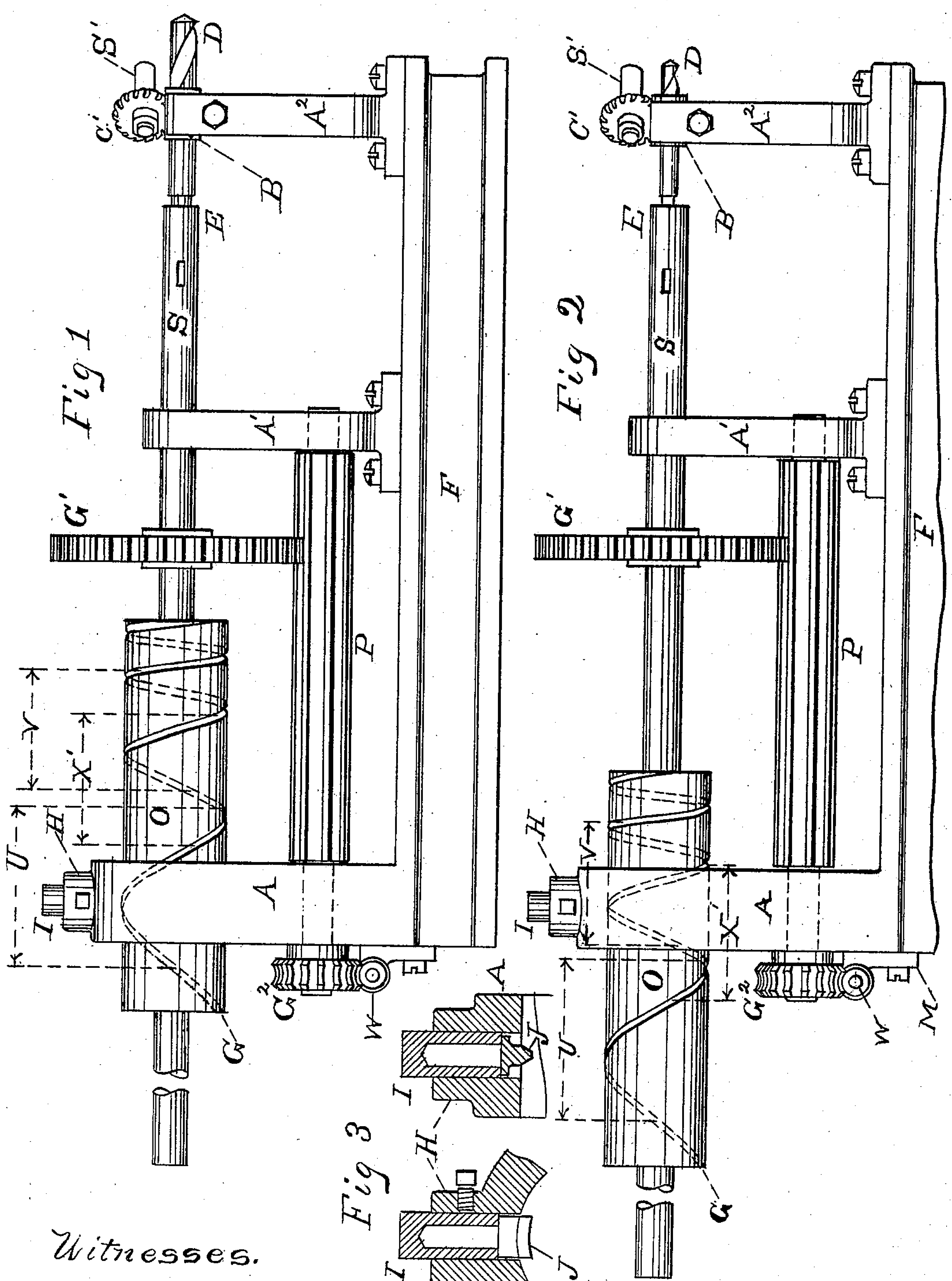
(No Model.) 3 Sheets--Sheet 1.

F. H. RICHARDS.

MACHINE FOR MAKING TWIST DRILLS.

No. 320,968. Patented June 30, 1885.



Witnesses.

