Sheet 1 - 2 Sheets

J. D. Brunton.

Machine for Sinking Shafts.

No. 80,056

Patented Jul. 21, 1868.

Fig. 1.

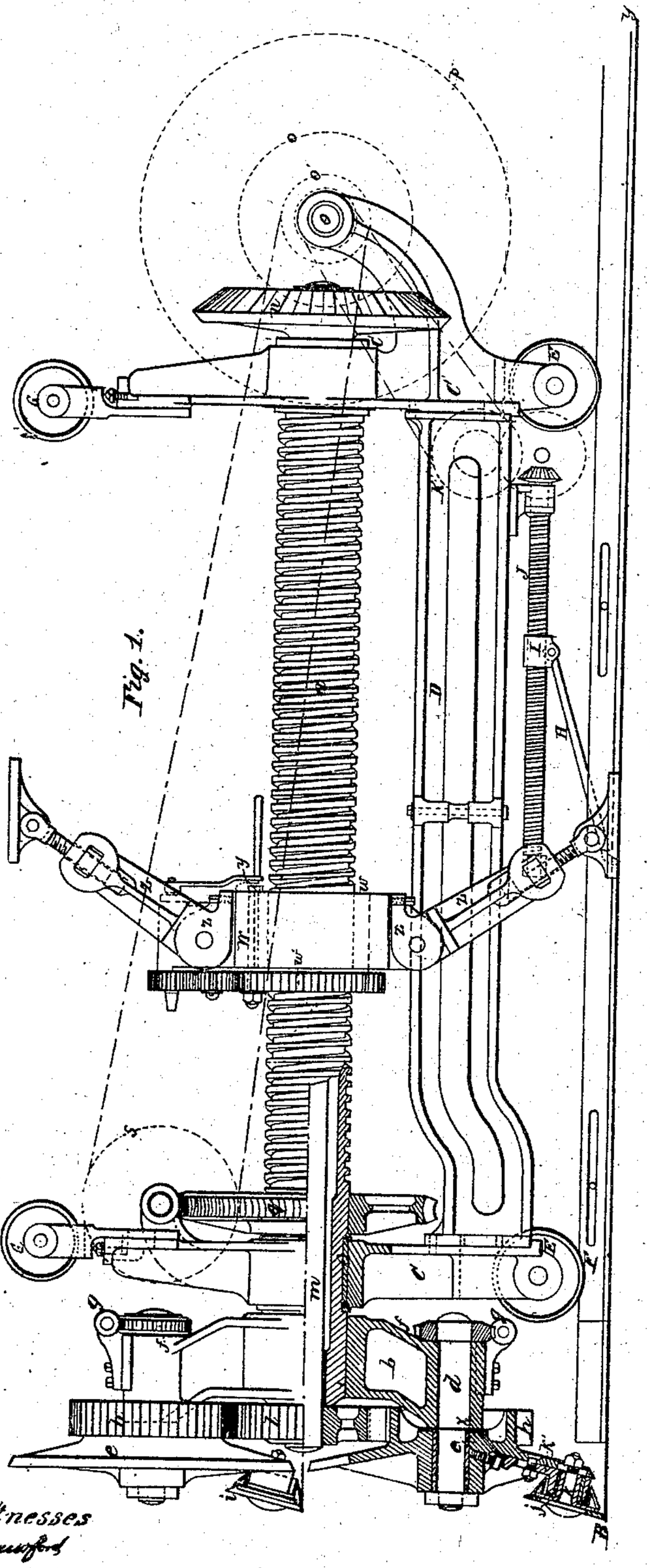
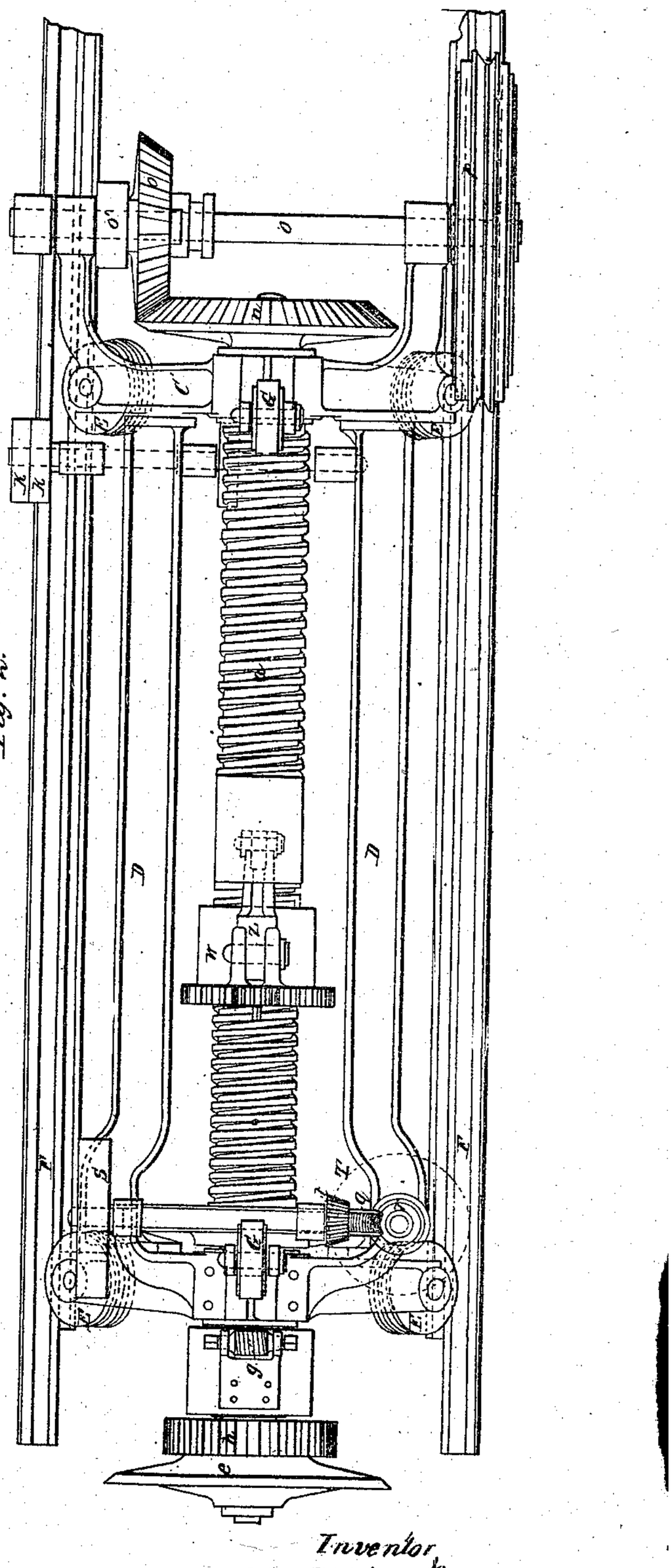


