No. 842,447. PATENTED JAN. 29, 1907.

J. F. COOLEY.

CYCLOIDOGRAPH.

APPLICATION FILED NOV. 15, 1902.

10 SHEETS—SHEET 1.

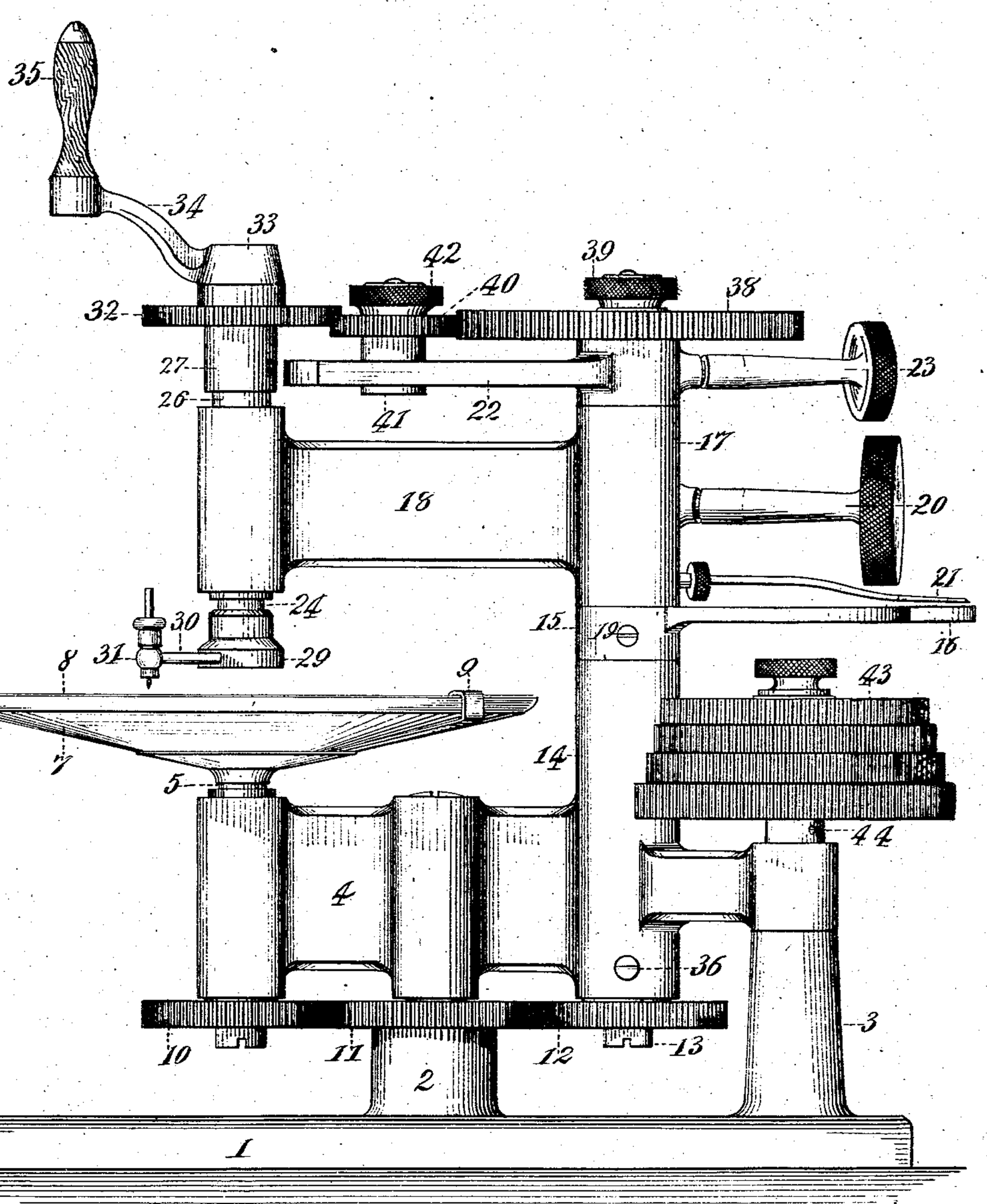


Fig. 1.

Witnesses:
E. L. Harlow
A. L. Mason

Inventor:
John F. Cooley
By J. L. Rusk
Atty

No. 842,447. PATENTED JAN. 29, 1907.

J. F. COOLEY.

CYCLOIDOGRAPH.

APPLICATION FILED NOV. 15, 1902.

10 SHEETS—SHEET 2.

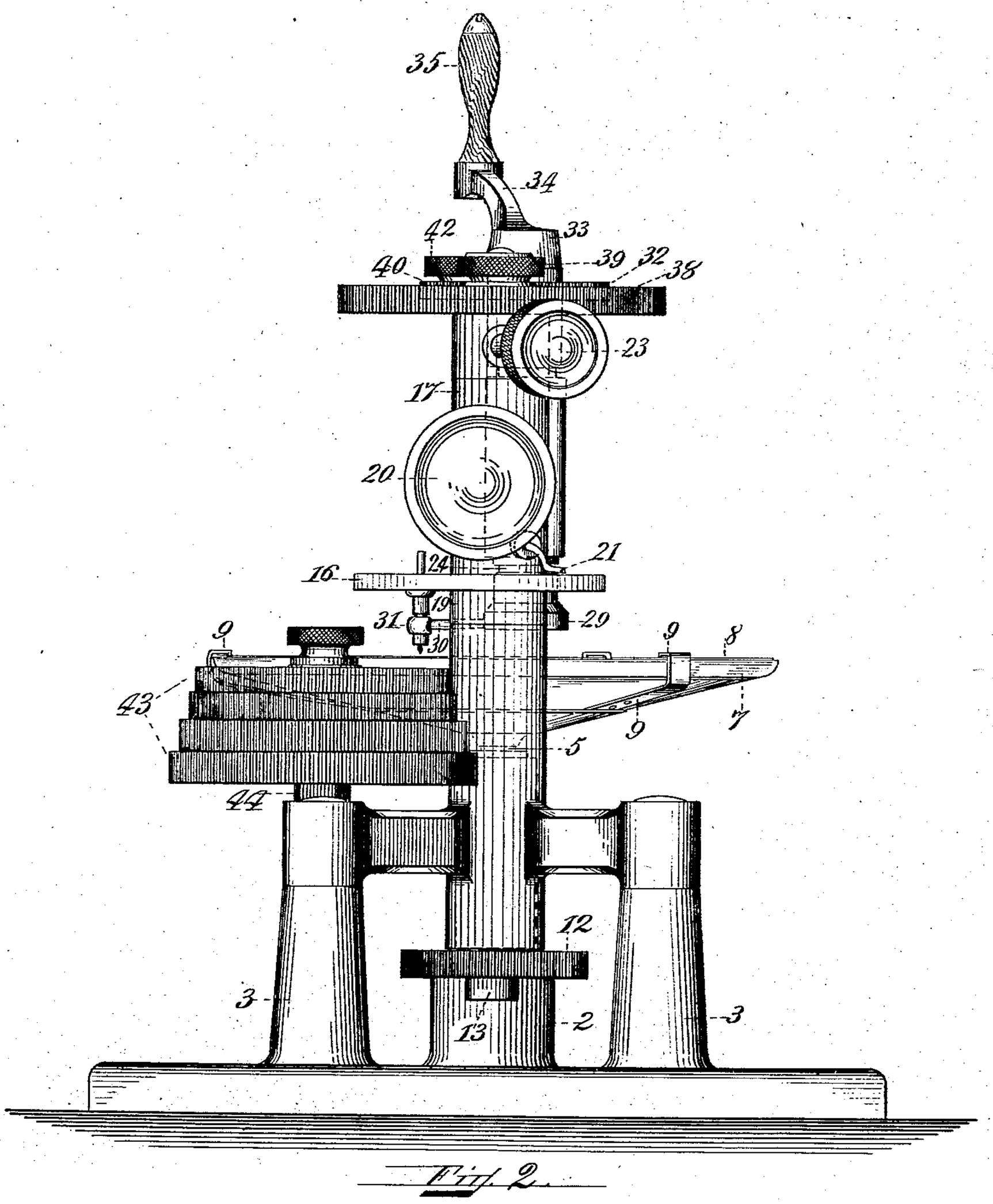


Fig. 2.

Witnesses:
E. L. Harlow
A. L. Wesser

Inventor:
John F. Cooley
By J. L. Rusk
Atty

No. 842,447. PATENTED JAN. 29, 1907.

J. F. COOLEY.

CYCLOIDOGRAPH.

APPLICATION FILED NOV. 15, 1902.

10 SHEETS—SHEET 3.

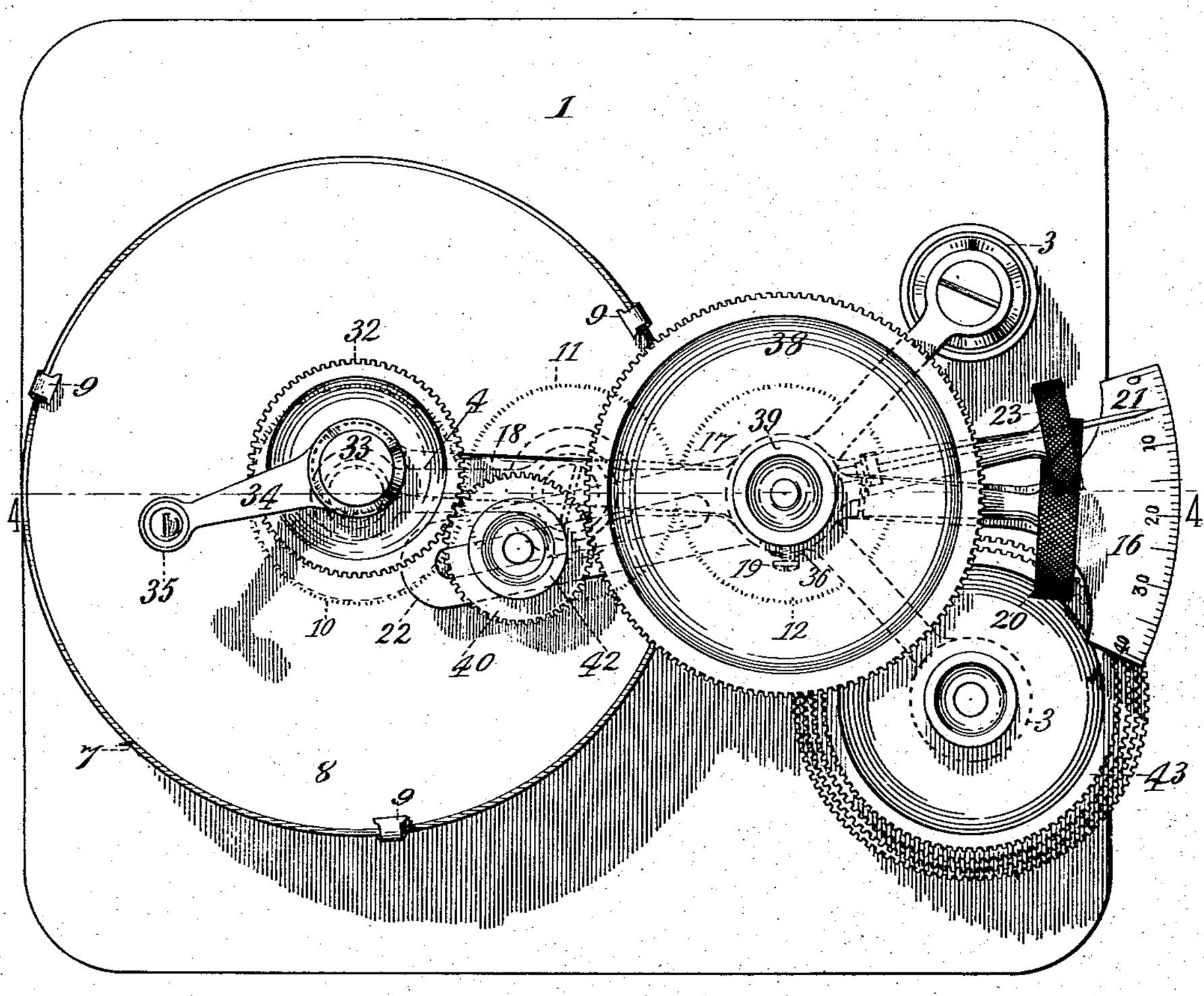


Fig. 3.

