(No Model.) 2 Sheets—Sheet 1.

# R. STANLEY.

## TUNNELING OR MINING MACHINE.

No. 504,180. Patented Aug. 29, 1893.

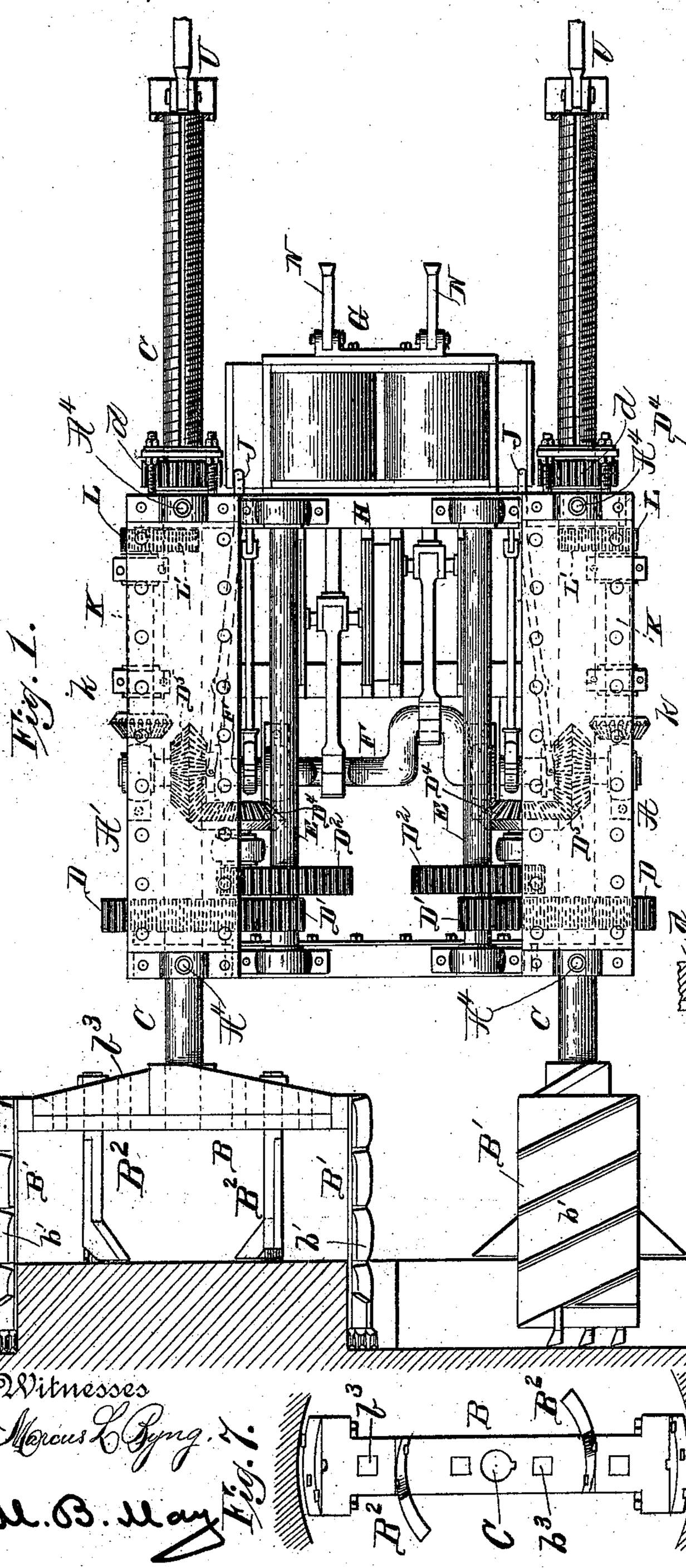

Fig. 1.

