No. 787,105. PATENTED APR. 11, 1905.

H. MAXIM.

MEANS FOR MANUFACTURING MULTIPERFORATED BODIES OF SMOKELESS POWDER.

APPLICATION FILED FEB. 8, 1901.

3 SHEETS—SHEET 1.

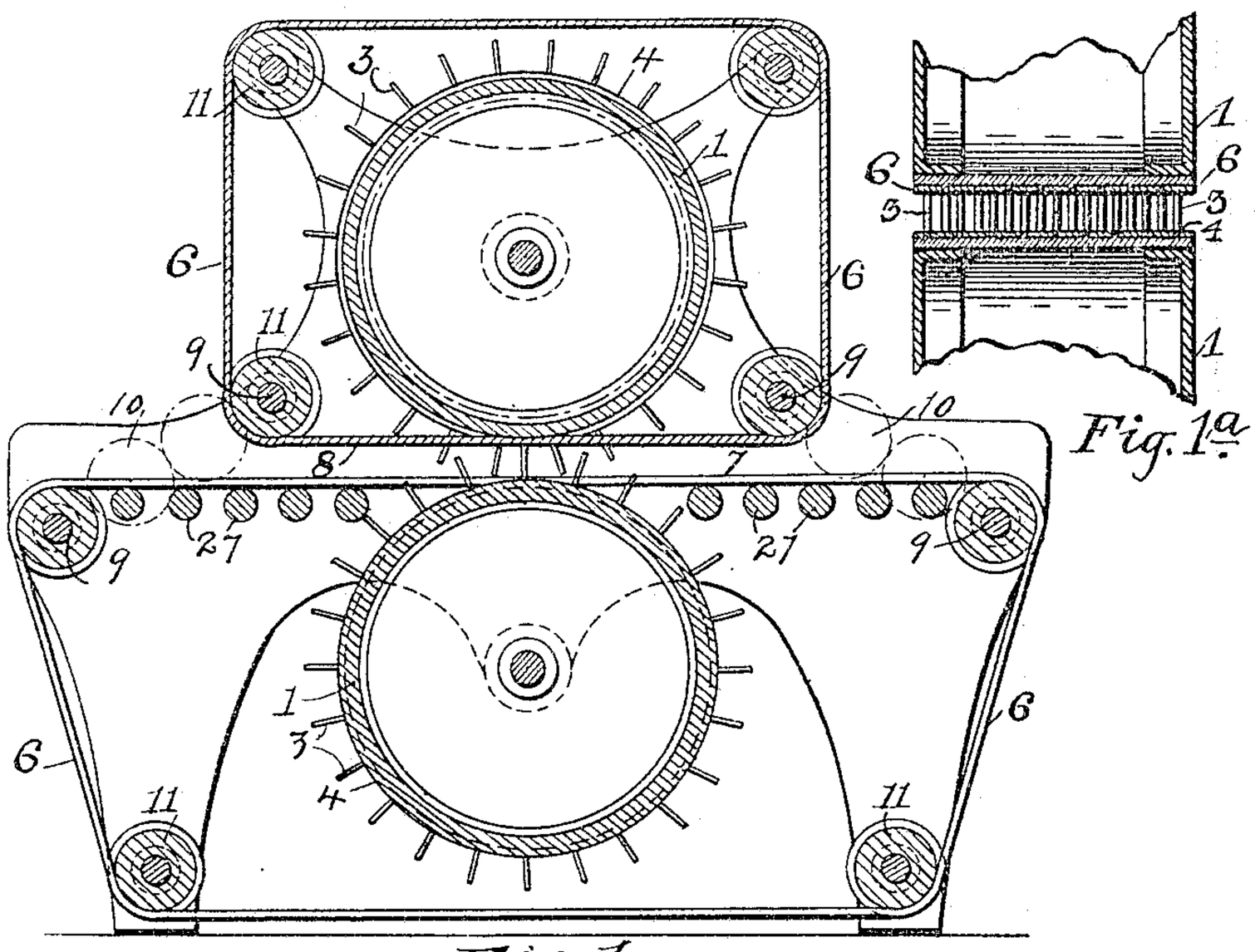

Fig. 1.

Fig. 1a.