Witnesses:
E. L. Harlow
A. L. Mason

Inventor:
John F. Cooley
By J. F. Rusk
Atty

No. 842,447. PATENTED JAN. 29, 1907.

J. F. COOLEY.

CYCLOIDOGRAPH.

APPLICATION FILED NOV. 15, 1902.

10 SHEETS—SHEET 4.

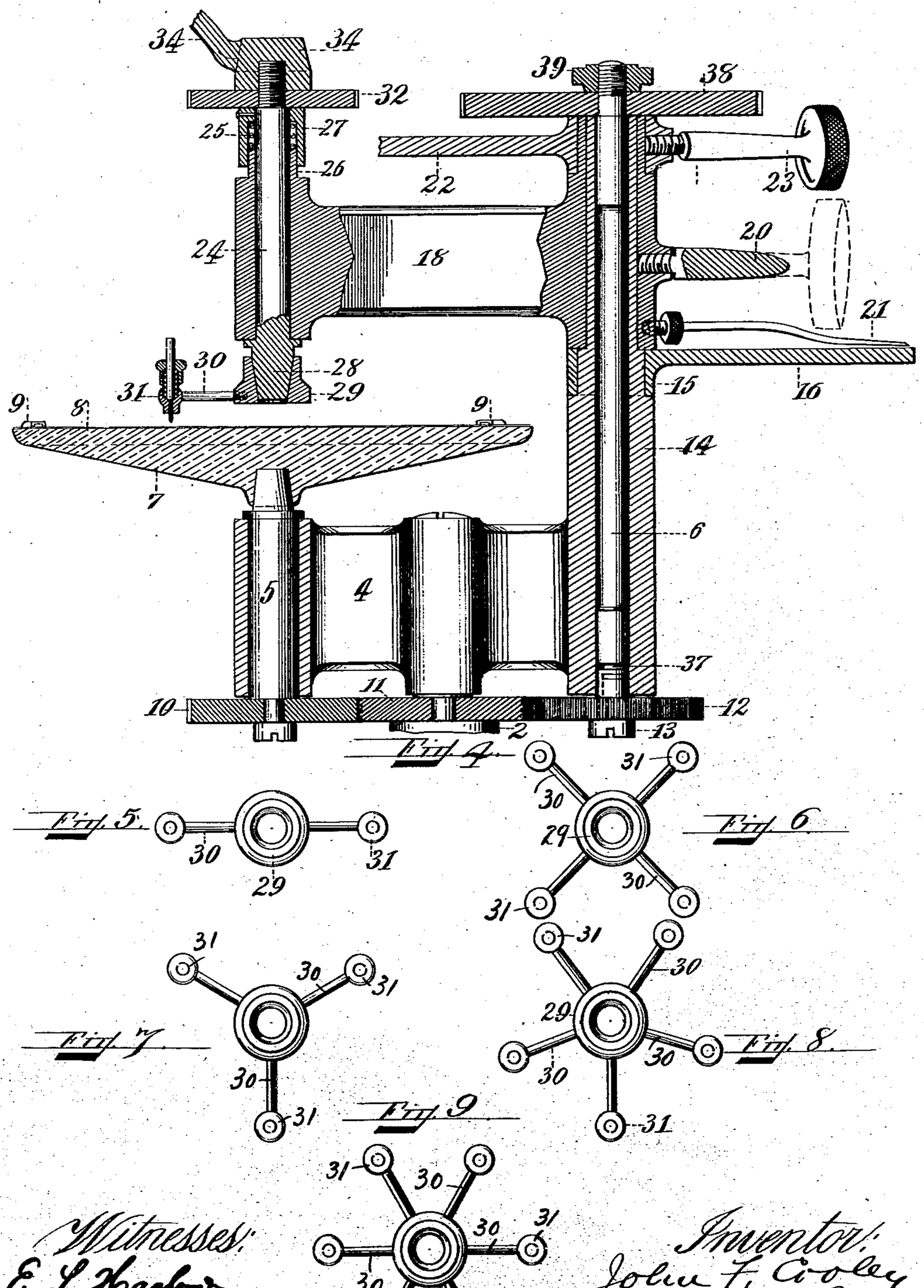


Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 9.

Witnesses:
E. L. Hasbrouck
A. L. Wesson

Inventor:
John F. Cooley
By J. J. Burke
Atty

No. 842,447. PATENTED JAN. 29, 1907.

J. F. COOLEY.

CYCLOIDOGRAPH.

APPLICATION FILED NOV. 15, 1902.

10 SHEETS—SHEET 5.

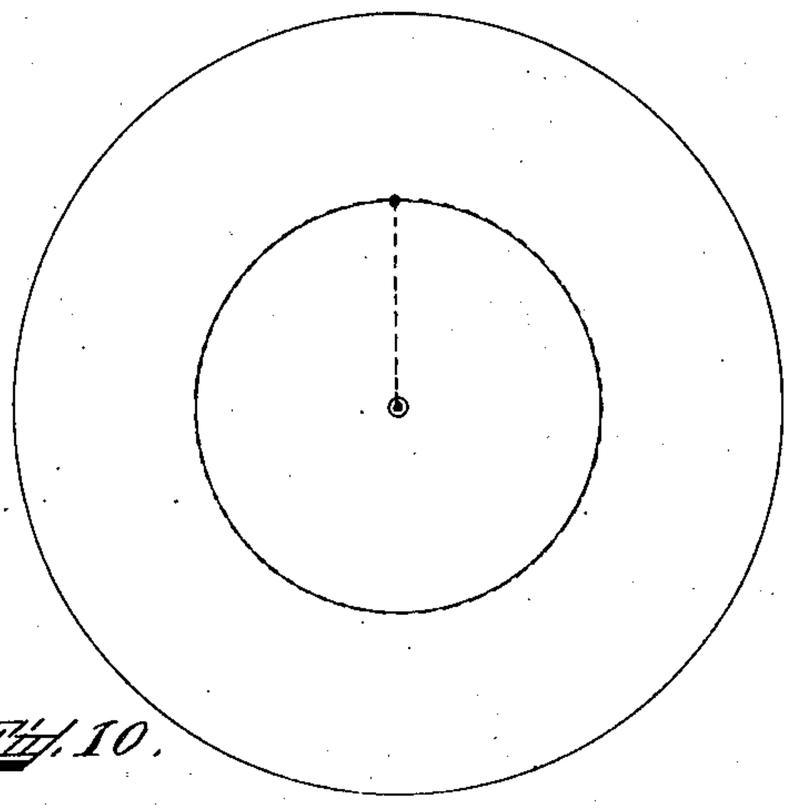


Fig. 10.

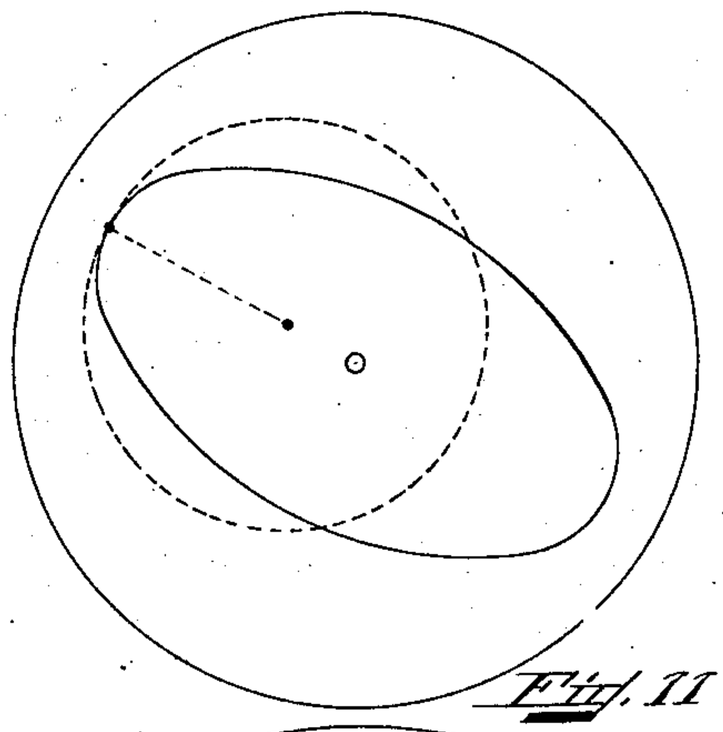


Fig. 11.

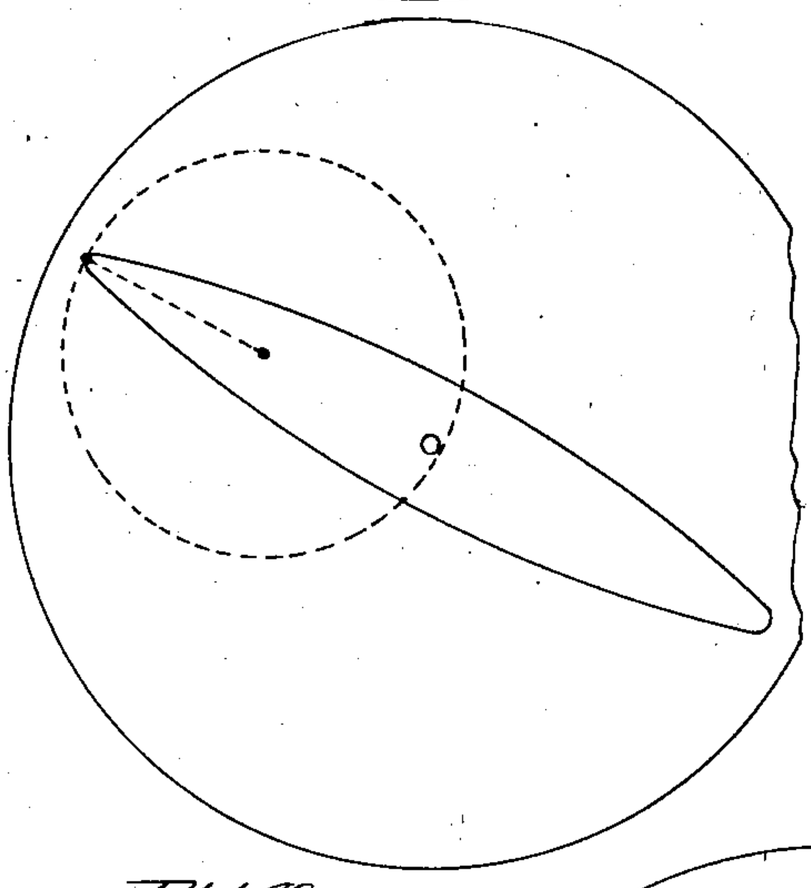


Fig. 12.

