

Oct. 30, 1923.

1,472,034

S. A. ASQUITH

METAL WORKING MACHINE

Filed May 11, 1922

3 Sheets-Sheet 1

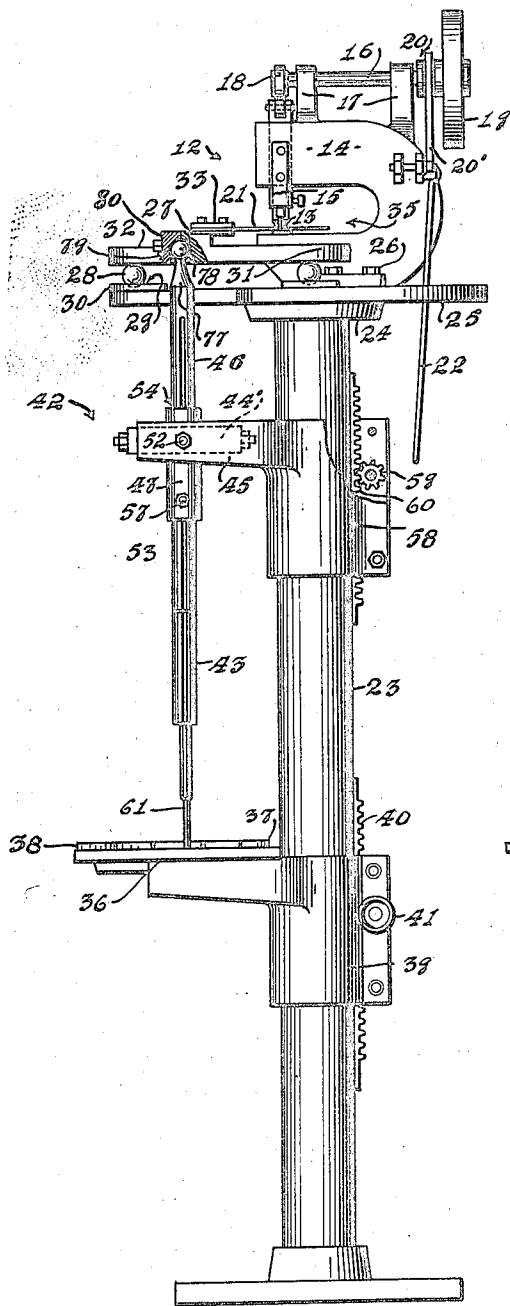


Fig. 1

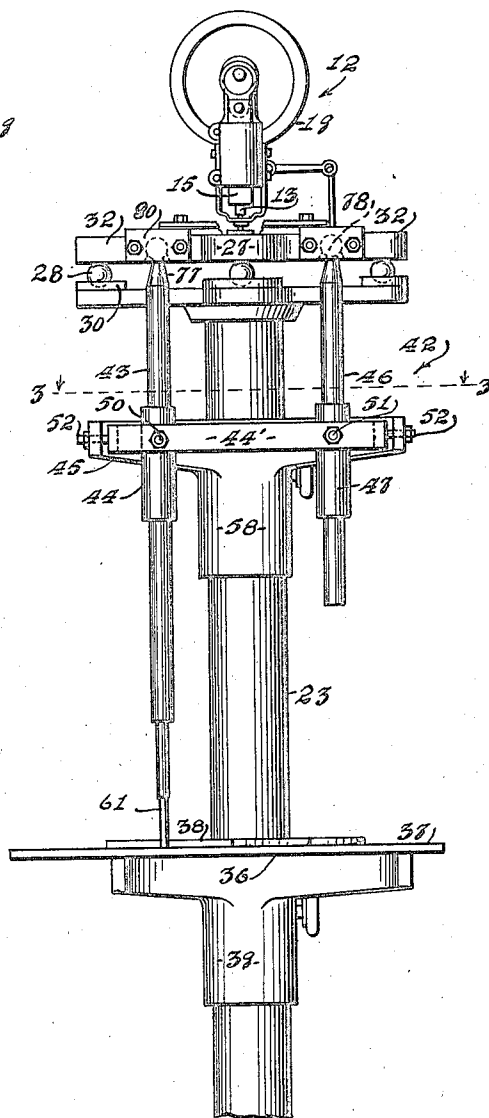


Fig. 2

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3 Sheets-Sheet 2

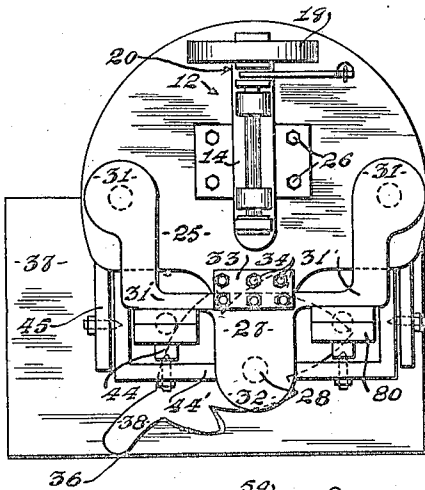


Fig. 5

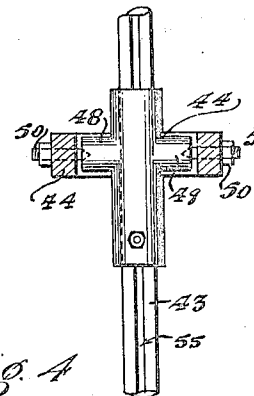


Fig. 4

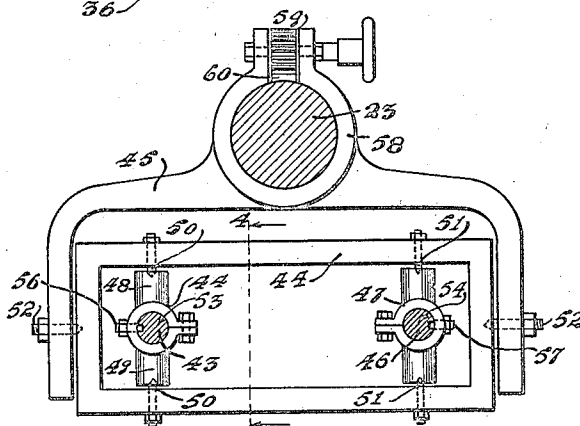


Fig. 3

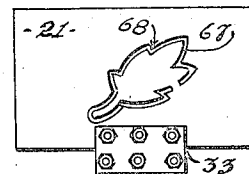


Fig. 8

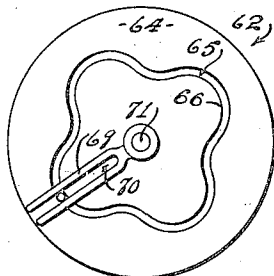


Fig. 6

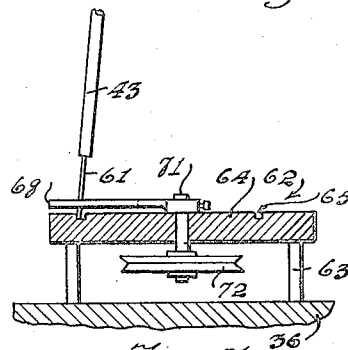


Fig. 7

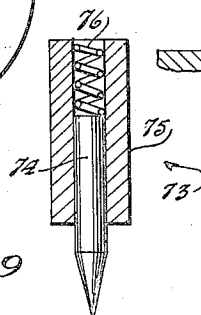


Fig. 9

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METAL WORKING MACHINE

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3 Sheets-Sheet 3

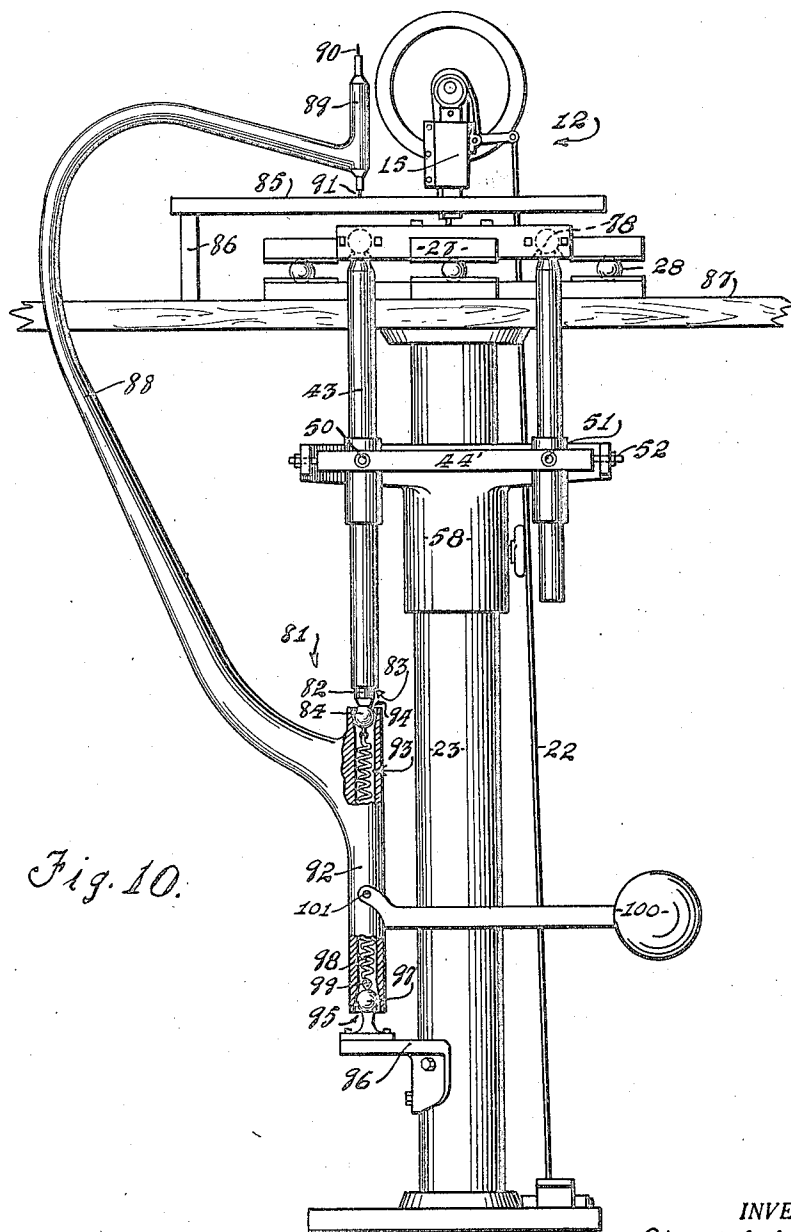


Fig. 10.

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UNITED STATES PATENT OFFICE.

STEAD A. ASQUITH, OF LOS ANGELES, CALIFORNIA.

METAL-WORKING MACHINE.

Application filed May 11, 1922. Serial No. 560,159.

To all whom it may concern:

Be it known that I, STEAD A. ASQUITH, a citizen of the United States, and a resident of Los Angeles, in the county of Los Angeles and State of California, have invented new and useful Improvements in Metal-Working Machines, of which the following is a specification.

This invention relates to the art of blanking forming, shaping, profiling, routing, punching or similarly working metal, and particularly sheet metal. The invention has for its main object the provision of a machine capable of reproducing work of the above class on a reduced scale directly from a pattern cut from paper, card board or other easily cut material, or directly from a drawing.

