No. 889,464. PATENTED JUNE 2, 1908.

G. W. JACKSON.

MACHINE FOR EXCAVATING TUNNELS.

APPLICATION FILED DEC. 6, 1907.

3 SHEETS—SHEET 1.

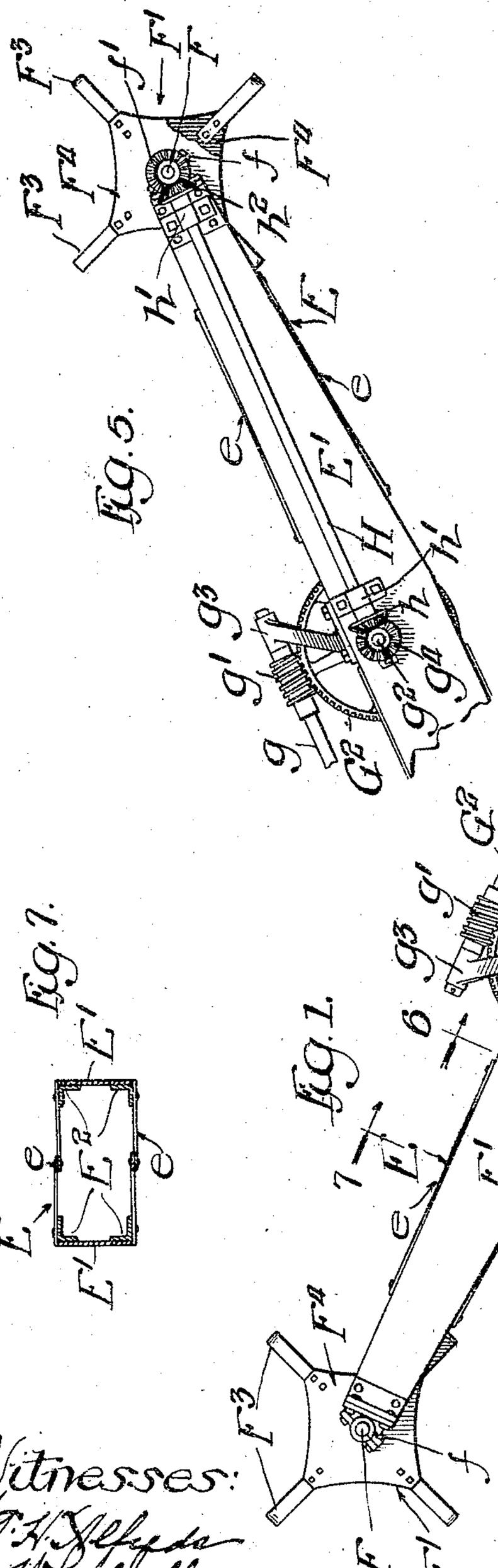

Fig. 5.

Fig. 7.

Fig. 1.

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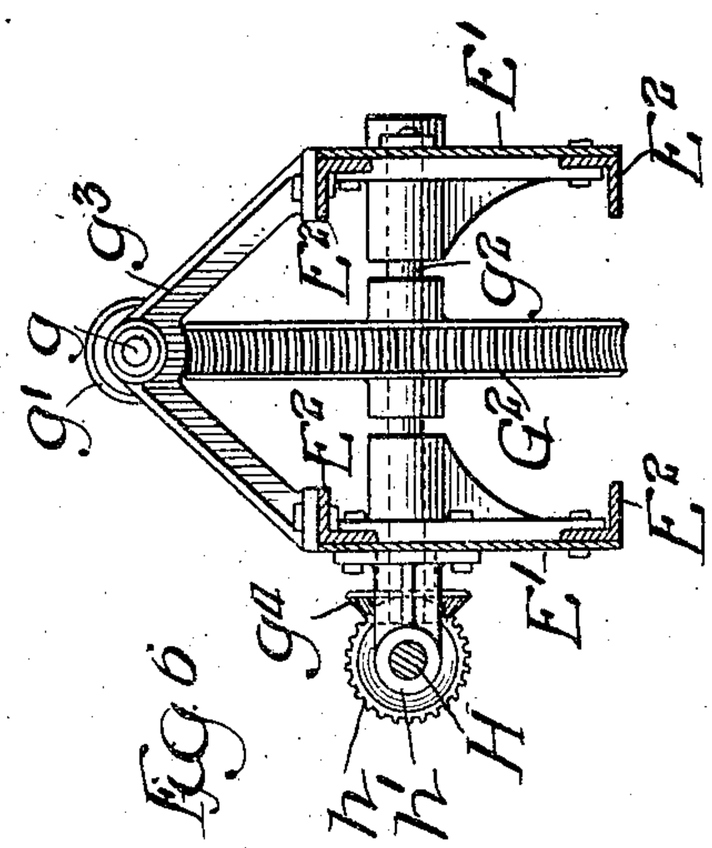