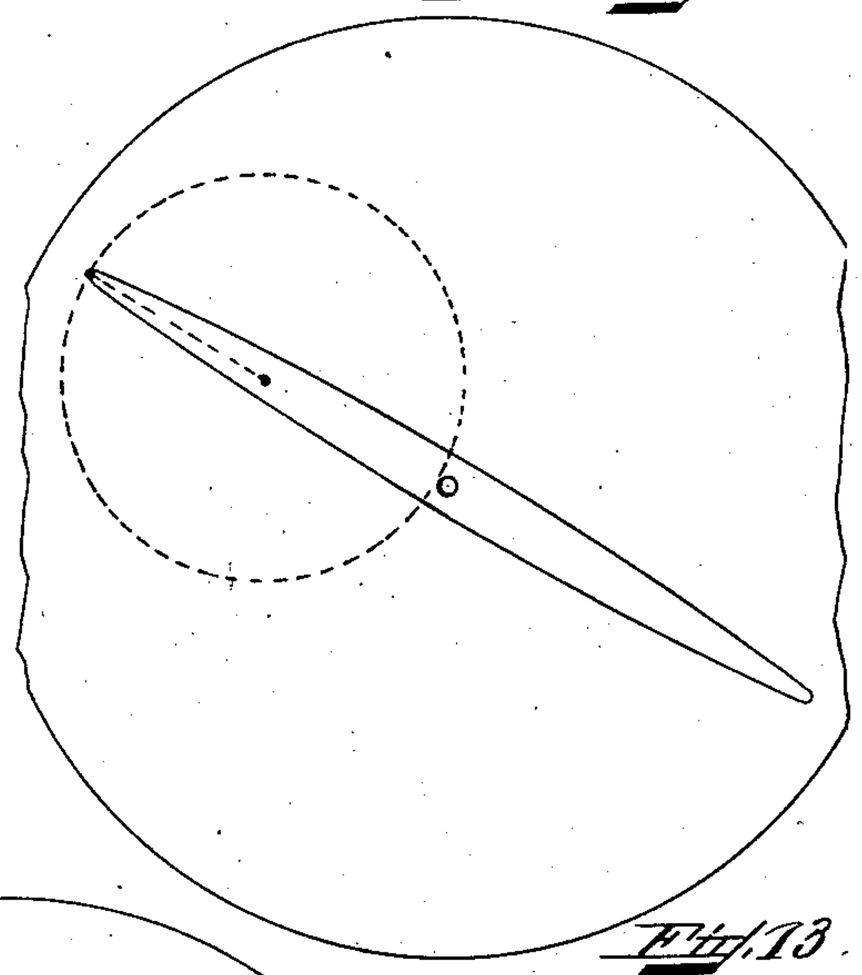


Fig. 13.

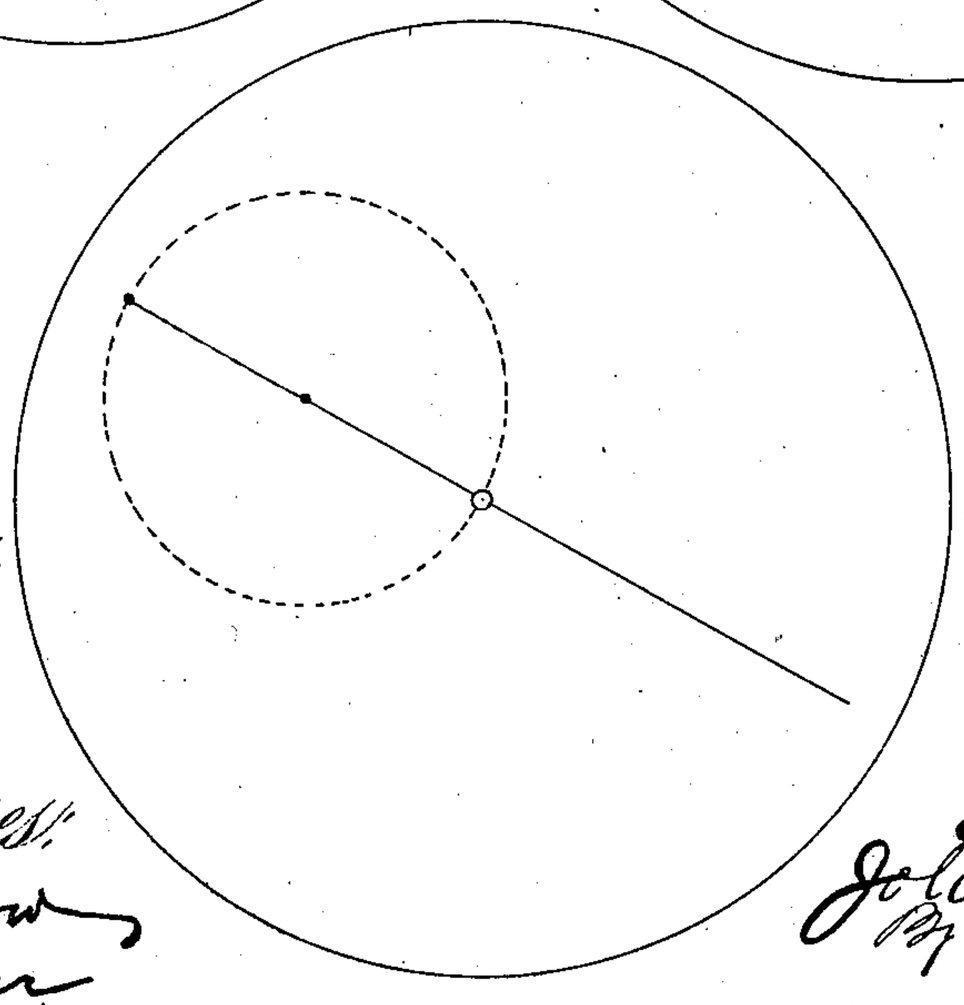


Fig. 14.

Witnesses:
E. L. Harlow
A. L. Mesner

Inventor:
John F. Cooley
By J. L. Rush
Atty

No. 842,447. PATENTED JAN. 29, 1907.

J. F. COOLEY.

CYCLOIDOGRAPH.

APPLICATION FILED NOV. 15, 1902.

10 SHEETS—SHEET 6.

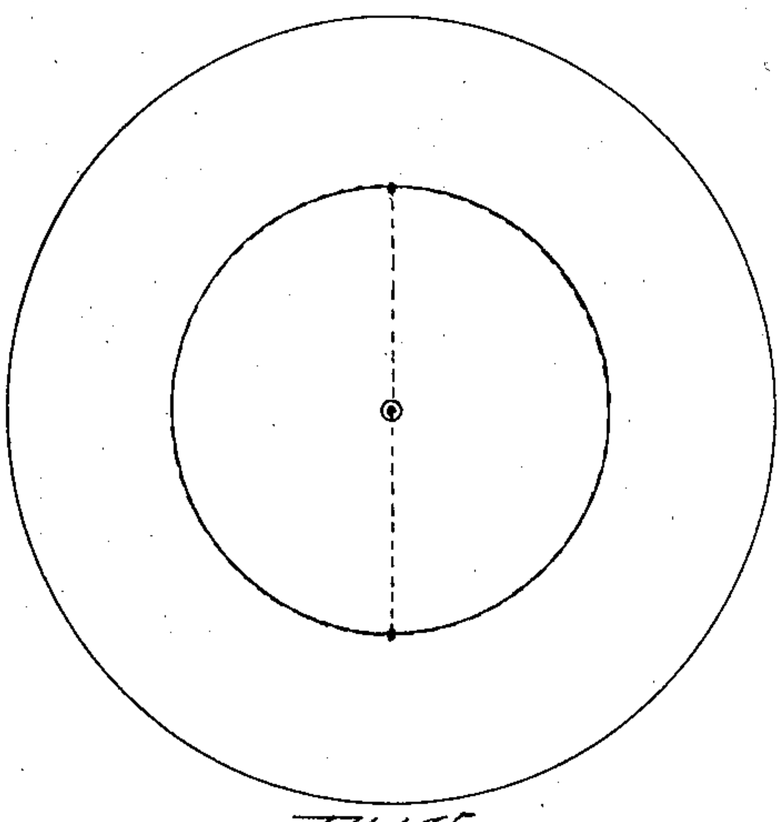
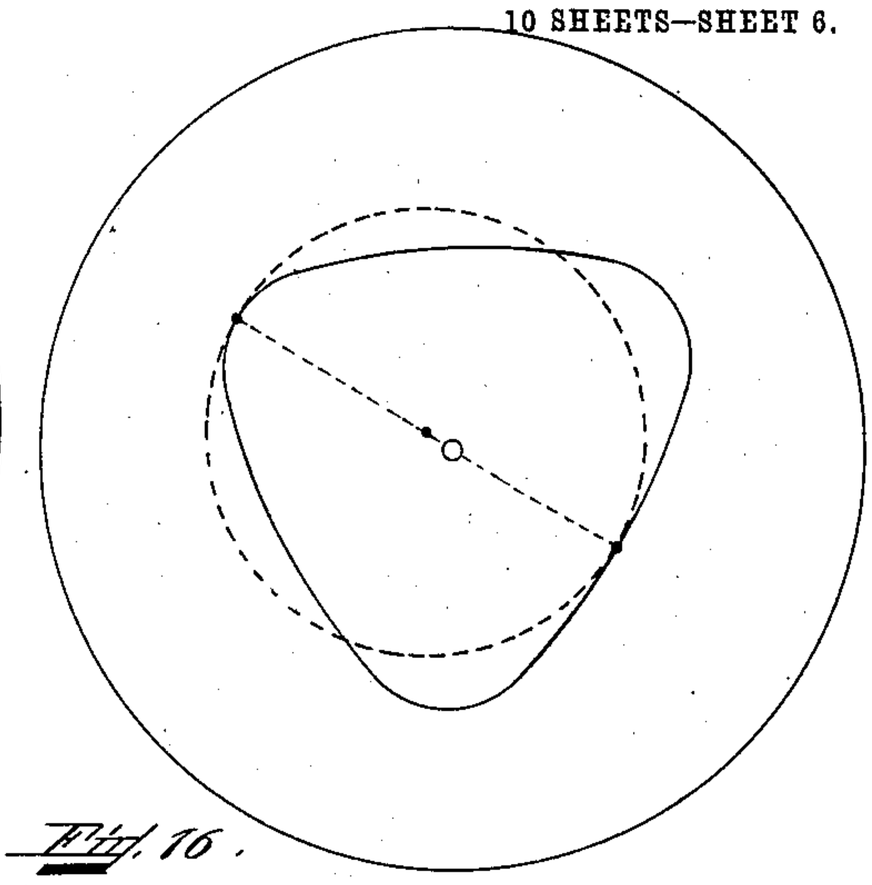


Fig. 15.