It will be understood in the consideration of the invention that experimental work, model building, making experimental forms for drawing sheet metal, and many allied arts require that each piece of metal required, that is other than some standard shape, be cut to shape by various improvised means. Such procedure results in all such work being extremely costly, and in each case of course a drawing is made for the mechanic to obtain dimensions from. Obviously if the piece of metal required can be quickly formed by using a large scale drawing for a pattern the cost of the work will be greatly reduced.

In view of the above it is another object of the invention to provide a machine capable of working the metal on a considerably smaller scale than the pattern, so that when small and extremely accurate parts are required a draughtsman of ordinary skill can lay out and cut the required pattern.

In manufacturing machines and devices of sheet metal it is often problematical to proceed to make dies for all parts when the manufacturer intends to begin with small production. Could such parts be turned out with reasonable speed in moderate quantities without first going to the expense of dies, such loss would be obviated, and the manufacturer would be enabled to redesign any part of the manufactured article until it became standardized.

It is therefore another object of the invention to provide a machine capable of reproducing metal machine parts and the like in small or large quantities and at reasonable

speed without requiring dies or patterns other than a thin card board pattern, or at best a wooden pattern.

Another object of the invention is to provide a machine of the aforesaid type which may be used for making its own metal pattern in the same scale from a drawing.

Another object of the invention is to provide a machine capable of cutting gears in a wide variety of sizes while requiring that only a few gear patterns be kept in stock. It will be understood that a two inch diameter No. 8 pitch gear, for example, is actually a one inch No. 16 pitch gear enlarged two diameters.

It will also be understood in the consideration of the invention that fine teeth gears and other metal machine parts with closely serrated margins must be blanked out by a plurality of blanking operations, and a plurality of dies are required. When gears and similar parts are made by one die in one operation, said die is high in first cost and is extremely weak. Gears are usually blanked by two or more operations, each operation cutting only every second, or third, or fourth tooth, according to the number of dies it is deemed advisable to use. Similar conditions exist in the art of manufacturing jewelry. Some of the forms required could not safely be blanked out with one die, and in fact single dies for some of the blanks required would be impractical, if not practically impossible to build.

In view of this it is another object of the invention to provide a machine capable of blanking out delicate work in one operation and without the use of any dies whatever.

Another object of the invention is the provision of a machine capable of cutting out experimental cams, empirically warped surfaces, profile gauges and the like, as well as dies and gauges for such articles. In work of this kind the mechanic is usually given a drawing on an enlarged scale and he must first lay out his work on metal in reduced scale. When the work is finally finished appreciable variations occur and the cost of master cams and similar metal gauges is excessive. When the characteristics of the cam or surface or the curves making up the cam or surface have been computed by calculus equations it is customary to first lay out the curves on an enlarged scale.

Obviously the provision of a machine capable of shaping a cam or empirical surface from a greatly enlarged drawing, will make for accuracy and speed in work of this nature.

5 Another object of the invention is the provision of a machine of the aforesaid type which may be operated by practically unskilled labor while retaining its accuracy.

10 Another object of the invention is the provision of sensitiveness combined with rigidity, so that while the machine may be used on delicate work it may be used on production without fear of variation in the parts being turned out.

15 Another object of the invention is the provision of compensating means for offsetting the effects of change of angularity of any and all of the moving parts.

20 Another object of the invention is the provision of a machine of the above character in which all adjustments may be rapidly made and in which all adjustable parts are securely held in adjusted position and are free from appreciable strain and vibration.

25 Another object of the invention is to provide means whereby both the pattern and the work may be seen by the operator.

30 Another object of the invention is the provision of a machine which may be employed for making calibration lines of extremely small scale with great accuracy.

35 A further object of the invention is to provide a machine of the aforesaid type in which all important bearings may be as devoid of friction and wear as possible, and also subject to minimum pressures; the use of balls and pivot screws for bearings being preferred.

40 Still other objects of the invention will appear or be specifically set forth as the description of my invention progresses, and said objects will be better understood by virtue of their occurrence in the specification.

45 A still further object of the invention is to provide a machine capable of cutting out large circular forms, such as armature discs, large gears, round drilling templates and the like, of such form that when divided into a plurality of equal segments of imaginary radial lines, each segment is the same as the others, so that a small segmental pattern may be used for cutting a complete circular piece of work.

50 I have illustrated by the accompanying drawings a practical embodiment of my invention and a modification thereof, as well as certain attachments for use in conjunction with said embodiments.

60 In the said drawings;

Figure 1, is a view in side elevation of said embodiment.

Figure 2, is a view thereof in front elevation.

65 Figure 3, is a view in enlarged detail sec-

tion as seen on a line 3—3 of Fig. 2 looking in the direction indicated by the arrows.

Figure 4, is a view in section seen on a line 4—4 of Fig. 3 looking in the direction indicated by the arrows.

Figure 5, is a plan view of the said embodiment.

Figure 6, is a plan view of an attachment for the machine, such as I propose for use in producing quantities of blanks from a 70 single pattern.

Figure 7, is a view in vertical section of the parts shown in Fig. 6.

Figure 8, is a plan view of a piece of sheet metal from which a blank is being cut; the 80 view showing the appearance of the blank immediately before it is completely cut.

Figure 9, is a view in vertical section of a modified form of tool.

Figure 10, is a view in side elevation of 85 a modified form of the invention.

More specifically, reference being had to Figs. 1 to 4 inclusive, 12 indicates a punch press capable of constantly reciprocating a punch 13. Any of the well known types of 90 punch presses or other metal cutting machines may be employed; however, in the form of the invention shown a common punch press is used, which includes essentially an anvil 14 holding a reciprocal punch 95 chuck 15; a drive shaft 16 supported by said anvil on bearings 17, and fitted with an eccentric 18 for imparting reciprocal movement to punch; a drive pulley 19 for rotating the drive shaft, and a clutch 20 between 100 said drive shaft and pulley. Punch presses of the type shown are well known in the metal working art and it is understood that when the clutch is thrown in, the chuck, and the punch held thereby, will reciprocate at a high rate of speed. Obviously by passing 105 a piece of sheet metal, such as 21, beneath the punch, the rapid action thereof will result in a continuous slot being cut in the metal; the slot being substantially the same width as the diameter of the punch, and the margins of said slot being extremely smooth. The clutch may be operated by a wire 22 110 passing downward to a usual foot pedal (not shown).