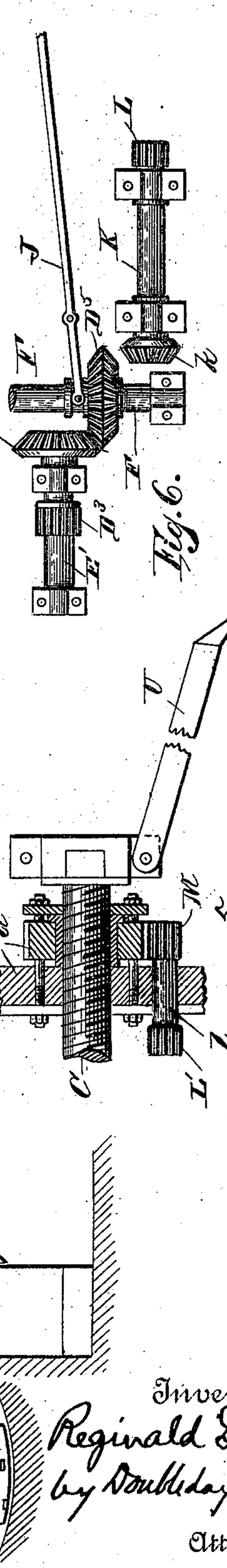

Fig. 6.



Fig. 5.



Fig. 7.



Fig. 4.

Witnesses
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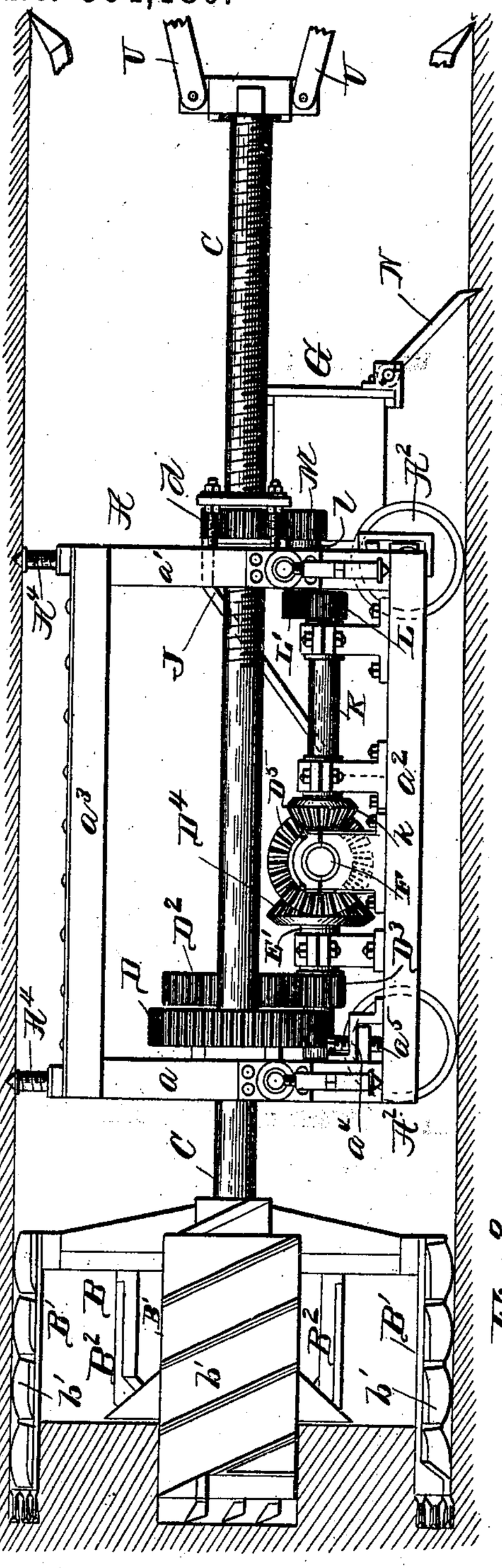

Fig. 2.