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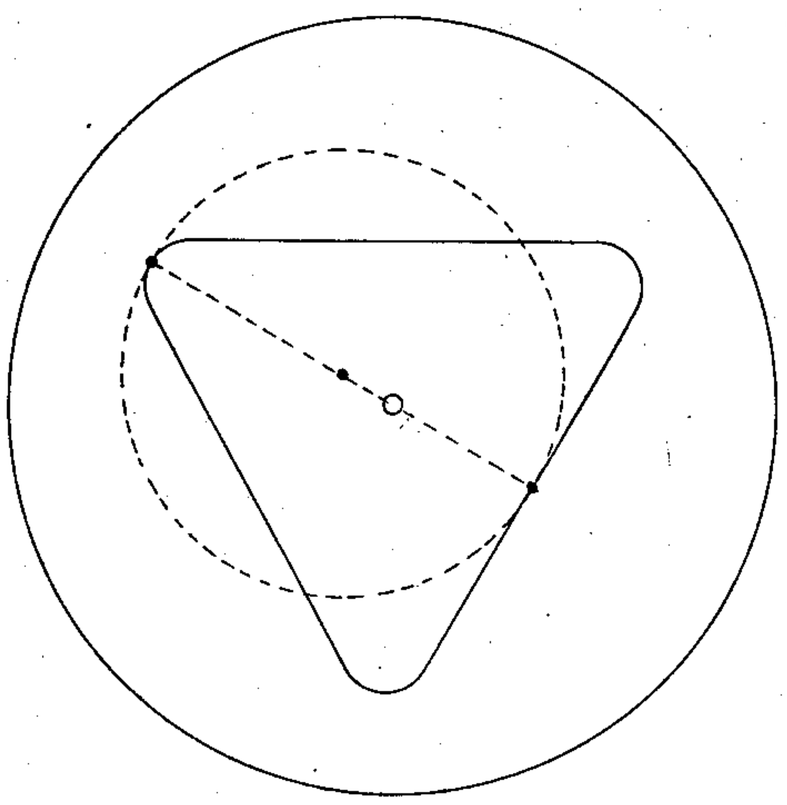


Fig. 17.

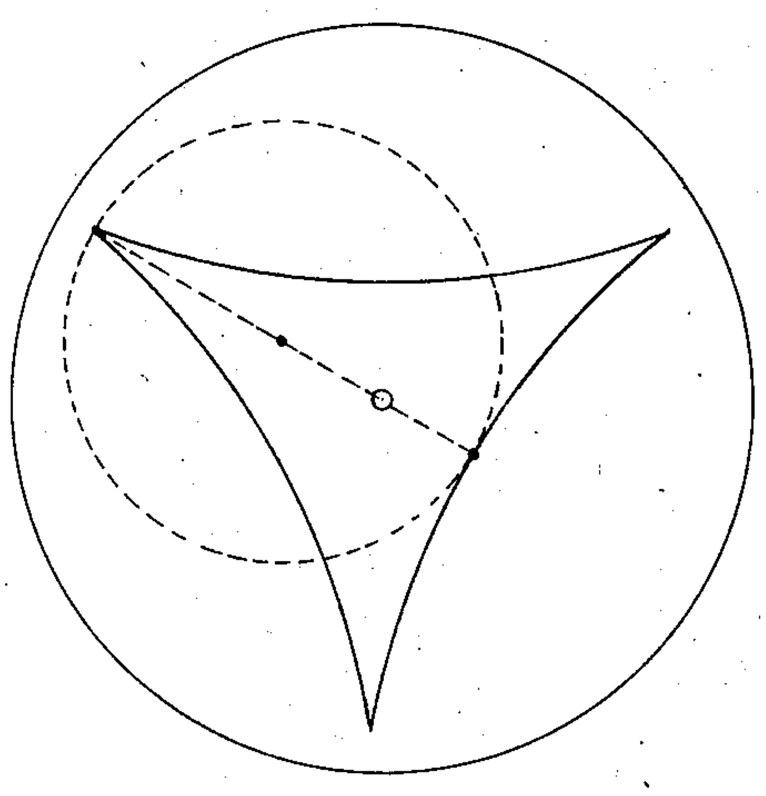


Fig. 18.

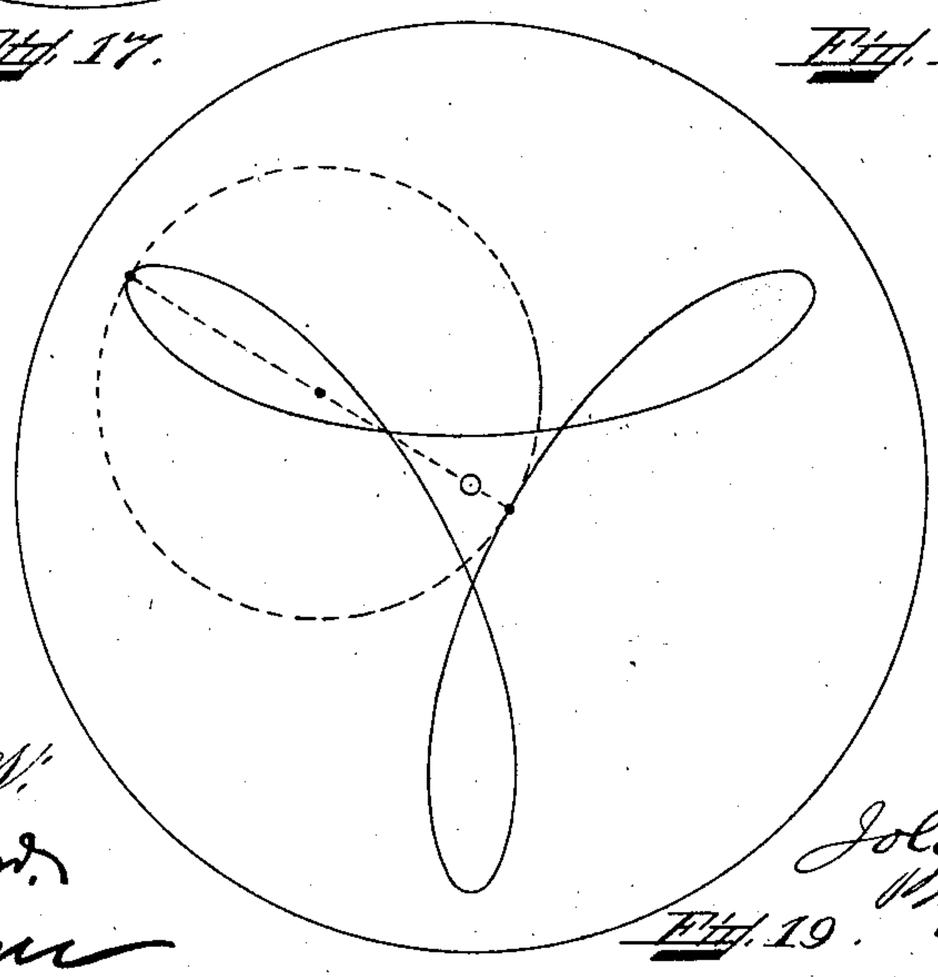


Fig. 19.

Witnesses:
E. L. Harlow.
C. L. Neeser

Inventor:
John F. Cooley
By J. S. Krepp
Atty

No. 842,447. PATENTED JAN. 29, 1907.

J. F. COOLEY.

CYCLOIDOGRAPH.

APPLICATION FILED NOV. 15, 1902. 10 SHEETS—SHEET 7.

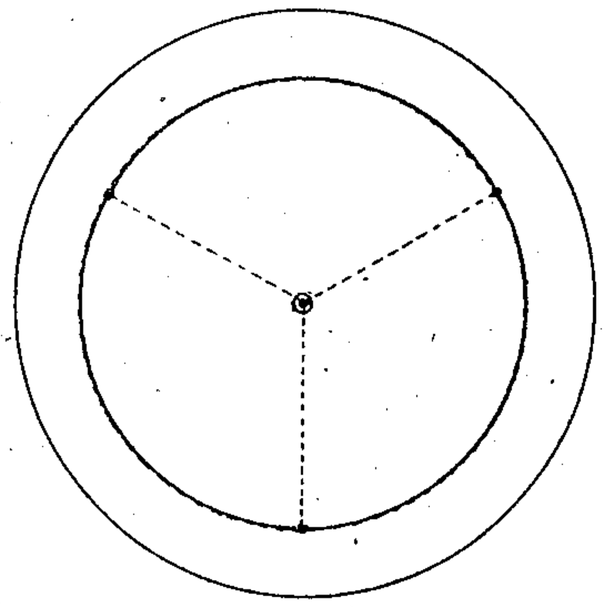
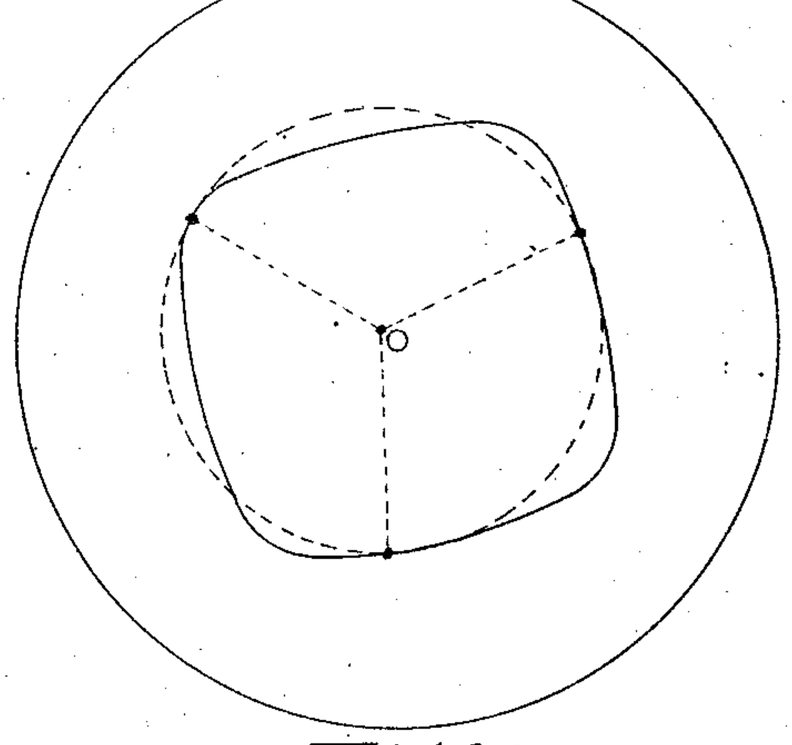


Fig. 20.