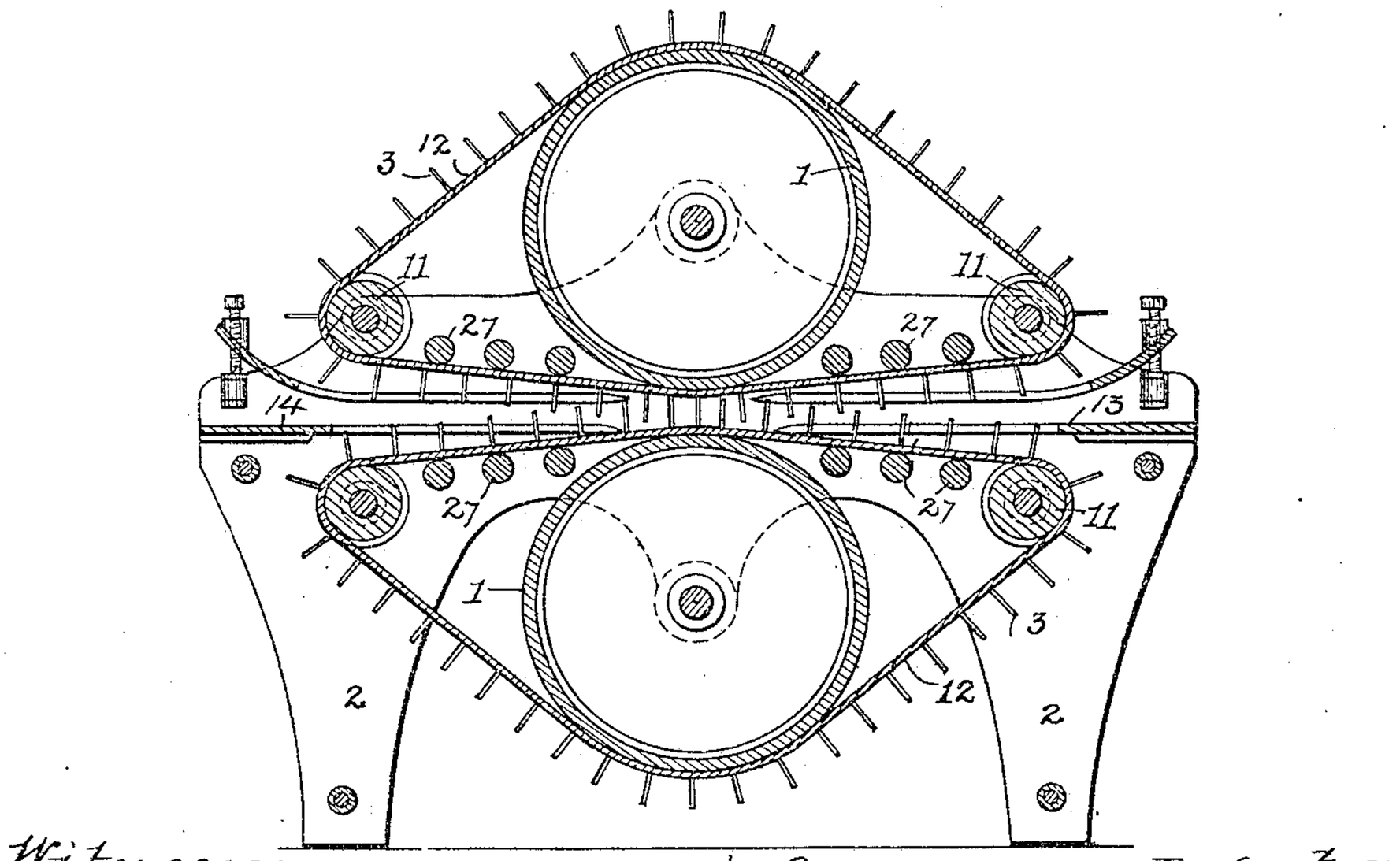

Fig. 2.

Witnesses.
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3 SHEETS—SHEET 2.

Fig. 3.