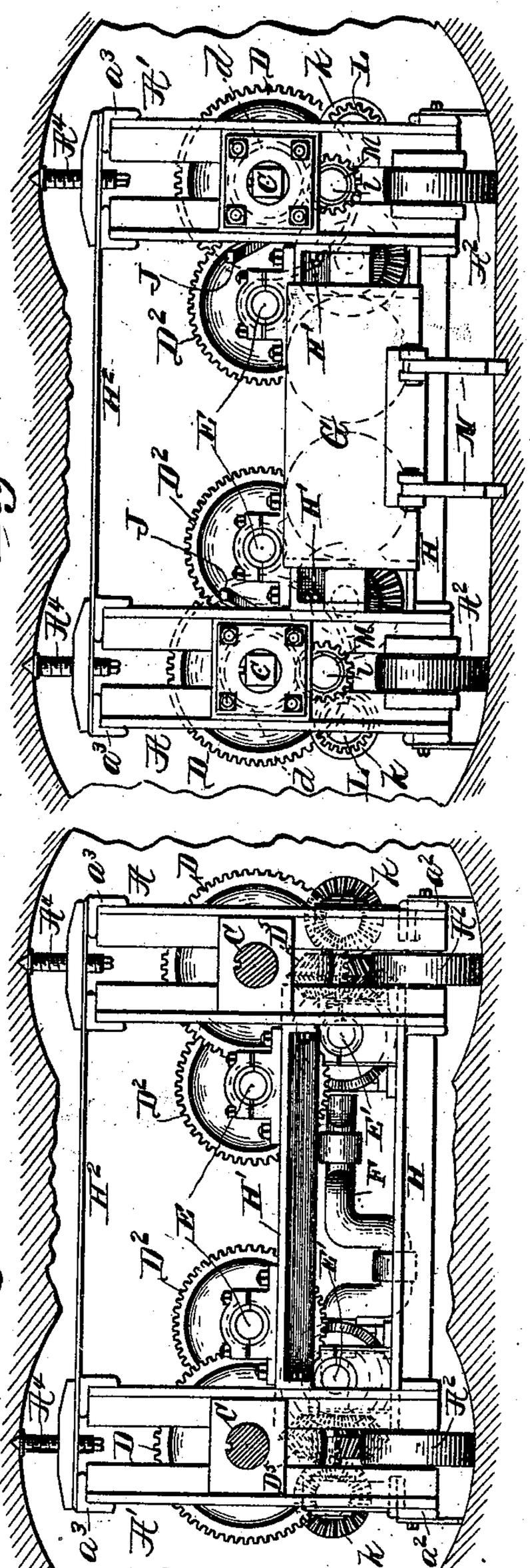

Fig. 4.



Fig. 3.

Witnesses
Marcus L. Byng.
Marcus B. Mayo

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# UNITED STATES PATENT OFFICE.

REGINALD STANLEY, OF NUNEATON, ENGLAND.

## TUNNELING OR MINING MACHINE.

SPECIFICATION forming part of Letters Patent No. 504,180, dated August 29, 1893.

Original application filed September 5, 1890, Serial No. 364,060. Divided and this application filed July 7, 1891. Serial No. 398,690. (No model.) Patented in England February 28, 1890, No. 3,595; in New South Wales June 27, 1891, No. 3,082; in Queensland June 29, 1891, No. 1,363; in New Zealand July 6, 1891, No. 5,078; in Canada December 16, 1891, No. 37,971, and in Germany February 5, 1892, No. 60,237.

*To all whom it may concern:*

Be it known that I, REGINALD STANLEY, a citizen of Great Britain, residing at Nuneaton, in the county of Warwick, England, have invented certain new and useful Improvements in Tunneling or Mining Machines, (which improvements are shown and described in the following Letters Patent, to wit: in Patent No. 60,237, dated February 5, 1892, granted to me in Germany; No. 3,595, dated February 28, 1890, granted in Great Britain; No. 1,363, dated June 29, 1891, granted in Queensland; No. 5,078, dated July 6, 1891, granted in New Zealand; No. 3,082, dated June 27, 1891, granted in New South Wales, and No. 37,971, dated December 16, 1891, granted in Canada,) of which the following is a specification, reference being had therein to the accompanying drawings.

In the machine which I have devised there are two sets of cutters; a main frame or bed comprising two parts, one part for each set of cutters, means for connecting the two parts of said frame, two carriers, one for each of said sets of cutters and adapted to be moved relatively to the bed, a train of cutter actuating gearing on each part of said frame; another train of gearing on each part of the bed frame for advancing the cutters relatively to the bed, and one or more engines supported upon the bed frame and adapted to actuate either of said sets of cutters, or both simultaneously. Preferably the cutters of each set are arranged to rotate around a horizontal axis and are held by arms secured to their carrier. It is also preferable that the two sets of cutters should be arranged on substantially the same horizontal lines, transverse of the machine, so that they shall be available for producing a relatively wide cut. There are numerous reasons why a cut of this sort should be of greater dimensions horizontally than vertically. For instance, in the entries in coal mines it is allowable, and necessary in most veins to have them from nine to twelve feet wide. In a six foot vein a single set of cutters of the sort herein described, while it may reach from top to bottom of the vein, will not open up more than half or two thirds of the entry horizontally and another operation by hand or machine is necessary. It is desirable to take the material out from the whole entry at one operation. In the smaller veins the room is so contracted, if a single cutting apparatus is used, that it is impossible to readily manipulate the machine and get out the cuttings and remove them to points behind the machine.