Fig. 6

Fig. 2.

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APPLICATION FILED DEC. 6, 1907. 3 SHEETS—SHEET 3.

Fig. 3.

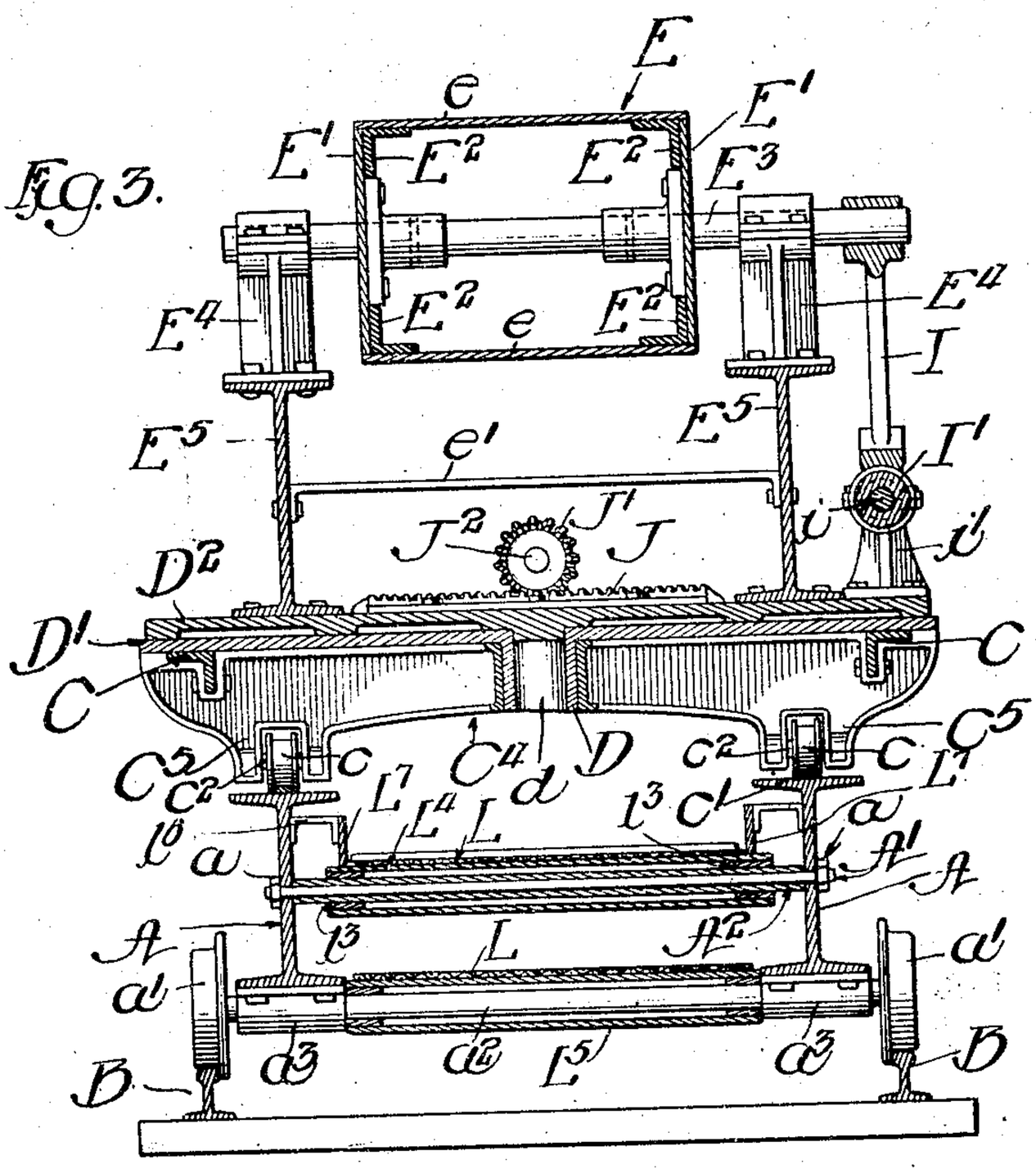
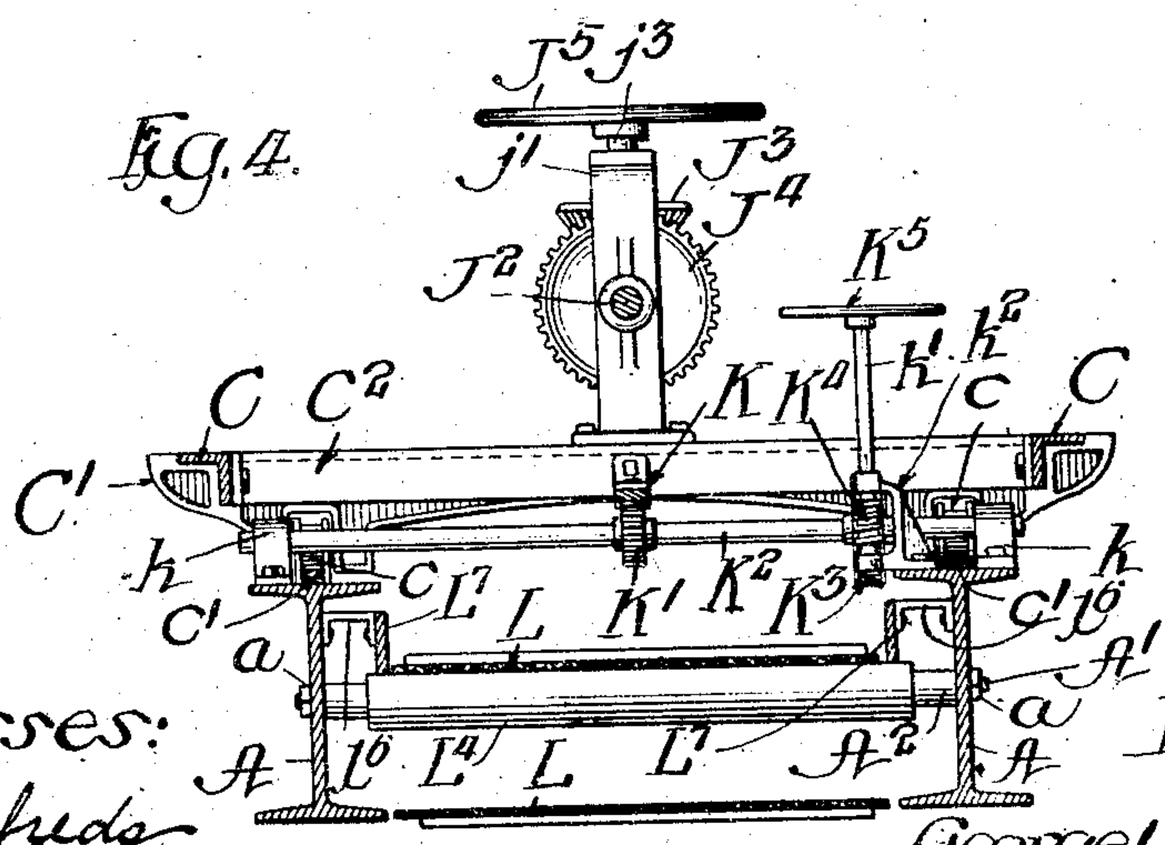


Fig. 4.