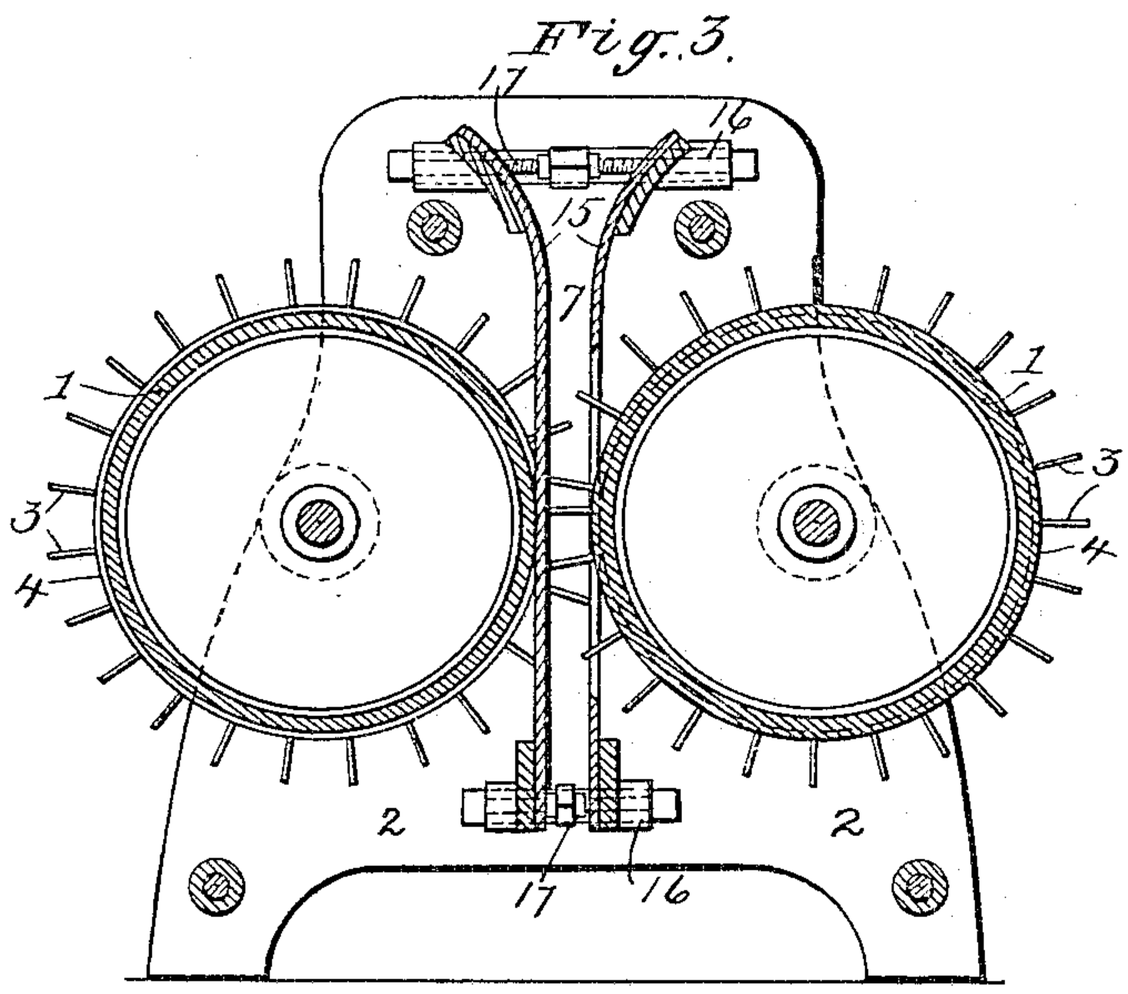

Fig. 11.

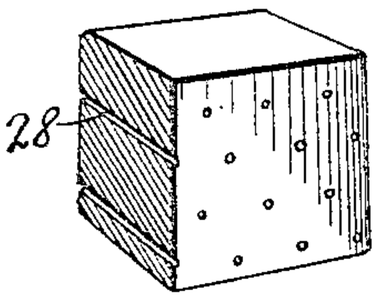

Fig. 7.

