J. N. GILBERT.

MACHINE FOR DISCHARGING PROJECTILES.

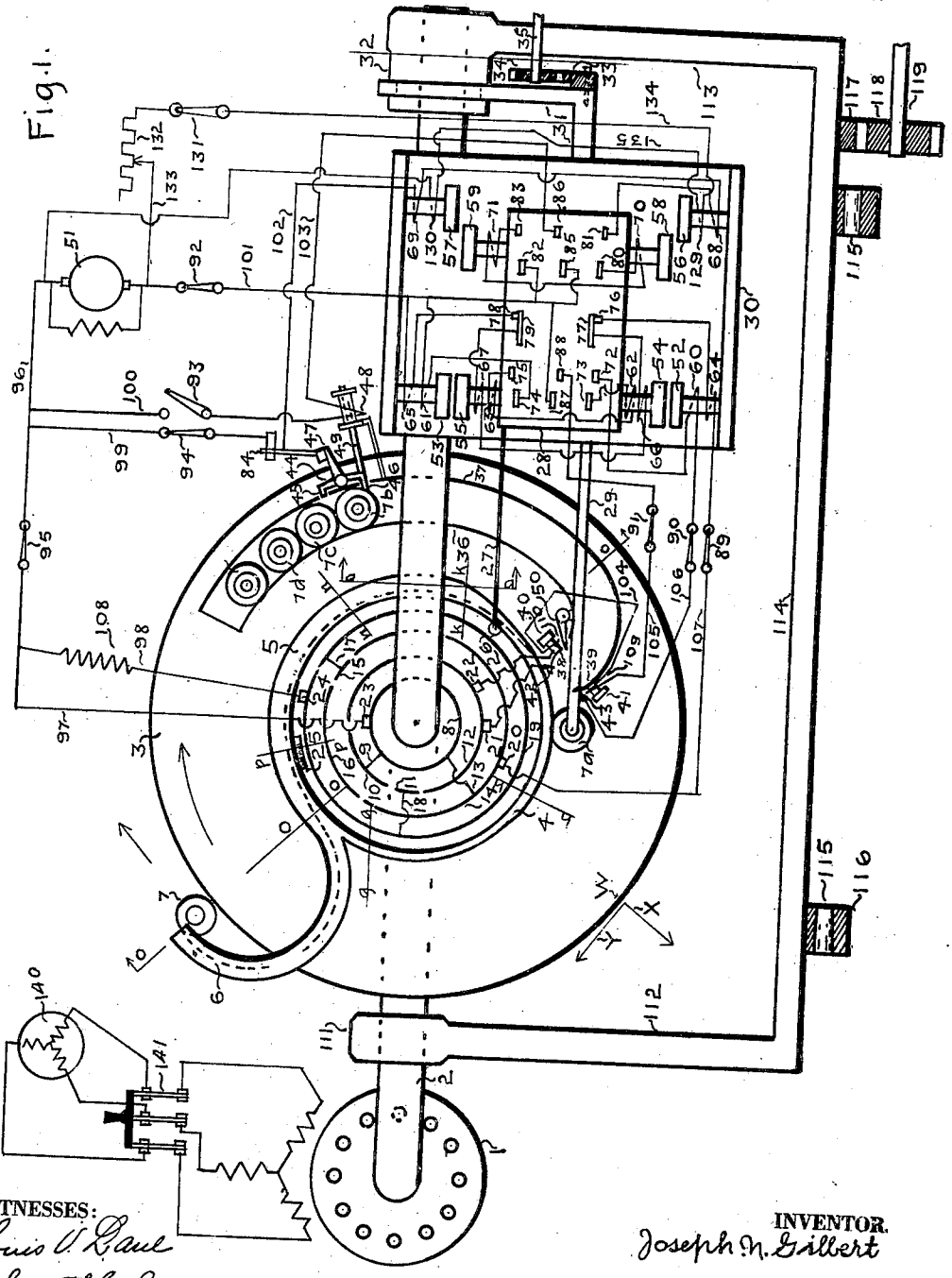
APPLICATION FILED MAR. 14, 1918.

1,376,013.

Patented Apr. 26, 1921.

4 SHEETS—SHEET 1.

Fig. 1.



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4 SHEETS—SHEET 2.

Fig. 2.