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UNITED STATES PATENT OFFICE.

GEORGE W. JACKSON, OF CHICAGO, ILLINOIS.

MACHINE FOR EXCAVATING TUNNELS.

No. 889,464. Specification of Letters Patent. Patented June 2, 1908.

Application filed December 6, 1907. Serial No. 405,419.

To all whom it may concern:

Be it known that I, GEORGE W. JACKSON, a citizen of the United States, and a resident of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Machines for Excavating Tunnels; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to improvements in excavating machines for constructing tunnels, for mining purposes and like uses, and the invention consists in the matters hereinafter set forth and more particularly pointed out in the appended claims.

The excavating machine herein shown as embodying the several features of my invention embraces, in general terms, a cutter arm having horizontally and vertically swinging movement, whereby it may be presented at varying horizontal and vertical angles to the breast of a tunnel or other part to be excavated or removed, and said arm carries at its outer or free end a cutter for cutting or loosening the material to be cut or loosened. The said cutter arm is carried by a main wheeled frame or truck and is directly supported on a carriage which is movable forwardly and rearwardly on said main frame. The machine embraces also a conveyer arranged beneath the cutter arm carriage to carry the material loosened by the cutter to the rear of the machine from which point it may be removed in any suitable manner. Movement of the carriage forwardly on the main frame advances the cutter toward the breast of the tunnel, or other material being excavated or cut away, through the range of movement of the carriage. When the carriage has reached the limit of its forward movement it is moved to its rearmost position and thereafter the main frame is advanced to bring the machine into an advanced position for operation, after which the carriage is advanced on the frame as the work proceeds in the same manner as before.

In the accompanying drawings:—Figure 1 is a side elevation of an excavating machine embodying my invention. Fig. 2 is a longitudinal vertical section through the main frame and carriage, showing the parts mounted thereupon. Fig. 3 is a transverse vertical section on line 3—3 of Fig. 2. Fig. 4 is a transverse vertical section on line 4—4 of Fig. 2. Fig. 5 is a view in elevation of the swinging cutter carrying arm, showing the reverse side from that shown in Fig. 1. Fig. 6 is a transverse section through said swinging arm, taken on line 6—6 of Fig. 1. Fig. 7 is a transverse section taken on line 7—7 of Fig. 1.

As shown in said drawings, A A designate the side members of the main wheeled frame or truck which are connected by transverse members consisting principally of tie rods A^1 extending between and through the side members A and spacing sleeves or tubes A^2 surrounding the tie rods and abutting at their ends against the inner faces of said side members. Nuts *a* screw-threaded on the outer ends of said rods clamp the side members between said nuts and the outer ends of said spacing tubes or sleeves. Said wheeled frame is provided with flanged wheels a^1 which rest and roll upon track rails B. Said side members, as herein shown, have the form of I-beams with their web portions in parallel vertical planes, and the tie rods A^1 extend through said webs. The wheels a^1 are fixed to the ends of axles a^2 which are mounted in journals a^3 bolted to the bottom flanges of the side members A.