The press is supported by a vertical column or standard 23, which is provided at the upper end with a flange 24 on which 115 rests a fixed plate 25 of relatively great area. Said plate in turn supports the anvil and both are secured to the standard by means of bolts 26 threaded into flange 24, to provide rigid assembly.

One of the salient features of the invention resides in the fact that the piece of 125 metal from which blanks are to be cut is fed through a predetermined path beneath the punch, so as to be acted upon thereby, while the anvil is obviously stationary at all times. For the above purpose a movable 130

work holder 27 is provided and is universally movable on a horizontal plane. To make such movement possible and as free from friction as possible, balls 28 are interposed
 5 between said work holder and plate 25. In the form shown, three balls are provided and each repose in a shallow socket 29 formed in hardened races 30, which form substantially integral parts of said plate. The work
 10 holder is made as light as possible consistent with strength and includes three interconnected pads 31—31 and 32, forming an integral unit. Each pad is positioned so that it rests upon one of the balls to provide three-
 15 point suspension, and to prevent tilting of the work holder in any direction.

A work clamp 33 is carried by the work holder, and the sheet metal is secured in said clamp by the act of tightening bolts 34. The
 20 metal when placed in the clamp extends, as shown, into a space 35 provided by the anvil and is now in position to be acted upon by the punch.

A pattern table 36 is provided, which may
 25 be disposed at any desired point relative to the punch, but which in the form shown is disposed below the work and is carried by the standard. Said table is provided with a flat upper surface 37, on which may be
 30 placed a pattern 38, and secured against movement by suitable means (not shown).

Integral with the table there is formed a split collar 39, which encompasses the standard so as to be slidable thereon with sufficient friction to tend to hold it in adjusted
 35 position. The standard is provided with a rack 40, and the collar carries a pinion (not shown) meshing therewith, so that by turning a wheel 41 the table may be raised or
 40 lowered.

In order that the work holder may be caused to scribe a path similar to the outline of the pattern and on a predetermined scale of reduction, pantographic means, as indicated by 42, are provided. My improved
 45 pantographic means, which embodies features peculiar to the complete machine, includes essentially, a tracer arm 43, a cruciform pivot element 44 forming a variable fulcrum therefor, a frame 44' in which said
 50 pivot element is trunnioned, and a yoke 45 adjusted vertically on the standard and in which the said frame is trunnioned.

One of the salient features of said pantographic means resides in a dummy arm 46, paralleling the tracer arm 43, and slidable in a pivot element 47, which is trunnioned in frame 44' in the same manner as pivot
 55 element 44.

Each pivot element is formed with horizontal trunnions 48 and 49, which are oscillatably mounted on pivot screws 50—50 and 51—51 carried by the frame. Said frame is oscillatably pivoted in the yoke by means of
 60 pivot screws 52—52, which are disposed at

right angles to screws 50 and 51. Now by reference particularly to Fig. 3 it will be seen that both the tracer arm and the dummy arm are capable, by virtue of the pivot element, of moving to either side of the
 70 vertical plane. The frame itself, which holds the pivot elements, it will be seen, is free to tilt in either direction, up or down, from the horizontal plane. Thus the pivot elements are movable universally relative to
 75 the two said planes, and the provision of pivot screws renders friction practically nil.

Both tracer arm and dummy arm are each slidable vertically in their respective pivot elements which are formed with a bore 53
 80 and 54 respectively. Each arm is also provided with a groove 55, so that set screws 56 and 57 respectively, prevent the arms from turning.

Each upper end of the arms is formed
 85 with a taper as at 77, and above the taper each arm terminates in a ball 78. The work holder is formed with two ball sockets 79 for receiving the ball end of the arms. A shell 80 is provided to form a split socket,
 90 so that the ball ends may be removed or adjusted, and it will be observed that by the provision of said shells the socket is more than semi-spherical, and as a result the arms are held against upward as well as down-
 95 ward movement. In this way the entire weight of the arms is taken by the work holder and therefore it is held upon its ball bearings at all times. It will also be seen that the arms are universally connected to
 100 the under side of the work holder at points intermediate of the balls, so that they provide a correct center of gravity for said work holder.

The yoke is provided with a collar 58
 105 formed integral therewith to encompass the standard. Said collar is provided with a pinion 59 meshing with a rack 60 carried by the standard; as in the case of the pattern table. Thus the pivot element may be raised
 110 or lowered between the work holder and the pattern table to change the fulcrum point of the arms. The tracer arm is provided with an extensible end 61, which may be removed and replaced by another, and said end is em-
 115 ployed for tracing the pattern.

In Figs 6 and 7 I have shown a duplicating pattern 62 which is used in conjunction with the machine for turning out
 120 quantities of work. Said pattern is held a slight distance above the pattern table by studs 63. The pattern includes a block 64 of wood or metal. Said block is formed with a groove 65 in which the end of the tracer arm reposes. The groove, obviously,
 125 must be of appreciable width, inasmuch as the diameter of the end to be used is predetermined by the diameter of the tool used, multiplied by the scale of reduction. Groove
 130 65 is of the same diameter as the tracer end,

with only minimum clearance, and it will be understood that it is the inner margin 66 of the groove that indicates the outline of the blank to be cut by the machine.

5 The pattern includes a bifurcated arm 69, formed with a slot 70, and fixed to rotate with a shaft 71. Said shaft is provided with a pulley 72 disposed below the block, and it will be apparent that as the pulley is

10 caused to rotate the bifurcated arm will cause the arm-end, held thereby, to trace the outline of the pattern.

