(No Model.) 5 Sheets—Sheet 1.

A. H. BRAINARD.

GEAR CUTTING MACHINE.

No. 255,409. Patented Mar. 28, 1882.

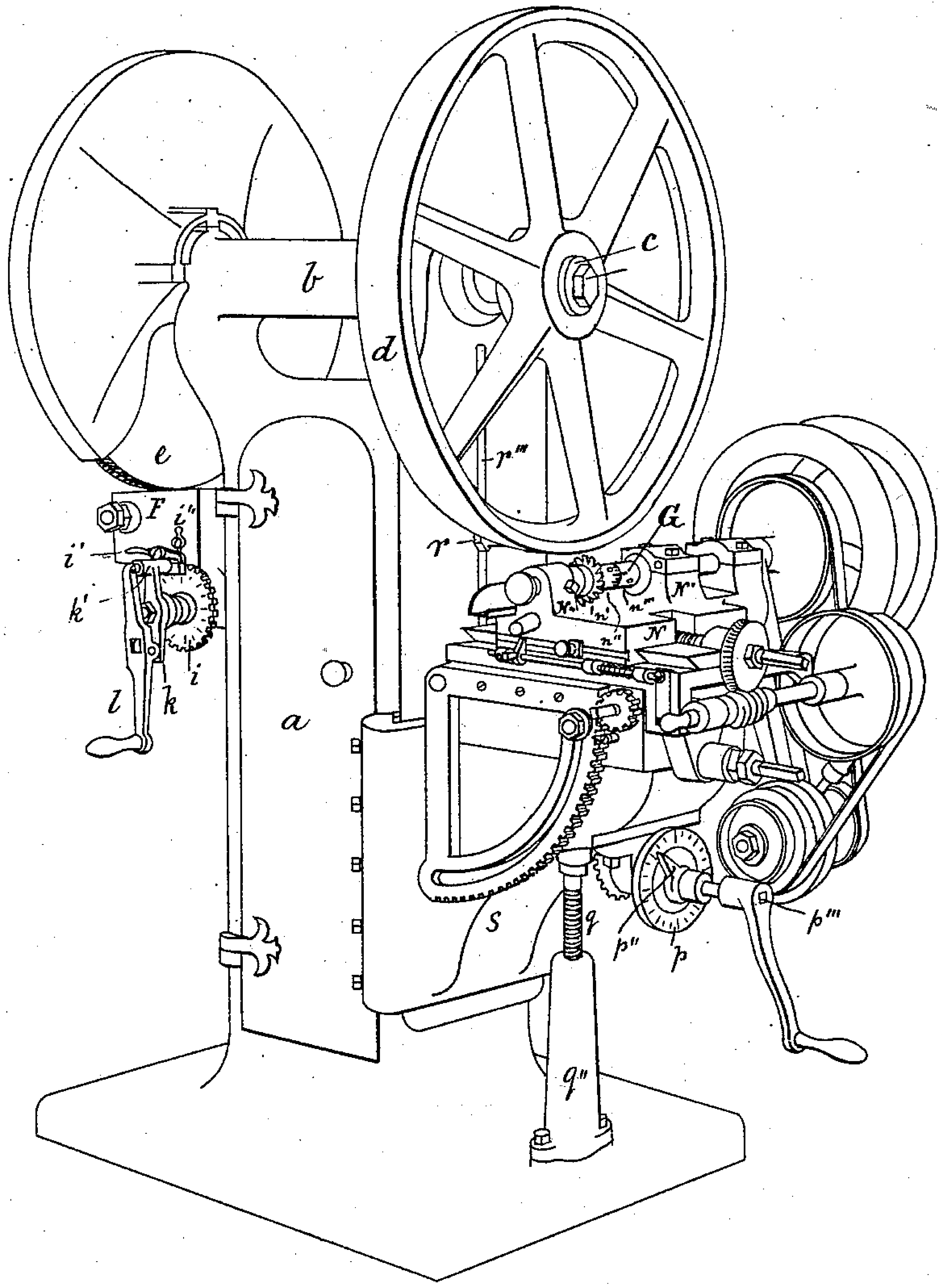

Fig. 1.

WITNESSES.

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by Alban Andrén

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A. H. BRAINARD.

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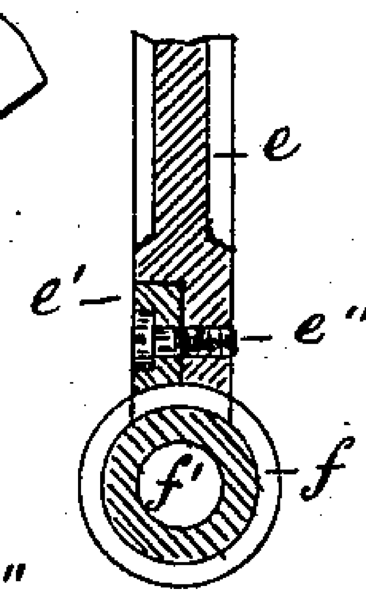
Fig. 7.