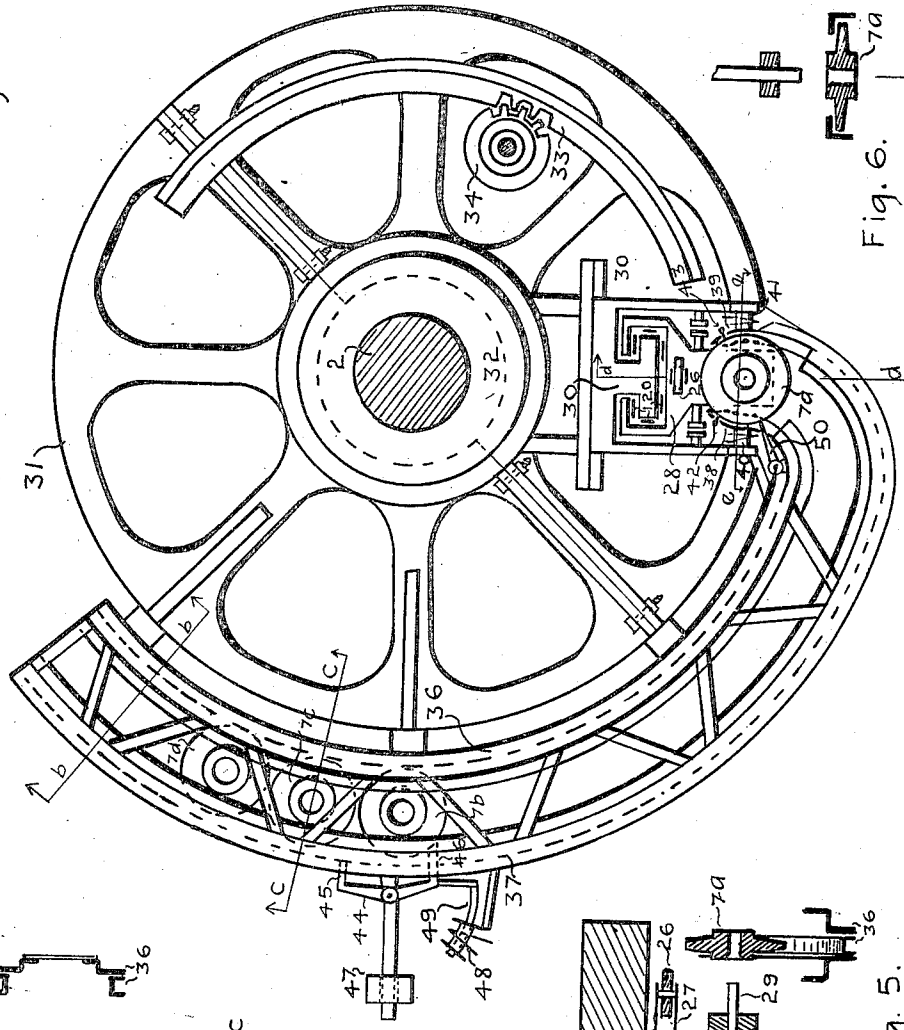


Fig. 6.

Fig. 3.

Fig. 4.

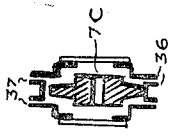


Fig. 5.

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MACHINE FOR DISCHARGING PROJECTILES.

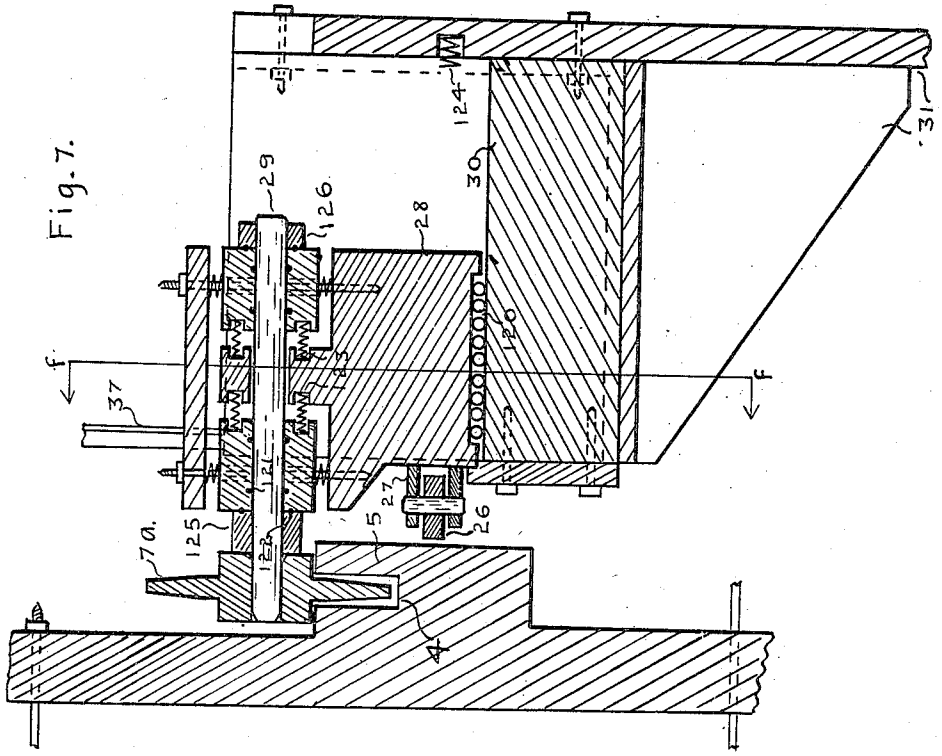
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4 SHEETS—SHEET 3.