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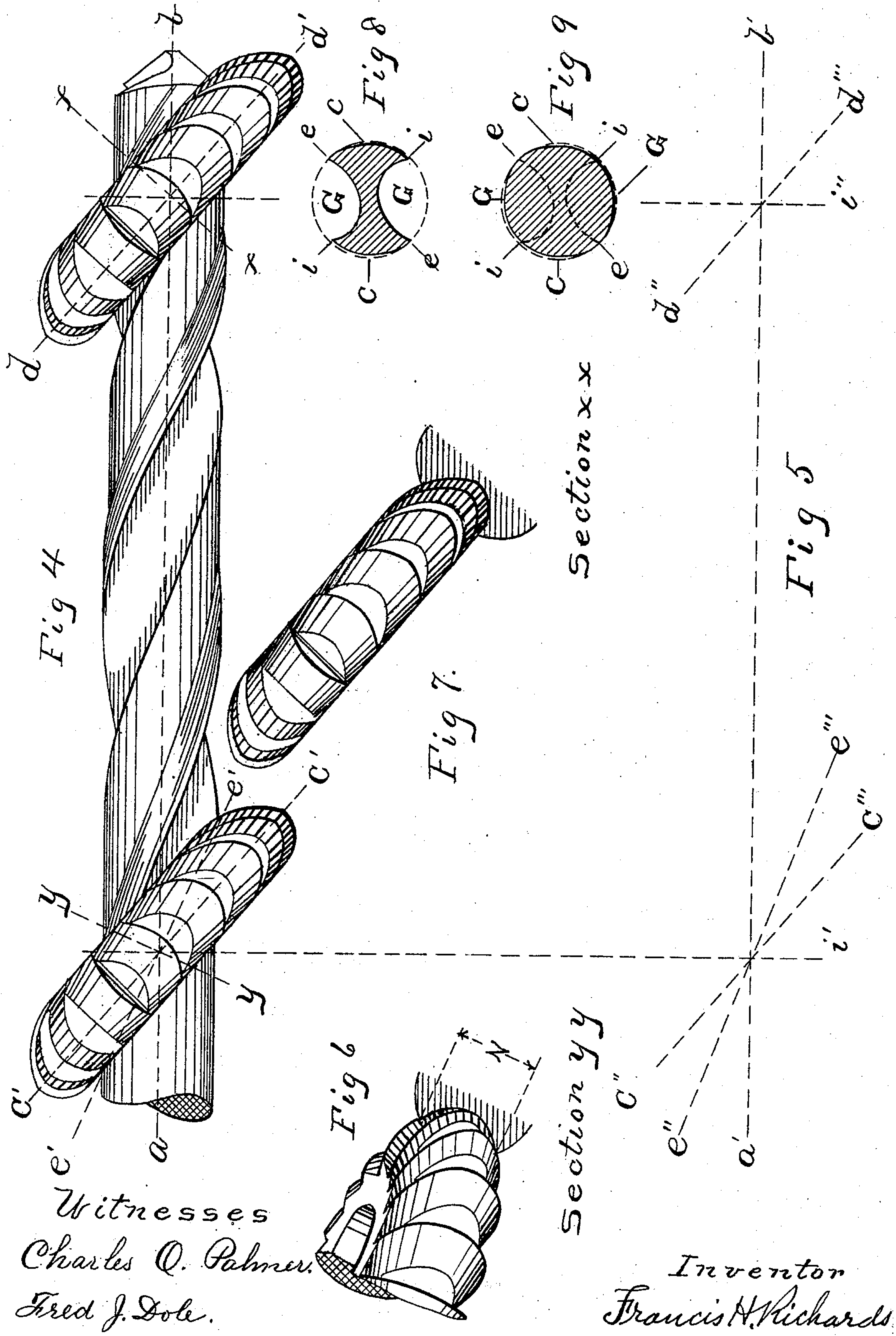

