No. 753,994. PATENTED MAR. 8, 1904.

H. MAXIM.

SMOKELESS POWDER ROD OR GRAIN AND PROCESS OF MAKING SAME.

APPLICATION FILED DEC. 8, 1898.

NO MODEL. 5 SHEETS—SHEET 1.

Fig. 1.

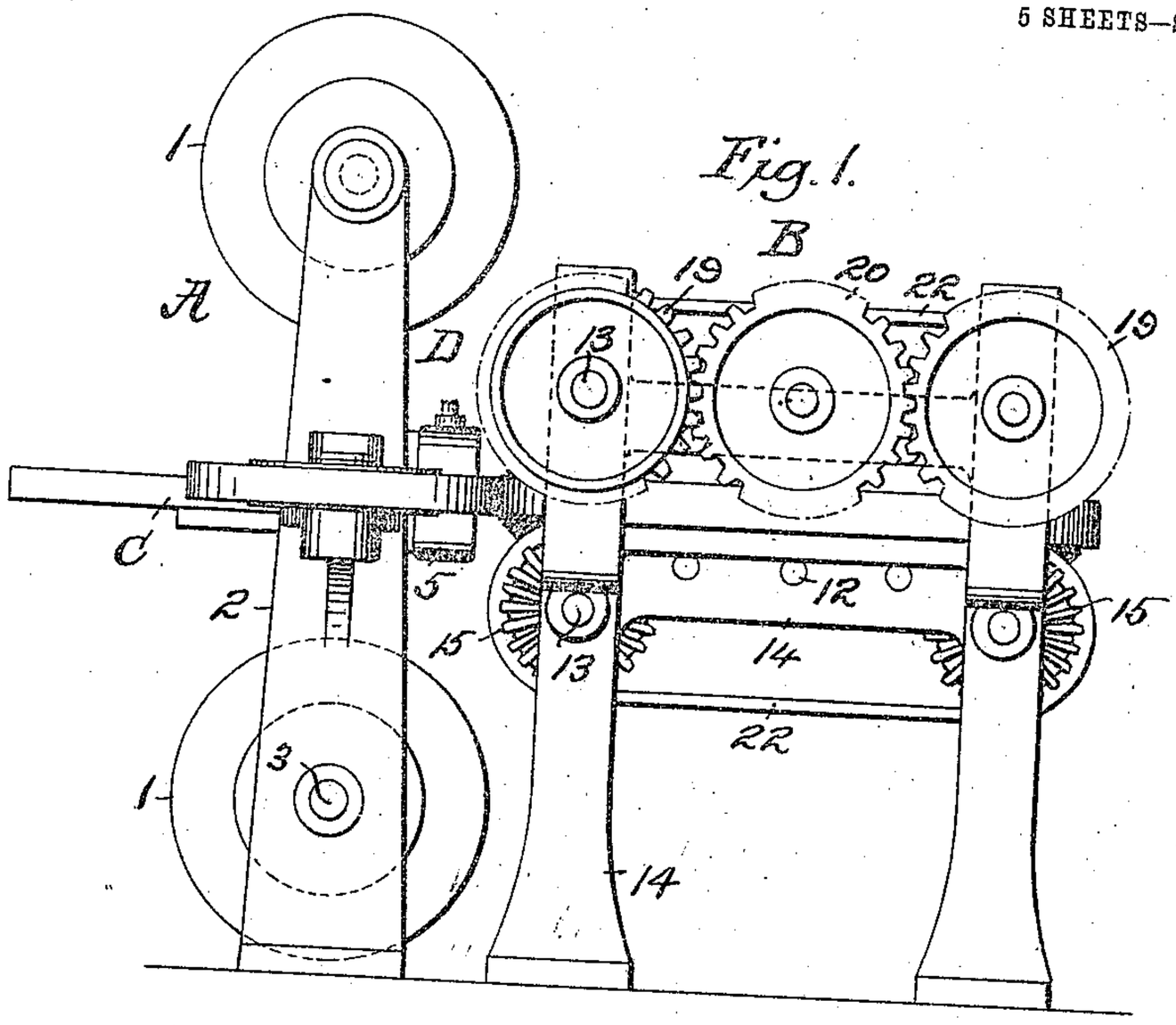
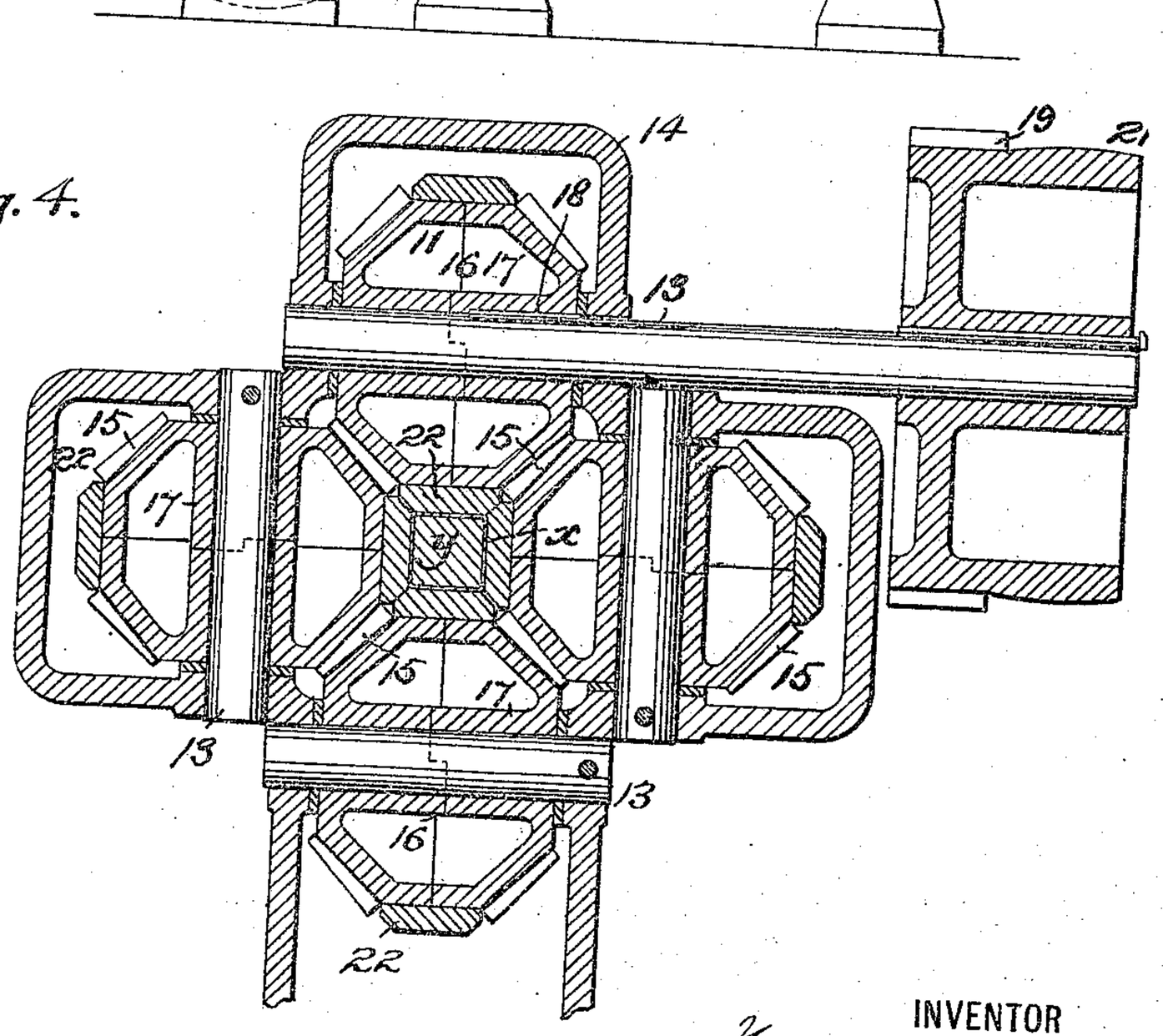