Fig. 2.



Witnesses

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Sheet 2-2 Sheets.

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UNITED STATES PATENT OFFICE.

JOHN DICKINSON BRUNTON, OF 6 LEIGHTON CRESCENT, KENTISH TOWN, LONDON, ENGLAND.

IMPROVED MACHINE FOR SINKING SHAFTS.

Specification forming part of Letters Patent No. **80,056,** dated July 21, 1868.

To all whom it may concern:

Be it known that I, JOHN DICKINSON BRUNTON, of 6 Leighton Crescent, Kentish Town, London, England, have invented certain Improvements in Machinery or Apparatus for Sinking Shafts or Pits and Driving Tunnels and Galleries; and I do declare the following to be a full, clear, and exact description of the same.

This invention consists of an arrangement whereby a cutter—or, as I prefer, three or more cutters, of steel or other suitable material—and of a circular form, is or are caused to revolve round an axis (which I distinguish as the "planetary axis") parallel, or nearly so, to the axis (which I distinguish as the "central axis") of the pit, tunnel, or gallery to be formed, and, as they revolve, to cut away or split off the rock or other strata against which they are made to act. While the cutter or cutters revolve round the planetary axis, (and this I call their "planetary motion") the axis itself is caused to move either in a circle concentric with the central axis of the pit, tunnel, or gallery, in which case the excavation or perforation will be of a circular or cylindrical form, or to move in any other figure round the central axis, by which a corresponding form will be given to the pit, tunnel, or gallery. This motion of the planetary axis, with its accompanying cutters, round the central axis I call the "orbital motion." By the combined orbital and planetary motions, together with another spiral motion, which, in the case of a pit, is downward upon the bottom, and in case of a tunnel or gallery is forward against the end, the cutters, as they revolve, cut or split the face of the rock into a spiral form having a pitch or angle of progress dependent in some degree on the nature of the rock or stratification operated on. The cutters are circular disks of steel or other suitable substance, and of a diameter proportioned to the size of the machine, having the whole circumference of their periphery formed into a cutting-edge, and are placed at right angles to their planes upon pivots or journals on which they can freely rotate. These journals are fitted into proper sockets or holders, which are fixed upon or form part of the chuck or face-plate, which revolves upon a pin or arbor the axis of which coincides with the planetary axis, and which chuck, together with its sockets and cutters, is caused to revolve on its arbor by means of toothed gear, or in any other convenient manner. Every disk, when in its socket, is inclined, toward the planetary axis at such an angle as may be found best suited to the nature of the rock or ground being wrought upon, and so that that part of the disk which for the moment is cutting shall be more distant from the planetary axis than the opposite part of the circumference. The cutters act upon the rock during about one-half of the planetary revolution, and the radius of the circle described by the edge of the cutters in their action upon the rock should be about one-half of the radius of any cylindrical pit, tunnel, or gallery to be formed, so that in every orbital revolution the cutter shall pass over and cut or split from the entire or almost the entire face of the bottom or end.

In driving tunnels or galleries I prefer to use two chucks or face-plates (which I call "cutter-chucks") carrying cutters, and the arbors on which they revolve I fix in opposite ends of a cross-head keyed upon a shaft the axis of which coincides with the central axis. This shaft is placed in suitable bearings and is borne upon a strong frame or carriage, which also supports the toothed gear, pulleys, and other means of imparting their proper motion to the several parts. Upon this central shaft I form a spiral thread or screw working into a fixed nut, by which a spiral motion is given to the shaft and cross-head with its chucks and cutters, and a simultaneous and corresponding forward (and in the case of sinking pits a revolving spiral) motion to the carriage. If convenient, upon the carriage may be placed a cylinder or cylinders with usual parts and connections, to which I supply either steam or compressed air, and from which motion may be given to the entire machine by cranks, or in any other convenient manner; or the motion may be obtained by means of a wire rope or belt from a prime mover at a distance. The structure of the carriage and the arrangement of the several parts may be modified to suit the form of the pit, tunnel, or gallery to be made, and in

the case of a pit it will usually be found most convenient to employ only one cutter-chuck.

In order to enable others skilled in the art to make and use my invention, I will now proceed to describe its construction and operation, reference being had to the accompanying drawings, which form a part of this specification, and in which—

Figure 1 (Drawing 1) is a side elevation of the machine, partly in section; Fig. 2, a plan view; Fig. 3, (Drawing 2,) an end view, partly in section; Fig. 4, an end view of the rear end of the machine, and Figs. 5 and 6 detached views of parts of the machine.

The line A B, Fig. 1, represents in section the end of the tunnel or gallery, and the lines A X B Y respectively represent in section the top and bottom of the tunnel. *a* is a hollow shaft resting on and revolving in the bearings *c c* of the carriage C, on which the entire machine is supported, and upon which it is carried forward. *b* is the cross-head, cast or keyed upon the shaft *a*. At its extremities the cross-head carries the arbors *d d*, upon which revolve the cutter-chucks *e e*. That portion of the arbor on which the chuck rotates is eccentric with that portion which is contained in the cross-head, as shown at X in this figure and in Fig. 5.

