No. 644,181. Patented Feb. 27, 1900.

C. H. LANE.

APPARATUS FOR SEPARATING METAL FROM ROCK.

(Application filed May 31, 1899.)

(No Model.) 4 Sheets—Sheet 1.

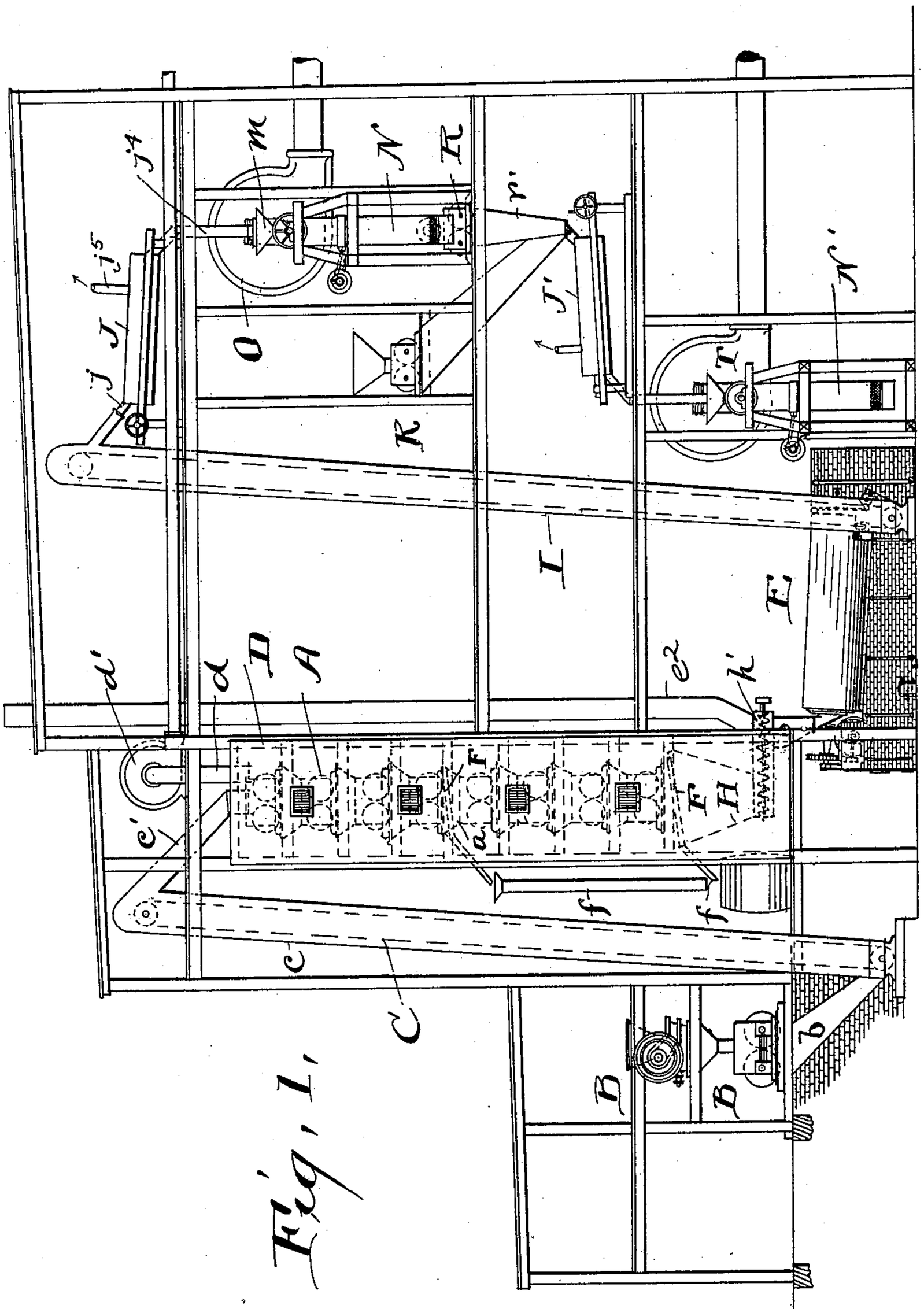

Fig. 1.