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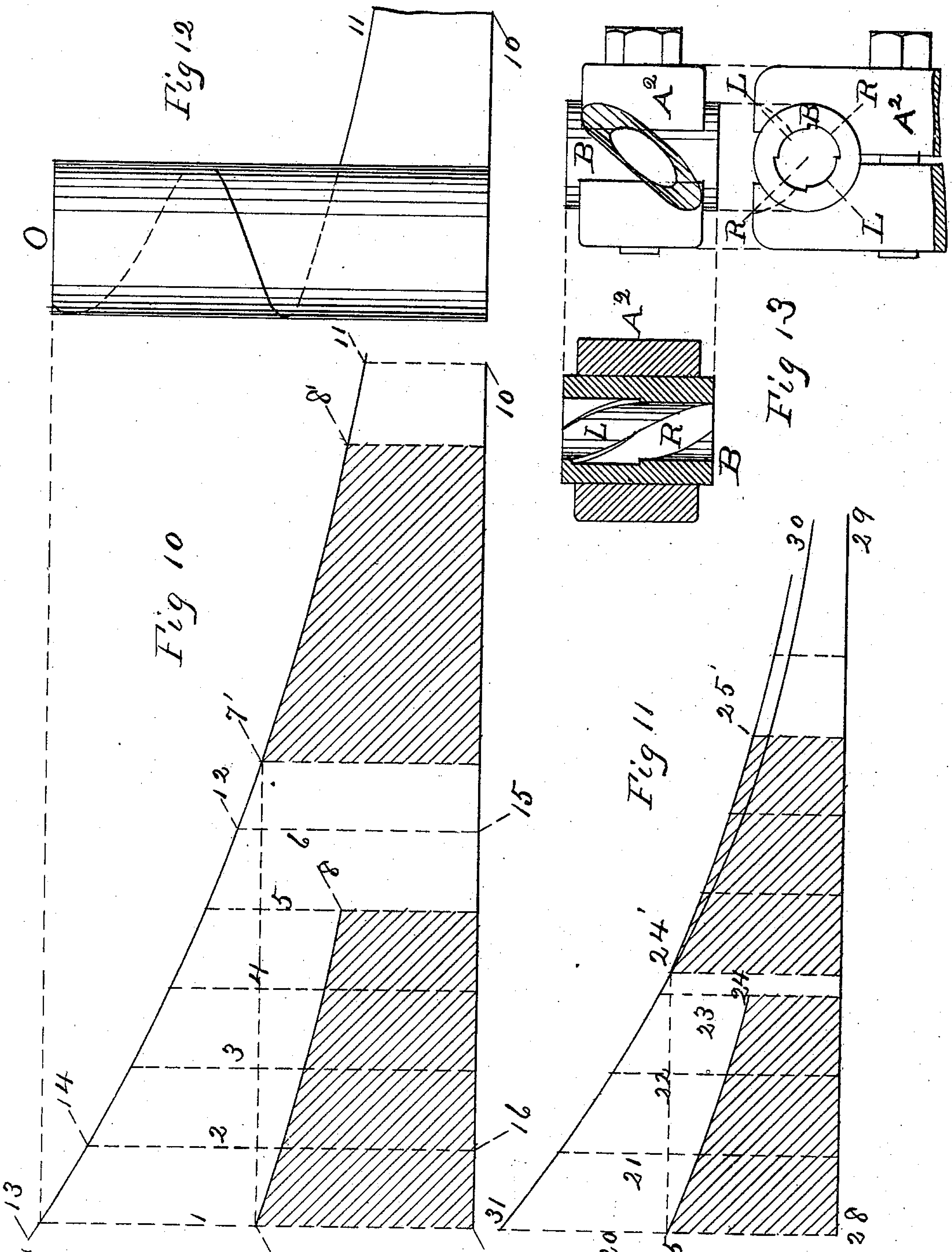

Witnesses —

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UNITED STATES PATENT OFFICE.

FRANCIS H. RICHARDS, OF CLEVELAND, OHIO, ASSIGNOR TO J. D. COX, JR., AND F. F. PRENTISS, BOTH OF SAME PLACE.

MACHINE FOR MAKING TWIST-DRILLS.

SPECIFICATION forming part of Letters Patent No. 320,968, dated June 30, 1885.

Application filed August 15, 1883. (No model.)

To all whom it may concern:

Be it known that I, FRANCIS H. RICHARDS, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented Improvements in Machines for Making Twist-Drills, of which the following is a specification, reference being had to the accompanying drawings.