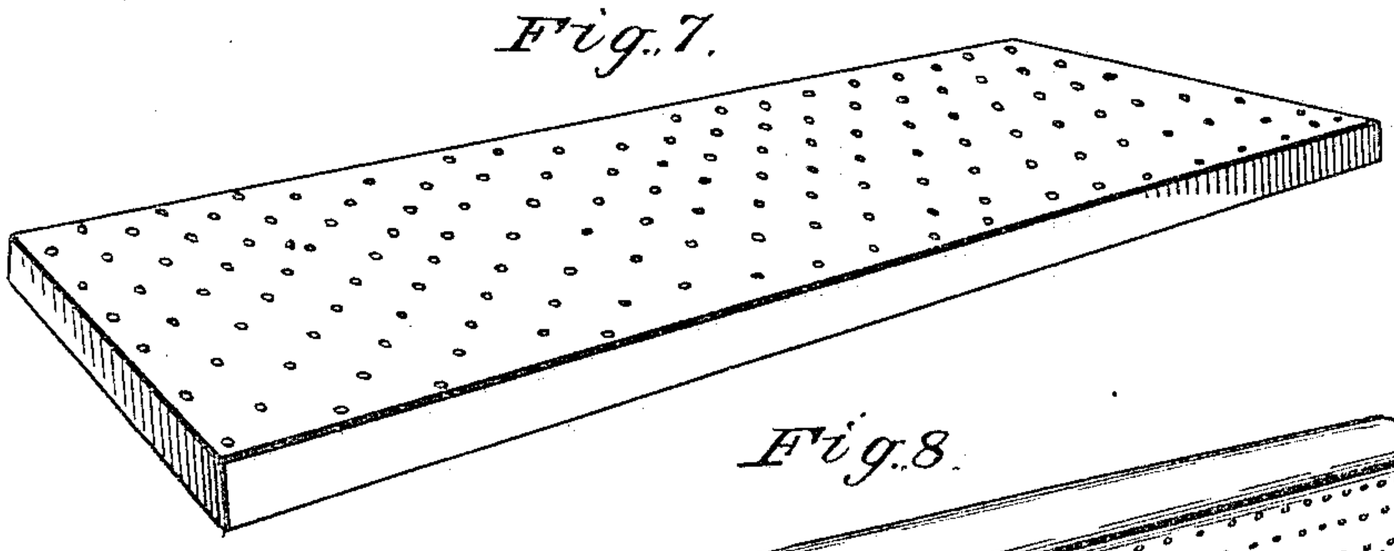

Fig. 8.

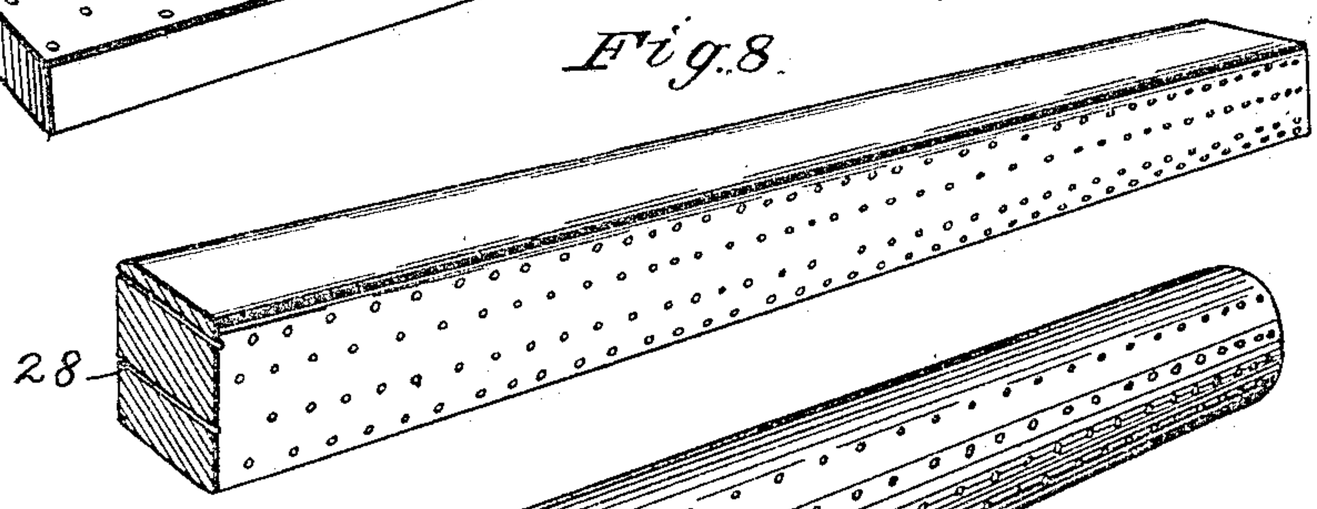

Fig. 9

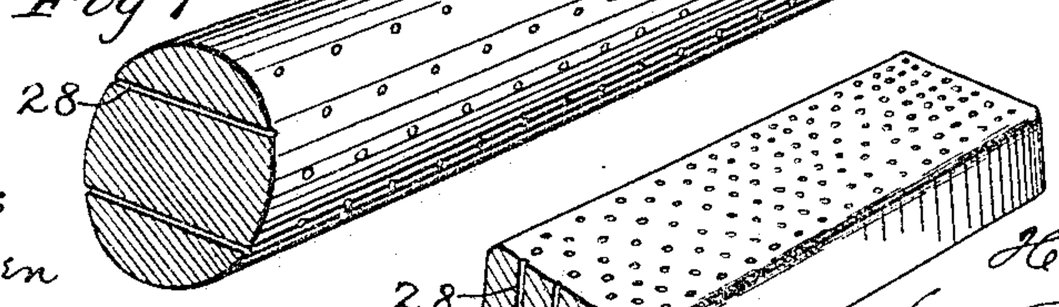

Fig. 10.

Witnesses
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No. 787,105. PATENTED APR. 11, 1905.

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MEANS FOR MANUFACTURING MULTIPERFORATED BODIES OF SMOKELESS POWDER.