Fig. 4.



WITNESSES:

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NO MODEL.

5 SHEETS—SHEET 2.

Fig. 2.

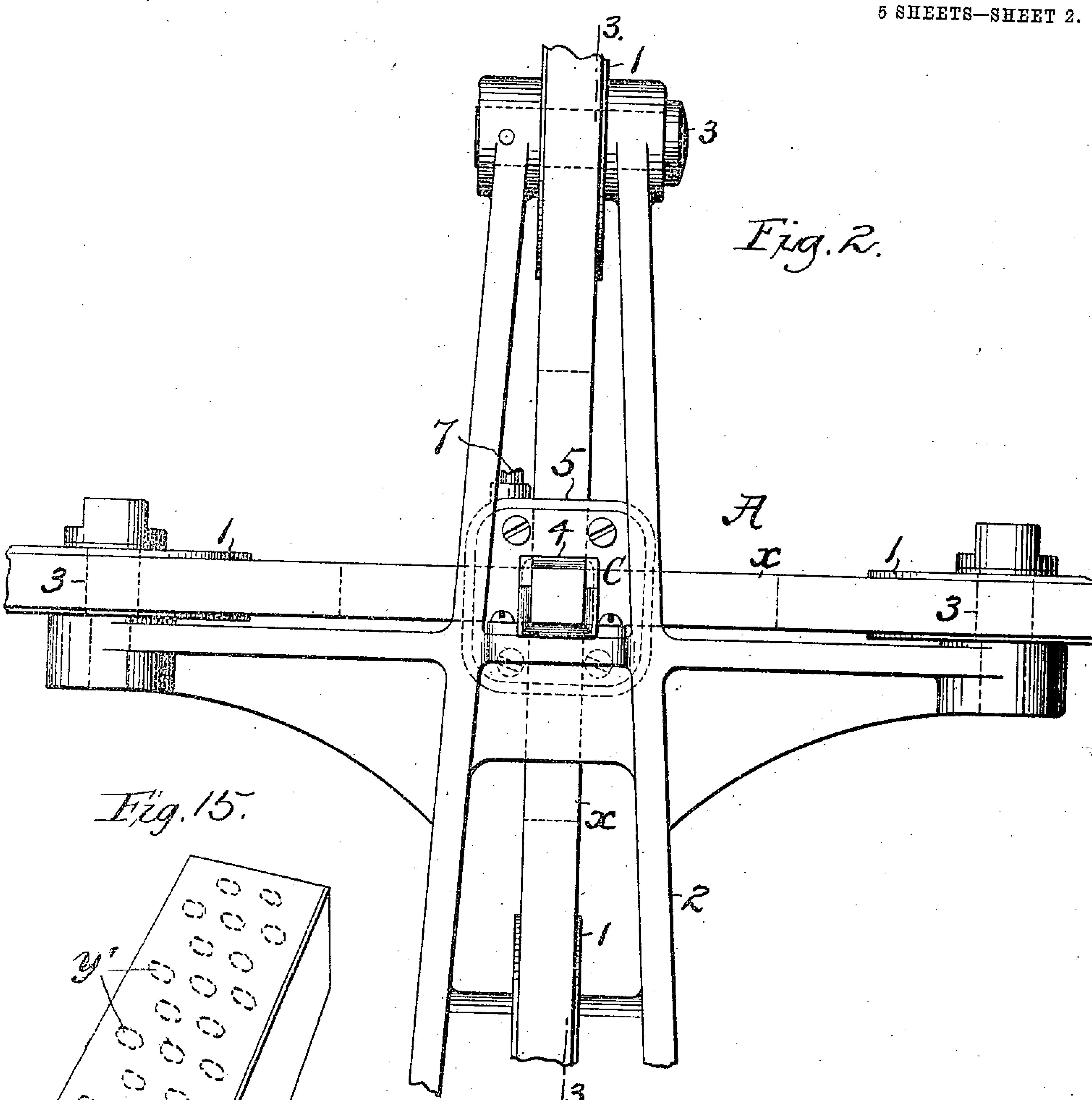
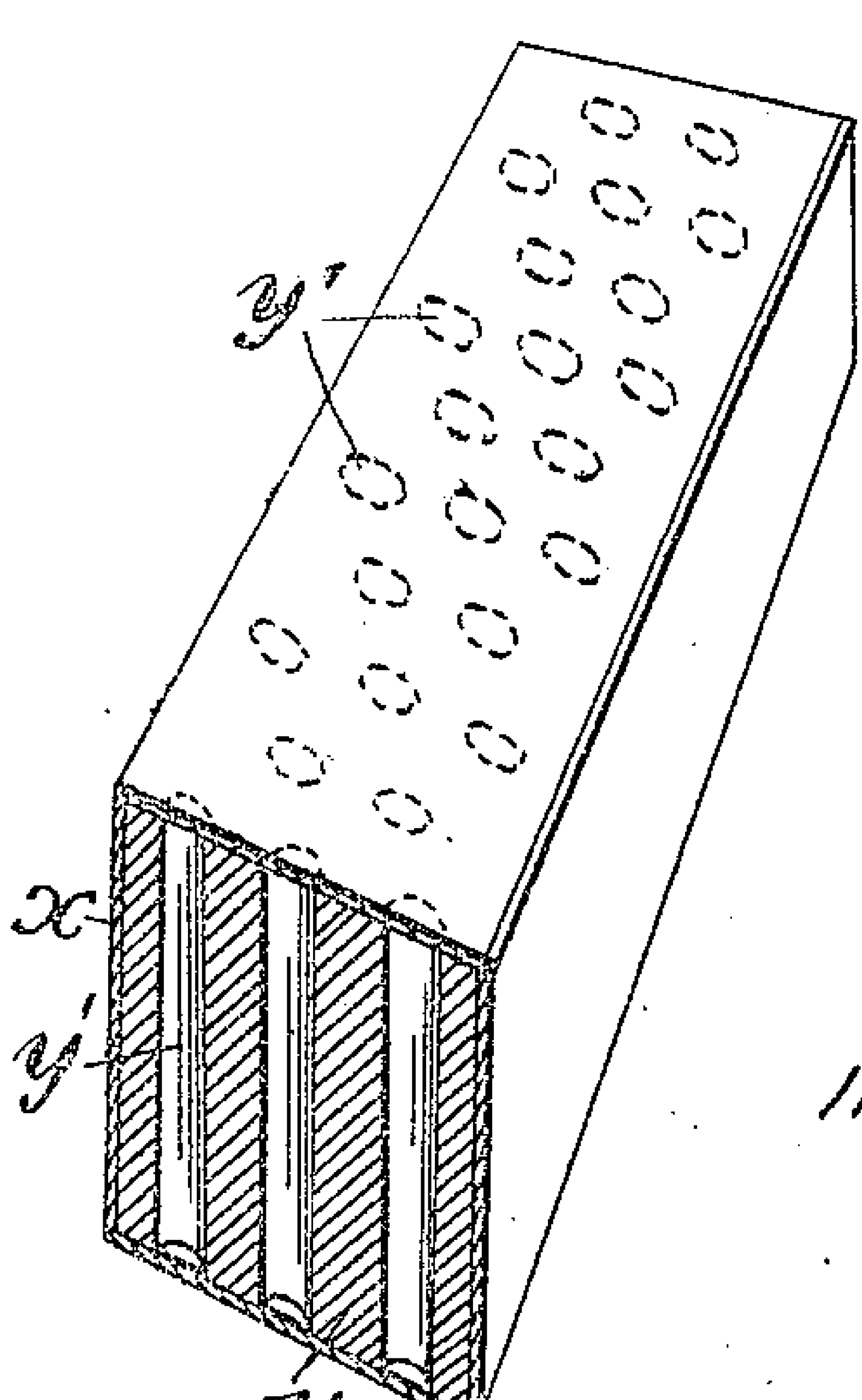


Fig. 15.