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By his Attorneys,
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Fig. 2.

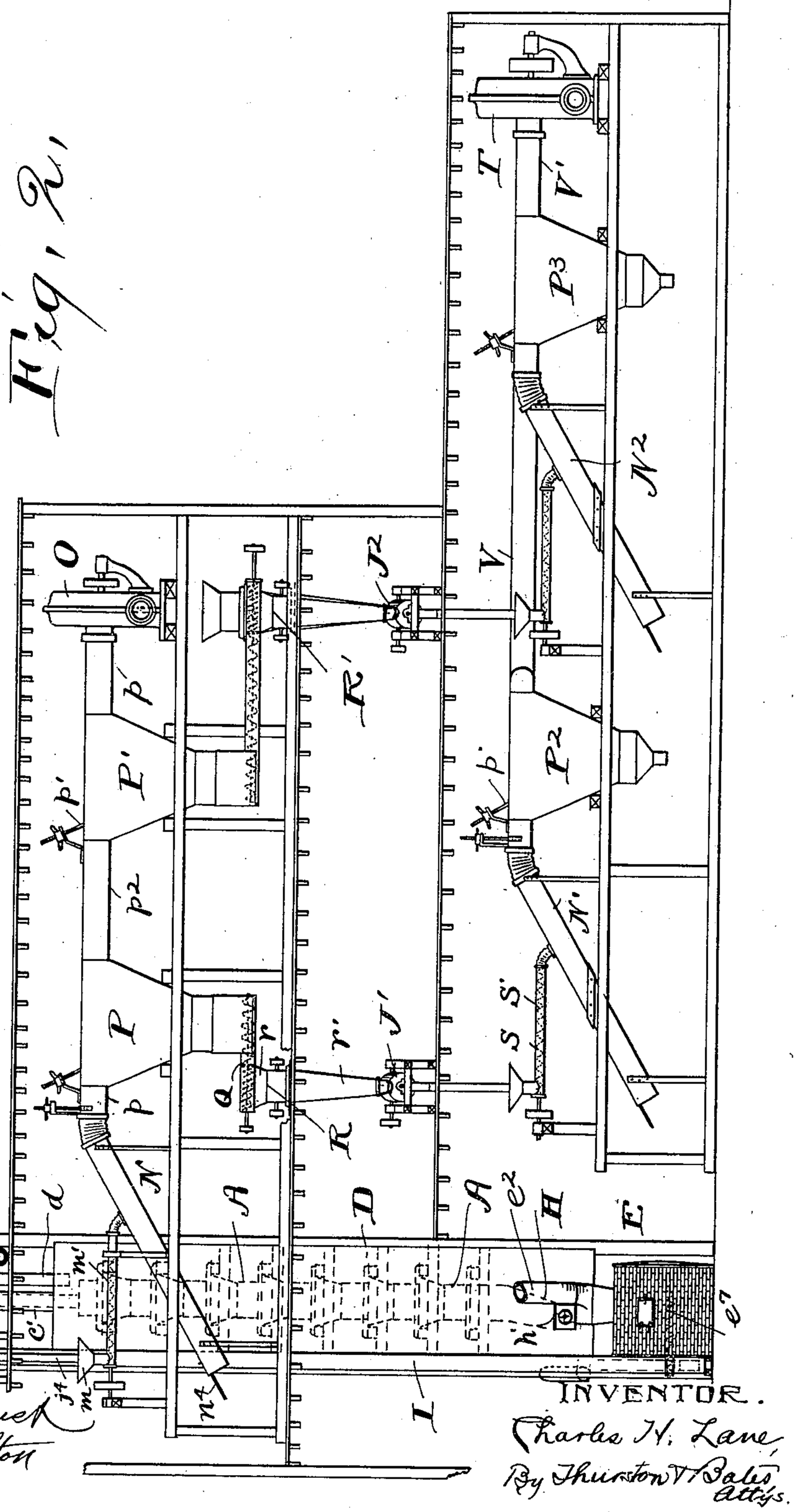