APPLICATION FILED FEB. 6, 1901.

3 SHEETS—SHEET 3.

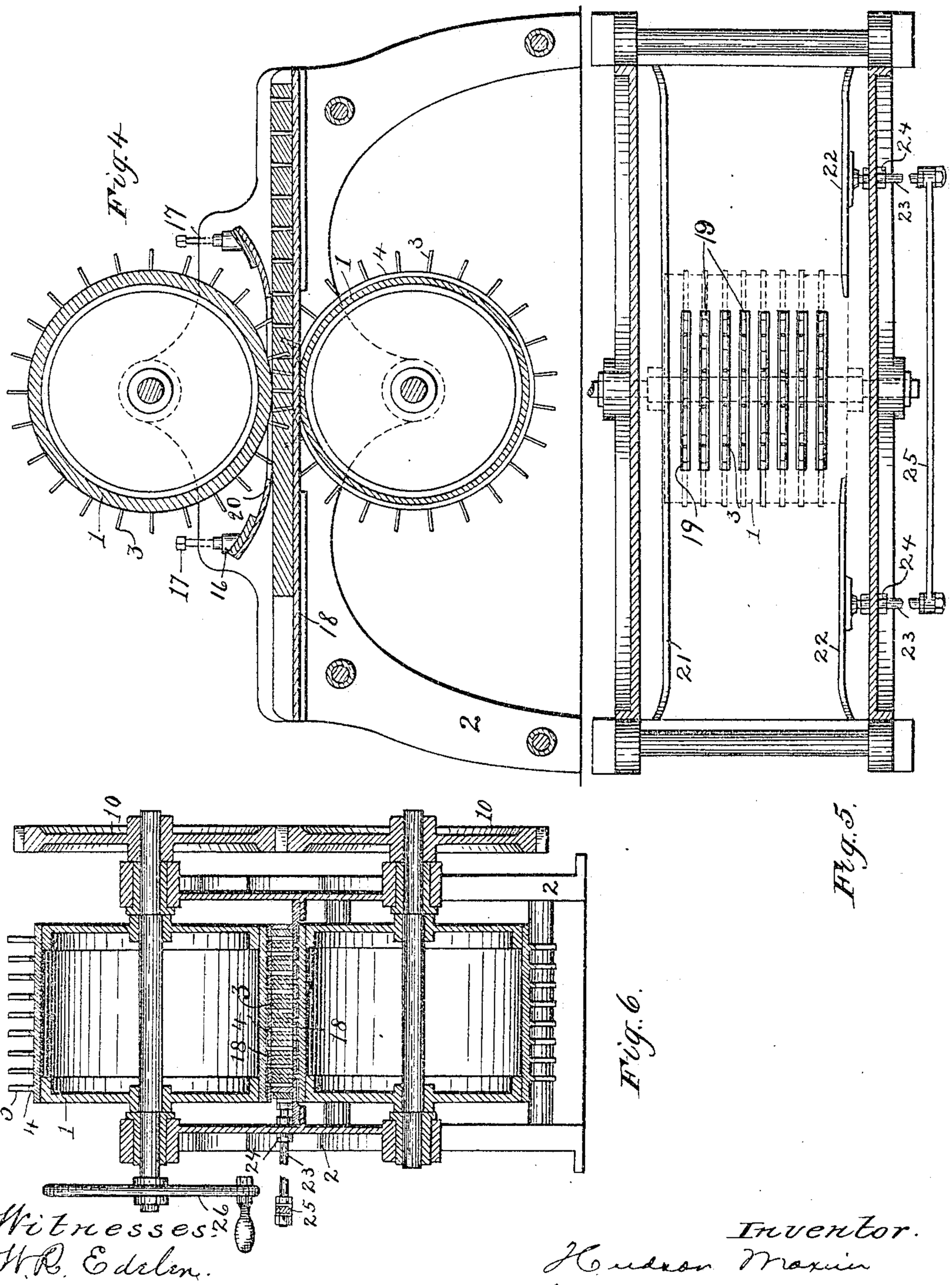

Fig. 5.

Fig. 6.

Witnesses:
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Inventor.
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by Philip Howard
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No. 787,105. Patented April 11, 1905.

UNITED STATES PATENT OFFICE.

HUDSON MAXIM, OF BROOKLYN, NEW YORK.

MEANS FOR MANUFACTURING MULTIPERFORATED BODIES OF SMOKELESS POWDER.

SPECIFICATION forming part of Letters Patent No. 787,105, dated April 11, 1905.

Application filed February 8, 1901. Serial No. 46,545.