The application and operation of the machine will be better understood from the following: When it is desired to work out a new design in metal, a drawing is first made, as is customary under any condition. The designer is in no way limited as to size, and even in the case of fine jewelry work, a draughtsman, or even an unskilled person

20 may sketch out the design on paper on as large a scale as possible. The drawing may be placed directly on the pattern table, or may be cut from the paper or cardboard on which it is made. Where holes, slots or

25 openings are required in the work, the said openings may be cut out from the drawing, or the outlines of the holes may be traced.

The pattern or drawing is placed upon the pattern table and the scale of reduction is determined by adjusting the yoke to provide the proper leverage for the arms. A round arm-end (in the case of patterns) is selected, which end is of increased diameter

30 relative to the punch used, in accordance with the scale of reduction. It will be apparent, by reference to Fig. 8, that it is the inner margin 67 of the slot 68 cut by the punch, which determines the outline of the

40 blank, and it is also the inner edge of the arm-end used which follows the pattern outline. Therefore the distance from the perimeter of the arm-end to its center should be proportionate to the distance

45 from the perimeter of the punch to the center thereof.

The sheet metal, from which it is desired to cut a blank in conformance with the pattern, is placed in the work holder. The

50 clutch is thrown in, whereupon the punch begins to reciprocate. Obviously, the first cut of the punch forms merely a round hole, but the operations of the punch are so rapid, as compared to the speed at which the metal

55 moves, that a continuous smooth edged slot is cut, as shown in Fig. 8. The operator traces the pattern with the arm-end until it is completely circumscribed, whereupon the blank being completely cut falls from

60 the metal. In the case of extremely delicate work it will be apparent that the work may be fed as slowly as desired, and parts may be gone over as required by retracing parts of the pattern. In following a profile or

65 groove pattern the arm-end is held lightly

against the margin of the profile or the inner edge of the slot.

When quantities of blanks are required from a single pattern, a pattern of the type shown in Figs. 6 and 7 may be employed.

70 It will be seen that the bifurcated arm may be caused to move at a predetermined rate in accordance with the speed of the punch and the nature of the metal from which the blanks are cut. Any of the well known auto-

75 matic means for starting and stopping punch presses and the like may be employed in conjunction with the machine for quantity production. Also any of the well known automatic feeds for feeding a strip of metal

80 forward as each blank is cut may be employed.

Preferably, in setting up a pattern on the table, said pattern is positioned so that its approximate center is axially aligned with the depending tracer arm when said arm has assumed vertical position. The extensible

85 arm-end is lifted to clear the pattern and then is positioned so that it rides on the table while abutting the edge of the pattern. In this position the tracer arm is angularly disposed relative to the vertical plane. With

90 this change in angularity, the ball end of the tracer arm would descend, were the arm fixed to its fulcrum. Since, however, it is

95 slidable in its fulcrum it will ride slightly upward in the pivot element. The work holder, it has been explained, always remains on the same plane.

As the tracer arm rides up in its pivot

100 element the extensible arm-end descends accordingly so as to remain in contact with the table. Thus the fulcrum point of the arm automatically alters itself in accordance with change of angularity of the arm

105 so that the same scale of reduction is always maintained. The ball end of the tracer arm fitting in the ball socket with minimum clearance causes the work holder to follow accurately the path traversed by said ball,

110 and obviously the ball remains always on the same plane. The dummy arm by virtue of its parallel relation with the tracer arm prevents the work holder from pivoting on

115 the ball end of the tracer arm, and the distance between the two said arms provides extreme rigidity. If the tracer arm is moved in a straight line along the direction

120 of the major axis of the frame 44', the work holder will move in that path only and cannot deviate. Such movement of the tracer arm results in the frame remaining motionless. The slightest deviation of the tracer

125 arm from alignment with the major axis of the frame will result in said frame tilting on its pivot. If the tracer arm is moved in a straight line along the minor axis of frame 44' the pivot elements remain motionless. During such movement the work holder is

130 likewise held against gyration on the ball

end of the tracer arm, by the dummy arm. All curved and angular lines are made up of combined movements of the pivot elements in the frame and movements of the frame relative to the yoke. At all times, however, the distance between the pattern table and work holder remain unchanged, and therefore the parallel relation of the two arms remain unchanged. In other words, the work holder forms part of a quadrilateral arrangement of rigid elements and its movement must always be in synchronism with the end of the tracer arm. The rigidity of the work holder, arms and frame considered collectively is apparent when viewed from the front of the machine, and neither arm can tilt in any direction relative to the other, since the points at which they are each universally mounted to the work holder is fixed.

In Fig. 9 I have shown a marker 73, which may be employed for marking calibrations, designs and the like on sheet metal by following an enlarged drawing.

Said marker includes a pointed stylus 74, reciprocal in a bore 75, and held yieldably outward by a spring 76. Said marker may be placed in the machine to take the place of the punch, and when used, the punch press remains motionless. The pressure of the spring co-acts with the sharp point of the marker to scribe lines on metal held in the work holder. In this way calibration lines, radial dials and any other markings may be made, and at all times the marker remains in vertical position, so that the width and depth of the lines cut are unvarying.

In Fig. 10 I have illustrated an attachment, indicated by 81, for the machine for use where it is required that the pattern and work may be jointly and closely observed by the operator. In applying this attachment the usual pattern table is removed and the extensible end of the tracer arm is removed. In place of said end, a rod 82 is inserted in a bore 83, formed in the tracer arm. This rod is formed with a ball 84 at the lower end thereof. The ball in this attachment is to be moved in accordance with the pattern to be traced, and it will be apparent that the movement of the work holder will be in synchronism with the movement of ball 84, just as said work holder moves in synchronism with the arm-end in the previously described form of the invention. A pattern table 85 is provided and may be disposed immediately above the work holder and is of course stationary, being mounted on legs 86, and secured to a work bench 87, in front of which the machine is placed.

