(No Model.) 5 Sheets—Sheet 1.

J. G. ARAM.

MULTIPLE TURNING LATHE.

No. 550,401. Patented Nov. 26, 1895.

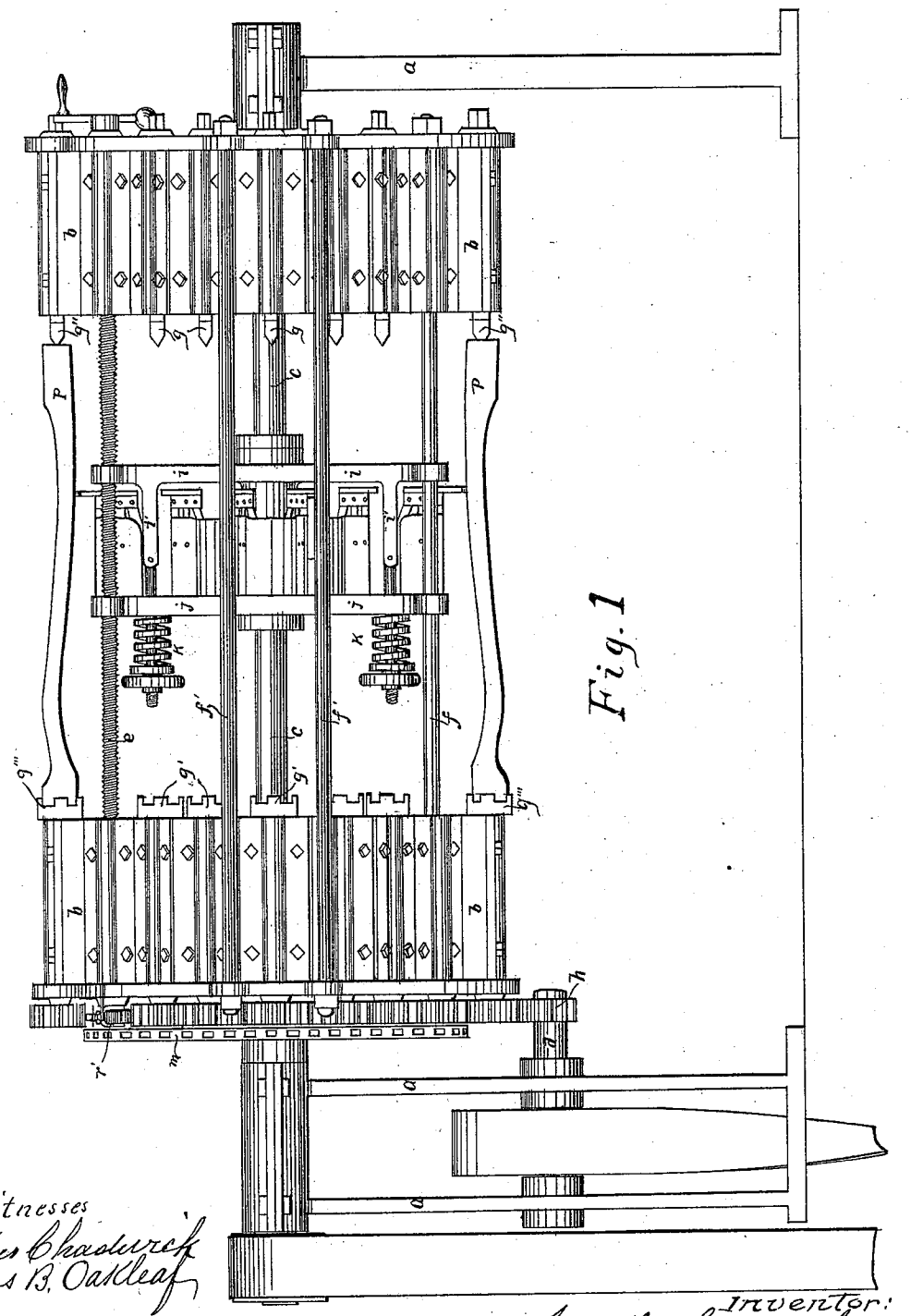

Fig. 1

Witnesses
Geo. Chadwick
Jos. B. Oakleaf

Inventor:
Jonathan Grundy Aram

(No Model.) 5 Sheets—Sheet 2.

J. G. ARAM.

MULTIPLE TURNING LATHE.

No. 550,401. Patented Nov. 26, 1895.