Fig. 7.



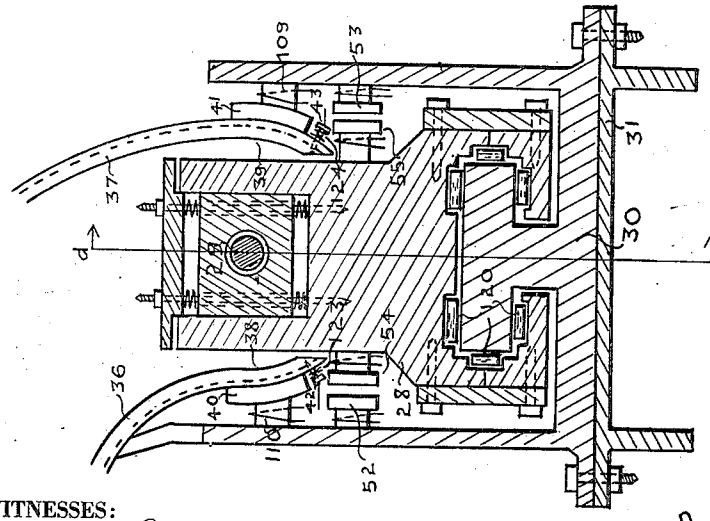


Fig. 8.

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4 SHEETS—SHEET 4.

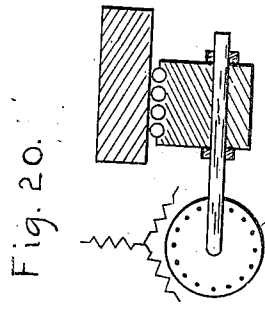


Fig. 20.

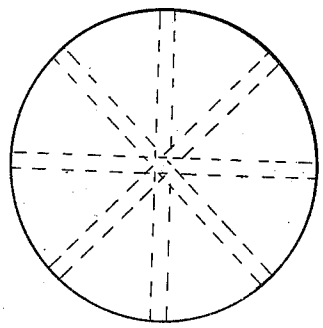


Fig. 10.

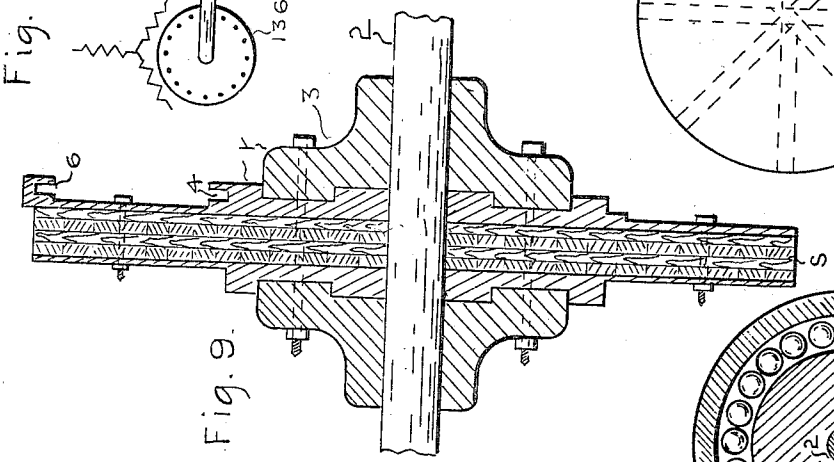


Fig. 9.

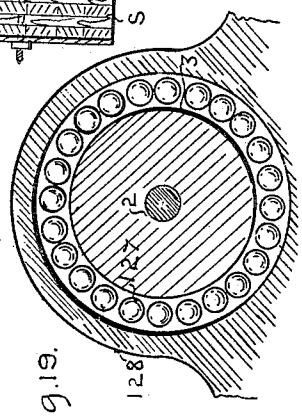


Fig. 19.

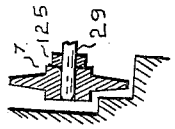


Fig. 11.

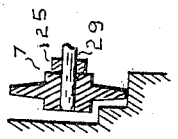


Fig. 12.

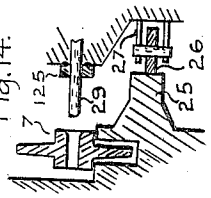


Fig. 14.