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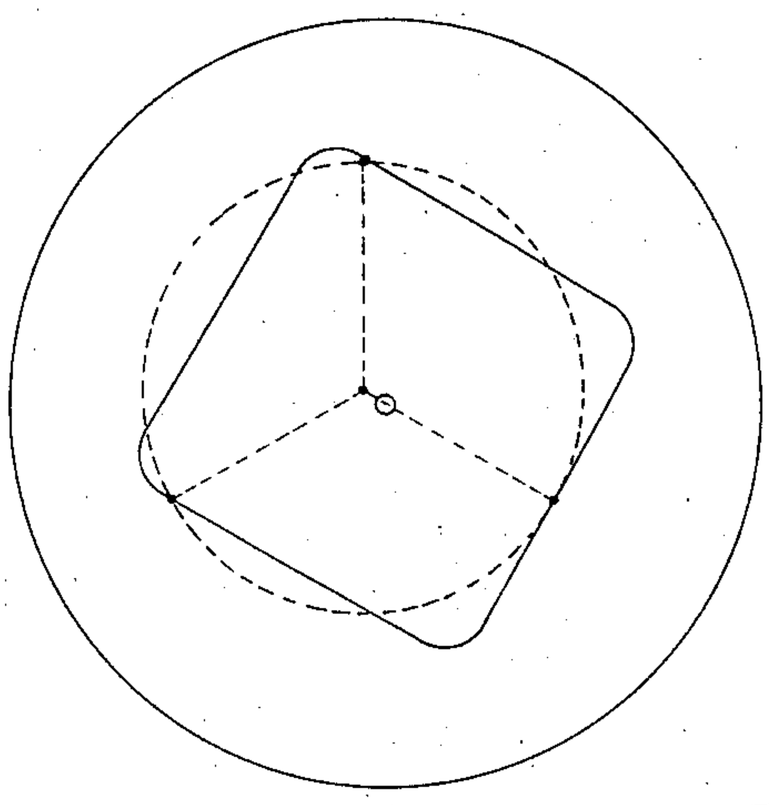

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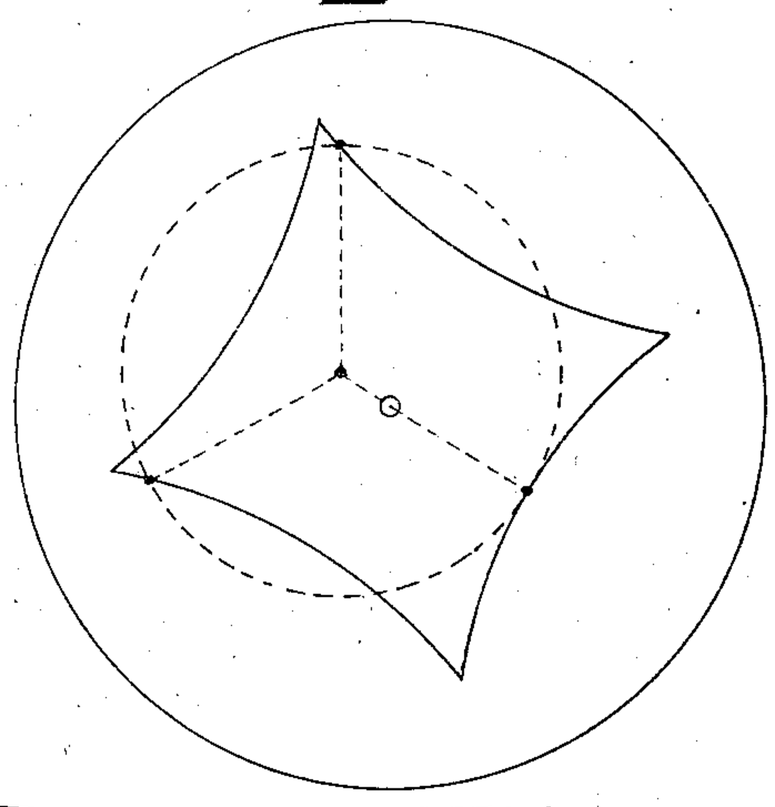

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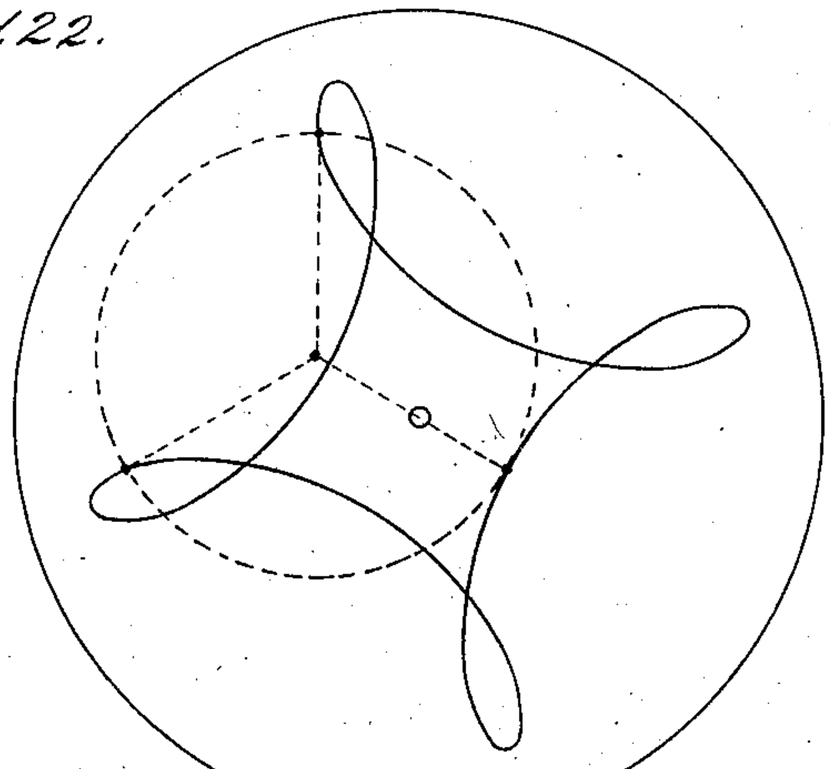


Fig. 24.

Witnesses:
E. L. Harbord
A. L. Wesser

Inventor:
John F. Cooley
By J. J. Rusk
Atty

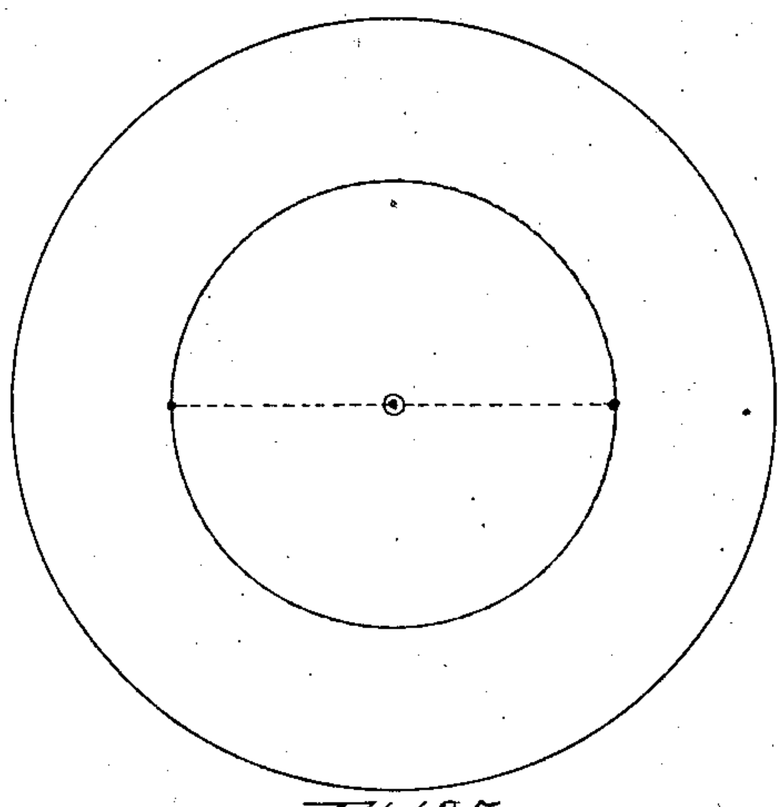
No. 842,447. PATENTED JAN. 29, 1907.

J. F. COOLEY.

CYCLOIDOGRAPH.

APPLICATION FILED NOV. 15, 1902.

10 SHEETS—SHEET 8.



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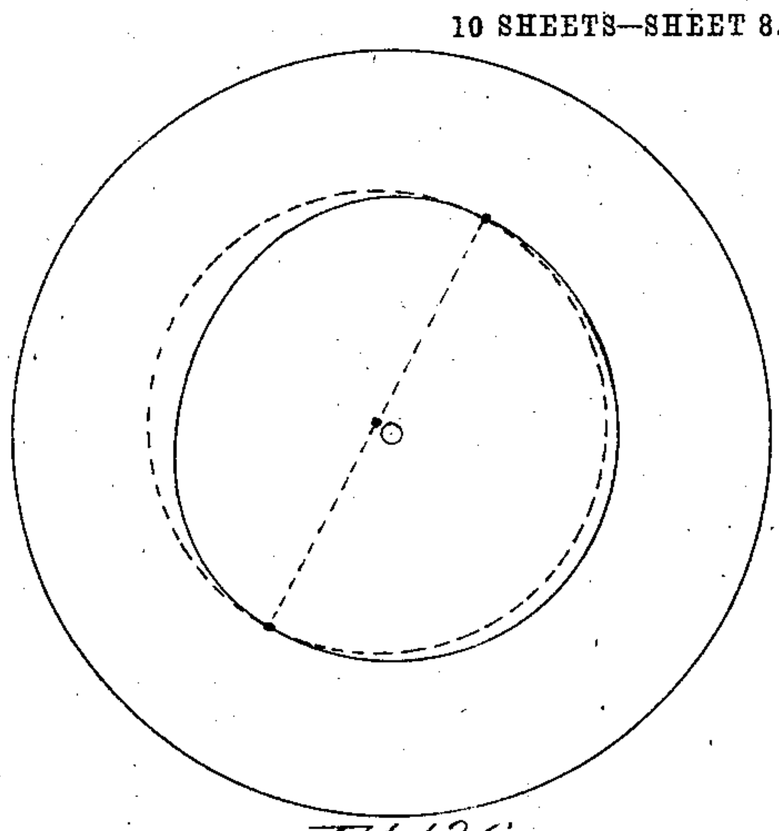

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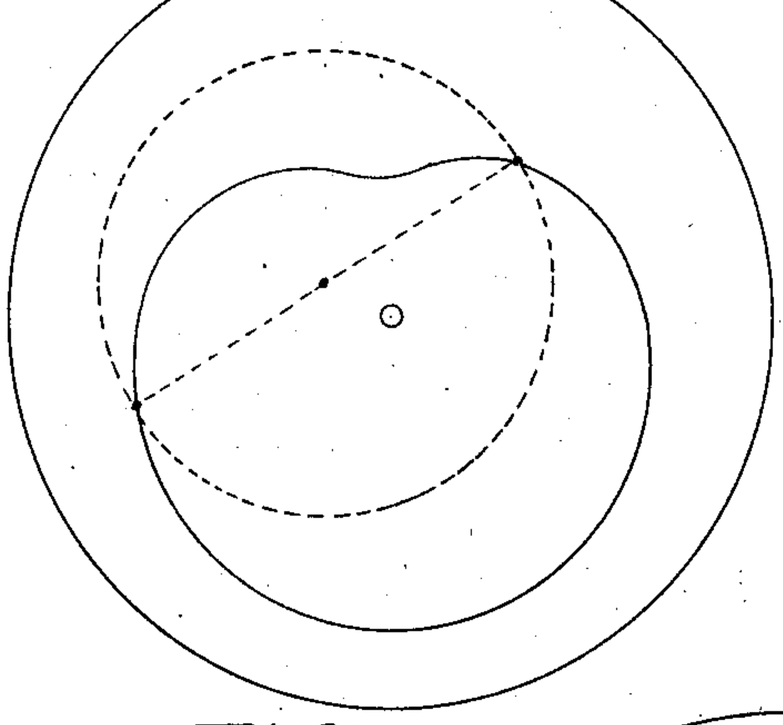