My invention relates more especially to the making of that class of twist-drills in which the grooves have an increasing pitch and an increasing cross-sectional area from the point of the drill toward the shank thereof.

The object of my invention is, chiefly, to provide means for forming the grooves of twist-drills to have a more perfect ratio or increment of increase in the pitch thereof for forming said grooves to have an increasing cross-sectional area from the point of the drill toward the shank thereof, and for making the grooves in a series of sizes of drills by a corresponding series of adjustments of the same mechanism at the same time preserving the aforesaid ratio of increase of the pitch thereof.

For the attainment of these objects my invention consists in certain mechanism, hereinafter described, for forming the grooves in twist-drills, in which the pitch of the said grooves made in a drill by means of said mechanism is determined by the pitch of the groove of a pattern-cylinder, forming, for the time, a part of said mechanism. It also consists in the nature of the curve of the said pattern-cylinder groove, whereby it is made to more perfectly perform its function of determining the pitch of the grooves of a series of sizes of drills.

Referring to the drawings, Figure 1 is a side elevation of a twist-drill-milling machine embodying my improvements with the parts adjusted to a position for milling the grooves of large drills. Fig. 2 is a similar view showing the parts as adjusted for milling the grooves of smaller drills than in the previous figure. Fig. 3 is a detail of Figs. 1 and 2. Fig. 4 is an enlarged plan view of a drill, showing the position of the milling-cutter in the two positions relative to the same. Fig. 5 is a diagram to more clearly show the axes, center lines, and angles of Fig. 4. Figs. 6 and 7 are sections of the drill shown in Fig. 4 in lines *x x* and *y y*, showing the relative cross-sectional area of the grooves at these points. Fig. 8 is a section of the drill near its point, and Fig. 9 is a section of the blank for the same before the forming of the grooves therein. Fig. 10 is a view, on a reduced scale, relative to Figs. 4 to 9, inclusive, showing the kind of curve employed for the groove of the pattern-cylinder. Fig. 11 is a similar view showing a curve made in an arbitrary manner, in order to explain by contrast the curve in Fig. 10, and Fig. 12 is a view showing the application of the said former curve to the forming of said groove. Fig. 13 is a detail of Figs. 1 and 2.

In the drawings, F is the frame of a twist-drill-milling machine having standards A, A′, and A^2 formed upon or secured thereto rigidly or adjustably, as preferred.

B is the bushing that supports the drill-blank D to the action of the milling-cutter C′, which is carried by an arbor, S′. (Only partially shown.) The bearing for said arbor S′ is not shown, but it may be of any construction suitable to hold and properly raise the same during the milling operation in the usual manner.

The mechanism I prefer to use for supporting and operating said spindle is shown in United States Patent No. 286,150, Figs. 1, 2, 6, and 7. This mechanism during the operation of cutting a groove moves the cutter slowly away from the blank for the purpose of forming the drill with a center of increasing thickness from the point toward the shank thereof; but it does not vary the angle of the cutter relative to the drill-blank. The cutter may and usually does, unless the drill is very large, finish the groove by a single cut. This may be done and the groove so made still have an increasing width sufficient to produce an increasing cross-sectional area thereof from the point toward the shank of the drill, provided the milling-cutter has the proper size and position and the pattern-cylinder groove has a sufficiently-increasing pitch, regard being had to the diameter and size of groove of the drill-blank to be operated upon. Said diameter and the ratio of increase of the pitch may be readily formed experimentally or by the method hereinafter explained. By referring to Fig. 4, which is a view closely approximating an example in actual practice, it will be seen that the position of the cutter—*i. e.*, its angle—corresponds very nearly to the pitch of the groove at the point of the drill, which angle is maintained throughout the operation of cutting the groove. During this operation the blank is fed spirally to the cutter by means of a pattern-cylinder having a groove of an increasing pitch, as hereinafter described. When the cutter is near the point of the drill, as seen in the direction of line d' d', said cutter and shape of drill-groove appear as in Fig. 7; but when near the shank, and seen in the direction of line e' e', (this line being supposed to be tangential to the drill-groove at this point,) said cutter and groove will appear as in Fig. 6, and the width z of the groove will obviously be greater than shown in Fig. 7.