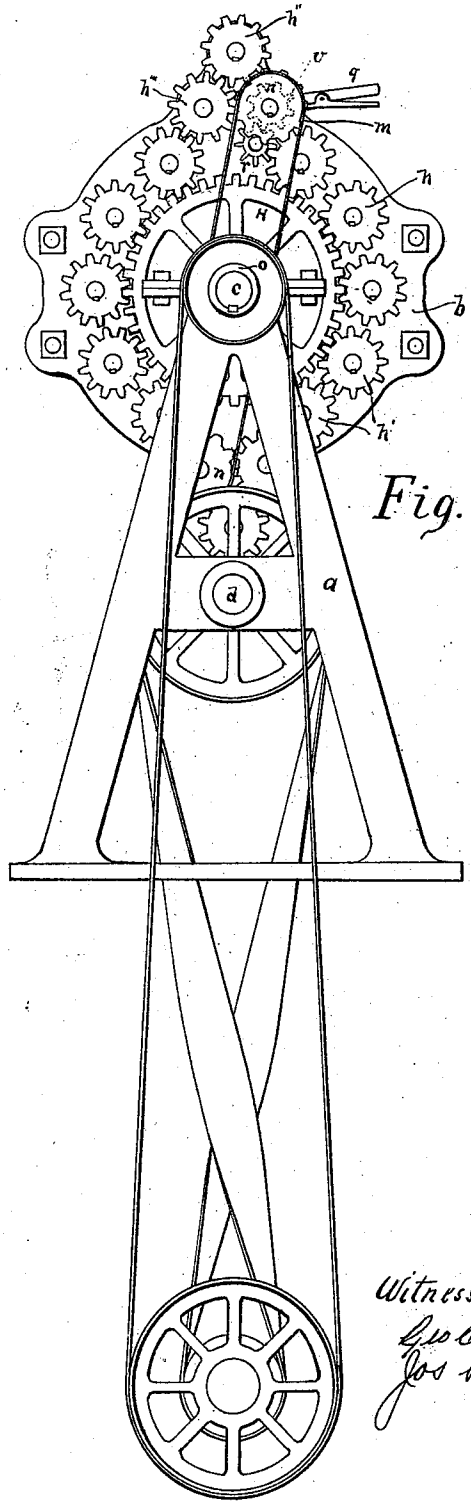

Fig. 2

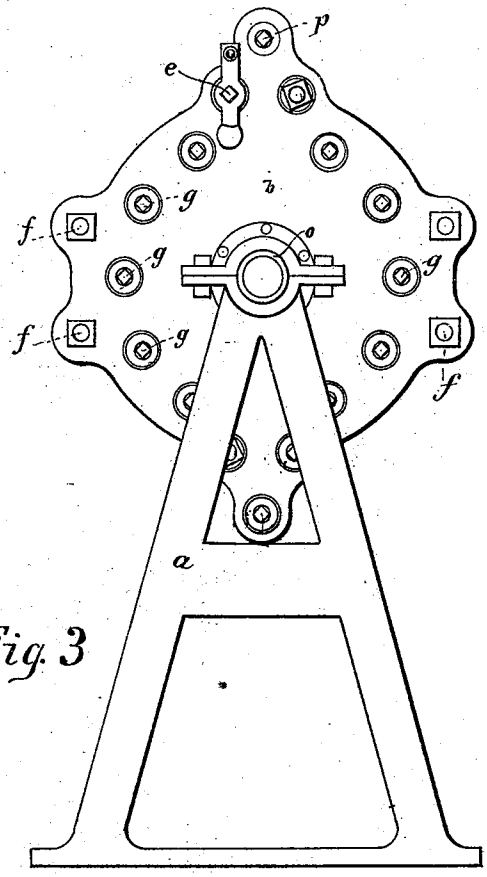

Fig. 3

Witnesses
Geo Chadwick
Jos B. Oakleaf

Inventor:
Jonathan Grundy Aram

(No Model.) 5 Sheets—Sheet 3.

J. G. ARAM.

MULTIPLE TURNING LATHE.

No. 550,401. Patented Nov. 26, 1895.

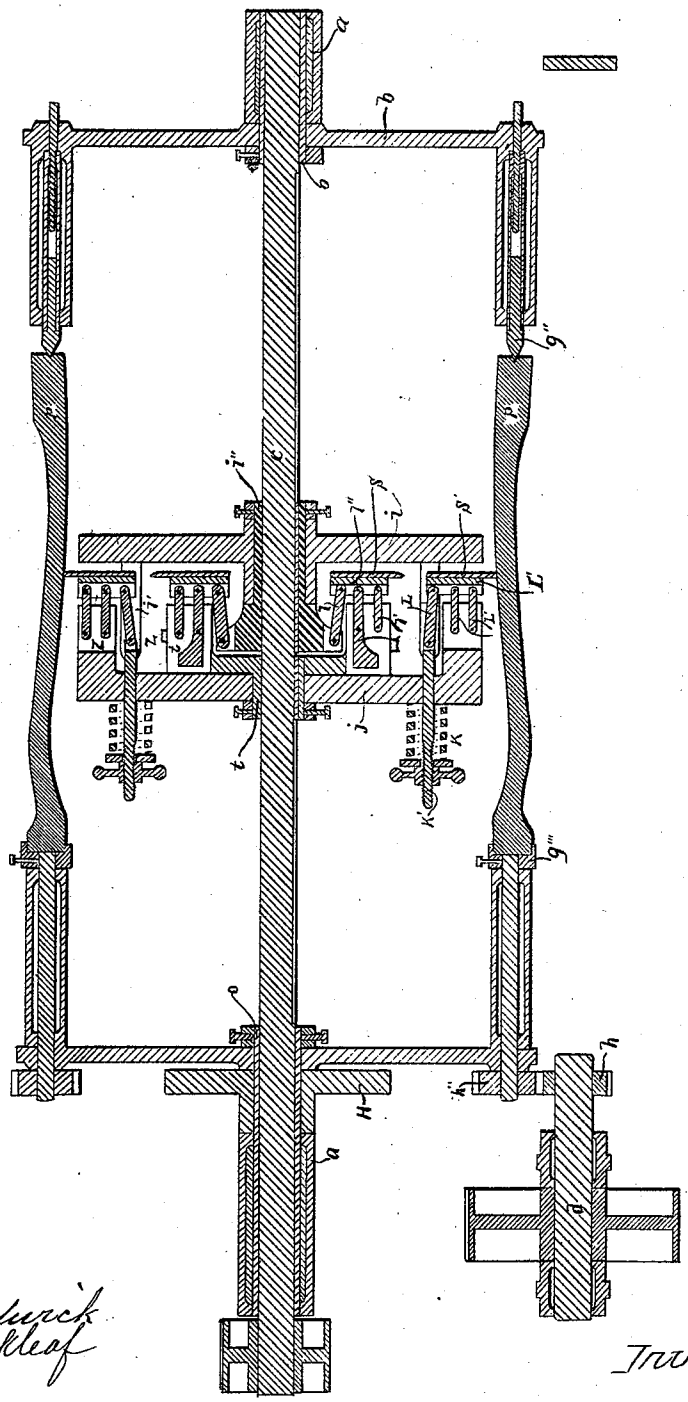

Fig. 4

Witnesses.
Geo Shadwick
Jos, B. Oakleaf

Inventor:
Jonathan Grundy Aram

(No Model.)