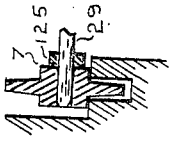


Fig. 13.

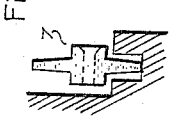


Fig. 15.

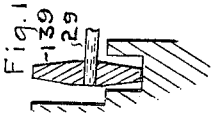


Fig. 16.

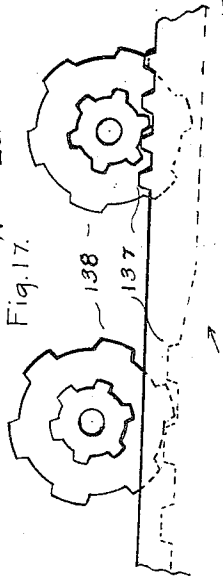


Fig. 17.

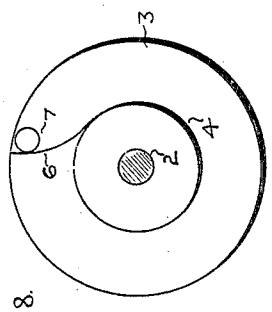


Fig. 18.

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MACHINE FOR DISCHARGING PROJECTILES.

1,376,013. Specification of Letters Patent. **Patented Apr. 26, 1921.**

Application filed March 14, 1918. Serial No. 222,431.

To all whom it may concern:

Be it known that I, JOSEPH N. GILBERT, a citizen of the United States, residing at 2614 Grand avenue, Minneapolis, in the county of Hennepin and State of Minnesota, have invented a new and useful Machine for Discharging Projectiles.

The objects of my invention are as follows:

(*a*) To discharge a projectile with a velocity sufficient for modern warfare, without the use of explosives.

(*b*) To discharge large projectiles in rapid succession and continuously for an indefinite period.

(*c*) To discharge said projectiles at any horizontal angle, or at any vertical angle.

(*d*) To vary either the horizontal or vertical angle of discharge during the interval of a succession of discharges, so that by observing where the projectiles are striking, the stream of projectiles may be turned directly upon the target.

The projectile discharged is a disk with a hub and a hole in the hub.

In addition to the motion imparted to the projectile in the direction of discharge, there is also imparted to the projectile a rotary motion around its hub.

This high speed rotation of the projectile around its hub, causes the projectile to remain upright in the vertical plane with its edge forward, just as a rolling hoop remains upright so long as it is rolling.

Also the rotary motion causes the roughened edge of the disk to cut away the air cushion that forms in front of the projectile, just the same as the teeth of a buzz saw cut through wood. By this means the air resistance is overcome to some extent, at the expense of the rotating energy, rather than at the expense of the discharge energy.

The appliance for imparting the discharge motion, also the rotating motion to the projectile, is a rotating main wheel, having attached to its side a projectile track having side guards. At the proper instant during the interval of the rotation of the main wheel, a shaft automatically pushes through the hole in the hub of the projectile, and pushes the projectile onto the projectile track.

The friction of the side guards on the hub of the projectile imparts a rotating energy to the projectile, and at the proper angular position of the main wheel, the shaft is automatically withdrawn from the hub thereby releasing the projectile which, due to the combined action of the imparted rotating energy and the action of centrifugal force, rolls along the projectile track.

A reverse curve in the track reverses the direction of the projectile, causing it to be rolling in a direction tangent to the radius of the main wheel when the projectile reaches the circumference of said main wheel.

Therefore, when the projectile rolls off of the end of the track, it is discharged into space with an initial velocity equal to the velocity of the circumference of the main wheel plus the rolling velocity of the projectile on the track.

For a more complete explanation of the working mechanism and the operation thereof, I will refer to the accompanying drawings, in which Figure 1 is a diagrammatic view of my invention, which I use in explaining the functions of the various cooperating parts.

Fig. 2 is a sectional view on line *a*. *a*. of Fig. 1 showing the projectile magazine and the supporting wheel by which the magazine is rotated into various positions in the vertical plane.

This view also shows the various coöperating parts used in transferring the projectile from the magazine to the projectile track.

Fig. 3 is a sectional view of the magazine on line *b*. *b*. of Fig. 2 showing the open side where the projectile is inserted into the magazine.

Fig. 4 is a sectional view on line *c*. *c*. of Fig. 2 showing a projectile in the magazine.

Fig. 5 is a sectional view on line *d*. *d*. of Fig. 2 showing the loading carriage and the supporting base on which it moves.

The carriage is here shown in the starting position ready to move forward, push the

shaft through the hub, and push the projectile out of the magazine.

Fig. 6 is a sectional view on line *e. e.* of Fig. 2 showing the magazine open on the side on which the projectile is pushed out.