As a means for causing the ball to travel in a path conforming to the outline of the pattern (not shown) a curved arm 88 is

provided; said arm extends upward to the pattern table and carries a double ended chuck 89 in which tracers 90 and 91 are carried. Said tracers take the place of the arm-end shown in the previously described form of the invention and are extensible. The curved arm is formed at the lower end with a vertically disposed portion 92, formed with a bore 93. Said bore terminates at each end in ball sockets 94 and 95, respectively. To the standard of the machine is secured a foot 96 formed with a ball end 97, in vertical alignment with the tracer arm. Ball 97 reposes in socket 95, so that the weight of the curved arm is taken by foot 96, and the ball 84 reposes in socket 94, so that the weight of the rod is taken by portion 92. All parts are held in position by a tension spring 98, connecting said balls and attached to screw eyes 99. A counter weight 100 is secured to portion 92 of the curved arm as at 101.

The operation of this form of the invention is the same as that of the previously described form as regards the action of the tool and the manner of tracing the pattern, etc. Now it will be seen that the curved arm pivots on ball 97, and therefore ball 84 moves synchronously with the extensible tracer carried at the upper end of the arm. As any change in angularity of the tracer arm takes place, the distance between the work table and the ball 84 increases, inasmuch as the rod carrying ball 84 is slidable in the bore of the tracer arm. In this way change of angularity is compensated for, so that the scale of reduction remains unaltered.

The distance between the centers of the balls is fixed, and the distance between the ball 84 and the surface of the pattern table is fixed. We will assume the relation to be 3 to 1. If the pivot elements are disposed midway between ball 84 and the work holder, then the scale of reduction is 3 to 1. Assuming that the pivot elements are raised so that the work holder travels 1 to 4 as compared with ball 84, then the actual scale of reduction followed by the machine will be 12 to 1. It will be seen that with this attachment greater reductions may be employed by a machine of minimum height while retaining full accuracy, and obviously, where such great reduction is employed it is particularly advantageous to have the work and pattern jointly visible at close range.

Now it will be seen that I have provided a machine for cutting, shaping, marking and otherwise working metal or other material, and in which a simple improvised pattern may be employed for turning out blanks even of extremely small dimension. A wide variety of uses for machines built in conformance with my invention will sug-

gest themselves to those skilled in the art, and

While I have shown the machine described as having a reciprocating tool in the form of a common punch, it will be apparent that rotary tools such as millers, routers and the like may be employed instead of a punch by imparting rotary motion thereto, and other reciprocating tools, such as broaches, saws and the like may be employed, without enlarging the scope of my invention within the appended claims, and

While I have shown a specific construction and arrangement of parts, other constructions and arrangements of parts may be employed without enlarging the scope of my invention within the appended claims. I claim:

1. In a metal working machine, a work holder universally movable on a fixed plane, a tracer arm universally connected to said work holder, a sleeve in which said arm is slidable, a vertically adjustable element for holding said sleeve at any predetermined point intermediate of the ends of said tracer arm; said sleeve universally mounted in said element, a dummy arm spaced from said tracer arm universally connected to said work holder, and a second sleeve in which said dummy arm is slidable; said second sleeve also universally mounted in said vertically adjustable element.

2. In a metal working machine, a work holder universally movable on a fixed plane, a tracer arm universally connected to said work holder, a sleeve in which said arm is slidable, a vertically adjustable element for holding said sleeve at any predetermined point intermediate of the ends of said tracer arm; said sleeve universally mounted in said element, a dummy arm spaced from said tracer arm universally connected to said work holder, and a second sleeve in which said dummy arm is slidable; said second sleeve also universally mounted in said vertically adjustable element, a pattern table below said work holder, and an extensible end to said tracer arm engaging said pattern table.

3. In a metal working machine, a work holder universally movable on a fixed plane, a tracer arm universally connected to said work holder, a sleeve in which said arm is slidable, a vertically adjustable element for holding said sleeve at any predetermined point intermediate of the ends of said tracer arm; said sleeve universally mounted in said element, a dummy arm spaced from said tracer arm universally connected to said work holder, and a second sleeve in which said dummy arm is slidable; said second sleeve also universally mounted in said vertically adjustable element, a pattern table below said work holder, and an extensible end to said tracer arm engaging

said pattern table; said pattern table vertically adjustable in axial alignment with said vertically adjustable element.

4. In a metal working machine, a work holder, a tracer arm having a tracer end and the other end universally connected to said work holder, a sleeve for said arm intermediate of the end thereof and in which said arm is slidable, a dummy arm universally connected to said work holder, a second sleeve in which said dummy arm is slidable, and common means for supporting said sleeves so that they are universally movable in synchronism with each other on a fixed plane.

5. In a metal working machine, a work holder, a tracer arm having a tracer end and the other end universally connected to said work holder, a sleeve for said arm intermediate of the end thereof and in which said arm is slidable, a dummy arm universally connected to said work holder, a second sleeve in which said dummy arm is slidable, a common means for supporting said sleeves so that they are universally movable in synchronism with each other on a fixed plane, and a vertically adjustable pattern table below said means.

6. In a metal working machine, a pair of spaced parallel arms, a work holder to which the upper ends of each arm are universally connected, a fulcrum element through which both arms are slidable; said fulcrum element held on a given plane while permitting of synchronous universal movement of the said arms.

7. In a metal working machine, a pair of spaced parallel arms, a work holder to which the upper ends of each arm are universally connected, a fulcrum element through which both arms are slidable; said fulcrum element held on a given plane while permitting of synchronous universal movement of the said arms, a pattern table held in axial alignment with said fulcrum element, and an extensible tracer end to one of said arms connecting with said pattern table.