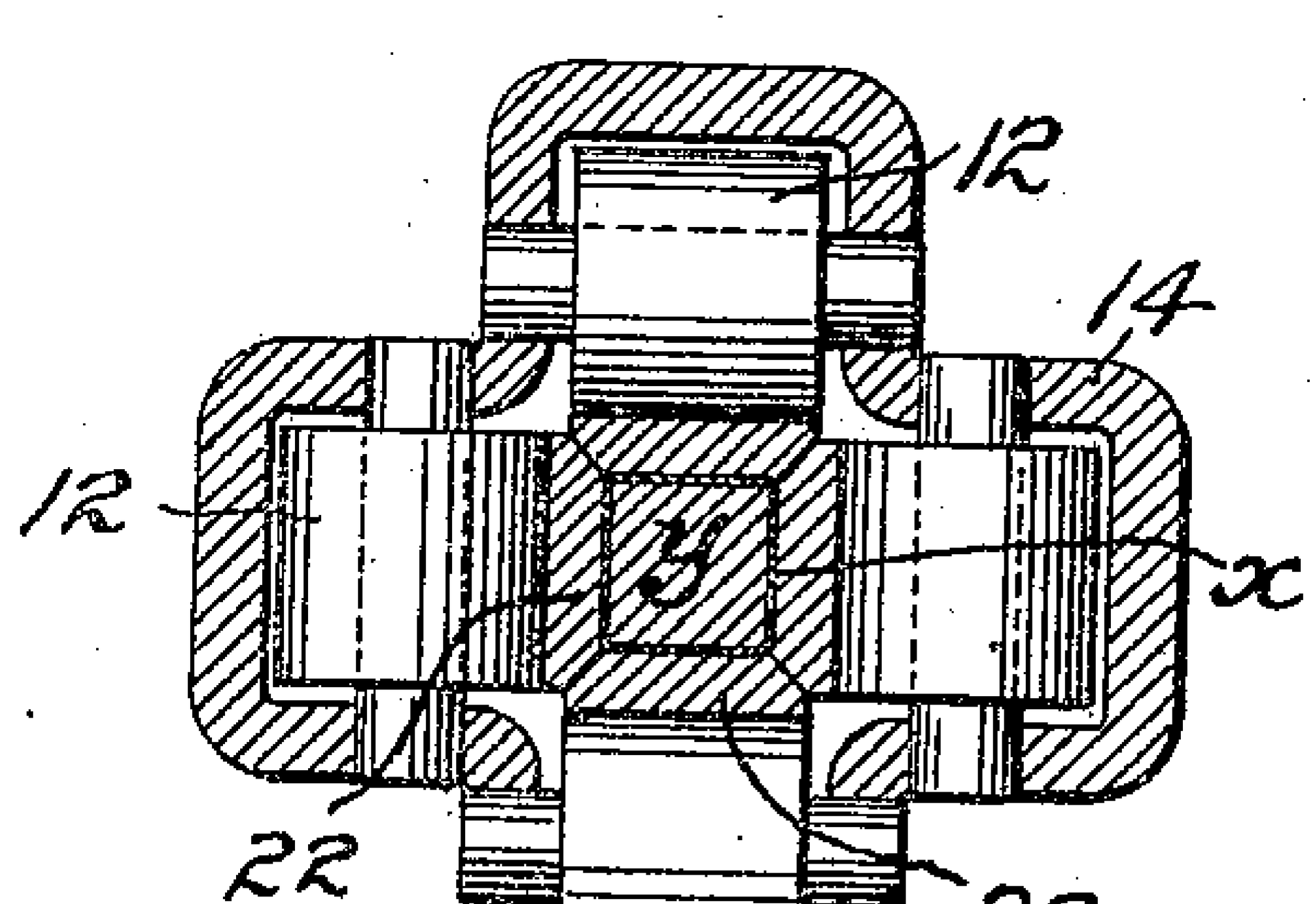


Fig. 5.

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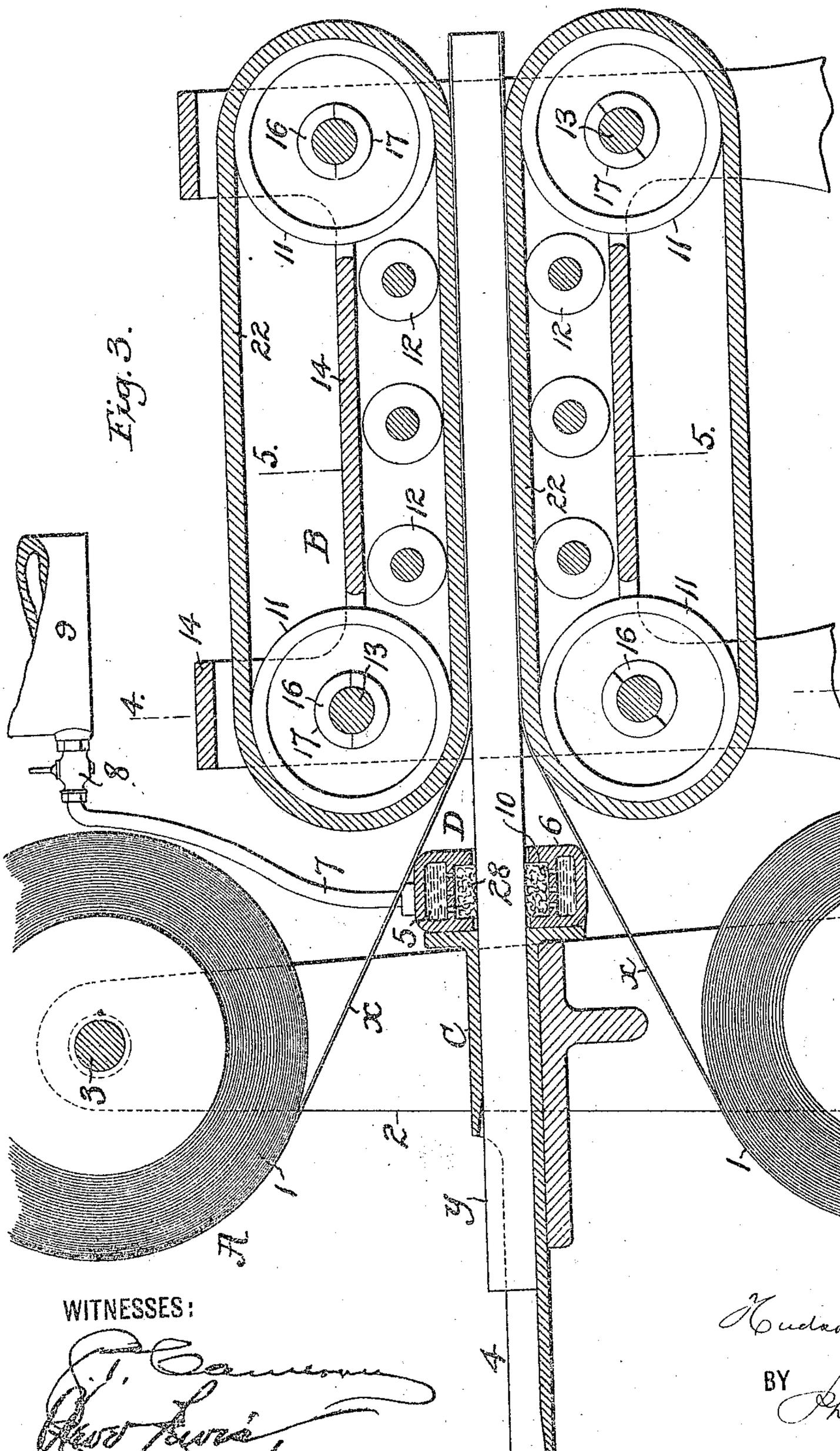
APPLICATION FILED DEC. 8, 1898.