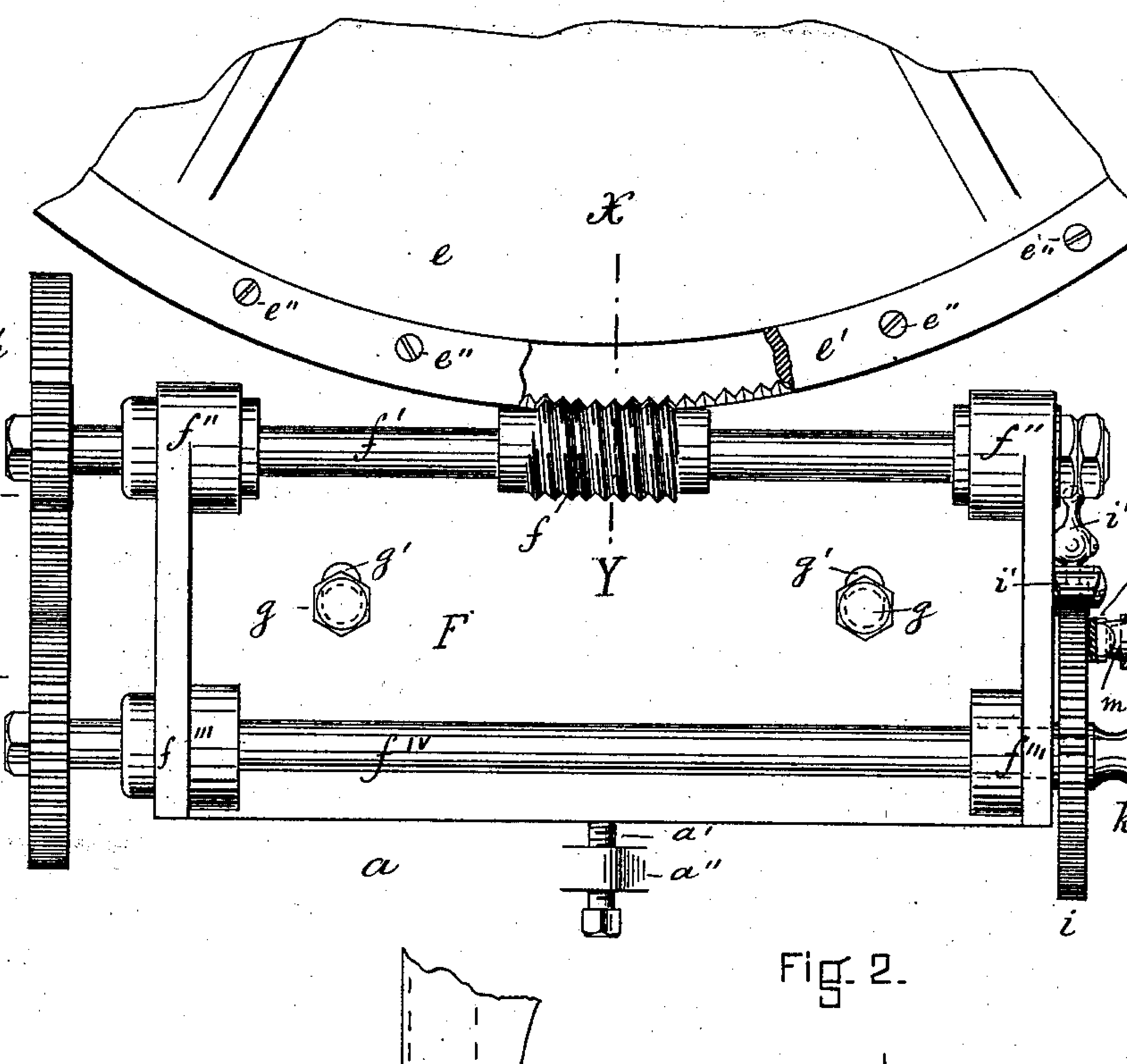


Fig. 2.