The bushing B is shown enlarged in projection in Fig. 13 as held in A^2 by clamping, and having formed therein spiral enlargements R to allow the ridges on the drill-blank to pass through, leaving the surfaces L to support the said blank by the cylindrical portion thereof only. The spiral enlargements R are made wider than the ridges of the drill-blank, because of the different degrees of spirality of said ridges at different points in their length. In the top of bushing B an opening, N, Fig. 13, is made, through which the milling-cutter has access to blank D.

The spindle S is provided at E with a suitable socket, chuck, or other device to hold the drill-blank D and with a gear, G′, whereby it is rotated. It is supported at one end by bearing A′, and its opposite end passes centrally through and is supported by the pattern-cylinder O, which is supported in a bearing in standard A. This cylinder O has a spiral groove, G, formed therein of a geometrically-increasing pitch uniform with the pitch of the drill-grooves to be formed by the machine.

On the top of A is a boss, H, in which a thimble, I, is secured by a set-screw, as shown, or otherwise, as may be preferred, for holding in place the swivel resistance-pin J, which is of a shuttle-shaped form at its lower end and fitted to slide in the groove G of cylinder O, and to revolve in I to conform to the varying pitch of the said groove as the said cylinder slides by it.

A long pinion, P, meshing with gear G of spindle S, is supported in bearings A A′, and carries a worm-wheel, G^2, which is acted upon by worm W, carried in bracket-bearing M. Power being applied to W, the worm-wheel G^2 and pinion P are thereby rotated, and by means of the latter and gear G′ the motion is communicated to spindle S at any point of its longitudinal movement.

In operation the pattern-cylinder O is so adjusted to position upon spindle S that such a portion of the groove G shall be operative to move the said spindle longitudinally during its rotation, as is uniform in pitch with the required pitch of the grooves to be made in the drill-blank D. It will be noticed that Figs. 1 and 2 are alike except in the position of pattern-cylinder O upon spindle S, and the size of the drill-blank being grooved. In Fig. 1 a portion, U, of the groove G is shown as being used for a large-sized drill, and in Fig. 2 another portion, V, thereof is shown as being used for a proportionally-smaller one. For an intermediate size still another portion, as X′, of the pattern-groove would be selected. Thus, by a series of simple adjustments of the pattern-cylinder O upon spindle S, different portions of the same pattern-groove G are made operative, as described, thereby enabling the machine to be used for grooving a series comprising a considerable number of drills without a different pattern-cylinder. The pattern-cylinder O being now rigidly secured in proper position upon spindle S and a proper motion applied to W, it is obvious that while the gearing described acts to revolve said spindle S, the pin P′ and groove G will operate to impart a simultaneous longitudinal movement thereto having a velocity relative to the velocity of rotation, proportional to the pitch of that portion of said groove traversed by said pin P′, thereby feeding drill-blank D to the action of milling-cutter C, to form grooves therein uniform in pitch with the said portion of groove G.

In order to form the groove G in the pattern-cylinder to have such a curve as required to properly accomplish the object of my invention, I proceed as follows: Upon a sheet of suitable material the curve 11 12 13, Fig. 10, is so laid out that if the space between it and the base-line 9 10 is divided by ordinates at equal distances apart, as 1 2 3 4 5 6, the length of said ordinates will be in geometrical progression—that is to say, if the value of ordinate 6 be multipled by the given ratio of the progression, the product is equal to the value of ordinate 5. The value of ordinate 5 being then multiplied by the same ratio, the resulting product is equal to the value of ordinate 4, and so on as far as required. The curve is extended in the reverse direction by a similar process of division instead of by multiplication. Thus, if the length of ordinate 6 equals 8 and the geometrical ratio of an increasing series is $\frac{10}{9}$ then the length of ordinate 5 will be equal to $8\times\frac{10}{9}=\frac{80}{9}=8\frac{8}{9}$. A sufficient length of the curve being determined, the sheet is next cut to the form shown at 9 10 11 12 13, and wound upon the plain pattern-cylinder, as shown in Fig. 12, so that the ordinates 1 2 3 4, &c., are parallel to the axis of said cylinder, and the curve 11 12 13 forms the proper spiral for the groove G, which is then made according thereto.