With an apparatus of the sort herein provided I cannot only work over a larger area of the the heading but with it can provide more room for the manipulation of the machine and of the materials removed thereby. Again, whatever be the depth of the machine, or the dimensions of the cut made by it, it is frequently found necessary to apply hand tools, of the nature of levers, wedges, drills, or the like, for the purpose of removing the central core left by the cutters. By forming two grooves or cuts, either overlapping or independent of each other, I am enabled to apply to greater advantage tools of the sort referred to, and can more easily attack, break down, and remove any coal or other material which may resist the operation of the cutters on the machine, or which may be left as the core.

Another important advantage incident to having two sets of more or less independent cutters, one of which can be thrown out of operation while the other is acting, is this, namely, that the two cutters can be employed alternately; that is to say a cut may be made with one of them, and then while the other cutter is being advanced, the core and débris produced by the first cutter can be carried back, and the intervening web can be attached. Therefore there is plenty of room at all times for getting at and removing the loosened material.

It is further preferable that the two sets of cutters should revolve in opposite directions in order that they shall balance each other in respect to the strains and the re-actionary thrust which they exert upon the machine generally, and upon the braces or devices by which the bed frame is held stationary during the cutting. With tunneling or mining

machines of all sorts, one of the most difficult problems has been to construct and arrange the parts so that there should be no re-actionary thrust, either in a line directly backward or toward one side, or the other horizontally, or upward or downward. Such thrust, and the disadvantageous strains incident thereto, have been experienced in using all machines provided with a single cutter or set of cutters. By furnishing the machine with two sets of oppositely moving cutters, as are herein provided, I, to a large extent, overcome the difficulties which have been incident to other machines from this cause.

I am aware of the fact that machines have been heretofore devised comprising two sets of oppositely moving chain cutters, mounted to move on horizontal lines, and also aware that two sets of oppositely reciprocating saw cutters have been used, in horizontal lines, and I do not claim such mechanisms. But I believe myself to be the first to have arranged two vertically revolving cutters so as to move oppositely and simultaneously and produce a kerf of such dimensions that the entire machine can follow the cutters.

Figure 1 is a top plan view of a machine embodying my invention. Fig. 2 is a side elevation. Fig. 3 is a front view of the machine with the cutter detached. Fig. 4 is a rear view. Figs. 5 and 6 are sections on the lines $x$--$x$ and $y$—$y$ respectively, and Fig. 7 is a face view of the cutters.

The main frame or bed as shown in the drawings comprises two vertically arranged parts A, A′, at the sides and horizontally arranged connecting parts. The details of the bed frame may be of any suitable sort. As shown in the drawings each side part is composed of uprights $a$, $a'$ joined at the bottom by sills $a^2$ and at the top by girders $a^3$, together with any additional connecting bars and braces which may be found desirable.

$A^2$, $A^2$, are supporting wheels. Preferably there are two on each side arranged on the central longitudinal plane of each part A, A′ of the frame.

$A^4$, $A^4$, are binding screws or jacks for engaging the roof and fastening the machine firmly in position.

H, H, represent cross bars arranged substantially horizontally and rigidly secured by bolts or equivalents to the side parts A, A′, of the frame, and near the bottom thereof. H′, H′, are other connecting bars secured to the side parts nearer the centers horizontally, thereof, and $H^2$ are cross connecting bars or braces at the top.

In the present machine the two sets of cutting mechanisms and other operative parts, are provided with a common frame or bed whose parts are rigidly secured throughout, in contradistinction from other double tunnel cutting machines which I have devised, (as shown in my application, Serial No. 364,060, filed September 5, 1890, of which this is a division) and wherein the two side parts with their cutting and other apparatus were adapted to be moved or adjusted relatively to each other, so that when I use the word "rigidly" in connection with the securing together of the different parts I mean that the parts are bolted, or non-adjustably secured, together.

By preference most of the parts of the frame or bed which I have above described are made of angle irons because of the relatively greater strength incident thereto in proportion to the weight.