5 SHEETS—SHEET 3.

NO MODEL.

Fig. 3.



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NO MODEL. 5 SHEETS—SHEET 4.

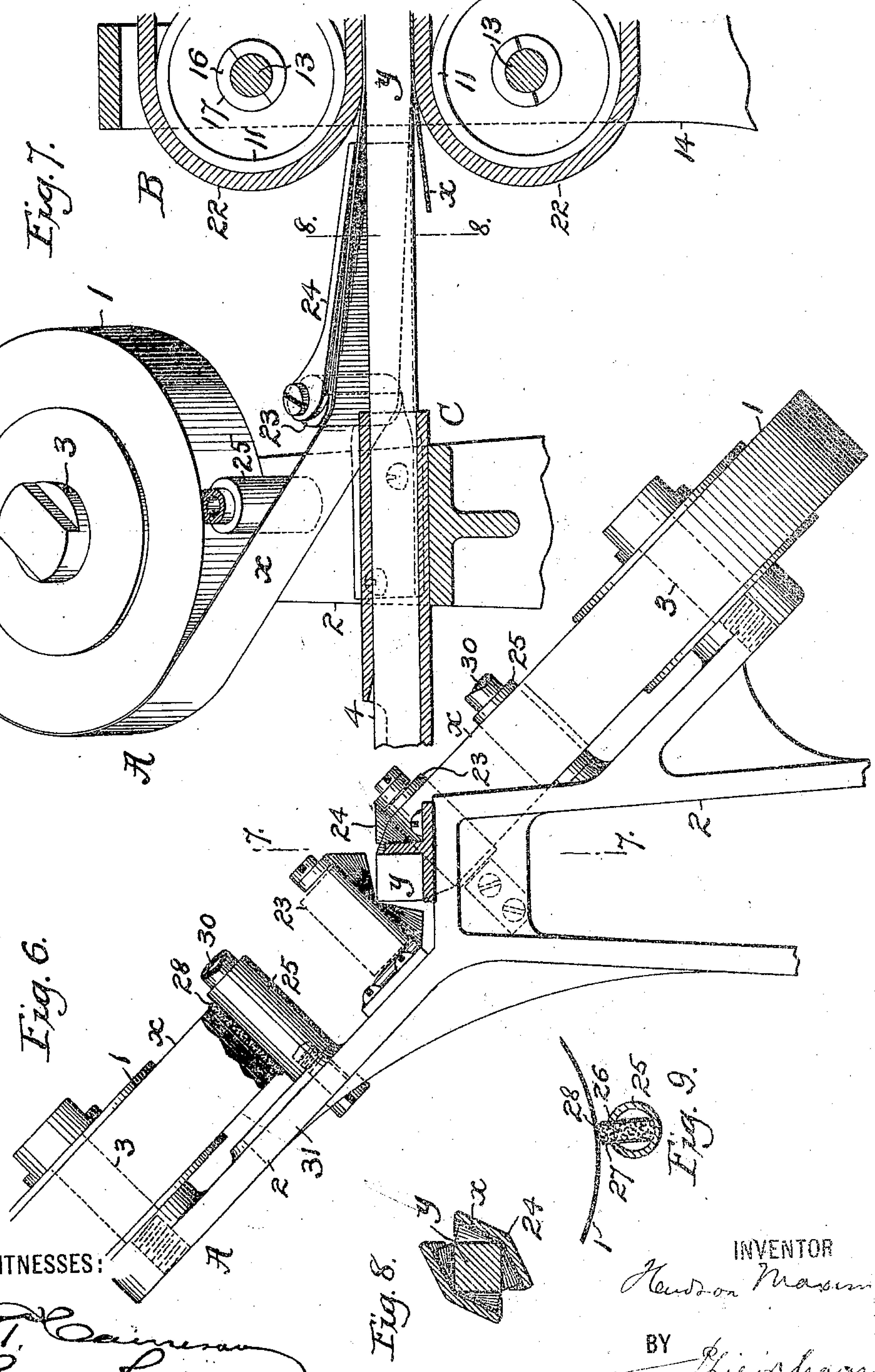

Fig. 7.

Fig. 6.

Fig. 8.

Fig. 9.

WITNESSES:

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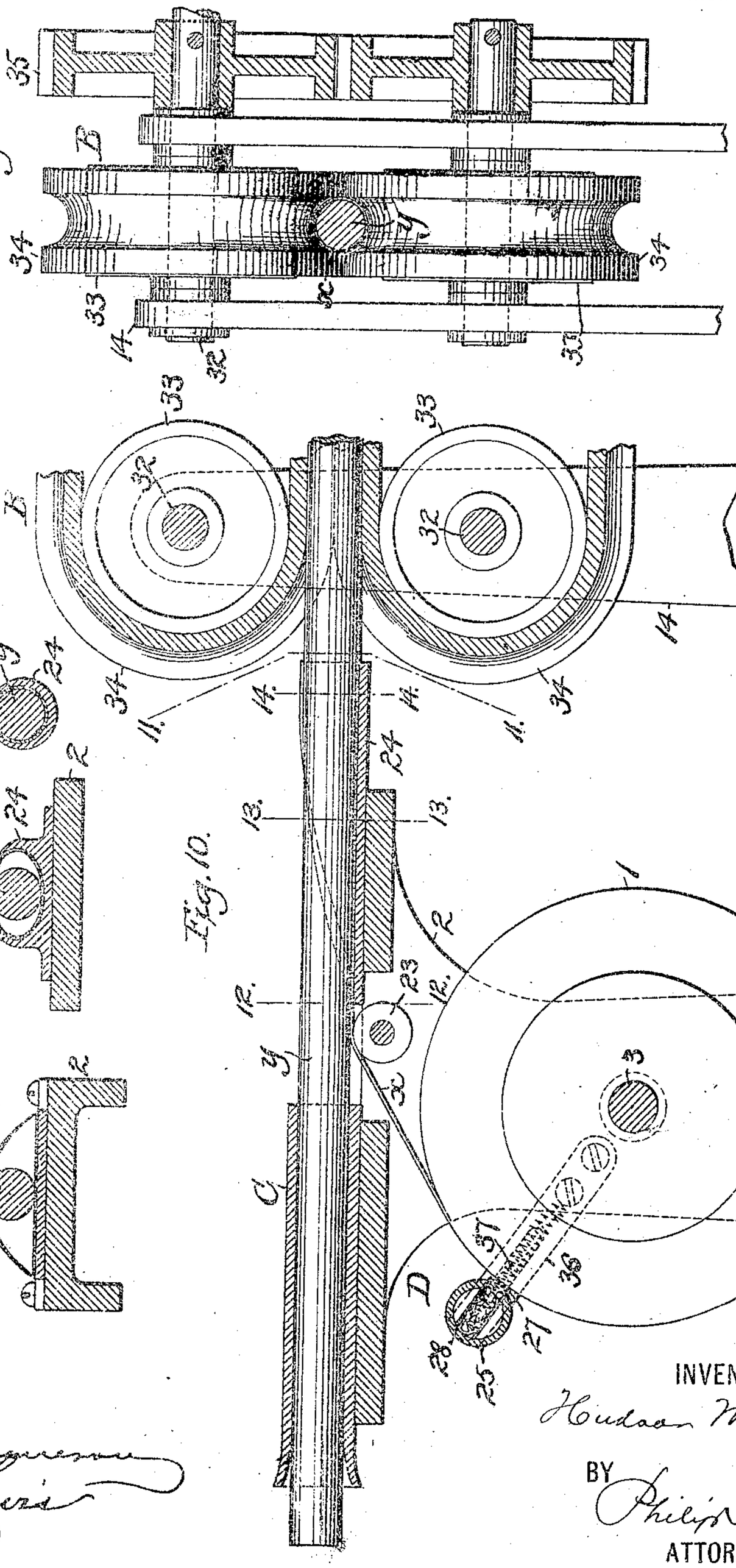
NO MODEL. 5 SHEETS—SHEET 5.



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No. 753,994. Patented March 8, 1904.

UNITED STATES PATENT OFFICE.

HUDSON MAXIM, OF NEW YORK, N. Y.

SMOKELESS-POWDER ROD OR GRAIN AND PROCESS OF MAKING SAME.

SPECIFICATION forming part of Letters Patent No. 753,994, dated March 8, 1904.

Application filed December 8, 1898. Serial No. 698,601. (No specimens.)

To all whom it may concern:

Be it known that I, HUDSON MAXIM, a citizen of the United States, residing in the city and State of New York, have invented a new and useful Smokeless-Powder Rod or Grain and Process of Making Same, which are fully set forth in the following specification.

The present invention relates to improvements in multiperforated rods or grains of smokeless powder and processes of making the same, and has particular reference to the covering or protection of the external surfaces of multiperforated powder-grains against the flame of ignition in the gun in order that the grains may be first ignited within the perforations and the ignition of the external surfaces delayed to such an extent that the grains may be wholly or quite consumed from within the perforations.

The primary object of this invention is to produce grains of smokeless powder for ordnance which shall present the minimum of combustion area to the flame of ignition and the maximum of combustion area at the instant before the perforations become tangent or intersect with one another from interior combustion, thereby yielding such progressive evolvement of gases as to well maintain the pressure behind the projectile in its flight throughout the entire length of the gun. As the initial pressure is in direct proportion to the amount of initial burning-surface presented by the powder-grains per unit of weight, it is obvious that much less pressure will be exerted under like conditions of confinement when all the other surfaces of the grain are protected from the flame of ignition except those within the perforations. The advantages of the powder-grains made and protected exteriorly in this manner are that larger charges may be employed and still give lower pressures than otherwise. In throwing aerial torpedoes from ordnance it is especially desirable to employ a powder which shall give a low initial pressure and also maintain the pressure substantially equal to the muzzle. Such ballistic results are best secured by the employment of powder-grains made and exteriorly protected as herein described.

The smokeless-powder material employed is preferably that which, with varying percentages and proportions of mixed guncottons or of guncottons and nitroglycerin, is now generally used in the art and which is plastic when containing a suitable solvent and which may by well-known methods be molded into any desired shape and which after the contained solvent is evaporated will be practically amorphous in character or of a colloidal nature impervious to the flame of its combustion in the gun.

In carrying out the invention I preferably proceed substantially in the following manner: A covering material in long thin strips, such as paper or celluloid, is wound upon rolls or spools, and one or a plurality of such spools are so positioned in an apparatus, as hereinafter fully described, that a continuous supply of covering material is furnished to, or is passed through, a former, by which the covering material is brought in contact with the surface of a rod or strip of powder material being passed through the apparatus, a pressure device squeezing the covering or compressing it upon the surface of the powder material and which is made to adhere to the surface of the same by previously wetting the powder-surface with a solvent of it, such as acetone, whereby it is rendered adhesive, or I may and sometimes do when employing a colloidal covering material, such as celluloid or paper impregnated or filled with a colloidal substance, wet with a suitable solvent, such as acetone, one surface of the covering material, whereby by being attacked by the solvent it is made adhesive and caused to adhere to the surface of the powder material when compressed thereon.