To all whom it may concern:

Be it known that I, HUDSON MAXIM, a resident of Brooklyn, New York, have invented a new and useful Improvement in Means for Manufacturing Multiperforated Bodies of Smokeless Powder, which invention is fully set forth in the following specification.

This invention relates to an apparatus for making multiperforated rods or grains of plastic material, and has particular reference to the manufacture of explosive compounds of the kind now generally known as "smokeless powders" and also to the product made thereby.

The object of the present invention is mainly to produce rods or grains of multiperforated smokeless powder of such physical character and configuration as shall be best suited for obtaining the highest ballistic results in guns and at the same time cheapen its cost of manufacture. It is desirable in order to attain the highest ballistics that the combustion area presented to the flame of ignition shall both within the perforations and upon the exterior surfaces of the grains be as small as possible per unit of weight of material and that the total burning area shall increase as much as possible to a maximum just before the perforations become tangent by enlargement from interior combustion. Consequently it is obvious that the perforations should be comparatively small and the grains comparatively large, the perforations being sufficiently numerous and so disposed with respect to one another that the material between them shall be wholly consumed before the projectile leaves the gun.

When rods or grains of smokeless-powder material are made by stuffing through a forming-die, whereby the grains or rods are longitudinally perforated by mandrels interposed in the path of the material, the number of perforations found most practicable is seven or nineteen, and if the mandrels be made very small they are apt to spring or become distorted by the material passing over them, and the grains are apt to be irregularly perforated. Furthermore, as the perforations can only be made of a certain length without exposing the grain to disruption by the pressure of the products of combustion within the perforations the grains must be cut approximately short and cannot be made in the form of rods approximating the length of the powder-chamber of the gun. The present invention obviates these difficulties. Moreover, it presents an advantage in the case of material that is stuffed or squirted, because larger rods or strips are thus formed and adapted to smaller guns, so that more material is handled in a given time than would be the case when squirting through a very small die.

In carrying out my invention I preferably proceed in the following manner: The smokeless-powder material is prepared in the usual way and then stuffed or squirted through a forming-die which produces a rod or strip of material of a desired shape. The strips are then passed through the perforating apparatus and cut in suitable lengths for use and then dried and when dried are preferably of a colloidal nature. The material is preferably stuffed in a warm state, so that the strips become stiffened upon cooling and before perforating, or the same may be partially dried before perforating. The rods or strips are then placed upon carrying-belts or stationary guides and passed between rolls or cylinders or belts provided with perforating-pins. The pins are so disposed upon their carriers with respect to one another that one half of the perforations are made by those on the one side and the other half by those on the other side of the rod or strip being perforated, and said pins are arranged so that the space is provided for the carrying-belts or stationary guides over the rolls without interfering with the perforating-pins. The pins are also preferably mounted upon raised ribs extending around the periphery of the perforating-rolls, and the carrying-belts or guides lie between and come flush with the top of the ribs, so that a smooth or uniform surface is presented to the smokeless-powder material at the point of greatest bearing pressure between the rolls, and the opposing belts or guides upon converse sides of the smokeless-powder material serve as a backing to support the material against the thrust of the perforating-pins from the other side,

it being preferred to arrange a belt on the one side of the material opposite a row of pins on the other side and to alternate the belts or guides and rows of pins on the surface of each roll.

By perforating the material substantially equally from opposite sides the withdrawing of the pins from the one side serves equally to pull the material from the pins on the other side, so that to a great extent the perforating-pins themselves serve as their own strippers, and the function of the belts or guides is or may be mainly to support, guide, and convey the material.

It is obvious that the perforating-pins may be made very small in diameter without danger of distortion.

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 a vertical longitudinal section of the improved apparatus. Fig. 1ª is a broken longitudinal section of the rolls, taken at right angles to Fig. 1. Figs. 2, 3, and 4 are similar sections of modifications of the apparatus. Fig. 5 is a sectional plan view of the apparatus shown in Fig. 4. Fig. 6 is a vertical cross-section of the same. Fig. 7 is a perspective view of the full-sized strip of powder multiperforated according to the present invention. Fig. 8 is a similar view of a square rod of powder. Fig. 9 is a similar view of a circular rod of powder. Fig. 10 is a similar view of a section of a strip or rod of powder, and Fig. 11 is a perspective view of a cubical grain of powder multiperforated according to the present invention.