5 Sheets—Sheet 4.

J. G. ARAM.

MULTIPLE TURNING LATHE.

No. 550,401. Patented Nov. 26, 1895.

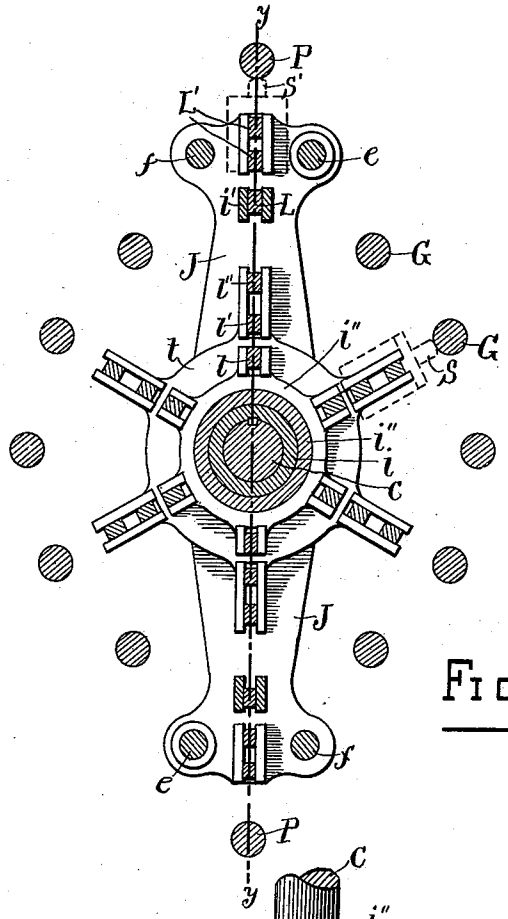

FIG. 5.

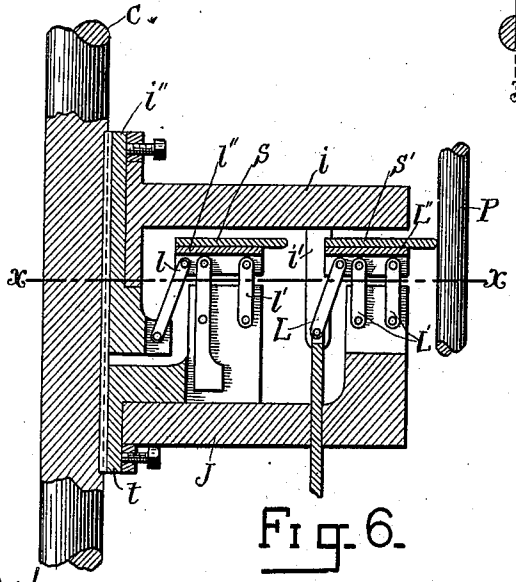

FIG. 6.

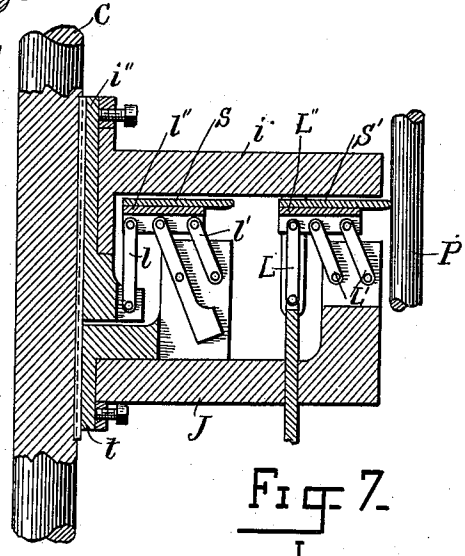

FIG. 7.

WITNESSES:
Fred W. Hersey.
M. G. Armstrong

INVENTOR:
Jonathan Grundy Aram,
By Charles H. Roberts
his Attorney.

(No Model.) 5 Sheets—Sheet 5.

J. G. ARAM.

MULTIPLE TURNING LATHE.

No. 550,401. Patented Nov. 26, 1895.

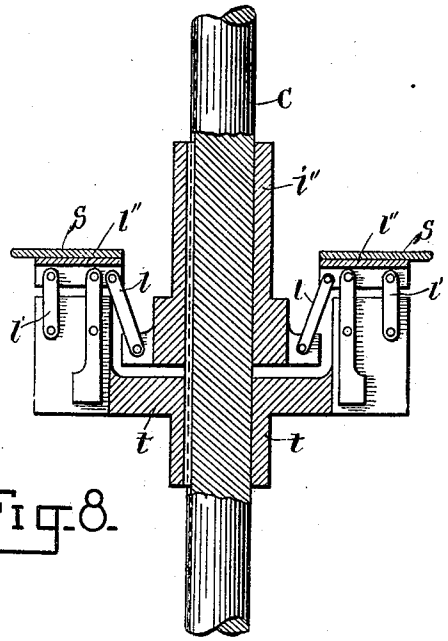

FIG. 8.

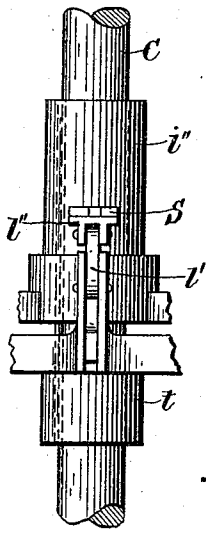

FIG. 9.