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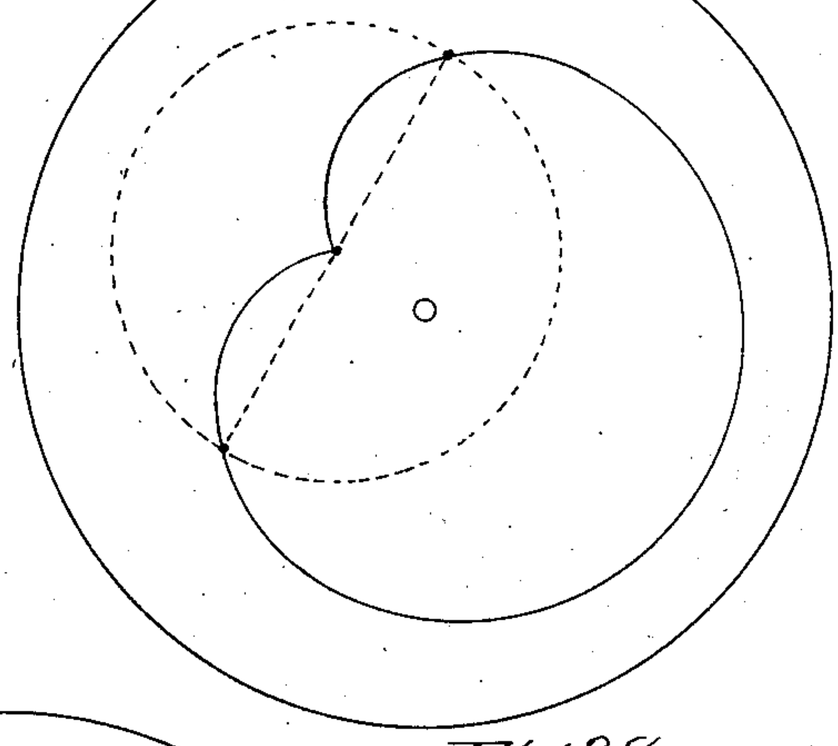

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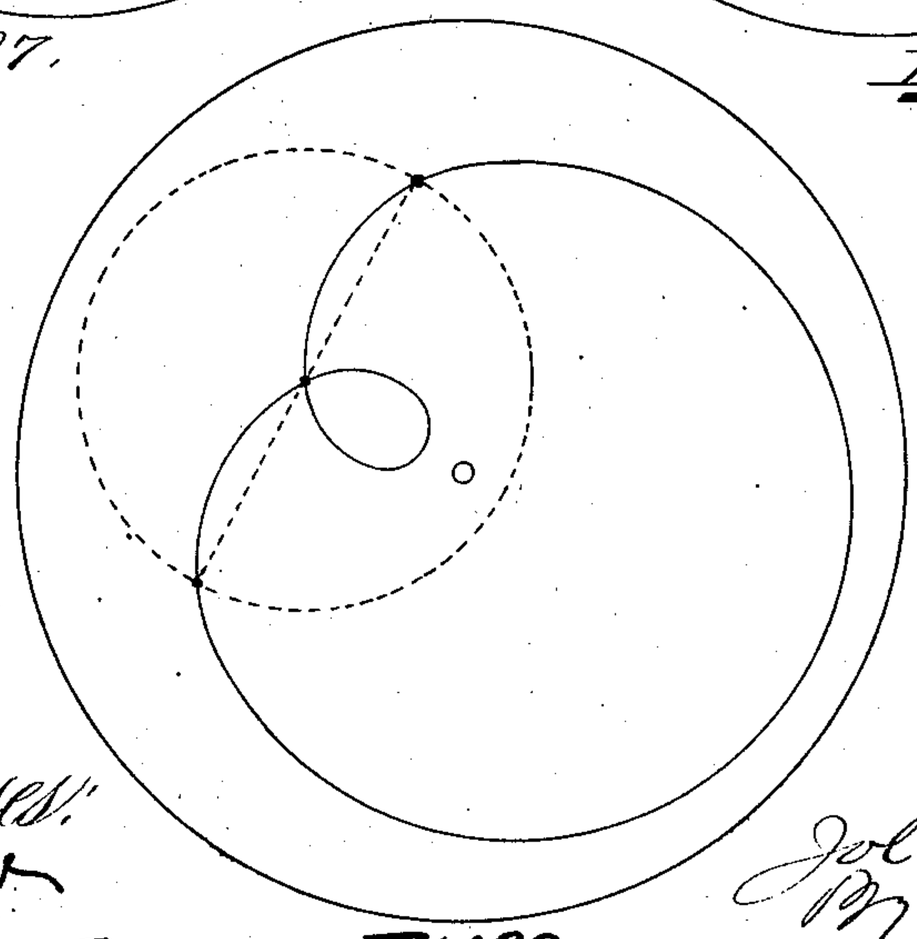

Fig. 29.

Witnesses:
E. L. Harlow
A. D. Nesson

Inventor:
John F. Cooley
By J. L. Rush
Atty

No. 842,447. PATENTED JAN. 29, 1907.

J. F. COOLEY.

CYCLOIDOGRAPH.

APPLICATION FILED NOV. 15, 1902.

10 SHEETS—SHEET 9.

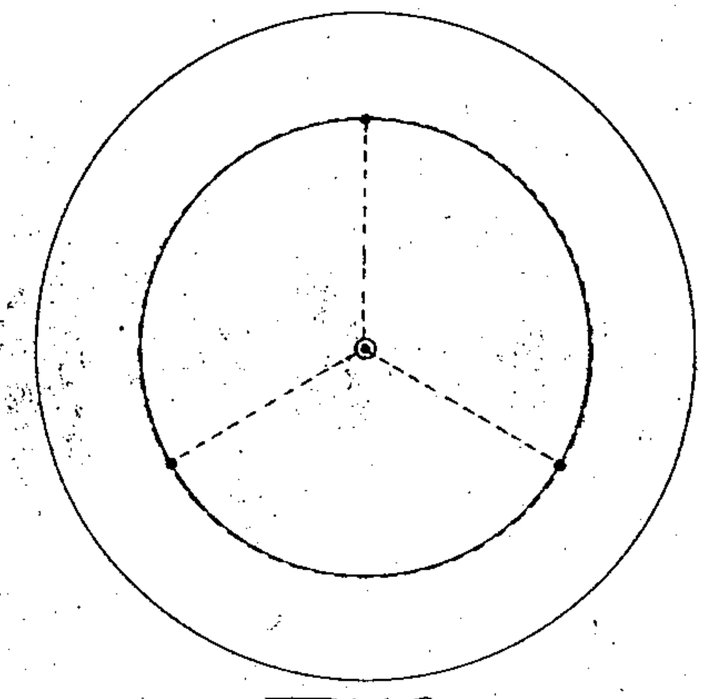

Fig. 30.

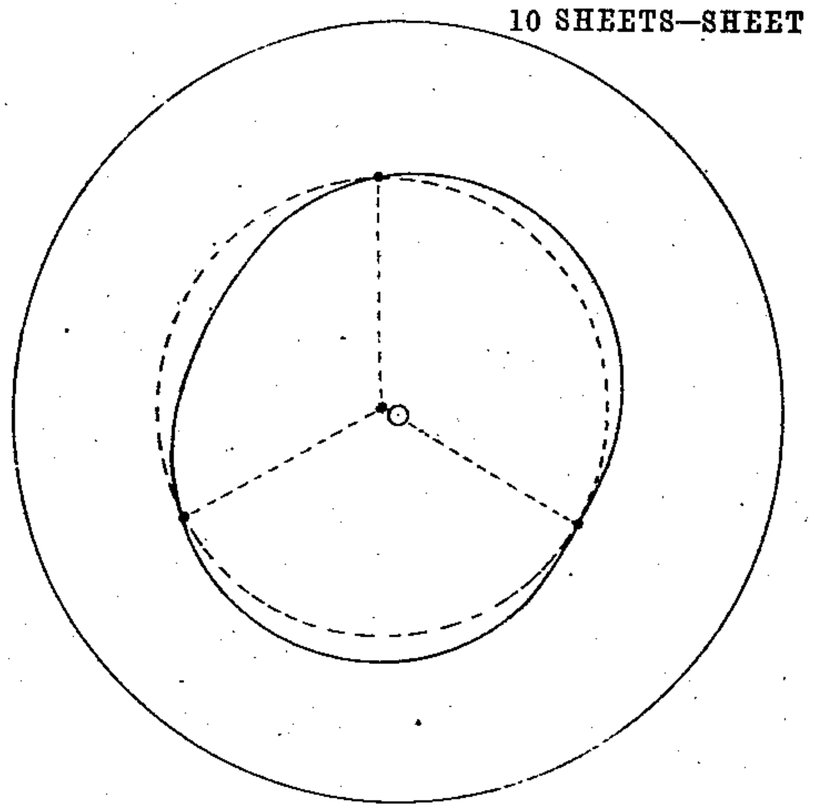

Fig. 31.

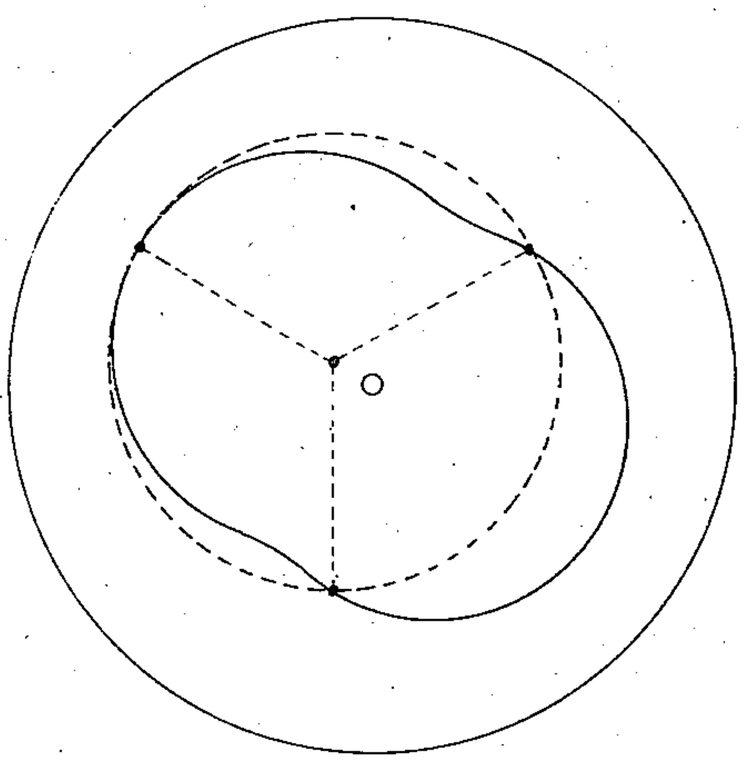

Fig. 32.

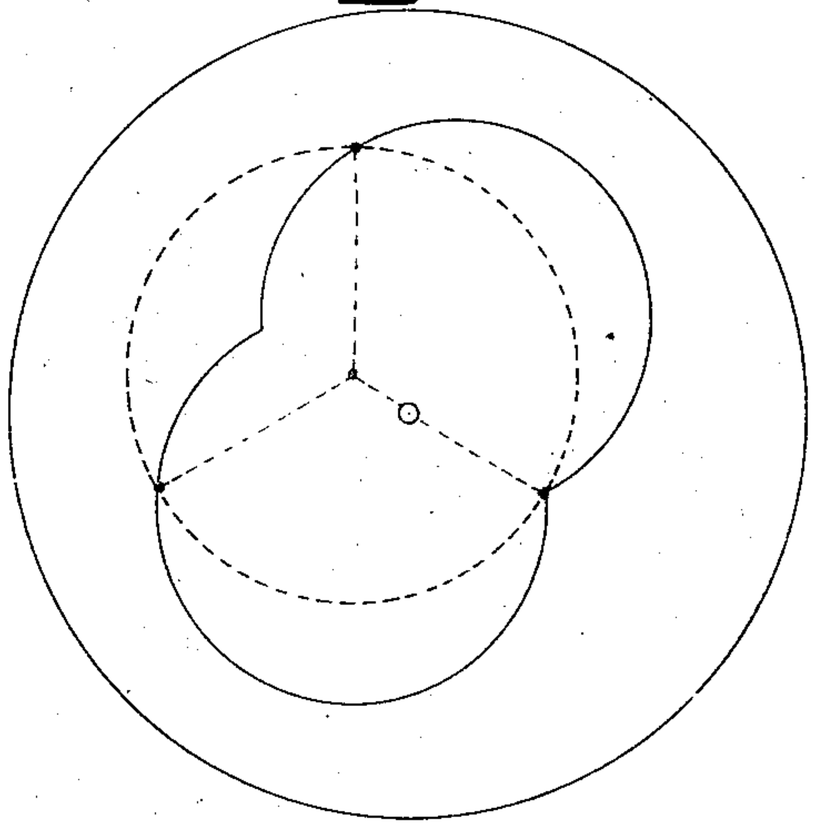

Fig. 33.