C C designate the longitudinal members, and C^1 C^2 C^3 and C^4 the transverse members of the forwardly and rearwardly shifting carriage on the main frame which directly supports the cutter carrying arm. Certain of said transverse members are of special form and constitute supports for parts of the machine, as will be hereinafter described. Said carriage is provided with rollers or wheels *c c* which rest and roll upon track rails c^1 c^1 laid upon the side members of the main frame. The transverse members C^1 and C^4 are formed at their ends to provide lugs C^5 which receive the trunnions or shafts c^2 of the carriage supporting rollers *c*. The transverse member C^4 is centrally enlarged in its horizontal dimensions and is provided with a vertical opening in which is bolted a hollow bearing sleeve D depending from and integral with a horizontal plate D^1 which rests upon the transverse member C^4 and the side members C C, which latter are elevated at their forward ends, as best shown in Fig. 2. A second horizontal plate D^2 rests upon the plate D^1 and is provided with a central pivot stud *d* which extends downwardly into the hollow bearing sleeve D. The parts just described

constitute a turn-table upon which the swinging arm E of the machine and the parts carried thereby are supported.

The particular form of the cutter carrying arm herein shown is that of a latticed girder, it comprising two laterally separated plates E^1 E^1, stiffened by means of angle bars E^2 E^2 riveted to their margins, and connected by cross-members *e e* (Fig. 7). Said cutter carrying arm is supported near its rear end upon a horizontal shaft E^3 which extends transversely through the side members E^1 and beyond said side members. The ends of said shaft are mounted in pillow blocks E^4 rising from a frame and supported on the upper horizontal plate D^2 of the turn-table before described. The arm supporting frame consists of two side plates E^5 having the form of I-beams, which are bolted at their lower flanged margins of the horizontal plate D^2, and transverse connecting struts e^1 bolted or otherwise fixed rigidly to said side plates. The horizontal shaft E^3 is fixed to the cutter carrying arm and constitutes the horizontal pivot about which the arm swings vertically, and the stud *d* of the upper member or plate of the turn-table constitutes the vertical pivot about which the arm swings in its horizontal movement.

To the forward end of the cutter carrying arm are bolted a pair of journal members *f f* in which is journaled a horizontal shaft F which carries a rotary cutter F^1 that is constructed as follows: Said rotary cutter consists of a plurality of U-shaped cutting blades F^3 F^3 attached at their ends to laterally separated plates F^4 F^4 which are fixed in any suitable manner to the shaft F. The looped or closed portions of the blades are sharpened to constitute cutting edges, and the side members or legs thereof are detachably fixed to the laterally separated plates F^4 F^4, as by the bolts shown in Figs. 1 and 5. One end of said cutter shaft F extends beyond its bearing member *f*, and to said extended shaft end is fixed a beveled gear f^1 (Fig. 5). The cutter is driven by a motor G, which may conveniently be an electric motor, supported on a bracket or shelf G^1 carried by the rear end of the cutter carrying arm. The armature shaft of said motor is connected with and drives a shaft *g* which carries at its outer end a worm g^1 meshing with a worm wheel G^2 which is arranged between the two side members of the cutter carrying arm and is fixed to a shaft g^2 which is journaled in said members. The outer end of the worm shaft *g* is journaled in a bearing g^3 which is supported on the side members of said arm, as most clearly shown in Figs. 1, 5 and 6. To one end of said shaft g^2 is fixed a beveled gear g^4 (Fig. 5) which meshes with a beveled gear *h* fixed to the inner end of a longitudinal shaft H mounted in bearings h^1 h^1 bolted to the side face of the arm, as shown in Fig. 5. The outer end of said shaft H carries a beveled gear h^2 which meshes with the beveled gear f^1 of the cutter shaft F. By means of the gearing described the cutter F^1 is rotated and the proportions of the gears are such that the speed imparted by the motor to the cutter is suitably reduced, as is obvious.

It will be observed that the position of the motor on the cutter carrying arm is such, with respect to the pivot shaft E^3 of the arm, that the weight of the motor tends to counterbalance the weight of that part of the arm between the pivot shaft and the cutter. Thus the arm may be raised from a lower to a higher position to adjust the cutter to a new cut on the breast of the tunnel, or other work, with the exertion of relatively small power and the use of relatively light actuating mechanism as compared to a machine in which the principal weight carried by the arm is between its pivot and the cutter. The free end of the arm is overweighted sufficiently to neutralize the average thrust on the arm, due to the reaction of the cutting blades, as the arm swings downwardly to bring the blades in cutting contact with the work. Thus the arm is approximately counterbalanced when the cutter is in operation.