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Fig. 3,

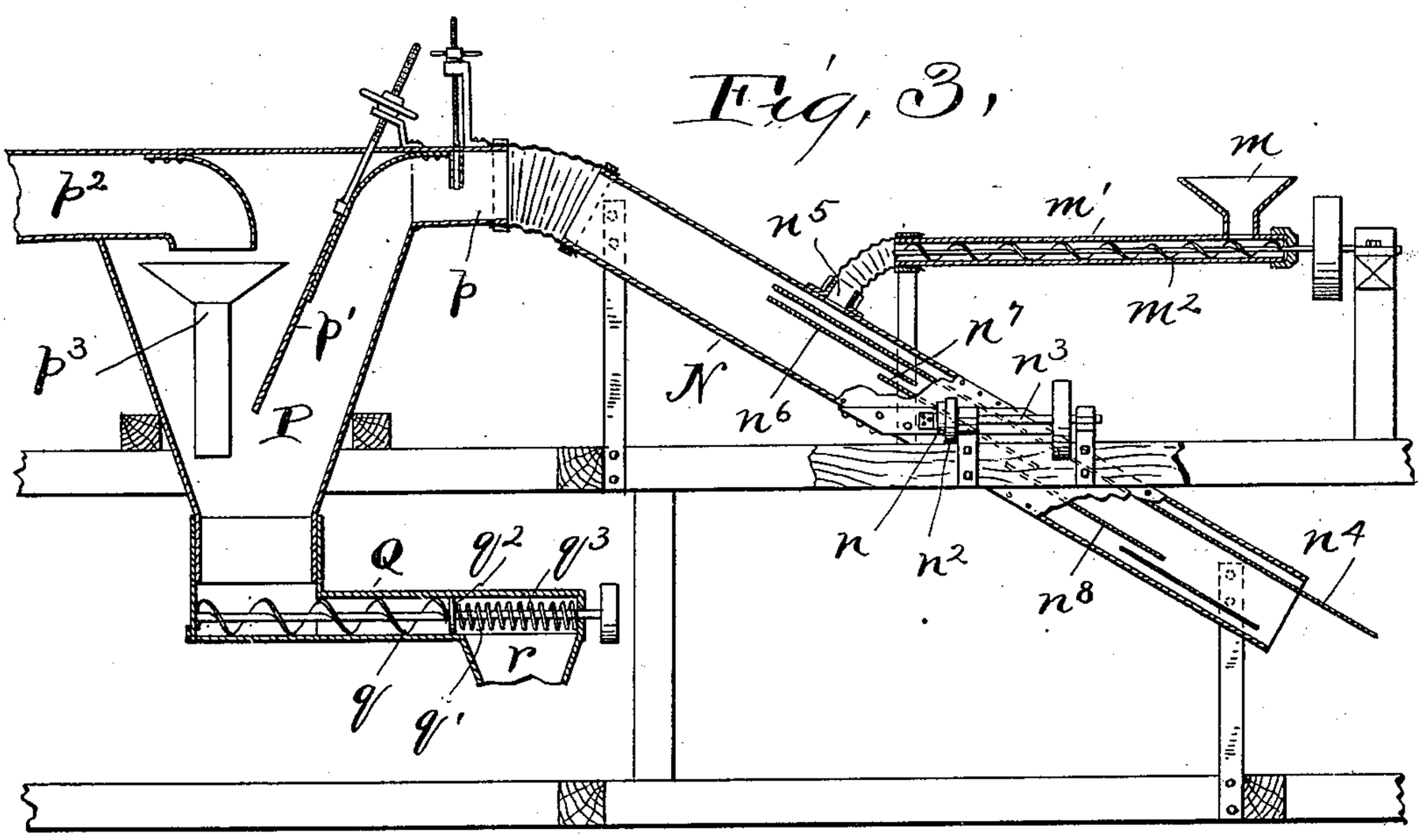

Fig. 4,

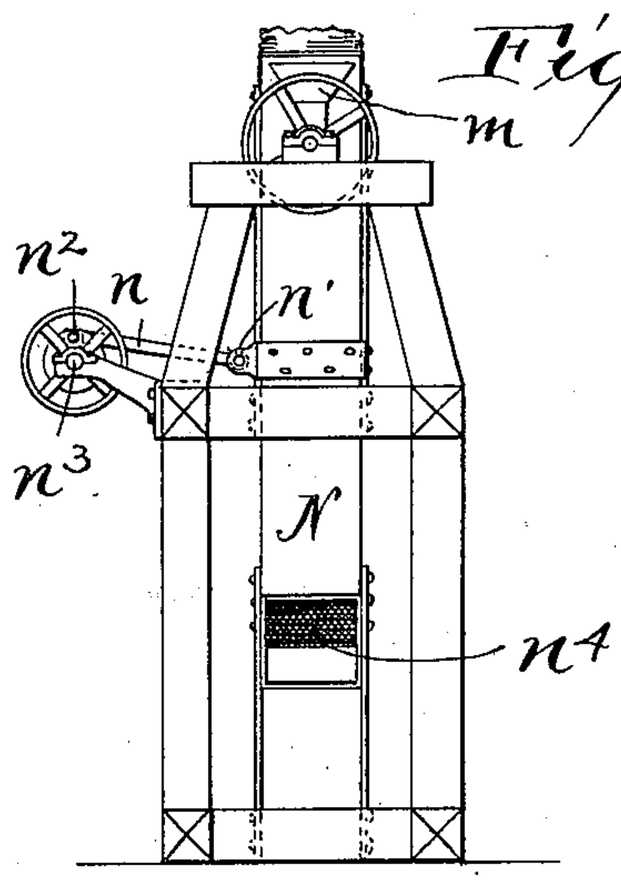