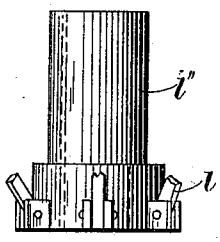

FIG. 10.

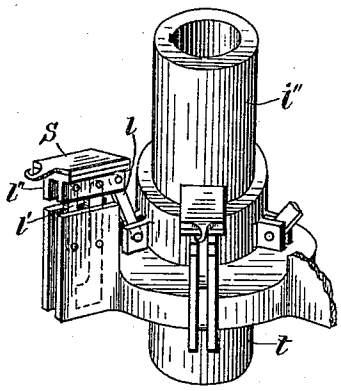

FIG. 11.

WITNESSES:
Fred W. Hersey.
M. G. Armstrong.

INVENTOR:
Jonathan Grundy Aram
By Charles A. Peirce
his attorney

UNITED STATES PATENT OFFICE.

JONATHAN GRUNDY ARAM, OF MOLINE, ILLINOIS.

MULTIPLE TURNING-LATHE.

SPECIFICATION forming part of Letters Patent No. 550,401, dated November 26, 1895.

Application filed August 1, 1892. Serial No. 441,884. (No model.)

To all whom it may concern:

Be it known that I, JONATHAN GRUNDY ARAM, residing at Moline, in the county of Rock Island and State of Illinois, have invented a new and useful Multiple Turning-Lathe and Copying-Machine, of which the following is a specification.

The object of my invention is the production of a machine which will operate upon, turn, plane, or shape one or many blanks or pieces of material at the same time, conformably to a pattern, a gage, or the designing hand of the operator, and will copy or reproduce from a pattern forms either regular or irregular and either singly or in multiple. I attain these objects—viz., the turning of one or many pieces at one time, conformably to a pattern or otherwise—by the mechanism illustrated in the accompanying drawings.

Figure 1 is a longitudinal view of the machine. Fig. 2 is an end view showing the gearing employed to drive the cutter, the live-spindles, and the feed-screws. Fig. 3 is a view of the opposite end of the machine, showing the location of the patterns, feed-screws, and centers for blanks with reference to each other and to their adjustment about the shaft C. Fig. 4 is a longitudinal section of a part of the machine, showing the patterns, tracing mechanism, and its connected rotating cutting mechanism. Fig. 5 is a cross-section on the line $x\ x$ of Fig. 4. Figs. 6 and 7 are enlarged sections of one-half of the cutter-head, Fig. 6 showing the cutter advanced and Fig. 7 showing the cutter drawn back. Fig. 8, partly in section, shows two opposite cutters of the six cutters shown in the cutter-head, omitting the tracing mechanism which is shown in Figs. 6 and 7. Fig. 9 is an elevation of Fig. 8, looking at it from the left. Fig. 10 is an elevation of i'' in Fig. 8, looking at it from the left. Fig. 11 is a perspective of one front and one side of the cutter with hubs and links shown in section in Figs. 6 and 7.

Similar letters refer to similar parts throughout the several views.

My device consists, essentially, of a rotating cutter-head or reducing mechanism, easily expansible and contractible radially and operated from a central shaft, said cutting mechanism being connected with and having its contraction and expansion governed by an expansible and contractible tracer adapted to trace the conformation of a rotating pattern. As the tracer follows the pattern from end to end thereof and follows the conformation of the pattern, moving to or from its center, it imparts to the cutting periphery of the revolving cutters similar advancing and retreating action, the cutters expanding and contracting in the rotating head and causing said periphery, as it traverses the blank from end to end, to describe and cut to a line which is exactly similar to that described or followed by the tracer as it moves from end to end of the pattern. The knives or cutters conform in shape to the tracer and thus are enabled to follow it in every eccentric or other movement and reproduce the shape of the pattern in the blank. The blank is fixed to occupy the same position with regard to the cutting mechanism that the pattern occupies as to the tracer. Both pattern and blank turn slowly and synchronously, thus submitting all of their surfaces to the tracer and the cutter, respectively. Similar radial action of the tracer and cutters is secured by the use of parallel bars or links.

In the machine shown in the drawings I use two patterns and two tracers; but it is obvious that a single pattern or single tracer may be used.

The machine may be described as follows: The main frame a is composed chiefly of standards, between which the secondary frame b, which is divided into fields or spaces, in which are located the operative parts of the machine, is held. This frame b is centrally supported on two short hollow pieces of shafting or pipe o, which are secured and held in line by the standards a, and around which said frame b and its contents may be rotated in order to readily load the spindles with blanks and unload them when the turning is completed. The frame b is stationary when the machine is in operation.

A shaft c, to one end of which a pulley H′ is keyed to drive it, is passed through the pipe-bearings o and held in place lengthwise by said pulley at one end and by a collar bolted at the other end. In the left-hand standards a is also boxed a shaft d, as shown

in Figs. 2 and 4, which is provided with a driving-pulley and with a spur gear-wheel *h*, as shown in Fig. 4, the use of which will be hereinafter described.

The frame *b* is itself composed of two ends held together by six rods or bolts *f*. Its central space is occupied by a horizontal slotted shaft *c*, on which slides longitudinally a rotary cutter-head *t*. Next adjoining this central space and equally distant from the slotted shaft are adjusted and held on centers *g* the blanks or pieces of material to be operated upon.

In a field outside of that in which the blanks are located the feed-screws *e* and bolts *f* are arranged. In a still further extended field or circle and diametrically opposite each other are located the two patterns or forms P P.