A geometrical curve I consider superior to others for this purpose, because of this quality: When each ordinate of one portion of the curve is divided or multiplied by the same number, the curve thus produced is identical with some other portion of the original curve. This result is represented in Fig. 10, where the ordinates 1 2 3 4 5 of the curve 11 12 13 are divided by 2, producing the curve 7 8, which, being moved to the right a sufficient distance in a direction parallel to the base-line 9 10, is found to coincide with another portion of the said curve 11 12 13, as shown at 7′ 8′.

Owing to the circumstance that a geometrical curve has the above property, the manufacture of pattern-cylinders, in which the grooves have a terminal pitch greater or less than the original, is greatly facilitated by having the groove of such original or master pattern-cylinder made according thereto. The said master pattern-cylinder being fixed in the place of the usual leading-screw in a suitable screw-cutting lathe, and the proper change-wheels being employed, grooves may then be cut in other pattern-cylinders of a greater or lesser pitch, as required. Thus, for instance, if the master pattern-groove is adapted for use in grooving drills of from three-fourths to one and one-half inches diameter, another may be made therefrom adapted for drills of from one-fourth to one inch diameter, so that drills of from three-fourths to one inch diameter may be grooved by using the coarser end of the pattern-groove having the least pitch or by using the finer end of that having the greatest pitch, as may be most convenient.

A pattern-cylinder having a groove of the curve herein described is adapted not only for use in twist-drill groove-milling machines, but also for use in other machines for performing other operations in their manufacture—as, for instance, in backing-off machines; and so accurately may the pattern-cylinders be grooved by the method above described that the milling may be performed in one machine using the finer part of one pattern-groove and the backing-off in another machine using the coarser part of another pattern-groove having a coarser pitch, the drills being rigidly fixed in this case in the spindle S and no guide employed other than bushing B or its equivalent.

In order to illustrate still more clearly the peculiar advantages of a geometrical curve for the purpose herein described, I show in Fig. 11 another curve, 30 31, more nearly that usually employed and laid out in an arbitrary manner. By dividing similarly, as before, the ordinates 20 21 22 23 we obtain the curve 24 25, which, being moved in a direction parallel to the base-line 28 29 toward the right, is found not to coincide with any part of the original curve 30 31. Pattern-cylinders, therefore, having grooves made conformable to such curve cannot be properly made or used in the manner hereinbefore described.

To obtain in practice for the curve 11 12 13, such as described a ratio great enough to form the groove G of a sufficiently-increasing pitch, so that the grooves made in the drill-blank may have an increasing cross-sectional area, I prefer the following method: The most desirable pitch of the groove at the point of a drill of given size is first chosen, and the corresponding angle laid off at $d'' d'''$ and at $c'' c'''$, Fig. 5, which lines correspond to the positions of the milling-cutter at $d d'$ and $c' c'$, Fig. 4. The size of the drill and angle of cutter now being known, a suitable cutter is next selected, preferably having a diameter between three and four times the diameter of the drill, and its form determined, substantially as described, in connection with Fig. 3 of United States Patent No 56,033. From these data the section x x, Fig. 7 is drawn, showing the cross-sectional area of the groove near the point of the drill, corresponding to the form of the cutter selected. The width of another section of the groove, y y, is next laid off at z, sufficient to secure the desired increase in its cross-sectional area at a point about one revolution of the spiral groove from the point where section x x is taken, Fig. 4, and the cutter is drawn therein at such an oblique projection, which is determined by the usual method of "laying off by points" from the form of the cutter as will form the said groove G of the designated width. A line $e'' e'''$, Fig. 5, is now drawn, making the same angle with line $c'' c'''$ as the plane of the cutter in Fig. 6 makes with the axis of the groove at the line where the section y y thereof is taken. Then the line $e'' e'''$ shows the pitch of the groove compared with axis $a' b'$ of the drill at the point i', about one revolution of the spiral from point i''. Now, referring to Fig. 10, lay off an ordinate, 6, which may be about equal to the longest drill to be milled in the machine, and fix one point, 12, of the required curve. Lay off 15 16, equal to the circumference of the pattern cylinder, draw ordinate 2 equal in length to ordinate 6, plus the distance $i' i''$, Fig. 5, thus locating another point, 14, of the desired curve. The pitch of the curve at points 12 and 14, as previously determined, is then laid off, and with these elements the rest of the curve developed after the usual mathematical methods for determining such questions.