Fig. 7 is a large scale section through the loading carriage on line *d. d.* of Fig. 2 and also shows a section of the projectile track.

In this view the wheel supporting the magazine and loading carriage base, is rotated through one hundred and eighty degrees from the angular position shown in the previous figures. This view shows the loading carriage above its base.

The carriage is here shown in the forward position, having pushed the projectile out of the magazine and is holding it in contact with the projectile track, near section *n. n.* of Fig. 1.

Fig. 8 is a sectional view on line *f. f.* of Fig. 7 showing how the loading carriage is supported on its base.

Fig. 9 is a sectional view of the main wheel on line *o. o.* of Fig. 1.

Fig. 10 shows the method of cross-laying the lumber employed in the main wheel construction.

Fig. 11 is a sectional view through the projectile and the projectile track between lines *g. g.* and *n. n.* of Fig. 1.

Fig. 12 is a section through projectile and track between lines *n. n.* and *k. k.* of Fig. 1.

Fig. 13 is a section through projectile and track between lines *k. k.* and *p. p.* of Fig. 1.

Fig. 14 is a section through projectile and track at line *p. p.* of Fig. 1.

Fig. 15 is a section through track between line *p. p.* of Fig. 1 and the discharge end of the track, or through the accelerative track.

Fig. 16 shows a modified form of projectile without a hub.

Fig. 17 shows a modified form of projectile and track, in which teeth are used to eliminate slippage.

Fig. 18 shows a modified form of track, in which the reversed curve, accelerative track ends in a radial direction.

Fig. 19 is a sectional view showing how an auxiliary casing may be used to support ball bearings which press against the main wheel for the purpose of counteracting the effect of the centrifugal force.

Fig. 20 is a sectional view through loading carriage showing a motor to rotate the loading shaft.

In Fig. 1 the motor 1, rotates shaft 2, to which is keyed the main wheel 3, attached to said main wheel is the circular projectile track 4, part of said track having side guards 5, said track being extended to form the reverse curve accelerative track 6, which reverses the direction of the projectiles 7, 7^a, 7^b, 7^c, 7^d, etc., so that the rolling direction of the projectile is in a direction normal to the radius of the main wheel when the projectile is discharged. 8 is a slip ring electrically connected by 9, to slip ring segment 10, which forms the complement of segments 11 and 12, said slip ring is also electrically connected by 13 to segment 14, which forms the complement of 15 and 16. Certain of said segments are electrically connected by 17 and 18 to slip ring 19. Bearing on said slip ring and segments are brushes 20, 21, 22, 23 and 24. The releasing lug 25 coöperates with the releasing wheel 26 and its support 27 to push back the loading carriage 28, which supports and operates the loading shaft 29. Supporting said carriage is carriage base 30, supported by the wheel 31 which is rotatable about the main shaft bearing 32.

The rotation of said wheel is performed by the rack 33 coöperating with pinion 34 turned by shaft 35.

The loading magazine comprises the guides 36 and 37, terminating respectively in the circular arcs 38 and 39, supporting respectively the magnet poles 40 and 41, also the electric contact points 42 and 43.

The magazine further comprises the pivoted lever 44, having arms 45 and 46, also the weighted lever arm 47, coöperating with solenoid 48 to operate plunger 49, releasing the projectiles which roll by gravity down the guides, acquiring sufficient momentum to carry them up into the arcs where they are held from rolling back, by the dog 50.

The direct current generator 51 supplies current for exciting the solenoids also the various magnet poles.

The stationary poles 52 and 53 on the carriage base coöperate respectively with the poles 54 and 55 on the movable carriage to produce the forward motion of the carriage, which pushes the projectile onto the track.

The stationary poles 56 and 57 coöperate with the movable poles 58 and 59 to assist the releasing lug and releasing wheel to push the carriage into the back position.

Coils 60 and 61 magnetizing stationary poles, coöperate with coils 62 and 63, magnetizing movable poles, to start the forward motion of the carriage, while coils 64 and 65 coöperate with coils 66 and 67 to complete the forward motion of the carriage.

Coils 68 and 69 magnetize the stationary poles, while 70 and 71 magnetize the movable poles for completing the backward motion of the carriages. The sliding contacts 72, 73, 74, and 75 coöperate with the contacts in the arc terminals, for closing the circuit that starts the forward motion of the carriage. 76 contacts with 77 and 78 contacts with 79 to close the circuit that completes the forward motion and holds the carriage in the forward position.

The electrical contacts 80, 81, 82 and 83, coöperate with the switch 84 to close the circuit that completes the backward motion

of the carriage. Contacts 85 and 86 are to close the solenoid circuit, while contacts 87 and 88 are connections in the pole coils on the magazine terminals. 89, 90, 91, 92, 93, 94 and 95 are single pole switches.

