon the slides.

In order to give the table D rotary motion, (in whatever position it may be placed transversely or longitudinally,) the neck D′ is fitted with a toothed wheel F, with which gears a pinion F′, the pivot of which latter is adjustably carried in slots formed in straps F^2, mounted to loosely embrace the neck D′ of the table D. Pivoted to and extending from the strap F^2 extends a pair of links G, jointed to a pair of links H, which latter pivot on a vertical counter-shaft J, carried in bracket-bearings J′ J^2 from the frame E of the machine. The links G and H are adjustable in length and carry a spur-wheel G′, gearing with a pinion H′, held to the counter-shaft J by a feather and groove, so as to allow the latter to be adjusted vertically. By these means, which permit of varying the size of the gear-wheels, any desired ratio of speed may be obtained between the shaft J and the table D, while the links also allow of the table being adjusted horizontally in any direction.

The counter-shaft J is conveniently rotated by, say, a worm-wheel K, (held thereto by a feather in the groove of the shaft J,) operated by a worm K′ on a horizontal shaft K^2, held in brackets from the frame E of the machine, and driven by belt and cone pulleys K^3, Fig. 5.

The vertical cutter-spindle L is carried above the table D by means of a forked bearing-bracket M, supported by vertical guides from the frame-standard E′, upon which it may be adjusted vertically by ordinary means, say by being connected to a vertical screw-shaft within the standard E′, (not shown in the drawings,) and such screw-shaft may be rotated by worm-gearing through a handle located as at M′ at Fig. 3. The bearings of the bracket M carry a vertical shaft N, extending upward, and between the fork of the bracket M and pivoting loosely upon the shaft N as a fulcrum is located a compound two-armed lever B B′. (Shown detached in plan view at Fig. 6.)

The front arm B of the lever carries the cutter-spindle L, and is adjustable in guides lengthwise upon the back arm B′, while the latter arm B′ is also formed with slotted horizontal guides to carry an adjustable bracket B^2, to which is jointed a laterally-extending connecting-rod C, the opposite end of which latter takes onto a crank-pin C′ on a crank-disk C^2, keyed onto the upper end of the counter-shaft J. The rotation of the shaft J will thus rock the lever-arms B B′, and the extent of such motion may be regulated by adjusting the crank-pin in the guide-groove C^3 of the crank-disk C^2.

In order to allow of the cutter-spindle L, its carrying-lever B B′, and bracket M being adjusted vertically, the upper end of shaft J is carried by a bracket J^3 below the crank-disk C^2, so that when the bracket M is raised or lowered the shaft J is also raised or lowered the groove and feathered connections of the various parts with such shaft allowing of the motion.

It will now be understood that the cutter-spindle L can be rocked or given radial reciprocations of any required extent, and the number of such reciprocations may bear any required proportion to the rotation or rotations of the table D.

To rotate the cutter-spindle L while allowing of its radial motions and of the vertical adjustment of its carrying-arm B, two pairs of jointed links P P′ are provided, connecting and loosely embracing the shaft N and the cutter-spindle L, respectively. Upon the shaft N is keyed a pinion N′, gearing with an idle-pinion Q on the joint-pin of links P P′. This pinion Q gears with a pinion L′, keyed or held by feather and groove, to the cutter-spindle L, so that upon revolving the shaft N the cutter-shaft L is also revolved, whatever position or radial translation motion is given to it.

The shaft N for communicating rotary motion to the cutter-bar L is extended upward and supported by a bearing-bracket E^2. Above the bearing E^2, and on the shaft N, there is located a bevel-wheel N^2, provided with a rib or feather to take into the groove of the shaft N, whereby the vertical adjustment of the bracket M, and consequently the rise or fall of the shaft N, is allowed for. The bevel-wheel N^2 gears with a bevel-wheel R, carried on a shaft R′, driven by speed-pulleys, by which motion is communicated, through the shaft N, to the cutter-bar L.