The patterns, having the same size and shape which they are intended to give to the blanks G, are secured on their respective centers with their corresponding sides toward the central shaft and are rotated slowly on said centers at the same speed and in the same direction as the blanks, by means of gear-wheels *h'*, Fig. 2.

The cutter-head *t* is cupped or hollowed out at one end and the other end is provided with a hub or shank bored to fit the central shaft, said hub or bearing being provided with a key or feather so fitted that it may slide on the slotted shaft *c* between the ends of the frame *b* while being rotated. Bored to fit this hub *t* and secured endwise thereon by a collar is a casting *j*, having two arms, which extend to and around the feed-screw *e* and one of the bolts *f* at each extremity of the casting, as shown in Fig. 5. Each arm is provided with one threaded nut *e'*, through which the feed-screws pass, and they also have a sliding fit on the bolts *f*. By means of the screws *e* the arms and the revolving cutter-head *t*, with its connections, the rotary link-carrier *i''* and sliding link-carrier *i* and the tracer S' may all be carried longitudinally, while the head *t* and rotating link-carrier *i''* only, revolve with the shaft. *j* has only a sliding motion and is moved by the feed-screw.

i is the sliding link-carrier and has a sliding motion and a reciprocating motion in the cutting of ovals.

The arms *j* have two horizontal fingers *z* at each extremity, and just outside the inner circle of the field which the patterns occupy the fingers are vertically in line with the cup end of the cutter-head *t*. Between these fingers and one above the other are pivoted two horizontal parallel bars L'. Past the finger-ends these two bars are coupled together by a vertical block L''. In the outer end of said block is placed an adjustable tracer S', directly without which the patterns P rotate. To the inner end of each block L'' are coupled bar-links L, the use of which will be hereinafter described. A hub or link carrier *i''*, bored to fit the central shaft *c* and having one end enlarged to fill the cup of the cutter-head *t* and provided with a bearing on its outer end for a casting *i*, is secured endwise by a collar. Said casting is provided with arms which project to and around and slide freely on the feed-screw *e* and one of the bolts *f* at each extremity, like the casting *j* aforesaid. Said arms are provided near each end with horizontal fingers *i'*, which slide under and are connected by means of the bar-links L to the parallel bars L', and when the tracers are pressed inwardly the pressure on the links moves the link-carrying arms *i'*. By this means the enlarged end of the link-bearing hub slides into the cup or bowl of the cutter-head *t*. At equal distances apart and parallel to the central shaft *c* openings or passage-ways are cut in the bowl of the cutter-head and continued through the enlarged part of the hub or link carrier which it surrounds.

Within each opening of the cutter-head is pivoted a set of parallel bars, exact duplicates of those pivoted between the fingers of the arms, Fig. 4, with this exception—that each of the bars nearest the central shaft has one arm weighted to balance the knives S. These bars are provided with corresponding bar-links which are pivoted within the rotating link-carrier *i''*, before mentioned. The pivoted blocks *l''* carry segments of circular-saws or other suitable knives which radiate from the center of the cutter-head. It will thus be seen that any movement of the tracer to approach the pattern is communicated at once to the knives. Passing through the arms of the cutter-head are coupling-rods *k'*, pivoted to the fingers of the link-carrier arms *i'*. These rods are provided with thumb-nuts between which and the sliding cutter-arms *j* are placed springs K, Fig. 4, which pull toward each other the two sets of arms, and so draw out of range the knives and tracers by closing the blades when the machine is running slowly or stops and out of the way while the machine is being loaded with blanks. The function of these springs may be explained as follows:

My machine relies upon the centrifugal force generated by the rotation of its cutting mechanism for the expansion of the cutter-head or the advancement of the cutters to their work. When the machine starts up and the shaft rotates rapidly, the rotating hinged or pivoted knives would be expanded to their full limit if the connected tracer did not meet the resistance of the pattern. Thus the knives are forced outward and toward their work by centrifugal force and inward or reversely by the resistance of the walls of the pattern exerted against the tracer, which is connected with the knives. As the centrifugal force, if the cutting mechanism is revolved rapidly or is heavy, may be sufficient to injure or indent the pattern or otherwise

injuriously affect it or injuriously affect the operation of the machine, springs are provided by which the centrifugal force and the consequent pressure of the tracer upon the pattern may be reduced or modified. The rotary knives *s* are also balanced by the weighted bars, but the power of the springs is overcome by the centrifugal motion when the machine is running, which forces the tracers outwardly against the pattern, and the increasing side of the pattern forces them back again. This gives the sliding link-carrier *i* and its arms *i'* a sliding motion back and forth when cutting ovals, and the movement of the tracers is thereby given simultaneously to the knives. In other words, the movement of the tracer S' in its advance and retreat toward and from the center of the pattern causes the sliding carrier *i* to slip reciprocally and longitudinally on the shaft *c*, carrying with it the rotating link-carrier *i''*, which is boxed in it, as shown in Fig. 4. Said rotating link-carrier has an additional motion, however, besides the reciprocating motion received from the carrier, rotating with its attached cutter-head and cutters S swiftly with the shaft *c*, while the sliding link-carrier *i*, in which it turns, has only the longitudinal motion during the operation of the machine. The tracer controls the sliding link-carrier *i*, and the sliding link-carrier *i* in turn controls the rotary link-carrier *i''*, which revolves within it by sliding the said rotary link-carrier longitudinally to and fro on the shaft *c* as it revolves with said shaft. The result is that the tracer traverses the pattern in spiral progression from end to end, the pattern rotating slowly and presenting its surface to be traced, and the swift-running cutting periphery works accurately to a line similar to that described by the tracer, the blank occupying the same position relatively to the expanding and contracting cutter that the pattern does to the advancing and receding tracer, the blank rotating and presenting its surface to the cutting periphery in a manner similar to the action of the pattern with regard to the tracer. As the blanks rotate, they are shorn of surplus material by the cutters, the rotating blanks presenting their surface so that the cutters traverse them in a spiral way from end to end, producing duplicates of the pattern at each complete horizontal passage of the mechanism along the feed-screw.