96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106 and 107 are electrical conductors. 108 is an electrical resistance. 109 and 110 are pole coils on the magazine terminals. 111 is a main shaft bearing. 112 and 113 are bearing supports, resting on base 114, which bears on rollers 115, which bear on track 116. Said base is moved on the rollers, by the motion of the rack 117, coöperating with pinion 118, which is rotated by shaft 119.

120 are roller bearings while 121 and 122 are ball bearings. 123 and 124 are springs. 125 and 126 are collars to hold the loading shaft in position. 127 are ball bearings or rollers. 128 is an outer casing to hold the said ball bearing in contact with the main wheel. 129 and 130 are magnetizing coils of a low magnetomotive force. 131 is a single pole switch. 132 is a variable non-inductive resistance. 133, 134 and 135 are electrical conductors. 136 is an electric motor. 137 and 138 are teeth to prevent the slippage of the projectile. 139 is a projectile without a hub. 140 is a generator supplying energy to the motor that operates the rotating element. 141 is a switch connecting said generator to said motor.

Operation.—The operation of the machine is as follows:

With the loading carriage 28 in the forward position as shown in Fig. 1, with projectiles 7^b, 7^c and 7^d in the magazine as shown, and switch 121 open, all other switches being closed, except 93, as shown. Now close 121, starting motor 1, bringing the main wheel 3 up to speed on clockwise rotation.

As the releasing lug 25 is rotated around to the releasing wheel 26 the carriage is pushed back so that 80 and 82 contact respectively with 81 and 83 completing the electric back motion circuit, comprising conductors 96, 99, 94, 84 and 102, coils 69, 68, contacts 81 and 80, coils 70 and 71, contacts 83 and 82, conductor 101 and switch 92.

The closing of said back motion circuit magnetizes poles 56, 58, 57 and 59, drawing the carriage into the back position, causing 85 to contact with 86. Now close switch 93, this closes the solenoid circuit comprising 96, 100, 93, 48, 103, 86, 85, 101 and 92.

The closing of said solenoid circuit lifts plunger 49 and arm 46, releasing projectile 7^b. Said solenoid also lowers arm 45 preventing projectile 7^c from rolling forward. The solenoid action also opens switch 84, thereby opening the back motion circuit and releasing the carriage.

As 7^b is released, it rolls by gravity down the guides 36 and 37, acquiring sufficient momentum to raise, stop 50 and roll up into the magazine terminals, when 50 drops by gravity preventing the projectile from rolling back, while the magnetic poles 40 and 41 prevent the projectile from falling forward.

As the projectile moves into position into the magazine terminals, the projectile makes electrical connection between contacts 42 and 43, so that when segment 10 rotates around to contact with brush 21, the starting circuit comprising 96, 95, 97, 23, 8, 9, 10, 21, 42, the projectile 7^b, 43, 106, 90, 60, 72, 73, 62, 63, 75, 74, 61, 101, and 92 is closed.

This closing of the starting circuit magnetizes poles 52, 54, 53 and 55, starting the carriage forward.

As the carriage moves forward 76 and 78 contact respectively with 77 and 79, thereby closing the holding circuit comprising 96, 95, 97, 23, 8, 13, 14, 20, 107, 89, 64, 76, 77, 66, 67, 79, 78, 65, 101 and 92. This closing of the holding circuit continues the magnetization of the poles 52 and 54, 53 and 55, causing the forward motion of the carriage to continue until the shaft 29 enters the hole in the hub of projectile 7^b, pushing the projectile out of the magazine terminals 38 and 39, when it is pushed onto track 4 at some point between *gg* and *hh*, see Fig. 11 for track section.

As the track rotates until that portion of the track between *n. n.* and *k. k.* comes under the projectile, the track comes in contact with the rim of the projectile and starts the projectile rotating around shaft 29, see Fig. 12 for track section.

As the track rotates until that portion of the track between *k. k.* and *p. p.* comes under the projectile, the guards 5 will come in contact with the hub of the projectile, see Fig. 13 for track section.

As the wheel rotates to the angular position where the releasing lug 25 comes in contact with the releasing wheel 26, the carriage 28 is pushed back, the loading shaft 29 from the hub of the projectile (see Fig. 14 for section view of releasing action), thereby releasing the projectile which rolls forward first with the hub on the guards and then with the rim on the track, (see Fig. 15 for track section with the rim on the track), rolling around the accelerative curve 6, to the end of said curve as shown by the projectile 7, where it is discharged in a direction normal to the radius of the main wheel at the point of discharge.