Referring to Fig. 1, the apparatus consists, essentially, of two revolving perforating rolls or cylinders 1, mounted horizontally one above the other on a suitable frame 2. Each roll is provided with a plurality of rows 5 of radial perforating-pins 3, fixed equidistant on circular ribs or collars 4, extending around each roll. The distance between the rolls is governed by the thickness of the powder strip or rod to be perforated, and the pins are made of such a length as to completely perforate the rod or strip and to barely touch the opposite roll or the guides or belts carried thereby. The rows of pins are alternately situated on the two rolls, as illustrated more particularly in Fig. 6, and the pins on both rolls are so disposed as to provide for a staggered or zigzag row of perforations across the perforated strip, as shown in Figs. 7 to 11.

The apparatus also embodies means for conveying and guiding the material to be perforated to and between the rolls and in means for stripping the perforated material from the pins and rolls and for conveying the same away from the vicinity of the perforating device. These means are preferably embodied in a plurality of belts 6, which pass to and over the rolls 1 between the ribs or collars 4, heretofore mentioned, so that they are positively guided and lateral motion prevented and in such wise that one set of belts is in contact and rotates at an equal speed with one roll, while the other set of belts acts in a like manner with the other roll, the space 7 between the two sets serving as a path or channel for the passage of the plastic material to be perforated. It will be seen from this description that providing the belts are of the same thickness as the ribs or collars 4 the surface at the point directly between the rolls of maximum or complete perforation is completely flush throughout its width and presents no crevices or indentations into which the plastic powder could be forced by the opposing roll or perforating-pins. The belts 6 are preferably endless and for a suitable distance 8 are horizontal on each side of the rolls in order to convey the material firmly and accurately between and from the rolls. To secure this horizontal portion, there are provided two or more rollers 9 and 11, so situated on the machine that each set of belts may be so carried or guided as to completely encircle each roll respectively, as shown in the figure. I prefer to provide these smaller rollers with ribs or collars similar to ribs 4 on the large rolls. There is provided a series of yet smaller rollers 27 underneath the lower belt on each side of the perforating-roll, so that the belts at their horizontal portion will be prevented from sagging and will firmly support the material which they are guiding and conveying to the perforating device.

Suitable gears 10, as shown in dot-and-dash lines in Fig. 1, are provided for operating the small end rollers 9 in unison and at the same rate of surface speed as the perforating-rolls.

The operation of the apparatus is briefly as follows: The rod or strip to be perforated is placed on the moving series of lower belts at the horizontal portion 8 and is conveyed thereby in the channel or pathway between the upper and lower series of belts and thence to and between the perforating-rolls, the pins of which perforate in such a manner as not to disrupt or distort the grain, owing to the simultaneous entrance of the perforating-pins from opposite sides and the corresponding rate of speed of the belts and rolls. The action of perforating is clearly shown in Figs. 4 and 6. On the material emerging from the center line of the two cylinders and from the position of maximum or complete perforation the pins are gradually withdrawn from the material, but in such wise as to distribute equally the withdrawing force on the two sides of the strip, and therefore to secure the latter

from any distortion on its passing from the perforating device. It will be seen in like manner that the entire action of perforating, conveying, and withdrawing of the perforating-pins is balanced as to both sides of the strip and that the distortion of the grain or strip in any way is thereby prevented. It also will be seen that owing to the alternate position of the rows of perforating-pins and of the belts each of the latter acts as a support or backing for the powder while it is being perforated by that row of pins which is immediately opposite on the opposed roll.

Referring to Fig. 2, the perforating-pins on the rolls are dispensed with and instead are placed on broad belts 12, which converge as they approach the position of complete perforation in the rolls and diverge on passing from the rolls. This device provides for a more gradual perforation of the strip, although it will be readily understood that such gradual perforation can be attained by the device in Fig. 1 by constructing the perforating-rolls of very large diameter relative to the thickness of the material to be perforated or the space between the rolls. Where the perforating-belt is employed, a series of stationary guides 13, above and below the path of the material to the perforating device, is provided, together with a series of strippers 14, serving also as guides to strip the material from the pins and perforating-belts after passing between the rolls.

In Fig. 3 there is shown an apparatus with perforating-rolls similar to those in Fig. 1, but placed with their axes in the same horizontal plane, so that the powder is passed vertically down between the perforating-rolls and between the two sets of guides 15, one on each side of the material, which serve not only to guide the material to the perforating device, but also to guide and strip the material from the said device after being perforated. The guides are attached at each end to blocks 16 and screws 17, which are used to adjust the distance between the guides according to the thickness of the material to be perforated. The guides lie between the ribs or collars 4 on the rolls 1 in a like manner to the position of the belts 6 in Fig. 1.