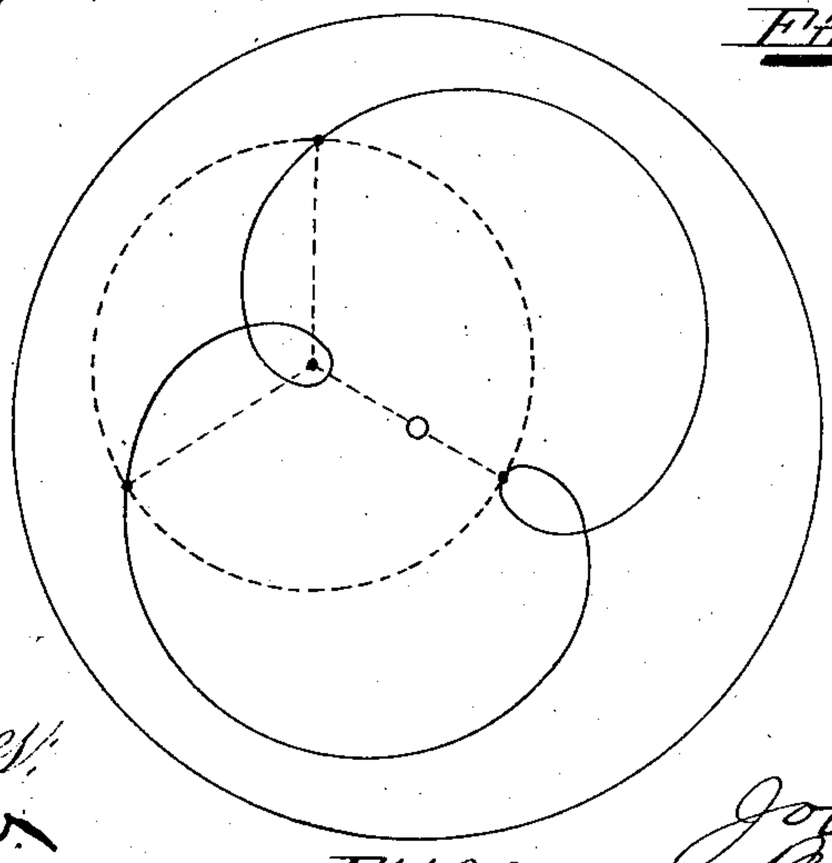

Fig. 34.

Witnesses:
E. L. Harlow.
A. L. Messer

Inventor:
John F. Cooley
By J. F. Burk
Atty

No. 842,447. PATENTED JAN. 29, 1907.

J. F. COOLEY.

CYCLOIDOGRAPH.

APPLICATION FILED NOV. 15, 1902.

10 SHEETS—SHEET 10.

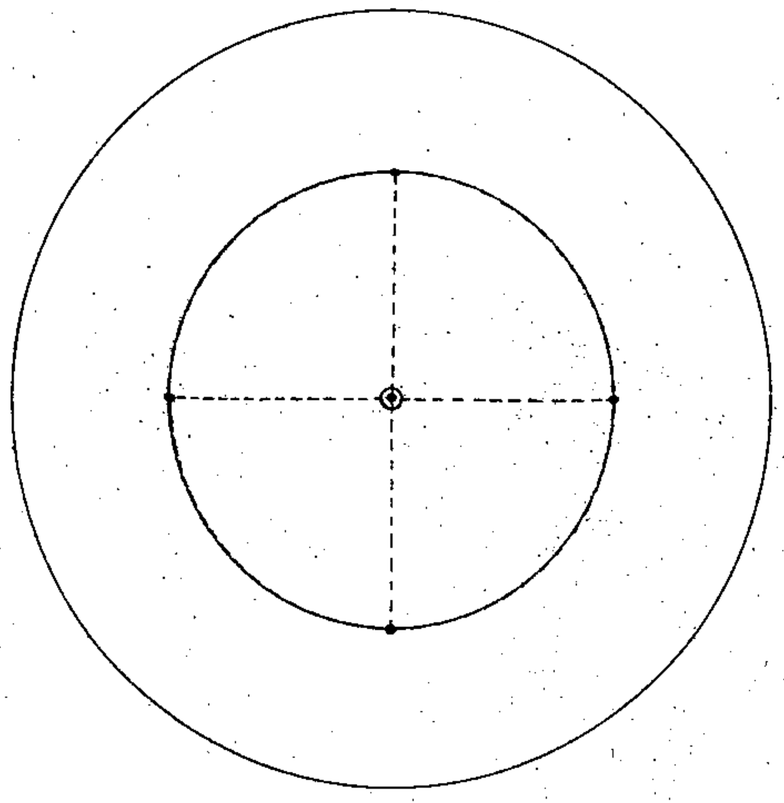

Fig. 35.

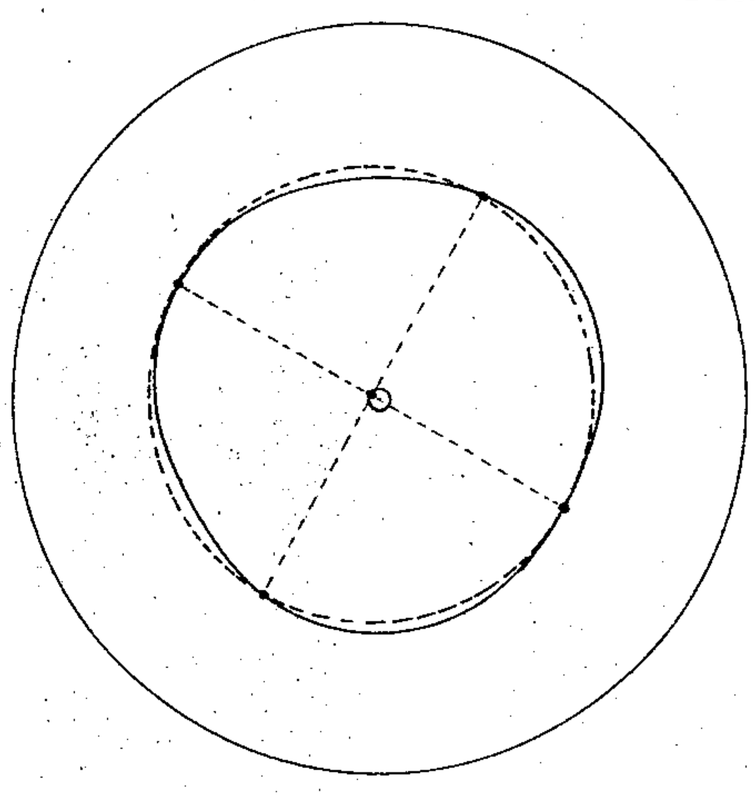

Fig. 36.

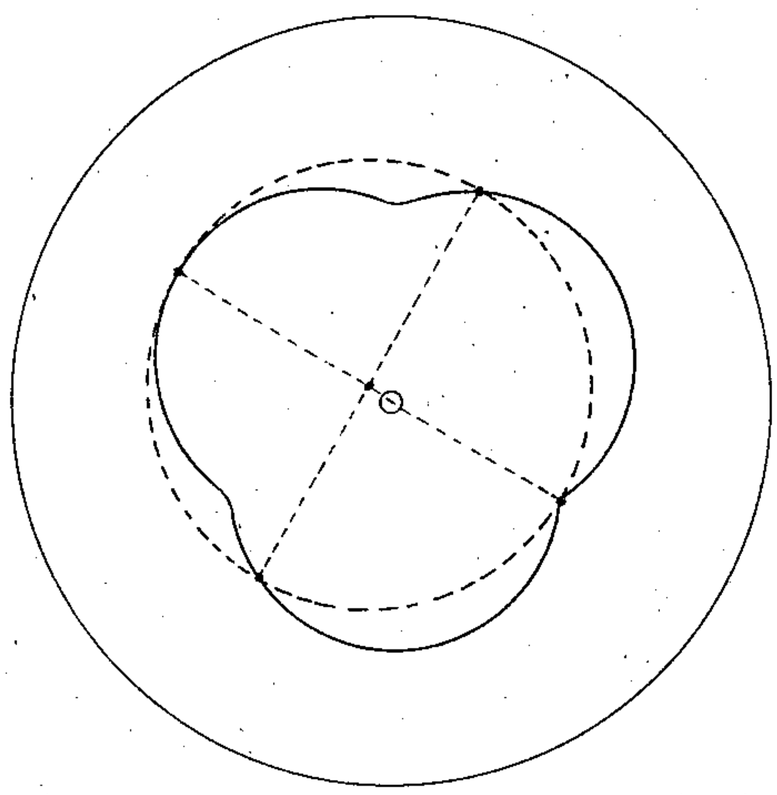

Fig. 37.

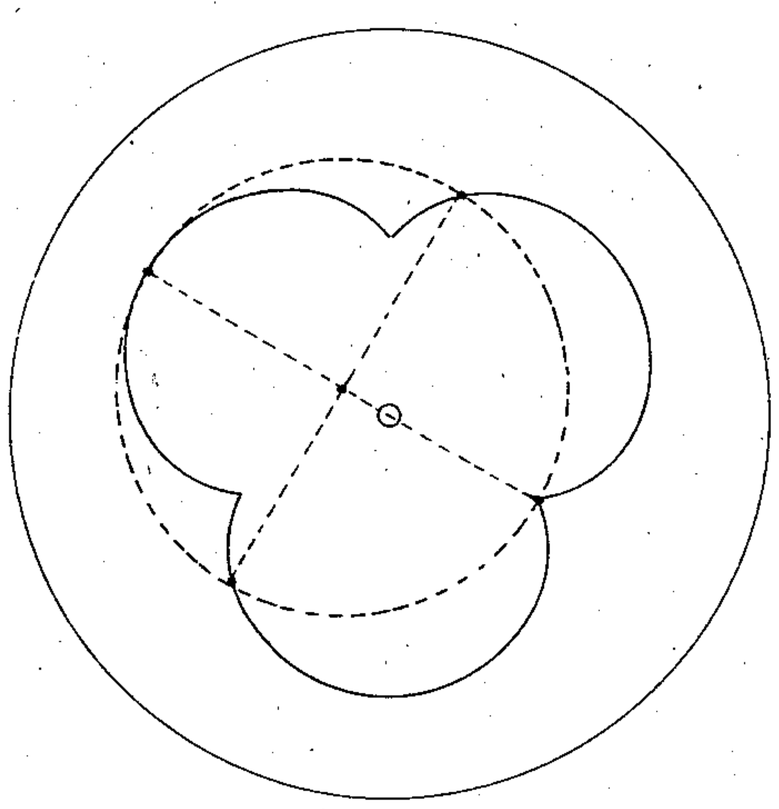

Fig. 38.