During the interval that the carriage was moving forward, the contact between 87 and 88 was broken, thereby opening the magnetizing circuit of the poles on the magazine terminals, just before 29 is pushed into the opening of the projectile, so that said poles will not oppose the action of 29 in pushing the projectile from the magazine terminals 38 and 39.

Also during the forward motion of the carriage, the contact is broken between 85 and 86, thereby opening the solenoid circuit releasing 49, so that the action of gravity on 47 will lift arm 45, releasing 7^c from the position shown and depressing the arm 46 intercepting 7^c in the position shown by 7^b. The action of gravity on 47 also closes switch 84, (again closing the back poles circuit) so that when 25 coöperating with 26, again pushes back 28 until 80 and 82 again contact respectively, with 81 and 83, the back motion circuit is closed and 28 is again brought into the back position, again contacting 85 and 86, closing the solenoid circuit 48 and releasing 7^c, and repeating the operation just as explained for 7^b. To keep the operation continuous additional projectiles are placed in the opening at the upper end of the magazine. See Fig. 3 for magazine section at loading end.

Since the circuit, comprising coils 68 and 69, which completes the back motion of the carriage, is opened, when the switch 84 is opened, at the time when the projectile is released, the coils 129 and 130 are used to hold the carriage from jarring out of the back position during the interval from the time the projectile is released until it reaches the terminals 38 and 39.

These coils are not of sufficient magnetizing force to oppose the forward motion of the carriage when the starting coil circuit is closed by the projectile entering the terminals 38 and 39.

The magnetizing force of 129 and 130 is adjusted by the variable resistance 132.

Forward motion.—It is necessary that the loading carriage does not start forward until there is a projectile in the terminals 38 and 39, it is also necessary that the carriage start only at such a time as to get the projectile under the track between *gg* and *hh*. Therefore the starting circuit is only closed when 42 and 43 are closed by a projectile and brush 21 is bearing on the short segment 10.

It is important that the holding circuit remain in action during the entire period that the projectile is on the track up until the releasing lug 25 contacts with wheel 26. Therefore, this circuit has slip ring contact during the interval that brush 20 is bearing on the long segment, 14. Hence the necessity for having two separate circuits for starting and for holding the carriage, and the necessity for providing that the contacts 72 and 73, also 74 and 75 of the starting circuit must start the carriage forward before contact is made between 76 and 77, also 78 and 79 of the holding circuit.

The function of segments 18 of the starting circuit and 15 of the closing circuit, is to close their respective circuits through resistance 108 before the circuits are opened.

Vertical angle of discharge.—Since with a given rolling velocity of the projectile, a given time is required for the projectile to travel from the releasing lug 25 to the discharge end of the accelerative track 6, as shown by the position of 7, and since the main wheel 3 rotates through a given angular distance in a given time, then any given angular position of the discharge end of the accelerative track 6 may be selected as the point of discharge of the projectile, by rotating 26 to contact with 25 at the proper angular position of the main wheel 3, allowing for the angular travel of 3 during the interval of projectile travel from 25 to discharge end of 6.

26 and 29 are in the same radial line and both attached to 28, see Fig. 2, so that any change in the angular position of 28, changes the angular position at which the projectile is loaded onto the track, the angular position at which the projectile is released, and consequently changes the angular position at which the projectile is discharged.

Therefore the vertical angle of discharge is varied by varying the angular position of the loading carriage 28, which is done by rotating pinion 34.

The angular position of 28, consequently the angle of discharge, may be varied during the interval of discharge.

Horizontal angle of discharge.—The horizontal angle of discharge is varied by rotating the entire machine in the horizontal plane, which is done by rotating pinion 118. The horizontal angle of discharge may also be varied during the interval of discharge.

Discharge velocity.—If we assume that the diameter of track 4 is equal to one-half the diameter of the main wheel 3, and that the diameter of the hub of the projectile is equal to one-half of the diameter of the rim of 7, also assume that there is no slippage between the hub of 7 and the side guards 5, and no slippage between the rim of 7 and the tracks 4 and 6, then it is obvious that with the hub of 7 in contact with 5, that the circumference velocity of the hub of 7 is equal to the circumference velocity of 5, also that the circumference velocity of the rim of 7 is equal to the circumference velocity of the rim of 3. Therefore after 7 is released at 25 and its rim comes in contact with 6, it rolls around 6 with a velocity equal to the circumference velocity of the main wheel, 3, plus the acceleration due to the action of centrifugal force on 7, while rolling around 6, and is discharged from the end of 6 with a velocity equal to the circumference velocity of 3, plus the velocity of travel at the end of 6; or twice the circumference velocity of 3 plus the acceleration due to the action of centrifugal force on 7 while rolling around 6. It is obvious that various velocities of travel of the rim of 7 on track 6 may be had by

varying either the ratio of the hub to the rim of 7 or by varying the ratio of the track 4 to the circumference of 3.