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Fig. 5.

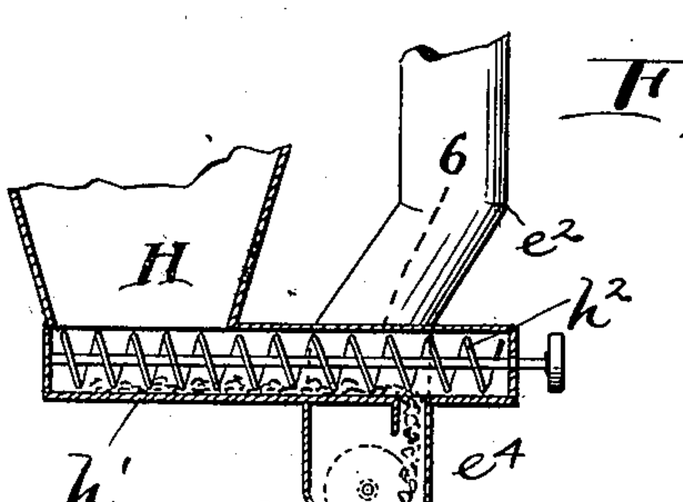
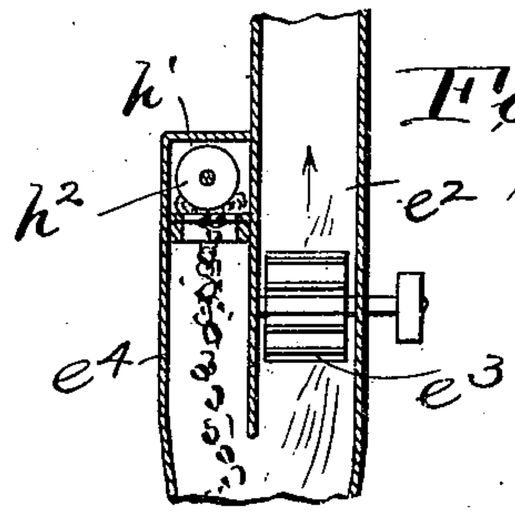


Fig. 6.