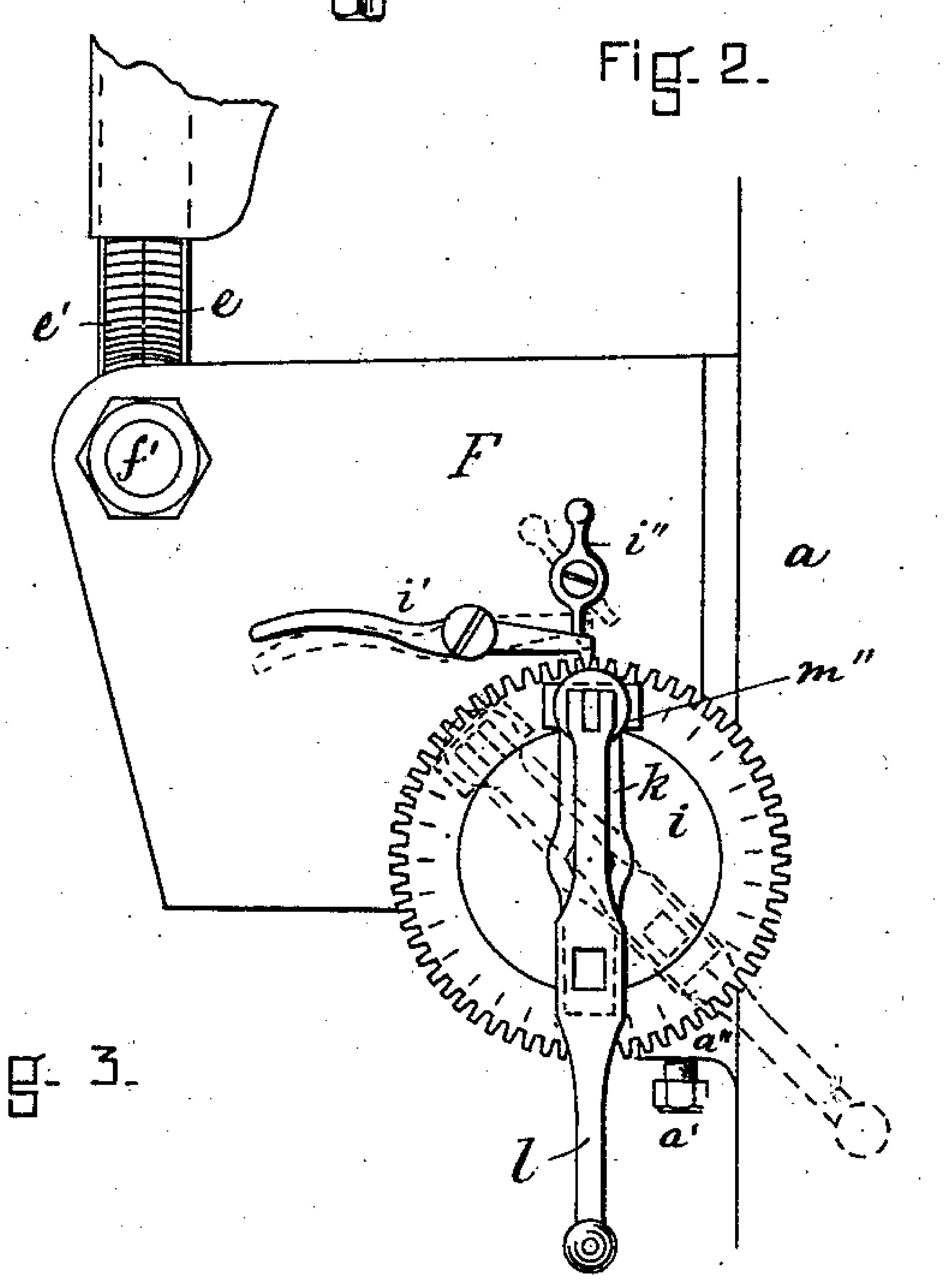


Fig. 3.

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GEAR CUTTING MACHINE.

No. 255,409. Patented Mar. 28, 1882.