The cutting mechanisms mounted upon this frame may be of any suitable sort. That selected for illustration comprises a cutter carrier of the form of a cross head or arms B secured to a shaft C. When an annular kerf is to be formed forwardly extending arms or bars B′ are used and the cutters or scrapers $b'$ are applied thereto. When the whole face of the material is to be cut away the cutters can be secured directly to the front face of the cross head or arms B.

In addition to the annular cutter arm B′, B′, I provide other cutter arms $B^2$, $B^2$, in order to remove part of the core left thereby. The radial arms B, B, have apertures $b^2$ at intervals in their faces, into which the tongues of the auxiliary cutters are secured by bolts or otherwise. In the drawings but two auxiliary cutter arms are shown, but it is obvious that as many as desired may be used so as to cut away the whole face of the material. As shown, the said arms $B^2$, $B^2$, are relatively wider at their front ends and have a tapered nose or projection which cleans away the slack in front of the cutters $b^4$. It will be seen that these cutter arms may be readily detached and secured at any distance from the center of the radial arms B, B, as the nature of the material may require, or may be left off entirely. The shaft C imparts rotary motion to the cutters and also advances them into the material.

As illustrated in the drawings the two cutting mechanisms, and the devices which rotate them, and also those which advance them are similar, and it is therefore not necessary to describe more than one thereof.

On each cutter carrier shaft there is a wheel D. With this engages a pinion D′ on a countershaft E. On said shaft there is a wheel $D^2$ which engages with a pinion $D^3$ on an intermediate shaft E′.

$D^4$ is a bevel wheel on the last said shaft driven by wheel $D^5$ on the crank shaft or engine shaft F. In this machine the crank shaft or power shaft is arranged transversely of the machine and it is connected directly to both sets of cutter driving gearing. By employing a single power shaft a single engine G only is required to operate both cutters. A double acting engine is shown having two cylinders and two pistons both connected to this power shaft.

A machine of this construction is well adapted for working material such as coal

when lying in low veins as the engines can be placed in relatively low planes, and their incident parts and the gearing driven thereby can be made compact; whereas when the engines are arranged vertically the extent is limited to which the machines can be shortened vertically.

As shown, I utilize the cross connecting parts of the bed or frame to support the engines and several of the above described shafts. The shafts E, E, are held in bearings supported upon the cross bars H', H', and the shaft E', E', and the crank shaft are held in bearings on the bars H, H. The wheel $D^5$ is a double bevel, and is adapted to slide on its shaft F, it having a shipping lever J for moving it into and out from engagement with wheel $D^4$. It will be seen that when these wheels $D^4$ and $D^5$ are in engagement, the engine will, through the above described train of gears cause the rotation of the cutters, and if both wheels $D^5$ are in engagement with their corresponding wheels $D^4$, both cutting mechanisms will be actuated.

In order to advance each cutting mechanism while it is at work the following means are preferably used: The cutter carrying shaft C is screw threaded along a sufficient portion thereof. With this a nut *d* can engage. Said nut is arranged near the rear vertical uprights of the frame, and on each side bears against a plate or block secured to said uprights. It is either formed integral with a series of gear teeth on its periphery, or is secured to a wheel having such teeth. This nut can be allowed to rotate relative to the cutter carrier, or can be locked to the bed or main frame in any suitable way, as for instance by a bolt adapted to engage with the frame and lie between two of the peripheral teeth. If while the cutter carrying shaft is rotating in the way above described this nut be thus locked it will be seen that the shaft C and the cutters will be caused to advance with a speed proportional to the pitch of the thread and the speed of rotation. The advancing is continued until the desired depth of cut has been reached. The bed or main frame can then be advanced toward the cutters by the following devices.

K is a shaft shown to be parallel to the shaft C, and having a bevel wheel *k* at one end and a spur pinion L at the other. Wheel *k* can engage with the aforesaid double bevel wheel $D^5$ if the latter be moved along the shaft F. The pinion L engages with a wheel L' on a shaft *l* mounted in the rear part of the frame and carrying also a wheel M which meshes with the aforesaid teeth on the nut *d*. Now if it be supposed that the cutter shafts C have been made stationary, and the bed or main frame released from the roof and floor by the loosening of the jacks $A^4$ the bed can be advanced toward the cutters by the engine as the shafts K and *l* can be rotated by the bevel wheels $D^5$ (the latter at such time being out of engagement with the cutter rotating gearing) in such way as to turn the nuts *d*, *d*, which will result in a pushing forward of the bed or frame. The cutters and their shafts may be made stationary in any suitable way as for instance by means of cows and braces such as I have shown in my earlier patents. One adapted for this purpose is shown at U.