The live-spindles and feed-screws are driven by the gear *h*, Fig. 4, before mentioned, which meshes with the gear *h''*, and an intermediate *h'''* drives the large central gear H, which is journaled on the pipe-box *o*. This central gear H distributes motion to all the others, and through another intermediate gear-wheel *h'''* turns the other or upper pattern-gear *h''*, which would not be otherwise connected with the driving-gear *h*. This system of gearing, besides rotating the live-spindles, is also used to operate the feed-screws *e*. The two intermediate gears *h'''* are journaled (not keyed fast) on the outer ends of the rods *f*. They rotate in a different direction from the gears *h'*. On the outer end of one feed-screw is journaled a swinging frame *q*, between the sides of which and keyed onto the feed-screw is a spur-gear *v*. This meshes with another gear *r*, journaled within the same frame. By means of a lever attached to said swinging frame the gear *r* can be swung into mesh with *h'*. This turns the gear *v* and the feed-screw *e* in one direction and carries the cutter and tracer longitudinally in one direction, while to carry the cutter back in the other directions the gear *r* is swung into mesh with *h'''*, the intermediate; or the gear *r* may be hung between those two intermediate gears, and thus stop the operation of the feed-screw on the cutter-head while all the spindles are turning and the cutters have the rotary and radial movement, and the tracers have the radial movement only, or the gear *r* may be turned in either direction by a wrench by hand as the nature of the work to be done may require. As the feed-screws when used must operate together in the same direction, they are provided with sprocket-wheels *n*, and connected by a link-belt *m* (Figs. 1 and 2) which crosses the outer face of the frame *b*. The sprocket-wheel *n*, which drives the link-belting, is keyed on the outer end of the feed-screw outside the swinging frame *q*, within which frame is keyed also the gear *v* on the same screw-shaft.

It is desirable to fasten the frame *b* at some point when the machine is in operation. As the machine will operate in either direction, one passage of the knife and its mechanism between the ends of the frame *b* turns one set of pieces, and another set is finished on the return passage. For convenience in putting in and taking out the work, as aforesaid, the driving-gear *h* is disengaged, and the frame *b* is rotated on its own axis. The central pulley which drives the knives and the pulley which drives the spindles and feed-screws are driven by counter-shaft. It is not essentially necessary that more than one pattern and tracer be used in the operation of this machine, and while I prefer two feed-screws to balance the machine properly and relieve it of all side strain, it is obvious that one feed-screw, one pattern, and one tracer only may be used.

While this machine may be used as a single lathe, I believe that I have produced and have here shown, first, a multiple turning-lathe which produces in fac-simile the pattern or model; second, a turning-lathe in which a number of blanks are held on fixed centers and whose relative parts are all and always equally distant from a common center which they surround; third, a multiple lathe in which the axis of the knife or knives and the axes of the blanks are not variable; fourth, the

only cutter-head whose dimensions, circumferentially, are governed by a tracer following in a spiral track and thus covering the surface of the pattern and adapted to reproduce all of it in multiple; fifth, a multiple turning-lathe in which the development of the blanks is uniform and synchronous, they resembling each other at all stages of their progress toward completion.

An important feature of my invention consists in overcoming the difficulty of conveying the slow movement of the merely reciprocating tracer to the swift-moving rotary cutter-head. My solution of this difficulty consists in, first, the adoption of duplicate or twin sets of parallel bars, one of which, carrying the tracer, is adapted, when in operation, to reciprocate or advance and retreat only. The other, carrying the knife or knives, is adapted not only to advance and retreat, thus slowly expanding and contracting the periphery of the cutter-head in unison with the tracer, but is also adapted to rotate swiftly; second, the employment of a fast and loose swivel or two-way connection for the two sets of bars, which, while it preserves the unison of radial action of the tracer and knife, yet allows the latter with its bars full liberty of rotation and allows an instantaneous plural reproduction or registration of said slow-tracer movement on the blanks.

It is obvious that by simply stopping the rotation of the pattern, while yet operating the cutting mechanism and the tracer and blanks, the shape of the longitudinal section acted upon by the tracer would be transferred to the entire circumference of the blanks, thereby producing concentric forms. To slide the cutter-head longitudinally without rotation, but with its radial opening-blades governed by a tracer, in turn controlled by a rotating pattern, said blades being arranged to cut or shape one or a multiplicity of rotating blanks, would also be to practice my invention.

The edge of the cutter should be of the same curvature as the frictional surface of the tracer in order to follow the trace. When the tracer sinks into a recess of the pattern, the cutter, if cutting a track of like conformation, will accurately excavate like recesses in the blanks. It is possible that the spring may be placed elsewhere and still perform the same functions. The machine, moreover, may be used without the spring; also, the weighted arms to balance the spring are not essential, but are of advantage in fine work.

A single tracer and knife may be used; but a plurality of knives is preferred to divide the strain and to make smoother work.

Another important feature of my machine is the plurality of fixed head and tail centers or spindles, and their arrangement so that all are reached by the cutter operating on a fixed shaft. In other words the axes of the centers holding the blanks and the axis of the cutters do not vary relatively to each other as in other machines. The variation is all in the expansible and contractible cutter, and this is firmly seated on a central shaft and works within the group of equally firm-seated blanks and from the center outward.