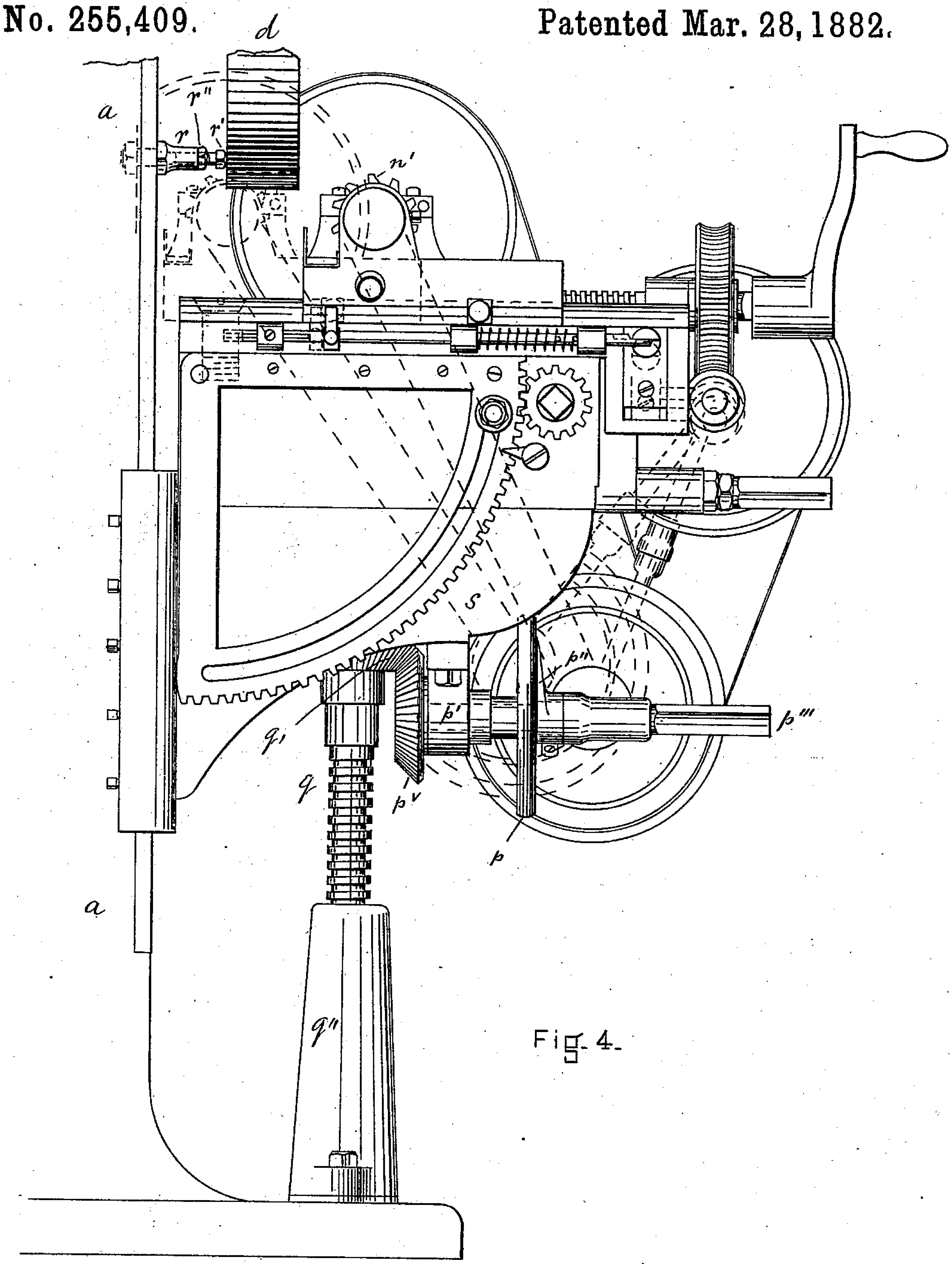

Fig. 4.

WITNESSES.

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(No Model.) 5 Sheets—Sheet 4.

A. H. BRAINARD.

GEAR CUTTING MACHINE.

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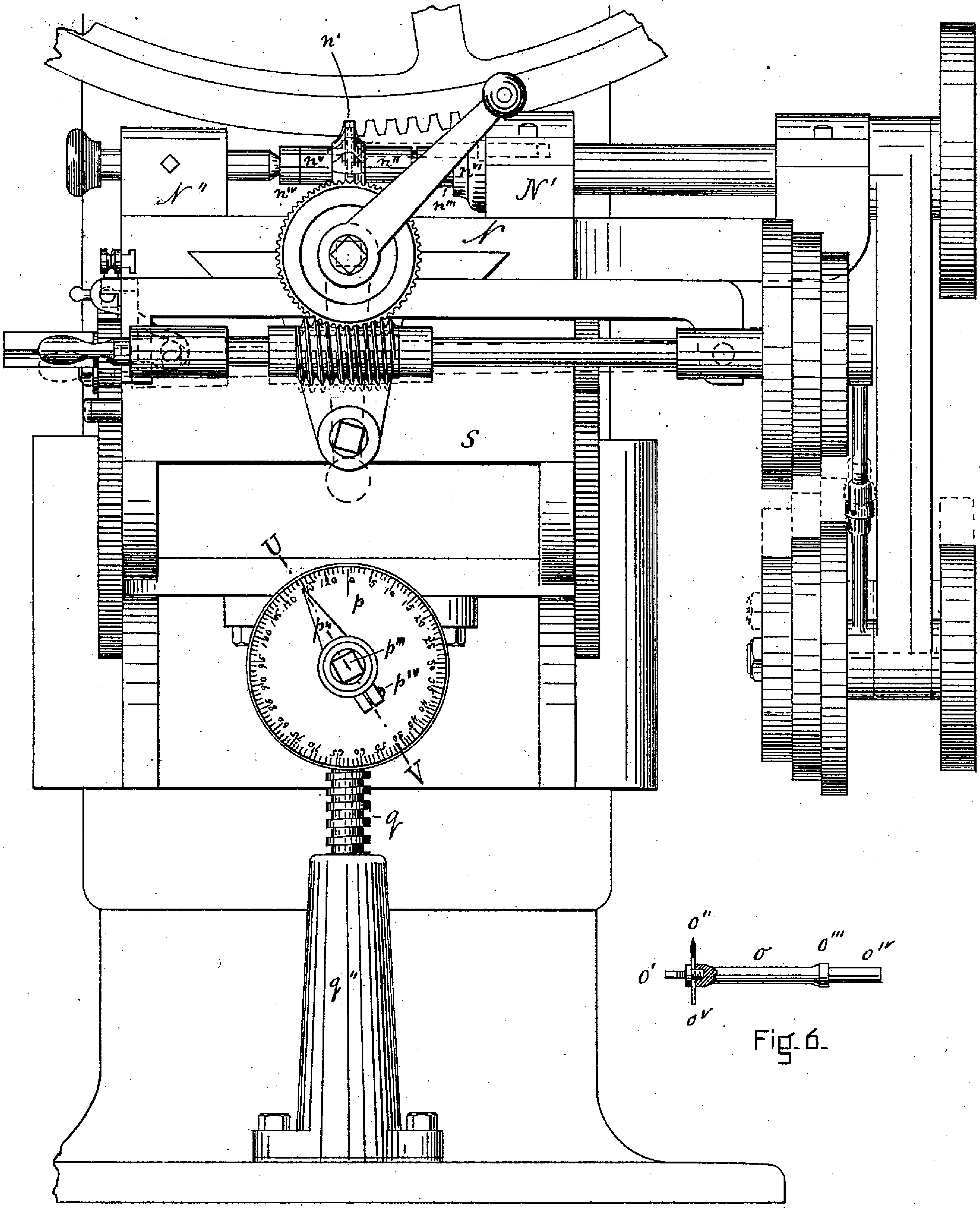

Fig. 6.

Fig. 5.

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(No Model.)

5 Sheets—Sheet 5.

A. H. BRAINARD.

GEAR CUTTING MACHINE.

No. 255,409.

Patented Mar. 28, 1882.