At N, N, there are jacks or braces near the central longitudinal line of the machine adapted to engage with the bottom of the tunnel and resist reaction or back thrust and assist in holding the machine to its work. In addition to these use may be made of bracing wedges such as are shown in my application, Serial No. 383,645, filed March 3, 1891.

It will now be seen that I provide a machine which is not only capable of cutting a double tunnel or driving two tunnels simultaneously, but one which does this by two entirely independent cutting mechanisms; that is to say cutting mechanisms which can be either started or stopped independently of each other. The independent clutches or shipping devices enable me to throw either or both of the cutters into or out of action. It is sometimes desirable to throw all of the power of the engine upon one of the cutters, as for instance when it is meeting unusually hard material. This can be accomplished by having the parts constructed and arranged as described. Again both cutters can be allowed to rotate while only one is permitted to advance longitudinally, as the locks which fasten the nuts can be withdrawn so that the nuts can run loose.

I have described the nut as being stationary when the cutter is to be advanced, but it will be seen that if the motion of the driving parts be reversed the cutter can be drawn back without moving the main frame; or the cutter can be made stationary and the main frame can be moved in either direction by giving proper motion to the driving parts.

The supporting wheels $A^2$, $A^2$, are each held in vertically adjustable bearings $a^4$ which can be moved up or down by means of screws $a^5$. By means of these devices the direction of the tunnel, in respect to vertical planes, can be modified readily at any time; and such variation of this direction is rendered frequently necessary when working materials which lie in variable veins, and over or under which run veins of slate or other excessively hard materials. And when a frame-work is used such as is herein shown, namely one having the two parts at the side wherein the cutter carriers are respectively supported, and an intermediate part rigidly secured to the said parts, the whole forming a solid, unitary structure, the devices above described permit the proper adjusting of the machine not only about transverse lines, but also about longitudinal lines. That is to say the machine can be bodily rocked laterally and at the same time the front end can be thrown up or down as may be required. Therefore all variations of the coal vein from a horizontal plane can

be readily followed. The frame is virtually carried upon adjustable pivotal supports at the front end and has, (in the wheels and the parts incident thereto) at the rear end, means for vertical adjustment around the axes of the said pivotal supports; and in respect to these parts there may be more or less variation so long as the essential matters of construction and operation are preserved.

It will be seen that there are a number of features of construction and arrangement incident to the cutter, its carrier, its gearing, &c., and to the part of the main frame that supports it, which are independent of the duplicating of the cutting mechanisms, and which, in fact, constitute material and important improvements in machines of this sort.

In many of the tunneling machines as heretofore constructed, in which the cutter and cutter carrier, were adapted to advance longitudinally relative to the frame, the power shaft, and more or less of the engine parts and the intermediate gearing and shafting, were supported in the upper part of the frame, above the horizontal planes of the cutter carrier. Under such construction and arrangement of the parts, the machine is made top heavy, and therefore difficult to manipulate and it requires at the top and the sides strong and numerous braces. Again by having the engines arranged vertically, as heretofore, with more or less of their incident parts in the upper part of the frame the vibrations caused thereby when in motion are much more troublesome and apt to interfere with the proper workings of the machine.

If the plan of constructing and arranging the parts herein shown be followed, whether in making single or double machines, these difficulties are overcome. The machine can be made so that there shall be practically none of the moving parts above the horizontal planes of the cutter carrier, and by having them below that they assist in holding the frame in proper position and the vibrations and jars are taken near the floor where they are much less serious in their effects upon the machine. I do not limit myself to the exact arrangement shown in this respect, as the end aimed at can be attained so long as the weighty and rapidly moving parts are brought down sufficiently far in relation to the cutter carrier. But I prefer substantially the arrangement shown by which (first) the cutter rotating shafting, the nut rotating shafting, the power shaft, and the engine are all placed below the top plane of the carrier whether in a single or double machine; (second) the main intermediate shaft of the cutter rotating mechanism is put in about the same horizontal planes as the cutter carrier as it is not ordinarily practicable to place it directly beneath the cutter carrier, because of the relatively large gear wheels necessary to obtain the proper speeds; and (third) the cutter rotating gearing and shafting are placed at one end of the frame, while the nut rotating gearing and shafting are at the other end, the power shaft being arranged transversely between them. This dividing of the operative parts enables me to bring the rapidly moving power shaft comparatively near the center of the machine, and also to arrange all of the parts compactly and in relatively low planes.