My machine has a central feed, cut, or operation, which acts on the circumference of the surrounding blanks, and a longitudinal feed which transmits this operation lengthwise.

Instead of a knife or cutter, any other kind of reducing mechanism may be used, as an emery-wheel or a sanded rubber, to reduce the blank to the proportions or the smoothness of the pattern.

What I claim, and desire to secure by Letters Patent of the United States, is—

1. In a copying machine the combination of a rotating, expansible, sliding cutter-head, expansible by the centrifugal force of its rotation, a non-rotary, expansible or extendible tracer connected with the cutter-head, and a pattern to be reproduced, substantially as described and shown.

2. In a copying machine the combination of a rotating, expansible, sliding cutter-head, expansible by the centrifugal force of its rotation, a non-rotary, expansible, or extendible tracer connected with the cutter-head, a pattern to be reproduced and a blank to be operated upon, substantially as described and shown.

3. The combination in a machine for forming objects after a pattern, of a cutter-head journaled on a shaft and in operating relation to a blank or blanks, and provided with an opening and closing blade or blades adapted to advance toward or retreat from the center of the blanks and limited and controlled in scope of movement by link or lever mechanism; a tracer provided with link or lever mechanism equivalent to the link or lever mechanism of the blades in scope of movement and adapted to advance toward and retreat from the center of the pattern, and operating in the same vertical plane, and supported by arms journaled on said shaft, said tracer being held in a radial relation to the center of the pattern toward which it advances or retreats, the same as or similar to the radial relation of the advancing and retreating blades to the center of the blank or blanks; and mechanism substantially as described for synchronously feeding the relative parts of pattern and blank to the tracer and blades.

4. In a machine for forming objects after a pattern, the combination of a bar or system of bars adapted to rotate and carry a tracer, a bar or system of bars adapted to carry an advancing and retreating knife or knives, a tight and loose connection for said tracer bar or bars and cutter bar or bars, said connection being adapted to give unison of radial action

while allowing one of the systems of bars a rotary motion, substantially as described and shown.

5. In a machine for forming objects after a pattern and having a pattern to be reproduced, and a tracer, a traveling cutter-head provided with a plurality of connected cutting points, all said cutting points being so connected as to be controlled equally and from a common pattern-controlled part, said cutter-head being provided with means for moving laterally and being adapted to cut or operate in three directions, namely: to cut or operate as it expands, to cut or operate as it contracts, and to cut or operate as it travels laterally by a movement bodily of the cutter-head.

6. In a machine for forming objects after a pattern, a cutter-head provided with a plurality of connected cutting points, all said cutting points being so connected as to be controlled equally and from a common pattern-controlled part.

7. In a machine for duplicating forms, the combination of a traveling expansible and contractible cutter-head, a tracer, a pattern which is the duplicate of the work, and means for causing such tracer to traverse the entire longitudinal and peripheral surface of such pattern.

8. In a machine for forming objects from a pattern, a tracer adapted to move over the surface of the pattern; a cutter or cutters adapted to carve or otherwise reduce a blank to a line similar to that described by the tracer in moving over the surface of the pattern; and two-way connecting mechanism connecting the tracer and cutter, said two-way connecting mechanism being adapted to maintain correspondence of radial action between tracer and cutter while allowing one of them a diverse action, substantially as described and shown.

9. In a multiple lathe the combination of a bar or system of bars adapted to advance and retreat and carry the tracer; a bar or system of bars adapted to carry an advancing and retreating reducing mechanism; and a swivel or two-way connection for said tracer bar or bars and said reducing mechanism bar or bars, said connection being adapted to permit unison of radial action while allowing one of the systems of bars movement or motion differing from that of the other system of bars, substantially as described and shown.

10. In a machine for forming objects after a pattern, the combination of a plurality of live and dead spindles for holding blanks, with a cutting or reducing mechanism centrally located as to the spindles and adapted to operate upon blanks within the spindles, said reducing mechanism and said spindles rotating upon axes which do not vary relatively to each other; a model or pattern to be duplicated, said pattern rotating against the tracer; a single tracer adapted to traverse longitudinally and in a spiral track or way, the regular or irregular surface of a rotating pattern; and connecting mechanism connecting the cutting or reducing mechanism and the tracer, substantially as described and shown.

11. In a machine for forming objects after a pattern, having a pattern and a tracer, the combination of a system of extensible, non-revolving or non-rotary links, bars, or levers; a system of extensible, rotating or revolving links, bars, or levers; cutting or reducing mechanism connected with said rotating or revolving links, bars, or levers; and a two-way connection connecting said two systems of bars and adapted to allow one set of bars to rotate or revolve while the other does not rotate or revolve.

12. In a machine for forming a plurality of objects after a pattern, the combination of a centrally-located, expansible and contractible rotating cutter-head adapted to operate at a point on a number of blanks, said point corresponding to the point of the model or pattern then in touch with a tracer; spindles for holding a plurality of blanks, said spindles being arranged in a group around the cutter-head yet within the radial reach of its knife or reducing mechanism; a pattern of the conformation desired to be plurally reproduced, and adapted to move against the tracer; a tracer adapted to traverse a pattern in a direction diverse to the movement of the pattern; a system of links or bars adapted to register the conformation of the pattern upon an arm; a like system of links or bars adapted to transfer said registry from the arm to the cutter-head, and means to connect and operate the several parts, substantially as described and shown.

13. In a machine for forming objects after a pattern, the combination of a cutter or knife adapted to revolve about a center at varying distances therefrom, and cut or turn a blank; a tracer adapted to move over the surface of a pattern; and two systems of parallel bars or links connecting the cutter and tracer and adapted to give to the cutter an action or movement corresponding to that of the tracer, substantially as described and shown.