Next referring to the mechanism herein shown for actuating the arm to swing it vertically about its horizontal axis, said parts are made as follows: I designates a worm gear segment which is fixed to one end of the horizontal pivot shaft E^3 (Figs. 1 and 3) and depends therefrom. Said gear segment meshes with a horizontal worm I^1 beneath the level of the cutter carrying arm. Said worm is carried by a worm shaft *i* which is journaled in bearing members i^1 bolted to and rising from the horizontal plate D^2. To the end of said worm shaft is fixed a hand-wheel I^2, through the medium of which the worm is rotated to impart, through the gear segment, vertical movement to said arm.

The mechanism herein shown for horizontally swinging the cutter carrying arm about its vertical axis is made as follows: J designates a bevel gear segment that is bolted or otherwise fixed to the upper face of the upper member D^2 of the turn-table. Meshing with said segment is a beveled gear J^1 carried by a longitudinally extending, horizontal shaft J^2 which is journaled in bearing members *j* j^1 supported on the transverse members C^2 C^3 of the carriage (Fig. 2). The bearing member j^1 is formed to provide also a bearing for a short vertical shaft j^3 which carries at its lower end a beveled gear J^3 meshing with a beveled gear J^4 on the adjacent end of said horizontal shaft J^2. The vertical shaft j^3 is provided at its upper end with a hand-wheel J^5 by means of which the parts are operated to effect the horizontal adjustment of the cutter carrying arm.

Any suitable means may be employed for

veyer belt, when the belt is extended beyond the front end of the machine frame, as herein shown. That which does not so fall on the belt is shoveled onto the belt by a workman, stationed for that purpose, at the base of the tunnel breast.

It will be understood that the meshing gears and other relatively moving parts of the machine may be incased to protect them from the clogging action of the dust and the material being operated upon.

While the construction of the machine has been described with considerable particularity as to details many of such details of construction may be varied without departure from the spirit of my invention. Moreover certain of the essential elements of the machine may be employed for other purposes than those herein specifically set forth.

I claim as my invention:—

1. A tunnel excavating machine comprising a wheeled frame, a carriage mounted on said frame, means for shifting the carriage forwardly and rearwardly on the frame, a cutter carrying arm mounted at one end on said frame, a cutter carried by the free end of said arm, a motor carried by said arm for operating the cutter, and means for imparting both a vertical and horizontal swinging movement to said arm.

2. A tunnel excavating machine comprising a wheeled frame, a carriage mounted on said frame, rack and pinion mechanism for shifting the carriage forwardly and rearwardly on said frame, a cutter carrying arm mounted at one end on the carriage, a motor carried by the arm for operating said cutter, and means for imparting both a horizontal and vertical swinging movement to said arm.

3. A tunnel excavating machine comprising a wheeled frame, a carriage mounted on the frame, means for shifting said carriage from front to rear of the frame comprising a rack on the carriage, a shaft on the wheeled frame carrying a pinion meshing with the rack, a worm-gear mechanism for rotating said shaft, a cutter carrying arm mounted on the carriage, means for imparting both a vertical and a horizontal swinging movement to said arm, a cutter carried by the free end of said arm, and a motor also carried by the arm and operatively connected with the cutter.

4. A tunnel excavating machine comprising a wheeled frame, a carriage mounted on said frame, means for shifting the carriage forwardly and rearwardly on said frame, a horizontally rotative turn table mounted on said carriage, a vertically swinging cutter carrying arm mounted on said turn-table, a cutter carried by the free end of the arm and a motor carried also by said arm and operatively connected with said cutter.

5. The combination with a supporting frame, of a horizontally and vertically swinging arm mounted thereon, a cutter carried by the free end of said arm, and a motor for operating said cutter and carried by the arm on the side of its horizontal pivot remote from said cutter, whereby the motor and the rear end of the arm tend to counterbalance the end of the arm which carries the cutter.