In Fig. 16 is shown a projectile 139 without a hub, and since there is no hub to roll on 5, the only rotating velocity imparted to 139 is from the rim rolling on 4.

The projectile 139 is best adapted to a projectile of small diameter, and a small radius accelerative track 6, with a consequent large radius track 4. Assuming the diameter of 4 equal to three-fourths the diameter of 3, and assuming no slippage, then would 139 be discharged from the end of 6 with a velocity equal to one and three-fourths times the circumference of 3, plus the acceleration due to the action of centrifugal force on 139 while rolling around 6.

In Fig. 18 the projectile would be discharged with a velocity which is a resultant of the velocity of travel of 7 at the end of 6 and the circumference velocity of 3. The direction of discharge being along the line of the diagonal of the parallelogram of velocities. This resultant velocity will be increased as the angular distance of 6 is increased until 6 reaches the curvature shown in Fig. 1.

Increase of velocity due to centrifugal force.—If a projectile were attached rigid to any point in the circumference of 3 and 3 rotated clockwise, then with the projectile in any angular position as shown by *w*. Fig. 1 there is a centrifugal force acting on the projectile in the direction *x*. However, if the projectile were released at this point it would not move in the direction *x*, but in the direction *y*, which is the direction in which that part of the circumference to which the projectile is attached is moving at the time that the projectile is released. There is no motion in the direction *x* for the reason that the element of time that the force acts enters into the motion imparted to a body. And on the projectile in question the centrifugal force acts only when the projectile is rigid and can not move, the force ceasing at the instant that the projectile is released. But if a projectile be released at any point between the circumference and the center of the rotating wheel, say at 25, then the centrifugal force will act on the projectile during the time the projectile is traveling from 25 to the discharge end of the track. Therefore in traveling around the accelerating track 6, the projectile has a velocity due to the rotating velocity imparted by the hub rolling on 5 plus the acceleration imparted by the centrifugal force acting on the projectile as previously stated.

In the construction of the main wheel the parts designated by *r* are cast steel or nickel aluminum, while the parts designated by *s* are spruce, Georgia pine or Oregon fir.

However, the design of the wheel, also the materials employed, may be changed to conform to the size and speed of the main wheel and to the size of the projectiles to be discharged.

Teeth may be employed as shown by 138 and 137 to prevent slippage of the hub on the side guards, also to prevent slippage of the rim of the projectile on the track.

One of the difficulties of supplying resistance against self-destruction by the centrifugal force of a rotating wheel, lies in the fact that any additional resisting material added to the wheel increases the centrifugal force to be resisted. Fig. 19 shows how an external stationary casing 128, restraining balls 127, may be used to oppose the centrifugal force within the rotating wheel. Other means of external pressure, such as compressed air inclosed by a water seal, may also be used.

While I have shown the rotary motion imparted to the projectile by contacting with the projectile track, it is obvious that other means may be employed to impart the rotary motion, without departing from the spirit of my invention.

The section of 4 from *gg* to near *pp* could be as shown in Fig. 11, having side guard for releasing purposes only, and the rotary motion imparted to 7 by a motor connected to 29, shown at Fig. 20.

I believe the following ideas comprised in my invention are novel:

First: The releasing of a projectile at a point between the circumference and the center, or at the center of a rotating wheel, so that the projectile is acted upon by centrifugal force while traveling to the point of discharge, and the utilizing of said action to increase the discharge velocity of the projectile.

Second: The holding of a projectile free to rotate with its rim in contact with a moving track, so as to impart a rotary motion to the projectile, and the releasing of the projectile so as to convert the rotary motion into a rolling motion, and the utilizing of the rolling motion to increase the discharge velocity of the projectile.

Third: The making of the track contact with a hub of less diameter than the rim of the projectile so as to multiply the rotary motion imparted to the projectile.

Fourth: The use of a reverse curve so as to turn the rolling motion of the projectile tangent to the circumference of the main wheel at the point of discharge.

Fifth: The varying of the vertical angle of discharge, by varying the angular position of the loading device.

I claim:

1. In a centrifugal gun, a rotary discharger, a projectile track thereon, said track having a portion thereof concentric with the center of rotation of said dis-

charger and a portion thereof extending radially, means to supply and hold projectiles in contact with said concentric portion throughout a part revolution and release said projectiles thereon whereby they are given an initial rotation.

2. In a centrifugal gun, a rotary discharger, a projectile track thereon, said track having a portion thereof concentric with the center of rotation of said discharger and a portion thereof extending radially, means to supply and impart a rotary motion to projectiles, and means to release said projectiles on said track.

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Witnesses:
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