14. In a lathe the combination of a rotary cutting or reducing mechanism adapted to expand or contract its cutting surface, and adapted to cut or operate both while expanding and while contracting its cutting surface; a blank or blanks to be operated on and spindles or other means to secure the blank or blanks; a pattern or model to be duplicated; a single tracer adapted to move over the entire surface of the pattern or model to be duplicated and impart its movements to said cutting or reducing mechanism; connecting mechanism connecting the tracer and the cutting or reducing mechanism; and means to rotate the cutting mechanism, spindles and pattern, and to feed the machine, substantially as described and shown.

15. In a machine for forming objects after

a pattern, the combination of the extensible tracer; a rotating, expansible or extensible cutting or reducing mechanism and means to connect the same; a pattern to be reproduced; and a spring adapted to modify the pressure of the trace against the pattern resulting from the centrifugal force of the connected rotary cutting and reducing mechanism, substantially as described and shown.

16. In a machine for forming objects after a pattern, the combination of the extensible tracer; a rotating, expansible or extensible cutting or reducing mechanism, and means to connect the same; a pattern to be reproduced; and a spring adapted to restrain the movement of the tracer against the pattern resulting from the centrifugal force of the connected rotating cutting or reducing mechanism, substantially as described and shown.

17. In a machine for forming objects after a pattern, the combination of the tracer; a rotating, expansible or extensible cutting or reducing mechanism and means to connect the same; a pattern to be reproduced; and a spring adapted to restrain and regulate the centrifugal movement of the cutting or reducing mechanism toward the pattern, substantially as described and shown.

18. In a machine for forming objects after a pattern, the combination of the tracer; a rotary, expansible or extensible cutting or reducing mechanism and means to connect the same; a pattern to be reproduced; and a spring adapted to automatically withdraw, while the machine is at rest, the knives or cutting points of the reducing mechanism from their operating point, to allow the loading of the machine with blanks.

19. In a multiple turning lathe the combination and arrangement of a plurality of driving spindles for holding in the same vertical plane and turning on their axes a plurality of blanks and a pattern to be copied, said spindles being arranged on radial lines from and surrounding a common shaft about which they may be turned; a cutter-head provided with opening and closing blades, and adapted to revolve independently on said shaft, and carrying an extendible, non-rotating tracer provided with a bearing surface adapted to trace the surface of the pattern, said tracer and blades being connected by mechanism substantially such as described for imparting to the cutting periphery of the knife the same progression to and from the centers of the surrounding blanks as that made by the radial movement of the tracer toward the center of the pattern, all substantially as described and shown.

20. In a machine for forming objects after a pattern, a rotating cutter-head rotating on a shaft and provided with one or more opening and closing blades coupled between collars surrounding the shaft, said blades being adapted to be retracted or extended by the approach and retreat of the collars toward, or from, each other, substantially as described and shown.

21. In a machine for forming objects after a pattern the combination with the rotating pattern and a rotary, expansible and contractible cutter, of a non-rotary tracer adapted to trace both a vertical and longitudinal profile of the pattern and connecting mechanism connecting the tracer and cutter and adapted to control the cutter while permitting it to rotate while the tracer does not rotate, substantially as described and shown.

22. In a machine for forming objects after a pattern, the combination with a rotating pattern and a rotary, expansible and contractible cutter, of a non-rotary tracer adapted to trace both a vertical and longitudinal profile of the pattern; connecting mechanism connecting the tracer and cutter; and means to operate the cutting mechanism, pattern, and tracer, and to feed the machine, substantially as described and shown.

23. In a machine for turning irregular forms, having a rotary, expansible and contractible cutter, and a tracer, the combination of a rotating pattern support; an extensible and contractible non-rotary tracer adapted to trace a pattern seated in said support in a plane perpendicular to the axis of rotation of said support; and machinery to rotate the pattern support, and to extend and retract the tracer.

24. In a lathe the combination of a centrally-located, rotary, expansible and contractible reducing mechanism adapted to reduce or cut a blank both as it expands and as it contracts; a plurality of spindles adapted to hold blanks and grouped about and in radial reach of the rotary reducing mechanism and at equal distances therefrom; and a single, non-rotary tracer connected with said reducing mechanism and adapted to trace both a vertical and longitudinal profile of the pattern, and also adapted through its connected reducing mechanism to register its movements upon each of the blanks; and machinery for connecting and operating the parts, substantially as described and shown.

25. In a machine for forming objects after a pattern, the combination of a centrally-located, expansible and contractible reducing mechanism adapted to reduce or cut a blank both as it expands and as it contracts; a plurality of spindles adapted to hold blanks and grouped about and in radial reach of the reducing mechanism and at equal distances therefrom; a non-rotary tracer connected with said reducing mechanism and adapted to traverse the pattern and also adapted through its connected reducing mechanism, to register its movements in the same vertical plane upon each of the blanks; and machinery for connecting and operating the parts, substantially as described and shown.

26. In a machine for duplicating objects, the combination of the shaft *c;* cutter-head *t;*

rotating link-carrier i''; tracer S'; bars L', L', L''; cutter S; bars l, l', l''; sliding link-carrier i; arms j; main frame a; secondary frame b; and means to operate the several parts, substantially as described and shown.

27. In a machine for duplicating objects, the combination of the shaft c; cutter-head t; rotating link-carrier i''; tracer S'; bars L, L', L''; cutter S; bars l, l', l''; sliding link-carrier i; arms j; springs k; pattern P; main frame a; secondary frame b; and means to operate the several parts, substantially as described and shown.

JONATHAN GRUNDY ARAM.

Witnesses:
GEO. CHADWICK,
JOSEPH B. OAKLEAF.