The rods or strips of powder material may be rectangular in cross-section, round or oval, or, when rectangular, with corners rounded, or the strips may be of any desired shape, and either one to several strips of covering material may be applied to a single rod or strip, according to the shape thereof and to the forming apparatus employed, all as hereinafter fully described, explained, and illustrated.

In applying the covering material the seams are made to overlap, so that the surface is fully protected. The thickness of the covering material employed is preferably such as to protect the surface of the powder against the flame of ignition and of combustion up to a point just before the complete consumption of the grain, but which covering material shall be burned through and the surface of the powder attacked by the flame just prior to the intersections of the perforations with one another and the complete consumption of the grain in order that no unburned covering material may be left to produce dust or smoke or material to foul the gun.

The covering material which I prefer to employ is celluloid, which will be consumed much less rapidly than the body of powder itself. It is obvious, however, to those skilled in the art that the covering material, although non-explosive, will be wholly consumed and without smoke by free oxygen or by robbing the carbonic-acid gas present of one molecule of its oxygen with the production of a larger percentage than otherwise in the products of combustion of carbonic oxid.

When employing especially rectangular rods or strips of powder material, all of the lateral surfaces except one may be covered, thereby closing the mouths of the perforations upon one side and leaving them open upon the other side, and protecting the two other sides, or the mouths of the perforations may be closed upon all sides if the covering material employed is sufficiently fragile over the perforations upon one side, so as to be disrupted under the pressure in the gun, thereby admitting the combustion-flame to the perforations.

The above particulars relate to the covering of powder-grains after they have been perforated, but I may cover them prior to perforating; in which case they are perforated through the covering material. However, there is a material advantage in thoroughly drying the powder—that is to say, in completely evaporating the solvent from the same before affixing the cover in order that the powder rod or grain may be shrunk to its minimum dimensions in order to prevent any alteration in size or shrinking away from the cover or warping of the cover after its application. Furthermore, there is a freer exit of solvent from the powder—that is to say, the powder is more readily dried before than after the application of the covering.

It is obvious that any desired form of multi-perforation may be employed—as, for example, the powder may be stuffed in the usual way, forming round bars longitudinally perforated. These may be covered and then cut into desired lengths—that is to say, of a length which shall be as long as required, but which shall not be sufficiently long as to endanger the disruption of the grain from excessive pressure within the perforations. The preferable form, however, is the transversely-perforated rod or strip.

With this general statement of some of the leading features and advantages of the invention I have in order to make the same more clearly understood shown in the accompanying drawings means of carrying it into practical effect without thereby limiting the improvements in their useful applications to the particular construction taken for illustration herein.

In the drawings, Figure 1 is an elevation of the improved apparatus. Fig. 2 is a front end elevation of the same. Fig. 3 is a vertical longitudinal section on the line 3 3 of Fig. 2. Fig. 4 is a vertical cross-section on the line 4 4 of Fig. 3. Fig. 5 is a similar section on the line 5 5 of Fig. 3. Fig. 6 is an end elevation of a modified form of the apparatus, showing the use of only two cover-feed rollers and strips. Fig. 7 is a cross-section of the modification shown in Fig. 6 on the line 7 7 thereof. Fig. 8 is a cross-section of the cover former and guide and the powder on the line 8 8 of Fig. 7. Fig. 9 is a transverse cross-section of the paper-moistening device employed as shown in the modification in Figs. 6 and 7. Fig. 10 is a side elevation, partly in section, of a modification designed for covering round rods with a single strip of material. Fig. 11 is a part sectional part end elevation thereof; and Figs. 12, 13, and 14 are sectional views on the lines 12 12, 13 13, and 14 14 of Fig. 1. Fig. 15 is a perspective view of a rod or grain covered as herein described.

Referring to Figs. 1 to 5, inclusive, the improved apparatus consists, essentially, in a cover supply and feed device A, a device B for compressing the cover-strips upon the powder in such a manner as to secure their firm adhesion thereto, and a guide C for guiding the strip or rod of powder to be covered.

The cover-feed device may be of any suitable form that can be adapted to supply covering material to strips or rods of powder, as required, but in the present modification comprises four rolls 1, each composed of a continuous covering-strip *x* and mounted upon a removable spindle 3, supported by a frame 2. The rolls are so disposed around a center along which the strip of powder is passed that they are substantially at right angles to each other, forming pairs, the members of each pair being opposite and on opposite sides of the path of the powder-strip. It will be understood that in this case the number of rolls and their disposition relative to one another is determined by the like number and disposition of the sides of the powder-strip. If the powder-strip has six sides, there may be six rolls, the peripheral surface of each of which

is preferably parallel with that side of the powder-strip which is to be covered by material supplied from the covering-roll.

The guide C for directing the powder *y* to the cover-compressing device consists of a metallic tube of such shape in cross-section as to approximately fit the powder-strip. It is secured to the frame immediately between the cover-feed rollers and has a portion 4 of its forward part open to allow the powder-strip to be entered easily and conveniently.

The apparatus is also provided with a moistening device D, which is supported by the guide C, and in this instance moistens with acetone the surface of the powder-strip as it emerges from the guide-tube and before it enters the cover-compressor. Obviously any other suitable solvent or partial solvent of the material of which the powder is made or that of which the cover is composed may be employed. The moistening device is composed of an annular channel or manifold 5, inclosed in a ring 6, which surrounds the path of the powder-strip and is connected by a pipe 7, controlled by a stop-cock 8, with any suitable reservoir 9 or supply of the solvent needed. The ring also consists on its inner side of an open recess or channel 10 in communication with the manifold and receiving a suitable absorbent substance 28—such as, for instance, felt, wool, cotton, or other suitable fibrous material—which bears firmly against the surfaces of the powder as it emerges from the guide-tube.