8. A metal working machine, including a reciprocal tool, relatively fixed means for reciprocating said tool, a work holder universally movable on a fixed plane, a pattern table disposed on a plane paralleling that on which said work holder moves, and pantographic means for controlling movement of said work holder; said pantographic means adjustable to provide a variety of reproduction scales.

9. In a metal working machine, a pair of spaced parallel arms, a work holder to which the upper ends of each arm are universally connected, a fulcrum element through which both arms are slidable; said fulcrum element held on a given plane while permitting of synchronous universal

movement of the said arms, a pattern table above said work holder, a tracer arm having its lower end universally mounted at a point fixed relative to said pattern table; the other end of said tracer arm extending to said pattern table, and an extension to said tracer arm universally connected to the lower end of one of said parallel arms.

10. Pantographic means for moving a work holder on a given plane, including an arm universally connected to the work holder, a universally pivoted sleeve through which said arm is slidable, a second arm paralleling said first named arm and universally connected to said work holder at a point substantially spaced from that at which the first named arm connects, and means for causing said second named arm to move parallelly in synchronism with said first named arm.

11. Pantographic means for moving a work holder on a given plane, including an arm universally connected to the work holder, a universally pivoted sleeve through which said arm is slidable, a second arm paralleling said first named arm and universally connected to said work holder at a point substantially spaced from that at which the first named arm connects, and means for causing said second named arm to move parallelly in synchronism with said first named arm, and a tracer connected to the lower end of one of said arms.

12. In a metal working machine, a work holder freely slidable on a fixed plane, a tracer arm depending from said work holder and universally connected thereto so that the work holder takes the weight of said tracer arm, a sleeve below said work holder in which said arm is slidable; said sleeve mounted to move universally on a fixed plane, another arm depending from said work holder connected thereto similarly to said tracer arm, and means for causing said second named arm to move parallelly in synchronism with said first named arm.

13. A metal working machine, including means for actuating a tool in an unchanging path, a work holder movable universally on a horizontal plane, a tracer arm universally mounted in said work holder, a pivot element slidably encompassing said arm to provide a fulcrum therefor, a rigid frame in which said pivot element is trunnioned, and a fixed yoke in which said frame is trunnioned.

14. A metal working machine, including means for actuating a tool in an unchanging path, a work holder movable universally on a horizontal plane, a tracer arm universally mounted in said work holder, a pivot element slidably encompassing said arm to provide a fulcrum therefor, a rigid frame in which said pivot element is trunnioned, a fixed yoke in which said frame is trunnioned,

a second arm paralleling said first named arm and similarly connected to said work holder, and a second pivot element in which said second named arm is slidable; said second pivot element trunnioned in said rigid frame.

15. A metal working machine, including means for actuating a tool in an unchanging path, a work holder movable universally in a horizontal plane, a pattern table below said work holder, a tracer arm depending from said work holder and secured thereto by a universal joint so that the weight thereof is taken by said work holder, a pivot element slidably encompassing said arm to provide a fulcrum therefor, a rigid frame in which said pivot element is trunnioned, and a fixed yoke in which said frame is trunnioned.

16. A metal working machine, including means for actuating a tool in an unchanging path, a work holder movable universally in a horizontal plane, a pattern table below said work holder, a tracer arm depending from said work holder and secured thereto by a universal joint so that the weight thereof is taken by said work holder, a pivot element slidably encompassing said arm to provide a fulcrum therefor, a rigid frame in which said pivot element is trunnioned, a fixed yoke in which said frame is trunnioned, a dummy arm paralleling said tracer arm and universally suspended from said work holder, and a pivot element slidably encompassing said dummy arm to provide a fulcrum therefor, said last named pivot element paralleling said first named pivot element and pivoted to said frame in the same manner as said first named pivot element.

17. A metal working machine, including means for actuating a tool in an unchanging path, a work holder movable universally in a horizontal plane, a pair of spaced parallel arms, each universally mounted on the under side of said work holder to depend therefrom, a pivot element slidably encompassing each arm, and rigid means in which said pivot elements are each pivoted in a manner to hold said arms in spaced parallel relation to each other, and to permit of said arms tilting jointly to either side of the vertical plane only, said rigid means itself pivoted to permit of its tilting upward and downward only, relative to the horizontal plane.

18. A metal working machine, including means for actuating a tool in an unchanging path, a work holder movable universally in a horizontal plane, a pair of spaced parallel arms, each universally mounted on the under side of said work holder to depend therefrom, a pivot element slidably encompassing each arm, and rigid means in which said pivot elements are each pivoted in a

manner to hold said arms in spaced parallel relation to each other, and to permit of said arms tilting jointly to either side of the vertical plane only, said rigid means itself
 5 pivoted to permit of its tilting upward and downward only, relative to the horizontal plane, a pattern table disposed below and in substantially axial alignment with one of said arms, and an extensible tracer on one
 10 of said arms for tracing a pattern or outline on said table; the diameter of said tracer element being enlarged over the diameter of the tool in accordance with the scale of reduction desired.

15 19. A metal working machine, including means for rapidly moving a tool through an unchanging path, a plate below said tool, a work holder movable on a horizontal plane, balls interposed between said table
 20 and said plate, a tracer arm depending from said work holder and secured thereto by a universal joint so that the weight thereof is taken by said work holder, a pivot element slidably encompassing said arm to
 25 provide fulcrum therefor, a rigid frame in which said pivot element is trunnioned, and a fixed yoke in which said frame is trunnioned.

20. A metal working machine, including
 30 means for rapidly moving a tool through an unchanging path, a plate below said tool, a work holder movable over said plate, three balls interposed between said work holder and plate to provide frictionless bearings;
 35 said work holder formed substantially U shape to provide a space over which a sheet of metal may be held and centrally of which space said tool moves; one of said balls disposed under the forward end of said work
 40 holder, and each of the other balls disposed under opposite ends of said work holder rearwardly of the tool path, and pantographic means depending from said work holder and universally mounted on the under
 45 side thereof so that its weight holds said work holder upon said balls.