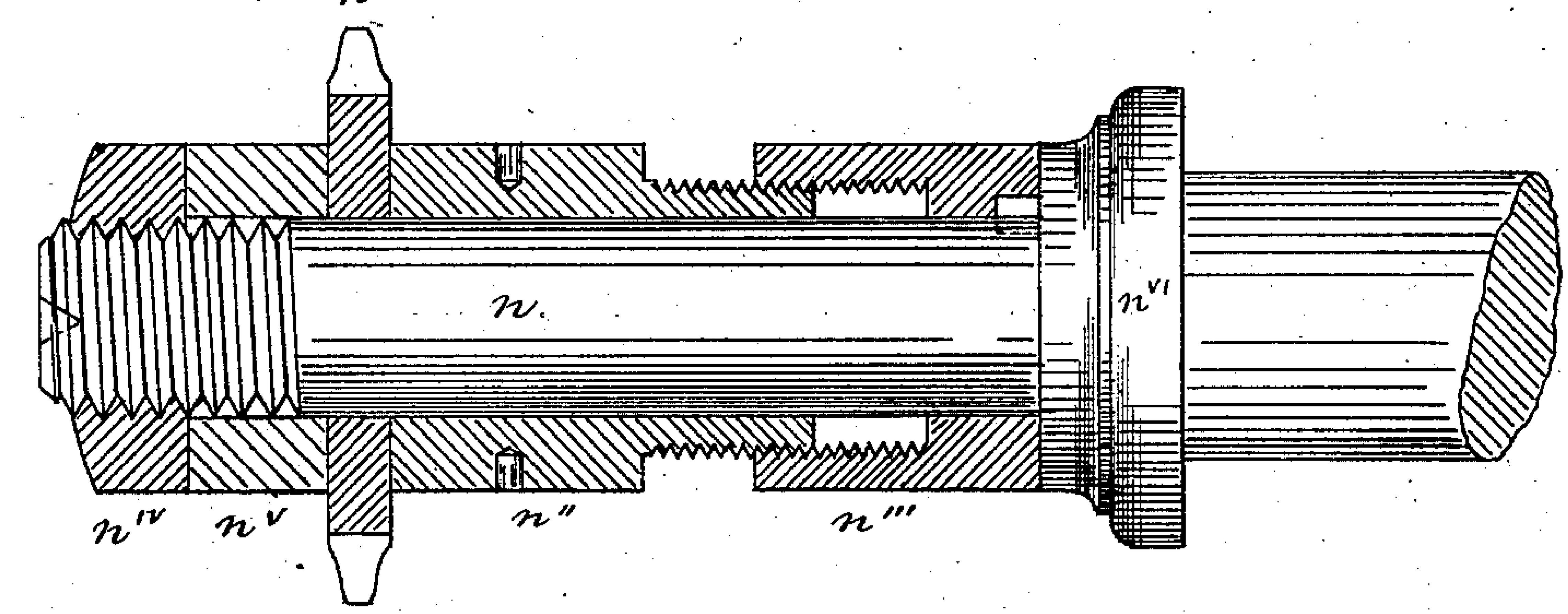

Fig. 8.