The cover-compressing device B, consists of a number of rolls 11 12, arranged on all sides of the rod of powder and carrying four endless belts 22, which are preferably of some elastic material, such as rubber, and each of which travels over the said rolls in contact on one side with the powder-cover *x* and in the direction of the movement of the powder-strip. Each belt is carried mainly by two end rollers 11, which are of comparatively large diameter and are mounted upon spindles 13 in the frame 14. Between the larger rollers a number of smaller rollers 12 are mounted on the frame and in a position to firmly press upon the back of each belt as it travels along with the strip of powder. The four larger rolls carrying the belts at each end of the compresser device are caused to revolve by a number of intermeshing miter-gears 15, mounted, respectively, one on each side of each roller 11 and meshing with each other transversely around the path of the powder-strip. In Fig. 4 there is shown a roller 11, divided in two parts transversely with respect to its center, each part being hollow and constructed integrally with the miter-gear 15. The two parts are secured together by tongues or mortises 16 and recesses on the inner face of their inside hubs 17. With this construction the spindles 13 need not revolve, as the whole system of miter-gears and rollers is operated without the use of shafts or spindles. In order to operate each system of miter-gears and rollers at each end of the frame 14, in which they are mounted, one spindle is secured to a miter-gear or half-roller by means of a key 18 or other suitable device and is extended out of the frame to carry a gear 19, which meshes with a gear 20 of a similar size, mounted between the two similar gears on each end of the compressing device. On one spindle there is also provided a pulley 21, so that all the belts and rollers 11 may be revolved by means of power applied thereto from any suitable source.

The powder-covering strips are taken, respectively, from each roll and passed between the elastic belts and the adhesive-moistened surfaces of the powder-strip, so that in their passage through the cover-compressing device they are firmly compressed and made to adhere to the powder-strips. As the strips of powder are passed from between the compressing-belts 22 the successive strips are separated by a pair of shears or other suitable device.

Referring now to the modification shown in Figs. 6 to 9, inclusive, the compressing device is similar to that before described; but the cover-feed device consists in this instance of but two rolls 1, feeding two covering-strips *x*, each of which are caused to cover two adjacent sides of the strip of powder. This is accomplished by mounting each roller with its peripheral surface opposite an edge of the powder-strip, and therefore at an angle of forty-five degrees with the sides of the powder-strip. The rollers are mounted, as heretofore, on a frame 2 opposite each other, and the covering-strip is fed from each roll to two small guide-rollers 23, having their axes parallel with the axes of the paper-rollers, but in close proximity to the edge of the powder strip, so that the cover-strip may pass between them and along the powder edge under a former 24, which longitudinally divides the paper into two parts and guides each part over the adjacent side of the powder-strip, the strip from one roller covering the two surfaces of the strip of powder, which surfaces terminate at the edge of which the roller is opposite. The powder, with its cover, then passes to and through the compressing device B, as before described. In this modification the strip of powder is not moistened with the solvent quickly, but instead a device is provided attached to the frame for moistening the surface of each roll 1 of covering material as it revolves in supplying the covering-strip to the powder. In this instance the moistening device consists of a cylinder 25, having a longitudinal slot 26, in which is forced between two supporting side plates 27 a quantity or a strip 28 of felt, which bears firmly against the periphery of the cover-roll. The

cylinder is supplied with a solvent through the opening 29 and may be adjusted radially to the roll through a slot 30 as the covering-strip is used.

Referring to Figs. 10 to 14, inclusive, the modification shown therein consists in a device for covering a circular rod of powder *y* with one covering-strip *x* from the feed-roll 1. However, a plurality of covering-strips may be used without departing from the invention. The covering-strip is passed over a small roller 23 and into the former 24ª, which transversely bends the covering-strip around to accurately fit the contour of the rod *y*, which also passes through the former and into the formed covering-strip from the guide C. As the covered powder-rod passes from the former it enters the compressing device B, which preferably consists in this instance of the belts 34, each having a longitudinal semicircular groove on their outer surface which conforms to the rod of powder as it passes through the compressor. The belts travel over the rolls 33, attached to the spindles 32 in the frame 14, and are caused to revolve at equal speeds by the intermeshing gears 35. The moistening device D in this modification consists of a cylinder 25, having absorbent material 28, supported by the side plates 27 in the slot 26 of the cylinder. As the covering-strip is stripped from the roll and its diameter decreased the cylinder is caused to travel toward its center in a guide 36 by means of a spring 37.

In Fig. 15 the powder rod or grain *y* is shown with the perforations *y'* covered with the combustible covering *x*, as will be clearly understood from the foregoing description.

What is claimed is—

1. In the manufacture of smokeless powder, the process herein described, which consists in molding smokeless-powder material into rods or strips while in a plastic state, due to a contained solvent, then evaporating the solvent to shrink and harden the material, and then applying a solvent to the surface of the rods or strips to render them adhesive, and then affixing a covering to the adhesive surface, substantially as described.

2. The herein-described process of manufacturing rods or grains of smokeless powder which consists in molding the same into rods or strips, while in a plastic state due to a contained solvent, multiperforating the rods or strips evaporating the solvent to shrink and harden the material, then rendering the rods or strips adhesive by application of a solvent to the surface thereof and then applying a covering to the rods or strips.

3. In the manufacture of smokeless powder, the herein-described process, which consists in molding the powder material into rods or strips, and then multiperforating the same, then drying, and then affixing a combustible non-explosive covering to the surface of the powder-body, and over the mouths of the perforations.

4. The herein-described multiperforated powder-grain having a combustible covering over its perforations adapted to be ruptured by the pressure of the powder-gases in the gun, said covering being secured to the grain without the interposition of cement.

5. The herein-described multiperforated powder-grain, having the openings of its perforations covered with a material adapted to be ruptured by the pressure of the powder-gases in the gun.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

HUDSON MAXIM.

Witnesses:
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ELISHA K. CAMP.