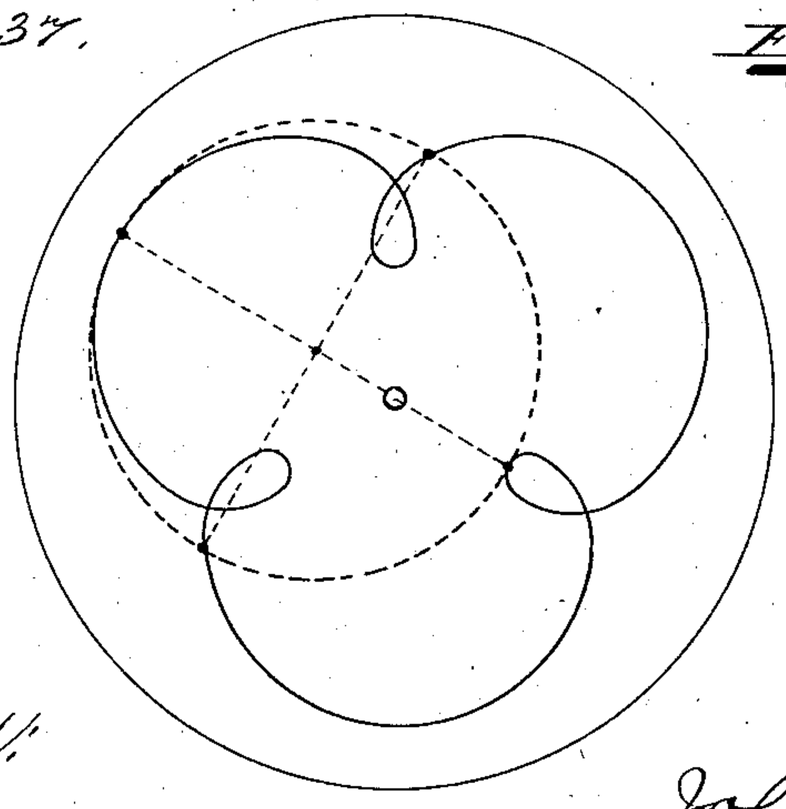

Fig. 39.

Witnesses:
E. L. Harlow
A. L. Wiener

Inventor:
John F. Cooley
By J. L. Chuck
Atty

UNITED STATES PATENT OFFICE.

JOHN FRANCIS COOLEY, OF BOSTON, MASSACHUSETTS, ASSIGNOR OF ONE-HALF TO COOLEY EPICYCLOIDAL ENGINE DEVELOPMENT COMPANY, OF JERSEY CITY, NEW JERSEY, AND BOSTON, MASSACHUSETTS, A CORPORATION OF NEW JERSEY.

CYCLOIDOGRAPH.

No. 842,447. Specification of Letters Patent. Patented Jan. 29, 1907.

Application filed November 15, 1902. Serial No. 131,518.

To all whom it may concern:

Be it known that I, JOHN FRANCIS COOLEY, a citizen of the United States, residing at Boston, in the county of Suffolk and State of Massachusetts, have invented certain new and useful Improvements in Cycloidographs, of which the following is a specification.

My invention relates to an instrument for describing cycloidal curves and is illustrated in the accompanying drawings, in which—

Figure 1 is a front elevation of the device. Fig. 2 is a side elevation. Fig. 3 is a plan. Fig. 4 is a vertical section on line 4 4, Fig. 3. Figs. 5, 6, 7, 8, and 9 are plan views of the scriber-head. Figs. 10 to 24, inclusive, show hypocycloidal, and Figs. 25 to 39, inclusive, show epicycloidal curves made by the instrument.

Referring to the drawings, a base 1 has mounted thereon posts 2 3, one of which, 2, carries a cross-bar 4, in which are rotatably mounted two vertical spindles 5 6. The spindle 5 carries a circular table 7 at its upper end, upon which is detachably secured paper 8, by means of clips 9. At its lower end the spindle 5 has keyed thereon a gear 10, meshing with a transmission-gear 11, loosely mounted on the post 2. The gear 11 meshes with a gear 12, keyed on the lower end of spindle 6 by means of a screw 13. The bar 4 carries at one end a hollow pedestal 14, upon which is mounted in succession the boss 15, of the offset-indicator plate 16 and the boss 17 of the arm 18. The offset-indicator plate is permanently set by screw 19. The arm 18 is adjustably set by a thumb-screw 20. An offset-indicating needle 21 is secured to the boss 17. A slotted arm 22 is rotatable, adjustably mounted upon the upper end of the boss 17, and is controlled by the thumb-screw 23.

The arm 18 carries the vertical spindle 24. This spindle is upwardly spring-pressed by means of a compression-spring 25, acting between the boss 26 and the cap 27, keyed to the spindle 24. Upon the tapered lower end 28 of the spindle 24 is pressed a head 29. This head 29 carries one or more radial arms 30, bearing spring-actuated scribers 31, of ordinary construction. Other heads, Figs. 5, 6, 7, 8, and 9, carrying a varying number of radial arms are supplied and are adapted to fit upon the lower end of the spindle 24. When the head carries a plurality of arms, Figs. 5 to 9, they are of equal length and equiangularly spaced about the head.

The arm 18 is of such length that by rotatably adjusting it on the pedestal 14 the axis of the spindle 24 may be made coincident with that of spindle 5. In this position of arm 18 the offset is indicated as zero by the needle 21 on plate 16. Upon the upper end of the spindle 24 is keyed a gear 32 by the screw-threaded boss 33 upon the crank 34, upon which is placed a handle 35 for operating the device.

The spindle 6 is reduced in size intermediate its length and is held from gravity-thrust by a screw 36 playing in an annular groove 37 in its lower head. On the upper end of the spindle 6 is keyed a gear 38 by means of the thumb-nut 39. A transmission-gear 40 meshes with the gears 32 38 upon the spindles 24 6. This transmission-gear 40 is mounted upon a stud-bolt 41, slidably adjustable in the slotted arm 22 and fastened in position by a thumb-screw 42.

The gears 32 38 are replaceable by gears 43 of different sizes. These when not in use are conveniently placed upon a stud-bolt 44, projecting from one of the posts 3.

The operation of the instrument is as follows: The gears 10 11 12 are merely transmission-gears of equal size, and spindles 5 6 therefore rotate at the same speed. Gears 38 32 on spindles 6 24 are of different size and therefore determine the correlative speeds of the spindles 6 24 and therefore of spindles 5 24. The gear 40 is merely a transmission-gear. In placing these gears a gear 38 is first keyed upon spindle 6. The gear 40 is then slid along the slotted arm 22 until it meshes with the gear 38. It is then fixed on arm 22 by the thumb-screw 42. Arm 22 is then rotated about the boss 17 until the gear 40 meshes with a gear 32, previously keyed in place on spindle 24. Arm 22 is then keyed to boss 17 by thumb-screw 23. The axes of the two spindles 5 24 are given fixed position of parallelism by rotating arm 18 about its bearing on the boss 14 to give any desired offset or distance between the parallel axes, and the arm 18 is then secured by the thumb-screw 20. Paper 8 having been placed on the table 7 by means of clips 9, the crank 34 is rotated and a downward pressure exerted upon the

crank-handle 35, compressing the spring 25 and bringing the scribing-points in contact with the paper, so as to describe various curves thereon. The spring-scribers 31 also aid in simultaneous and uniform action of the scribing-points.

The correlative speed of scribers and table determine the character of the curves formed. The importance of this invention is manifest particularly when the correlative speeds are expressible by consecutive numerals, as table-speed of "1" to scriber-speed of "2," or table-speed of "4" to scriber-speed of "3." In these instances cycloidal curves may be formed. It is found that hypocycloids are formed when the table has the lower speed and epicycloids when the table has the higher speed.

As to the number of scribing-points that may be used it is found that one scriber will always produce a single closed curve. It is also to be noted that the greatest number of scribers that can be used is equal to the consecutive numeral representing the table-speed, and the single closed curve formed will be the common path of all the scribers. As hereinbefore implied, these scribers are in general equiangularly spaced about their axis of rotation, and as they describe a common path it is obvious that fewer than the greatest number of scribers may be used, and these then will not be equiangularly spaced about the axis of rotation unless the number so used is a numerical factor of the greatest number that can be used—that is, in the case of Fig. 9 any number of the six scribers may be used, and these cannot be equiangularly spaced unless either two or three of them are used, in which case they may be so spaced. My invention contemplates the use of any desired number of scribers up to and including the greatest number that can be used. Applying these principles to specific data, it is found that curves are formed as follows:

Hypocycloids.

Scriber speed.	Table speed.	Greatest number of scribers.	Curve.
2	1	1	2 lobe (Figs. 10-14.)
3	2	2	3 lobe (Figs. 15-19.)
4	3	3	4 lobe (Figs. 20-24.)

Epicycloids.

Scriber speed.	Table speed.	Greatest number of scribers.	Curve.
1	2	2	1 lobe (Figs. 25-29.)
2	3	3	2 lobe (Figs. 30-34.)
3	4	4	3 lobe (Figs. 35-39.)

The six classes of curves enumerated are illustrated in the drawings by five examples of each showing the effect of a change in the offset between the axes of spindles 5 24 from zero, Figs. 10, 15, 20, 25, 30, and 35, to a maximum, Figs. 14, 19, 24, 29, 34, and 39. This offset is shown by the distance between the axis of spindle 5, (indicated by a small open circle,) and the axis of spindle 24, (indicated by the small full circle.) For clearness, the circular edge of the paper is shown in full line, concentric with its center of rotation, the small open circle; and the circular path of travel of the scribers is shown in dotted lines about their center of rotation, the small full circle. The arms radiating to the scribers are represented by dotted lines. The scribing points are represented by small full circles at the extremities of the arms. The greatest number of scribing-points is shown in every case.

Having thus described the nature of my invention and set forth a construction embodying the same, what I claim as new, and desire to secure by Letters Patent of the United States, is—

1. In a cycloidograph, a table, a head, both rotating in the same direction on separate parallel positionally-fixed axes at correlative speeds expressible by consecutive numerals, gearing connecting the table and head, a plurality of scribers carried by the head in contact with the table and at equal radial distances from its axis of rotation, and means for rotating the rotatable parts.

2. In a cycloidograph, a table, a head, both rotating in the same direction on separate parallel positionally-fixed axes at correlative speeds expressible by consecutive numerals, gearing connecting the table and head, a plurality of scribers carried by the head in contact with the table and at equal radial distances from its axis of rotation and equiangularly spaced thereabout, and means for rotating the rotatable parts.

3. In a cycloidograph, a table, a head, both rotating in the same direction on separate parallel positionally-fixed axes at correlative speeds expressible by consecutive numerals, gearing connecting the table and head, a plurality of scribers carried by the head in contact with the table and at equal radial distances from its axis of rotation and equiangularly spaced thereabout, the number of scribers being equal to the numeral representing the speed of the table, and means for rotating the rotatable parts.

In testimony whereof I have affixed my signature in presence of two witnesses.

JOHN FRANCIS COOLEY.

Witnesses:
A. L. MESSER,
C. A. STEWART.