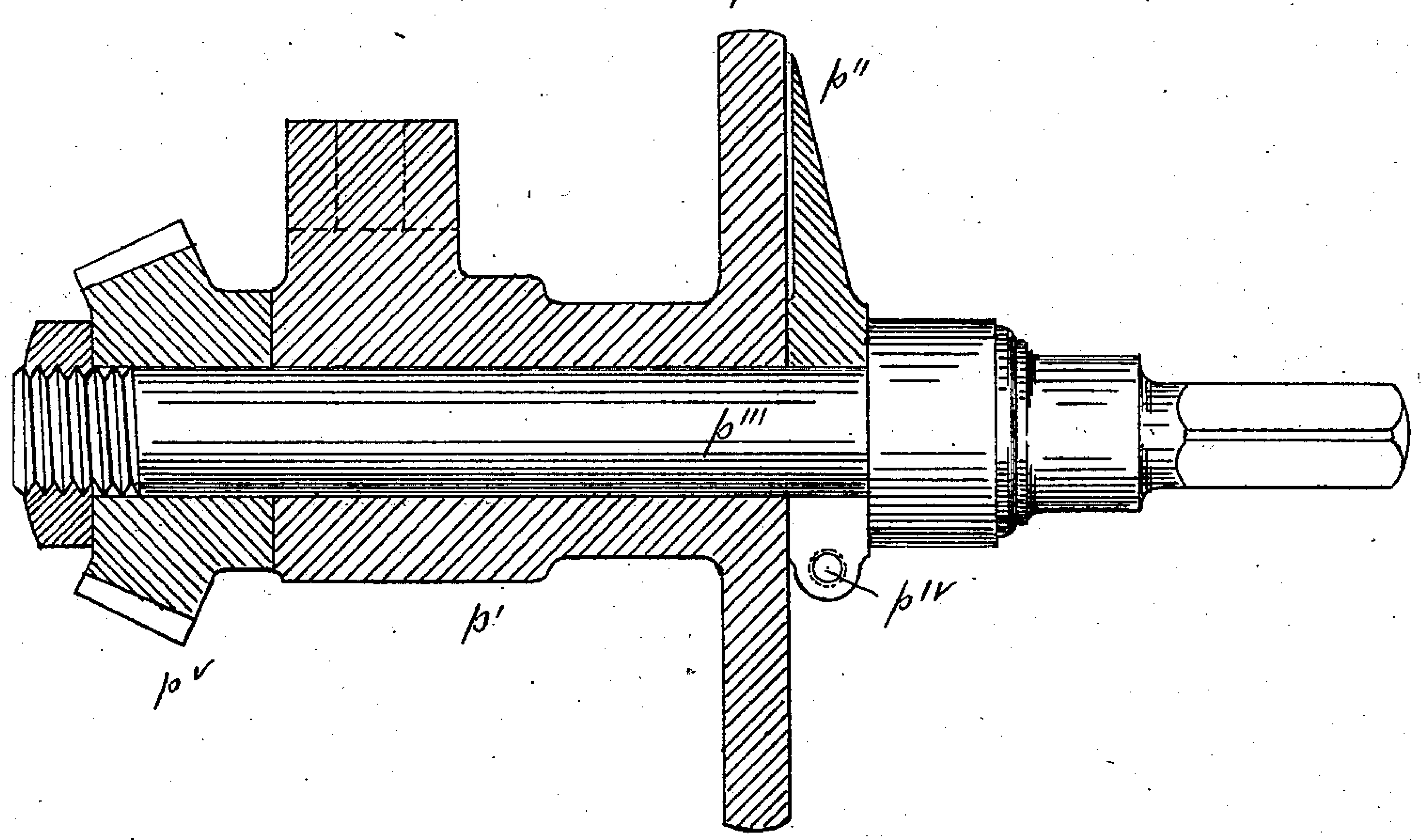

Fig. 9.

WITNESSES.

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UNITED STATES PATENT OFFICE.

AMOS H. BRAINARD, OF HYDE PARK, MASSACHUSETTS.

GEAR-CUTTING MACHINE.

SPECIFICATION forming part of Letters Patent No. 255,409, dated March 28, 1882.

Application filed September 19, 1881. (No model.)

To all whom it may concern:

Be it known that I, AMOS H. BRAINARD, a citizen of the United States, residing at Hyde Park, in the county of Norfolk and State of Massachusetts, have invented certain new and useful Improvements in Gear-Cutting Machines; and I do hereby declare that the same are fully described in the following specification and illustrated in the accompanying drawings.

On the drawings, Figure 1 represents a perspective view of the improved gear-cutting machine. Fig. 2 represents a detail rear view of the worm-wheel, its worm-shaft, and adjustable bracket. Fig. 3 represents a detail side view of the dividing mechanism for turning the worm-wheel and the gear to be cut. Fig. 4 represents a side elevation of the adjustable table for the cutter-shaft. Fig. 5 represents a partial front elevation of the machine. Fig. 6 represents a detail view of the centering device for arranging the cutter centrally with the axis of the wheel to be cut. Fig. 7 represents a cross-section of the worm and worm-wheel on the line X Y, shown in Fig. 2. Fig. 8 represents an enlarged central longitudinal section of the cutter-arbor and cutter; and Fig. 9 represents an enlarged cross-section on the line U V, shown in Fig. 5, showing the indicator for setting the cutter to the exact depth of the desired teeth to be cut on the wheel.

Similar letters refer to similar parts wherever they occur on the different parts of the drawings.

This machine is of that class of gear-cutters in which the necessary divisions are made by means of a worm and worm-wheel, as distinguished from those in which the dividing mechanism is either a dial drilled with the necessary number of holes or a spur and ratchet-wheels.

In this machine are several special devices to attain and maintain unusual accuracy, as will herein be more fully described.

a is the standard or frame of the machine, having in its upper end a bearing, *b*, for the shaft *c*, to the rear end of which is secured the worm-wheel *e*, and to the forward end of which is secured the wheel *d* that is to be cut.

f is the worm, and *f'* is the worm-wheel shaft by means of which the worm-wheel *e* is operated. The shaft *f'* is located in bearings *f'' f''* on the vertically-adjustable bracket F, the latter being adjustable up and down on the rear of the standard *a* by means of the set-screw *a'* passing through the screw-threaded ear or lug *a''*, cast on the standard *a*, and by these means the worm *f* can be adjusted in its relation to the worm-wheel *e* to the utmost nicety, and after being so adjusted the bracket F is firmly secured to the standard *a* by means of the set-screws *g g* passing through slot-holes *g' g'* in the bracket F and screwed into the standard *a*. The purpose or object to be attained by the above-named combination of worm-wheel *e*, worm-carrying bracket F, set-screw *a'*, and fastening-screws *g g* is accuracy and an entire absence of backlash. The combination used secures this by affording a means of adjusting the worm to such a depth in the worm-wheel that the slightest motion of the worm shall also move the worm-wheel, and this not only when the parts are new, but furnishes a ready and exact compensation for wear. This is a matter of much importance, not only in the attainment of accuracy in dividing, but in rigidly holding the worm-wheel without allowing it to move in the slightest degree, and thereby insuring a smoother cut for the teeth of gear-wheel on the other end of the arbor than is possible in ordinary gear-cutting machines. The bracket F is also provided with bearings *f''' f'''* for the dividing-shaft *f*^{iv}. *h h' h''* are the change-gears connecting the shafts *f'* and *f*^{iv} to convey motion from the latter to the former.