f is a worm-wheel fixed upon the arbor *d*, and *g* is a worm working into it. By means of the worm and wheel and the eccentricity in the arbor, as already described, the chuck can be moved a small distance outward or inward, so as to compensate for any wear of the cutters, by which the diameter of the pit, tunnel, or gallery formed might be diminished. The axis of the shaft *a* is that which I call the "central axis," and the axes of those parts of the arbors *d d* on which the chucks rotate are those which I call the "planetary axes," and are equidistant from the central axis. I prefer to cast the chuck *e* and the toothed wheel *h* in one piece.

i i are the cutters, of which I attach six to each chuck. *j j* are the pivots or journals on which they are at liberty freely to rotate. *k k* are the bolts holding them upon the pivots and in the sockets *k' k'*. These sockets are pieces distinct from the cutter-chucks, and are fixed to them by bolts and nuts or screws, and are formed, as shown in Fig. 5, with slots, to allow of the sockets being placed more distant from the center as the cutters become, by wear, of diminished diameter. The angle at which the cutters are set with the plane of the surface of the rock or other substance to be cut may be varied, and should be such as to enable the cutters most effectively to act. The central spur-wheel, *l*, gears into the wheels cast upon the back of the cutter-chucks *e e*, and is keyed upon a central shaft, *m*, concentric with and passing along the interior of the hollow shaft *a*. The shaft *m* revolves in proper bearings provided at each end of the shaft *a*, as shown in Fig. 1, and upon its outer extremity there is keyed a bevel-wheel, *n*, into which gears another bevel-wheel, *o*, which receives its motion from the prime mover by a wire rope and pulley, *p*, as shown in Figs. 1, 2, and 3, or in any other convenient way.

Upon the hollow shaft *a* is keyed a worm-wheel, *q*, into which gears a worm, *r*, Fig. 3. I actuate the worm *r*, and by it cause to revolve the wheel *q* and the shaft *a*, by means of the pulley S and the bevel-wheel and pinion T *t*. *s* is driven by a belt from the pulley *o'* upon the shaft O. It will be seen that the motion of the cutters, which I call the "planetary motion," is effected by the revolution of the shaft *m*, and that the motion of the planetary axes round the central axis, which I call the "orbital motion," is caused by the revolution of the shaft *a*. The relative speed of these shafts will regulate the "feed" supplied to each cutter, or, in other worns, the advance which each cutter makes beyond that which preceded it.

Upon the external circumference of the hollow shaft *a* is formed a screw, as shown in Figs. 1 and 2. Upon the screw is placed a nut, *w*, having a toothed wheel, *w'*, cast upon. The outer circumference of the nut is turned to receive a collar, W. By means of the key *y*, *w* and W can be held together, so that one cannot revolve without the other. Upon W are cast two or more lugs, Z Z, which carry arms *z z*. The outer ends of these arms are furnished with a screw and foot-plate, as shown in Figs. 1 and 2. By means of the screws these plates are brought into contact with the internal surface of the tunnel or gallery. The effect of the screw on the shaft *a*, when the machine is in operation, is to join firmly the arms *z z* in the tunnel or gallery, and so to constitute the nut *w*, with its collar W, a fulcrum or fixed point, from which the whole machine is forced forward against the face of the tunnel by the revolution of the shaft *a*. When *a* has been screwed through the nut *w* to the end of the thread upon it, the machine is stopped, the key *y* is slackened, and by means of handles and the pinions working into the wheel *w'* on the nut, Figs. 1 and 2, the nut *w* is screwed forward again to the inner end of the thread upon the shaft *a*, carrying with it the collar W and arms Z Z. The set-screw *w''*, working in a groove in the circumference of the nut *w*, prevents the collar W from slipping off the nut *w* at the same time that (in the slackened state of the key *y*) it allows the nut to revolve without carrying the collar and its arms round with it. The combined orbital and planetary motions, as described, together with the forward motion produced by the screw acting against the fixed nut *w*, cause the cutters to cut the face of the tunnel or gallery into a spiral form having its pitch or angle of progress equal to the pitch of the thread upon the shaft *a*. The cutters *i i* are circular disks of steel or other suitable substance, and may be from ten to twenty inches diameter and from half to one inch thick, according to the size of the machine and the nature of the rock or ground operated

upon. The whole circumference of their periphery is formed into a cutting-edge, and they are placed at right angles to their planes upon the pivots or journals *j j*, which, with the cutters, rotate freely in the sockets or holders *k' k'*. The radius of the circle described by the edge of the cutters in their action upon the rock should be about one-half of the radius of the cylindrical tunnel or gallery to be formed, so that in every orbital revolution the cutters shall pass over and cut from the entire or almost the entire face of the end.