6. The combination with a supporting frame, of a horizontally and vertically swinging arm mounted thereon, a cutter carried by the free end of said arm, and a motor for operating said cutter and carried by the arm on the side of its horizontal pivot remote from said cutter, whereby the motor and the rear end of the arm tend to counterbalance the end of the arm which carries the cutter, the arm being so proportioned with respect to its pivot that the free end thereof slightly overbalances the motor and the part of the arm in rear of said horizontal pivot.

7. The combination with a supporting frame, of a horizontally rotative turn-table mounted thereon, a vertically swinging arm mounted on a horizontal pivot carried by said turn-table, a cutter carried by the free end of said arm, a motor mounted also on said arm and operatively connected with said cutter, and means for swinging the arm vertically on its horizontal pivot comprising a gear segment mounted on and concentric with said pivot and depending therefrom, and a horizontal worm mounted on said frame below the level of the arm and meshing with said worm-gear segment.

8. A tunnel excavating machine comprising a cutter carrying arm, a cutter carried by the free end of said arm, a motor carried by the arm for operating said cutter, a frame on which said arm is supported, means for imparting both a vertical and horizontal swinging movement to the arm, and a conveying device mounted in said frame beneath the arm in position to receive the material loosened by the cutter for carrying the said material from the front to the rear of the machine.

9. A tunnel excavating machine comprising a cutter carrying arm, a cutter carried by the free end of said arm, a motor carried by the arm for operating said cutter, a frame on which said arm is supported, means for imparting both a vertical and horizontal swinging movement to the arm, and a conveyer belt trained about rollers mounted beneath said frame and having a part which extends forwardly from the frame beneath said arm for carrying the material loosened by the cutter from the front to the rear of the machine.

10. A tunnel excavating machine comprising a wheeled frame, a carriage thereon, means for shifting the carriage from front to rear of said frame, a swinging arm mounted on the carriage, a motor carried by the arm and operatively connected with said cutter, means for imparting both a vertical and a

shifting the cutter arm supporting carriage to present the cutter to or retract it from the work. The mechanism herein shown for this purpose is made as follows: K designates a horizontal, longitudinally extending rack bar, (Figs. 1 and 2) which is arranged centrally in the carriage frame and is fixed at its ends to the transverse members C^1 to C^4 of the carriage. The teeth of said rack bar face downwardly and mesh with a pinion K^1 carried by a transverse, horizontal shaft K^2 which is journaled in bearing members *k k* (Fig. 4) which are fixed to the top flanges of the I-beam members A of the main frame. Said shaft is provided at one end thereof with a worm wheel K^3 which meshes with a worm K^4 on a vertical worm shaft k^1 that is journaled in a bearing member k^2 fixed to the adjacent frame member A. Said shaft k^1 is provided at its upper end with a hand wheel K^5 by which it may be operated to rotate the pinion shaft K^2 and, through the rack bar, to shift the carriage longitudinally of the main frame. The worm K^4 and worm wheel K^3 serve to lock the carriage in any position to which it may be shifted by the rack and pinion mechanism described.