The worm-wheel *e* is made in two parts—namely, the main body *e* and the annular rim *e'*, the latter being made half as wide as the whole worm-wheel *e*, and fitted into an annular recess on the side of the worm-wheel *e*, and secured thereto by means of set-screws *e'' e''*, as shown in Figs. 2 and 7. The thread in the worm-wheel for the worm *f* is made one-half in the body of the wheel and one-half in the annular rim *e'*, and in this manner I obtain a divided worm-wheel in more easy, simple, and durable manner as compared with the usual way of making worm-wheels of two equally large disks or plates, which is objectionable in wheels of large size on account of the difficulty of getting a perfect bearing all over such large surfaces, and it would require very thick and heavy disks or plates to finish well. The same result is obtained in a more simple way in my arrangement and construction as above described.

I do not claim as my invention a worm-wheel made in two parts, as such have heretofore been made; but they have in fact been two wheels divided through their whole diameter. By making the worm-wheel as hereinabove described in accordance with my invention—that is, with a main body and a separate rim—the labor of making is very much simplified, and the strength and stability of the wheel increased without increasing its weight, a very important consideration in making wheels of large diameters.

When cutting bevel-gears with a rotary cutter it is usually necessary to make three cuts, the first directly to the center in a straight line, then one on each side of the center line to get the necessary difference in width of cut on the outer and inner ends of the teeth. In common practice this is altogether a matter of experiment with each bevel-gear, depending entirely on the eye and experience of the workman, and no certain way has heretofore been devised for cutting two bevel-gears exactly alike by a system of actual measurement in the gear-cutting machine itself. In my machine, after one gear has been cut correctly, or even one side of a tooth has been cut, a record can be made of the necessary amount of "set-over," and ever after that particular size gear can be cut exactly without further experiments. For this purpose I arrange upon the end of the shaft f^{iv} a toothed wheel, i, fitting loosely on said shaft, which can be held firmly in position by means of the latch-lever i' and locking-button i''. (Shown in full lines in Fig. 3.)

On the end of the shaft f^{iv} is firmly secured the crank-lever k, to the lower end of which is hinged the crank l. The upper end of the crank l is hinged to the rod m, projecting through a sleeve, k', on the lever k, as shown in Fig. 2. The rod m terminates as a pointer or pawl, m', which is adapted to rest in a notched plate, m'', secured to the outer face of the toothed wheel i, the pointer or pawl m' being actuated toward the wheel i by means of the coiled spring k'' within the sleeve k', as shown.

When cutting spur-gears wheel i is not used at all, and the lug m'' might be secured directly to the bracket F, dispensing with wheel i altogether; but when cutting bevel-gears it is necessary to use a cutter thin enough to pass through the narrowest part of the space between the teeth, and this would of course leave the outer and wider end of tooth in a wrong shape. Some means must therefore be used to set over the gear in such position that the cutter may form one side of the tooth, and then to set it in position to form the other. To accomplish this I release wheel i, and leaving the pointer or pawl m' in its seat m'', I rotate the notched wheel i, which then moves the worm f and worm-wheel e a sufficient distance to bring the tooth of bevel-gear on the arbor c of the machine in proper position for the cutter to form one side of the tooth. The wheel i is then locked, and the proper division for toothing the gear proceeds by raising the pawl m' out of its seat and rotating the crank l the requisite number of times, the wheel i remaining stationary until one side of all the teeth in the bevel-gear has been cut. The process of unlocking wheel i is now repeated, when it is rotated in the contrary direction the proper distance, relocked, and the gear-cutting proceeds as before. Thus when it becomes necessary to set over a bevel-wheel to make the side cut the button i'' is turned to the position shown in dotted lines in Fig. 3, and the latch i' is raised out of contact with the toothed wheel i, and leaving the pawl m' in its notch m'' the wheel i is turned by the crank l the requisite distance to one side. The teeth of the wheel i being numbered from each side of the upper tooth when in its normal position, it is evident that when the proper position of one side of the tooth of gear to be cut is ascertained the wheel i has only to be rotated the same distance from zero in the opposite direction to bring the other side of the tooth in its proper position, and a record can be made, saving any further trials with a gear of the same description; but while the above arrangement brings the gear-tooth in proper position, a change of position of the cutting-tool n' is also necessary upon the cutter-arbor n. To effect this an extensible collar made in two parts, n'' and n''', is used, as shown in Figs. 1, 5, and 8. The two parts of said extensible collar are composed of an outer shell, n'', having a male screw-thread fitting within a corresponding female screw-thread in the part n''', which latter is made stationary on the arbor n by means of a key or other equivalent device, and made to rest against the collar n^{vi} on the shaft n. On the periphery of the stationary part n''' is made a zero-mark, and on the periphery of the adjustable part n'' is a uniform series of numbered lines lengthwise upon its surface.