C C', Figs. 1, 2, 3, and 4, are the carriage, consisting of the fore part, *c*, Figs. 1, 2, and 4, the back part, C', Figs. 1, 3, 4, and the side beams, D D, Figs. 1, 2, 4, connecting the fore and back parts. E E, Figs. 1, 2, 3, 4, are double-flanged wheels rolling on two pairs of rails, F F. Uprights on the fore and back carriages support rollers G G, which are set firmly against the roof of the tunnel or gallery and contribute to keep the machine steadily in a central position. The rails F F lie on the floor of the tunnel or gallery, and are moved forward in alternate pairs along the floors by means of the thrusting-bars H H, Figs. 1, 4, which drop into holes made in the flanges of the rails, and which can be set in motion by means of the nuts I I upon the screws J J, actuated by the belt K from the shaft O and the intermediate bevel-and-spur gear, as shown in Figs. 1, 2, and 3. By this means a continued rail-track is provided for the machine as it advances. By the divergence of the center lines of the arbors *d d* from the plane of the central axis, as shown in Fig. 6, I provide for the clearance of the cutters from the face of the rock during that part of their revolution in which they are not cutting.

Although I have more particularly described this machine as applied to the driving of tunnels or galleries, it is equally applicable to the sinking of shafts or pits, it being simply requisite for such purpose to adapt the framework accordingly, which in practice may consist of top and bottom bed-plates bolted together at proper distances by means of suitable bolts and pillars. Conical rollers are fitted under the bottom bed-plate, and side rollers are attached to the edges of the bottom plate, which move around and against the interior cylindrical surface of the pit, and help to guide the machine as it revolves. The central shaft, together with the whole machine, revolves round its own axis as the machine describes its orbital revolution. A collar and arms similar to those shown in the drawings, with one internal nut, are used. The collar is connected to a spur or worm wheel, and the arms, being set firmly in the pit, hold the collar, with its internal nut, and the spur or worm wheel stationary, and thus afford a fixed point against which the shaft may screw itself downward, while the toothed circumference of the spur or worm wheel affords the means of carrying round the machine by the action of a pinion or worm driven by suitable gear from the main shaft. The cylinders of an engine to actuate or drive the machine may be carried between the bed-plates; or the machine may be driven by wire rope or belt from a prime mover at a distance. By the planetary rotation of the cutters round a center, combined with the orbital motion of that center round the central shaft, and the downward motion produced by the screw working in the nut in the interior of the collar, the cutters produce a spiral on the bottom of the pit having a pitch or rate of descent equal to the pitch of the screw, and this spiral form once given, the weight of the machine will be probably sufficient to keep the machine to its work.

The apparatus occupies only a part of the bottom of the pit, or the end of the tunnel or gallery being formed, and therefore, without any cessation of its working, constant access may be had for the removal of the debris produced and for attendance upon the machine, while pumps for the removal of water can be carried down coincidently with the progress of the work.

I claim as my invention and desire to secure by Letters Patent—

The construction and application of machinery or apparatus for sinking shafts and pits, and for driving or excavating tunnels, galleries, or adits, wherein one or more cutting disks are caused to revolve on their own axis or axes, such axis or axes revolving round a center, which also revolves round another fixed center, substantially as hereinbefore described.

In testimony whereof I have signed my name to this specification in presence of two subscribing witnesses.

JOHN DICKINSON BRUNTON.

Witnesses:
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CHAS. MILLS,
Clerks to I. H. Johnson, 47 Lincoln's Inn Fields.