A conveying device is provided for conveying material, which is loosened by the cutter, from the front to the rear of the machine, from which latter point said material may be removed in any suitable or preferred manner. Said conveying device is constructed as follows: L designates a horizontal conveyer belt which is located between the side members of the main frame and is trained about rollers L^1 L^2 at the front and rear ends, respectively, of said frame. The forward roller is mounted in a forward extension A^6 of the side members of the frame in order to bring the forward part of the conveyer belt closely adjacent to the breast of the tunnel or other work operated upon by the machine. In order to facilitate the reception of material by the belt, the forward roller L^1 is placed as low as is practicable and to this end the extensions A^6 are inclined downwardly and forwardly from the main frame. The shaft of said forward roller is journaled in bearings *l* carried by said extensions A^6. The shaft of the rear roller L^2 is journaled in bearings l^1 mounted on the web portions of the side members of the main frame. The upper lap of the conveyer belt is supported at intervals by idler rollers L^4 which are rotatively mounted, as herein shown, on the spacing tubes A^2 of the transverse members of the main frame of the machine. Said rollers, as herein shown, have bearing at their ends only on said spacing tubes, as best shown in Fig. 3, the central parts of the rollers being free from the spacing tubes. To this end the rollers are provided at their ends with hollow plugs l^3 which fit tightly in the ends of the rollers and are formed with bearing openings of a diameter to rotate freely on said spacing tubes. The lower lap of the conveyer belt is likewise supported at intervals upon rollers L^5 L^5, two of which are journaled upon the axles of the wheels a^1 a^1, and another or intermediate one of which is journaled in bearing members l^4 fastened to the bottom flanges of the side frame members A. Horizontal bars L^7 are arranged longitudinally at the sides of the upper lap of the belt conveyer to prevent the loosened material falling off of the same, as shown in Figs. 3 and 4. Said bars are attached to the side members of the frame by means of brackets l^6.

The conveyer belt is conveniently driven by a motor M, which may be an electric motor, and which is mounted on the rear end of the main frame of the machine. Said motor is operatively connected with the rear roller L^2 of the conveyer belt by means of a shaft *m* which carries at its upper end a beveled gear m^1 which meshes with a beveled gear m^2 on the motor shaft. The shaft *m* carries at its lower end a beveled gear m^3 which meshes with a beveled gear m^4 fixed to the shaft of the rear or driving roller of the conveyer belt.

The operation of my improved excavating machine will be obvious from the foregoing, but may be briefly stated as follows: The wheels a^1 of the main frame are first blocked to hold the machine from rearward movement, due to the action of the cutter on the tunnel breast. The cutter carrying arm is then adjusted, by means of the gear segment J and gear pinion J^1 to present the cutter to the tunnel breast at the proper horizontal angle. Thereafter the cutter carrying arm is swung vertically about its horizontal axis, through the medium of the worm gear segment I and worm I^1 so as to carry the cutter, which is driven by the motor during such swinging motion, into vertical contact with the breast of the tunnel and thereby remove a layer of earth of the width of the cutter blades in each vertical swing of the arm. After each vertical layer of the tunnel breast has been thus removed, the cutter arm is swung horizontally to present the cutter at another horizontal angle to the tunnel breast, and another layer cut away during the subsequent vertical swing of the arm. This operation is repeated until a section of the entire breast has been removed, after which the carriage is advanced, by the rack and pinion mechanism described, to bring the cutter into position for removing another section or layer of the tunnel breast in the same manner as before. From time to time the entire machine is moved forward on its track and is blocked to hold it in place. The loose material removed from the breast of the tunnel falls to the bottom of the tunnel. Some of this material falls directly on the forward part of the con-

horizontal swinging movement to said arm, and a conveying device mounted in said frame beneath the arm for carrying the material loosened by the cutter from the front to the rear of the machine.

11. A tunnel excavating machine comprising a cutter carrying arm, a cutter carried by the free end of said arm, a motor carried by the arm for operating said cutter, a frame on which said arm is supported, means for imparting both a vertical and horizontal swinging movement to the arm, a conveyer belt trained about rollers mounted in said frame and extending from front to rear of the machine for carrying the material loosened by the cutter to the rear end of the machine, the forward part of said conveyer belt being inclined downwardly, for the purpose set forth.

12. The combination with a supporting frame, of a horizontally and vertically swinging cutter carrying arm mounted thereon and extending forwardly therefrom, a cutter carried by the free end of said arm, means for operating said cutter and a conveyer belt arranged with its receiving end in front of said frame and below the arm for conveying the material from the front end of the machine.

In testimony, that I claim the foregoing as my invention I affix my signature in the presence of two witnesses, this 12th day of November A. D. 1907.

GEORGE W. JACKSON.

Witnesses:
F. A. CUTHSON,
WILLIAM CORBETT.