When the multiple-throw cam is to be cut upon a cylindrical block, the latter is mounted between centers S, as shown at Figs. 7 and 8. The gearing for rotating the table D is disconnected and the latter held stationary, while the cylindrical block A is rotated through the universally-jointed shaft T, supported by a bearing-bracket T′, carried from and revoluble upon the shaft J. The shaft T is driven when required by bevel-wheel T^2 thereon from a pinion T^3, mounted on the shaft J by a feather and groove. It will be understood that the cylinder to be cut is so speeded as to be revolved in the same ratio to the reciprocation of the cutter as would be the case with the rotating table D.

It should be observed that by this machine multiple-throw cams of the character shown at Figs. 1, 1^A, and 2 are produced by revolving the plate or block from which the cam is to be formed, while the cutter is simultaneously, and during one revolution of the plate or block, caused to perform movements identical with the motions of translation which would be performed by the bowl, Fig. 1, at the end of the arm B. Beyond this, it should be noted that with this machine cams to give any number of throws can be formed

by varying the relative number of revolutions of the crank-disk C^2, Fig. 2, with regard to the table D or to the block being cut. The throw of the cams to be formed can be also regulated according to the throw given by the said crank-disk C^2, and a cam can be formed to suit any length of arm such as B, Figs. 1 or 1^A, by proper horizontal adjustment of the lever-arm B, or of the slide B^2 of the lever-arm B′, and the position of the center N, Fig. 1, relative to the cam can be varied. In fact, the proportions of the cams produced can be varied to suit any position of the centers or proportions of the moving parts of the machinery which the cams are to actuate.

I claim—

1. In a machine for the manufacture of multiple-throw plate or cylindrical cams, the combination with a horizontally-adjustable work-table D for carrying the work to be cut, and means for mechanically rotating the said table; of a vertical cutter-spindle L above the work-table D, means for rotating the spindle L, a fulcrumed horizontal two-armed lever B B′, a fixed bracket M to carry the fulcrum of lever B B′, a bearing on the arm B to carry the rotary cutter-spindle L, and an adjustable-throw crank connected with the arm B′ to rock the said lever B B′ and give the required number of throws to the cutter-spindle relatively to one rotation of the work-table substantially as set forth.

2. In a machine for the manufacture of multiple-throw plate or cylindrical cams the combination with a horizontally-adjustable work-table D for carrying the work to be cut, and means for rotating the work-table; of a driven rotary vertical shaft J, an adjustable-throw crank on shaft J, a connecting-rod C therefrom, a horizontal two-armed rock-lever B B′ carried on a fulcrum from the framework, a horizontally-adjustable connection B^2 on lever-arm B′ with the connecting-rod C, whereby the lever B B′ is rocked, a vertical cutter-carrying spindle L carried by the lever-arm B, and means for axially rotating the said spindle L, and whereby the cutter is rocked a proper number of times to a revolution of the work-table substantially as set forth.

3. In a machine for the manufacture of multiple-throw plate or cylindrical cams, the combination with a horizontally-adjustable table D capable of being rotated, for carrying the plate or cylinder to be cut, a driven vertical shaft J, variable-speed tooth-gearing and link connections between shaft J, and table D, for rotating the table at a required relative speed; of a forked vertically-adjustable bracket-bearing M located above the table D, a vertical driven shaft N carried by the bracket M, a two-armed horizontal lever B B′ loosely fulcrumed on the shaft N between the arms of bracket M, a vertical cutter-carrying spindle L carried by lever-arm B, linked variable-speed gearing L′ Q N′ between driven shaft N and cutter-spindle L and gearing for rotating driven shaft N, a variable-throw crank-disk C^2 on shaft J, connecting rod C therefrom to lever-arm B′ to give a desired number of oscillations to the lever B B′ and cutter-spindle L, during one revolution of the table D as set forth.

JOHN PRICE.

Witnesses:
E. G. BREWER,
L. W. ROGERS.