21. A metal working machine, including means for rapidly moving a tool through
 50 an unchanging path, a plate below said tool, a work holder movable over said plate, three balls interposed between said work holder and plate to provide frictionless bearings; said work holder formed substantially
 55 U shape to provide a space over which a sheet of metal may be held and centrally of which space said tool moves; one of said balls disposed under the forward end of said work holder, and each of the other balls disposed under opposite ends of said work
 60 holder rearwardly of the tool path, a pair of spaced parallel arms universally mounted on the under side of said work holder so that the weight of said arms is taken by said work holder, a single horizontal rigid frame
 65 surrounding said parallel arms and disposed

below said plate, a vertical sleeve slidably encompassing each arm, trunnions on each sleeve integral therewith, pivot screws carried by said frame and engaging said trunnions, whereby said sleeves may oscillate in
 70 spaced parallel relation with each other, vertically adjustable means for holding said frame; said frame being pivoted to said means by pivot screws disposed at right angles to said first named pivot screws.

22. A metal working machine, including means for rapidly moving a tool through an unchanging path, a plate below said tool, a work holder movable over said plate, three balls interposed between said work
 80 holder and plate to provide frictionless bearings; said work holder formed substantially U shape to provide a space over which a sheet of metal may be held and centrally of which space said tool moves; one of said
 85 balls disposed under the forward end of said work holder, and each of the other balls disposed under opposite ends of said work holder rearwardly of the tool path, a pair of spaced parallel arms universally mounted
 90 on the under side of said work holder so that the weight of said arms is taken by said work holder, a single horizontal rigid frame surrounding said parallel arms and disposed below said plate, a vertical sleeve slidably
 95 encompassing each arm, trunnions on each sleeve integral therewith, pivot screws carried by said frame and engaging said trunnions, whereby said sleeves may oscillate in spaced parallel relation with each other,
 100 vertically adjustable means for holding said frame; said frame being pivoted to said means by pivot screws disposed at right angles to said first named pivot screws, an extensible end to one of said arms for tracing
 105 a pattern; the diameter of said extensible end being enlarged over the diameter of the tool in accordance with the scale of reduction desired, and the said vertically adjustable means being positioned in accordance
 110 with said scale of reduction.

23. A pantograph attachment for machines for controlling the movements of a work holder, including spaced parallel arms
 115 universally mounted to the work holder to depend therefrom, a pivot element for each arm slidably thereon, means in which each of said pivot elements is pivoted similarly, to oscillate similarly, and vertically adjustable means in which said first named means
 120 is pivoted at right angles to said pivot elements.

24. A pantograph attachment for machines for controlling the movements of a work holder, including spaced parallel
 125 arms universally mounted to the work holder to depend therefrom, a pivot element for each arm slidably thereon, means in which each of said pivot elements is pivoted similarly, to oscillate similarly, and vertically
 130

adjustable means in which said first named means is pivoted at right angles to said pivot elements; one of said arms having an extensible lower end for tracing a pattern, the diameter of said extensible end being increased over the diameter of the tool used in the machine in accordance with the scale of reduction required, and said vertically adjustable means being positioned in accordance with said scale of reduction.

25. A pantograph attachment for controlling movement of a work holder in machines having a tool moving through an unchanging path, a pair of spaced parallel arms universally mounted on said work holder to depend therefrom, a universally mounted fulcrum element for each arm in which each arm is slidable; said fulcrum elements being normally held in fixed vertical adjustment according to the scale of reduction required, and an extensible end to one of said arms for tracing a pattern, said extensible end being enlarged in diameter over the diameter of said tool in accordance with said scale of reduction.

26. A pantographic attachment for moving the work holder of a machine on a horizontal plane, including a pair of spaced parallel arms universally mounted on the under side of said work table so that the weight of said arms is taken by said work holder, a single horizontal rigid frame surrounding said parallel arms and disposed below said plate, a vertical sleeve slidably encompassing each arm, trunnions on each sleeve integral therewith, pivot screws carried by said frame and engaging said trunnions, whereby said sleeves may oscillate in spaced parallel relation with each other, vertically adjustable means for holding said frame; said frame being pivoted to said means by pivot screws disposed at right angles to said first named pivot screw.

27. A pantographic attachment for moving work holders of a machine in a horizontal plane, including, a pair of spaced paral-

lel arms, each universally mounted on the under side of said work holder to depend therefrom, a pivot element slidably encompassing each arm, and rigid means in which said pivot elements are each pivoted in a manner to hold said arms in spaced parallel relation to each other and to permit of said arms tilting jointly to each side of the vertical plane only, said rigid means itself pivoted to permit of its tilting upward and downward only, relative to the horizontal plane.

28. Pantographic means, for moving a work holder universally on a fixed plane, including, a pair of arms universally connected to the work holder; each at a point substantially spaced from the other, a pair of sleeves loosely encompassing each arm, a rigid frame in which both sleeves are separately trunnioned, and a fixed yoke in which said frame is trunnioned.

29. A metal working machine, including a movable work holder moving universally but on a fixed plane, a pair of parallel arms universally mounted to and depending from said work holder, pivot elements in which said arms are slidable, an extensible end to one of said arms, a pattern table disposed above said pivot elements, and a tracer arm universally connected to said extensible end and extending upward to said pattern table.

30. A metal working machine, including a movable work holder moving universally but on a fixed plane, a pair of parallel arms universally mounted to and depending from said work holder, pivot elements in which said arms are slidable, an extensible end to one of said arms, a pattern table disposed above said pivot elements, a tracer arm universally connected to said extensible end and extending upward to said pattern table, and a means disposed below and in vertical alignment with said extensible end, on which said arm is universally mounted.

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