I do not herein claim any of the subject-matters set forth in the claims of my earlier application hereinbefore referred to, Serial No. 364,060, filed September 5, 1890, wherein the present mechanism is shown in connection with another for the purpose of illustrating certain novel matters common to both, nor do I herein claim any of the combinations set forth in the claims in my application, Serial No. 364,378, filed September 8, 1890, for the reissue of Patent No. 414,893, dated November 12, 1889, preferring to claim therein all patentable matters which are common to the machine herein and to that in the said other application.

What I claim is—

1. In a tunneling or mining machine, the combination of the cutter, the cutter rotating gearing, the shaft at one end of said frame for driving said gearing, the nut, the shaft at the other end of said frame for rotating said nut and a transverse shaft adapted to drive both of the aforesaid shafts, substantially as set forth.

2. In a tunneling or mining machine, the combination of a cutter, a cutter carrier, a main frame, a gearing at the front end of said main frame for rotating the cutter, a gearing at the rear end of said frame for advancing the cutter or the frame, and a power shaft for driving both gearings and arranged transversely of the frame and below the cutter carrier, substantially as set forth.

3. In a tunneling or mining machine, the combination of the cutter, a cutter carrier, a main frame, cutter rotating gearing, gearing for advancing the cutters or the frame, a shaft for driving the first aforesaid gearing, a shaft for driving the last aforesaid gearing, both of said shafts being below the cutter carrier, one on one side of the central vertical longitudinal plane of said carrier, and the other on the other side thereof, the power shaft, and the engine, substantially as set forth.

4. In a tunneling or mining machine, the combination of the cutter, the cutter carrier, the main frame extending above the cutter carrier, the clamping devices for securing the frame to the roof, the nut engaging with the cutter carrier, and the nut rotating shaft and gearing located below the cutter carrier, substantially as set forth.

5. In a tunneling or mining machine, the combination of a cutter, a cutter carrier, a main frame, cutter rotating gearing, gearing for advancing the cutter or the frame, a power shaft, and a sliding wheel adapted to engage with either of said gearings, substantially as set forth.

6. In a tunneling or mining machine, the combination of the cutter, the cutter carrier, the main frame, a shaft for transmitting rotary motion to the cutter, a shaft on a line other than that of last said shaft for imparting longitudinal motion to the cutter or main frame, and a sliding wheel for driving said shafts and mounted on lines between the aforesaid lines, substantially as set forth.

7. In a tunneling or mining machine, the combination of the two cutting mechanisms, the two longitudinally advancing cutter carrying shafts, the stationary frame having two side parts, wherein are respectively mounted the said cutter carrying shafts, and an intermediate part bolted to the aforesaid parts, substantially as set forth.

8. In a tunneling or mining machine, the combination of the two independent vertically revolving cutters, the bed, the engine on the bed, the independent trains of gear for rotating the cutter carriers, the independent trains of gear for advancing the cutter carriers, and the adjustable wheels driven by the engine and adapted to engage alternately with the said two trains of gear, substantially as set forth.

9. The combination of the cutters, the cutter carriers, the transverse power shaft, the intermediate shafts situated longitudinally of the machine and above the power shaft, whereby the power shaft can be placed relatively low, and the engine situated on the rear of the main frame in the horizontal plane of the power shaft, substantially as set forth.

10. In a tunneling or mining machine, the combination of the bed, the cutter, the cutter carrier, the engine on the bed, the train of gear for rotating the cutter carrier, the train of gear for advancing the cutter carrier, and the sliding or adjustable wheel driven by the engine and adapted to engage alternately with the said two trains of gear, substantially as set forth.

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

REGINALD STANLEY.

Witnesses:
W. H. HARRIS,
*Notary Public, Birmingham.*
FREDERICK BAXTER,
*Birmingham, his Clerk.*