Referring to Figs. 4, 5, and 6, a horizontal machine is illustrated, which is provided with a table 18, situated tangentially over the lower roll and having a plurality of slots 19, through which the perforating-pins and collars 4 on the roll pass. The upper roll is provided with guides 20, which are slotted in like manner and for a like purpose as the table, it being understood that the table also serves as a guide and, together with the upper guide, conveys the material rigidly and accurately to and from the perforating device and also serves as strippers for stripping the material, as before mentioned. Should it be desired to employ rods or strips of powder of varying width and thickness, I have provided means whereby the guides are adjusted to such thicknesses, as by the regulating device of blocks 16 and screws 17 in Figs. 3 and 4. In Fig. 5 there is also shown a device consisting of a stationary side guide 21 and movable side guides 22, which latter may be adjusted laterally according to the width of material by the screws 23 and nuts 24, the bar 25 between the two screws serving to indicate the relative positions of the guides.

Suitable gears 10 for revolving the rolls in unison and at the same speed are provided in all instances, and means are also provided for revolving the rolls and belts from any suitable source of power, as by a hand-wheel 26.

Fig. 7 illustrates a strip of powder which has been perforated by the improved device and which may be cut into strips or sections of any shape desired for use in guns. Fig. 8 illustrates a substantially square rod of powder which has been cut from a longer perforated rod, showing one end grooved or corrugated by perforations 28, which have been intersected at the place of division on the original rod. This grooved end surface is also illustrated in the round rod, Fig. 9, in the rectangular rod, Fig. 10, and in the cube, Fig. 11.

The material may be formed into either rods or strips by stuffing, which is preferable; but it may also, of course, be done by rolling into sheets and then cutting the sheets into suitable form or into the form of strips before or after perforating.

What I claim is—

1. In a machine for perforating plastic material, the combination of perforating-pins, with means simultaneously impressing said pins into the material from opposite sides thereof and means supporting the material on both sides against the perforating pressure and opposite the said pins.

2. In a machine for perforating plastic material, the combination of perforating-pins, with means simultaneously impressing said pins into the material from opposite sides thereof, means supporting the material on both sides against the perforating pressure and opposite the pins and for stripping the material from the pins.

3. In a machine for perforating plastic material, the combination of perforating-pins carried by oppositely-disposed revolving supports and acting to simultaneously impress the pins into the material from opposite sides thereof, with means opposite the pins for supporting the material against perforating pressure.

4. In a machine for perforating plastic material, the combination of perforating-pins, with means simultaneously impressing said pins into the material from opposite sides thereof, and means opposite the pins for supporting said material on both sides against the

perforating pressure and provided with openings through which the pins project in the act of perforation.

5. In a machine for perforating plastic material, the combination of perforating-pins carried by oppositely-disposed revolving supports and acting to simultaneously impress the pins into the material from opposite sides but not at opposite points and means supporting the material on both sides against perforating pressure.

6. In a machine for perforating plastic material, the combination of oppositely-placed revolving supports, rows of perforating-pins carried by said supports in different transverse planes, means supporting the material against perforating pressure and stripping said material from the pins.

7. In a machine for perforating plastic material, the combination of oppositely-disposed revolving rollers having raised peripheral ribs thereon in different transverse planes and revolving belts supported in approximately tangential contact with said rollers between said ribs, whereby they act as a support for the plastic material against the perforating pressure of the pins.

8. In an apparatus for perforating plastic material, the combination of perforating-rolls having peripheral ribs, perforating-pins carried by said ribs and guides for guiding the material between said rolls.

9. In an apparatus for perforating plastic material the combination of perforating-rolls, a plurality of rows of perforating-pins carried by each roll and a plurality of guides over each roll, each guide lying between the contiguous rows of pins and opposite a row of pins on the opposed rolls.

10. In an apparatus for perforating plastic material the combination of perforating-rolls, pins carried by said rolls and a plurality of belts carrying the material through the rolls and supporting it on opposite sides thereof during perforating action.

11. In a machine for perforating plastic material, the combination of oppositely-disposed rolls, pins carried by said rolls, and means independent of the rolls for supporting the material on both sides against the perforating pressure, whereby the surface of the grain is perforated and remains flat.

12. In a machine for forming holes in plastic materials, the combination of oppositely-disposed rolls, means carried by said rolls for forming holes in said material, and means independent of the rolls for supporting the material on both sides against the pressure of the hole-forming means.

13. In a machine for forming holes in plastic material, the combination of hole-forming means carried by oppositely-disposed revoluble supports and acting to simultaneously impress said means into the material from opposite sides thereof, with supporting means for holding the material against the pressure of the hole-forming means.

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

HUDSON MAXIM.

Witnesses:
S. T. CAMERON,
REEVE LEWIS.