The end of the cutter-arbor n is screw-threaded, as shown in Fig. 8, and there provided with a nut, n^{iv}, and sleeve n^{v}, located between said nut and the cutting-tool n'. The requisite distance necessary to move the cutter having been determined, the nut n^{iv} is loosened, and the parts n'' n''' expanded or contracted to the necessary point, after which the nut n^{iv} is again tightened and the machine is ready for work. Like the device for moving the gear-wheel, so this device for changing the position of the cutter can be made a matter of record, so that it can ever afterward be adjusted with certainty upon the same description of bevel-gears. Furthermore, it is essential that the rotary cutter n' should be in a plane passing through the center of the arbor c of the machine which carries the gear d to be cut. The method of effecting this in common use is to turn the center arbor to a point at its outer end and running the parts carrying the cutter up to this point to adjust the cutter by it. This, especially in a machine worked with screws, involves much time and labor, and to obviate this I use a device as shown in Fig. 6. This consists of a rod of metal, o, tapped at its outer end for a set-screw, o', to secure an adjustable sharp-pointed strip of metal, o'', as shown. The other end of the rod o has a shoulder, o''', at a proper distance from the end of the shank o^{iv}. The device, after being properly fitted to the machine and adjusted by actual experiment, is used by inserting the shank o^{iv} up to its shoulder o''' in a socket bored out in the bearing N' of the cutter-arbor, as shown by dotted lines in Fig. 5, and the cutter set so that the center of its cutting-edge coincides with the sharp edge of the metal strip or gage o''. A slot, o^{v}, is made in the strip o'' to allow of its adjustment for different diameters of the cutters. Another careful adjustment needs to be made—namely, the depth of cut for the teeth for gear-wheels; and in practice this is so difficult that only by the aid of special gages made by experts can the average workman set a gear-cutter to the proper depth; but by the mechanism described below this machine can be set with mathematical exactness by any mechanic capable of running the machine. This mechanism consists of a dial, p, secured to the bearing p', and usually made in one piece with it. A finger or pointer, p'', loosely embraces the crank-shaft p''', one end of the pointer p'' being split or sawed through, and provided with a clamping-screw, p^{iv}, so that it can be clamped to turn with the shaft p''' or loosened to turn on it. The dial p is marked with zero at its central top edge, and has a series of lines upon its face to correspond with thousandths of an inch of elevation of the cutter-arbor and its attachments. In practice the gearing is commonly so arranged in relation to the elevating-screw q that a complete revolution of the crank-shaft p''' actuating it raises or depresses the cutter and its appendages one-eighth of an inch. The dial then having one hundred and twenty-five divisions, each division will correspond with one thousandth of an inch elevation. The setting for depth of tooth then proceeds as follows: The cutter and gear to be cut being in place, the cutter is raised under the gear till its outer edge or circumference is touched. The pointer p'', loosened upon the crank-shaft p''', is brought to zero-point and clamped there to the shaft. As the depth of cut for teeth of any given pitch is well known, the cutter needs only to be raised the requisite number of thousandths of an inch to be in position to make the proper depth of cut.

When cutting gear of considerable diameter the strain upon the arbor carrying it is very great, and the gear itself is liable to spring, causing the cutter to chatter, with danger of breakage, and making rough work. To prevent such chattering or yielding of the gear that is being cut I use the rim-rest shown in Fig. 4. It consists of a stud, r, secured to the standard a of the machine, and provided with an adjustable set-screw, r', and check-nut r'', as shown. The stud r may either be arranged to be vertically adjustable in a slot, r''', in the front of the machine, as shown in Fig. 1, or may be bolted to it with adjustment for different diameters of gears. The set-screw r', being set out till it touches the gear-rim d, supports the rim and prevents its vibration, by which smoother work is produced than could possibly be done without it.

S is the vertically-adjustable table or carriage, actuated up and down by means of bevel-gear p^{v} on crank-shaft p''' and bevel-gear q' on the vertical screw-shaft q, which works in the stationary nut q'', as usual. N is the laterally-adjustable cutter-shaft carriage, with its bearings N' N'', as usual.

The automatic feed mechanism shown in the drawings is similar to that described in a patent granted to me October 1, 1872, and is not subject-matter in the present application.

Having thus fully described the nature, construction, and operation of my invention, I wish to secure by Letters Patent, and claim—

1. In a gear-cutting machine, the worm-wheel e, in combination with the vertically-adjustable worm-carrying bracket F, adapted to be adjusted on the standard a by means of set-screw a', and having fastening-screws g g, as and for the purpose set forth.

2. In a gear-cutting machine, the dividing-shaft f^{iv}, its toothed wheel i, recessed plate m'', crank-lever k k', pawl m m', hinged crank l, latch i', and button i'', all combined and arranged to operate as and for the purpose described.

3. In a gear-cutting machine, the cutter-arbor n and cutter n', in combination with the extensible collar n'' n''' and fastening-nut n^{iv}, as and for the purpose set forth.

4. The herein-described centering device for centering the cutter n' with the arbor c, consisting of the rod o, set-screw o', adjustable pointed strip o'', collar o''', and shank o^{iv}, adapted to be inserted in a hole or slot in the bearing N' for the cutter-arbor, as set forth.

5. In a gear-cutting machine, the combination, with the crank-shaft p''' and intermediate mechanism for raising or lowering the carriage S, of the stationary and graduated dial p and adjustable index or pointer p'', as and for the purpose set forth.

6. In a gear-cutting machine, the vertically and laterally adjustable rim-rest r r' r'', adapted to be secured to the front of the standard a, and having its set-screw r' arranged to support the rim of the wheel d that is to be cut, as set forth.

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

AMOS H. BRAINARD.

Witnesses:

ALBAN ANDRÉN,
F. ALLEN.