The bushing B is especially designed for use when milling grooves in that kind of drill-blank having in cross-section a peripheral outline, as shown in Fig. 9, which, when the grooves are formed, appears as in Fig. 8, the said blank being of the general form of a cylinder, with ridges formed spirally thereon, and having the grooves G so formed therein as to make the cutting-edges e to be in the highest part of said ridges. A part of section c and a part of section G, Fig. 8, adjoining each other at i are circular and concentric, as shown more clearly by comparison with the dotted size-circle passing through point, e, and is the portion of the surface of the blank that slides upon surface L of the said bushing. It is not necessary that the bushing B be made in one piece, but it may be in two or more parts, as preferred, secured in position in the machine in any suitable manner.

The spindle S is shown herein as having a socket, E, for receiving the shank of the drill-blank D; but I do not limit myself to that construction, as any suitable form of chuck, clamp, or dog may be used in lieu thereof; but I have shown the form described merely to illustrate some means therefor.

I have herein used the expression "a metal-removing device" in referring to the milling-cutter C′ for the reason that the combination of mechanism described is also designed for use in connection with a grinding-wheel of any suitable kind as a substitute for said cutter in finishing the grooves of drills previously formed by forging or otherwise. In this application I have shown and described the pattern-cylinder O to be adjustable upon spindle S for the purpose of bringing into use the different portions thereof, as required; but if the said cylinder were fixed on said spindle—as, for instance, in the position shown in Fig. 1, and the resistance-pin J was constructed to be similarly adjusted to the required positions, as U, V, or X′, relative to said cylinder, it is obvious that the same result would be accomplished. I make no claim herein to such construction or adjustment of said resistance-pin; but in another application, Serial No. 103,851, I have described and claimed the same.

I do not claim, broadly, the combination of a metal-removing device and the spindle S having a pattern-cylinder adjustably secured thereon, as I am aware such a combination has been used, the said pattern-cylinder having in that case a groove of uniform pitch throughout its length; but I am not aware of such a combination having been used in which the said cylinder has a groove of increasing pitch, and is adjustable on said spindle, as or for the purpose herein described. Neither do I claim, broadly, a pattern-cylinder for twist-drill-making machines having a groove of increasing pitch, as I am aware such have been used; but I am not aware that any such have been used heretofore in which the said groove is of a curve having ordinates in a geometrical progression, as herein described. I make no claim herein to the twist-drill nor the drill-blank herein described, the same being introduced for the more ready explanation of my invention; but in so far as the same may embody patentable invention it forms in part the subject-matter of a separate application, Serial No. 101,993.

Having thus described my invention, I claim—

1. The improved twist-drill pattern-cylinder herein described having the groove G of a pitch increasing by a geometrical ratio, substantially as described, and for the purpose described.

2. In a twist-drill-making machine, the combination of a frame-work having bearing A and A′, spindle S, a pattern-cylinder having a groove of a pitch increasing by a geometrical ratio, said cylinder being adjustable longitudinally on said spindle, a resistance-pin carried in bearings A and fitting said groove, and spindle-turning mechanism, substantially as described, for rotating said spindle S, substantially as described.

3. In a twist-drill-milling machine, the combination of the cutter C′, formed substantially as described, a support, as B, for said drill, and drill holding and feeding mechanism, substantially as described, adapted to spirally feed the drill to the cutter, with a pitch increasing in geometrical ratio, substantially as set forth.

4. In a twist-drill-making machine, the combination of the drill-holding spindle S, gear G′, fixed thereon, the pinion P, meshing with said gear, and spindle-feeding mechanism, substantially as described, for imparting a longitudinal motion to said spindle and gear, substantially as set forth.

5. The drill-supporting bushing B, having bearing-surfaces L and enlargements R, substantially as and for the purpose described.

6. The combination of spindle S, gear G′, pinion P, spindle-feeding mechanism, substantially as described, for imparting longitudinal motion to said spindle, worm-gear G^2, fixed to said pinion, and worm W, substantially as set forth.

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