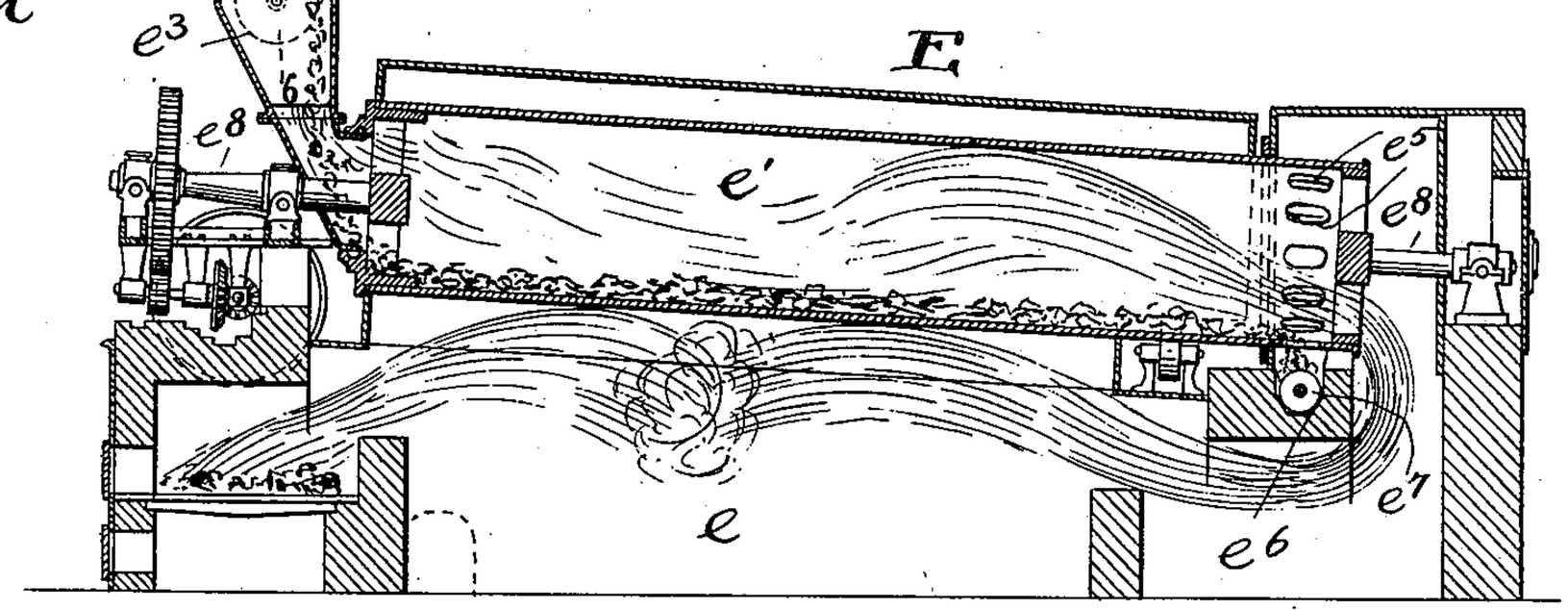
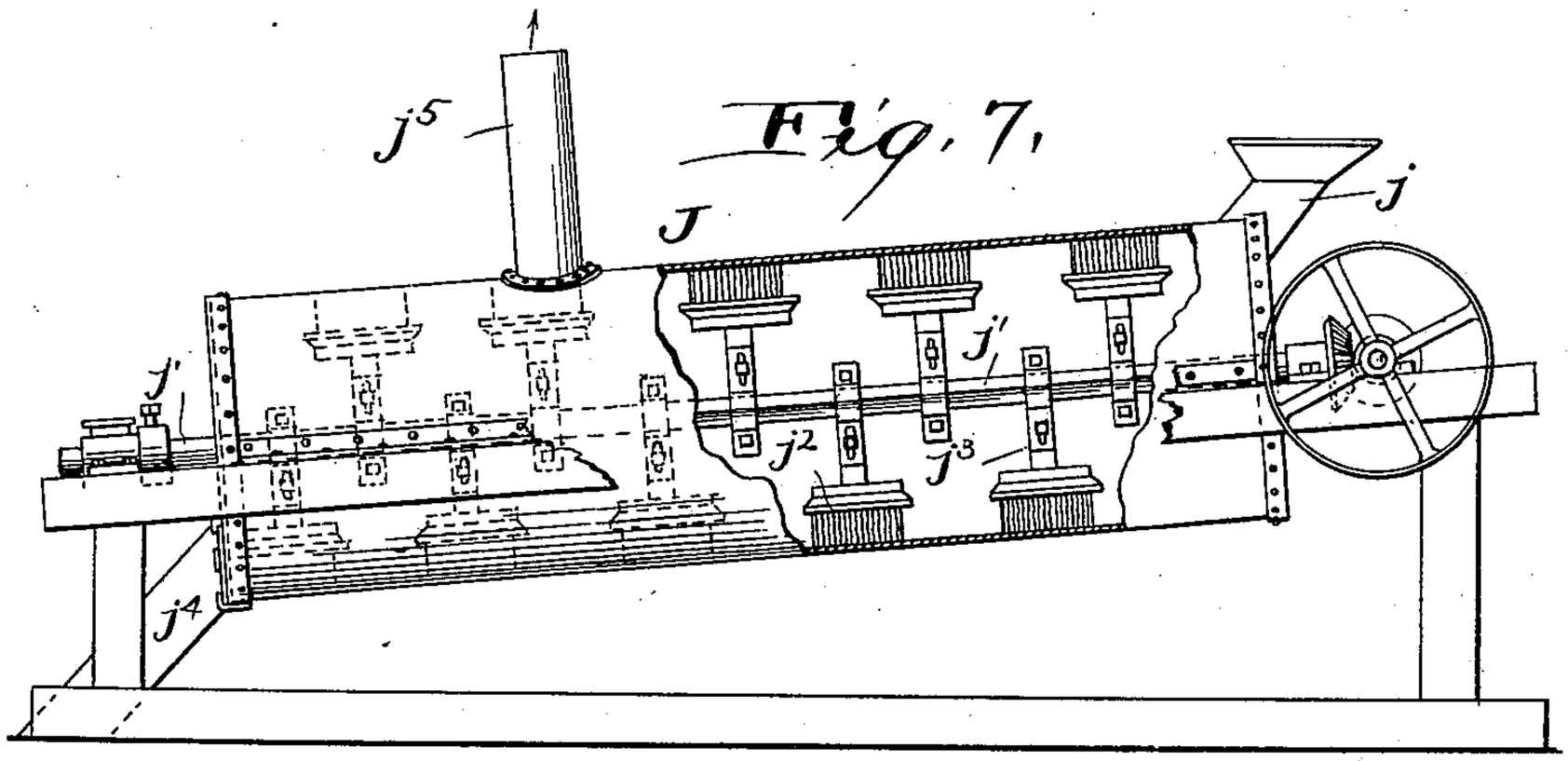


Fig. 7.



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UNITED STATES PATENT OFFICE.

CHARLES H. LANE, OF CLEVELAND, OHIO.

APPARATUS FOR SEPARATING METAL FROM ROCK.

SPECIFICATION forming part of Letters Patent No. 644,181, dated February 27, 1900.

Application filed May 31, 1899. Serial No. 718,834. (No model.)

To all whom it may concern:

Be it known that I, CHARLES H. LANE, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented a certain new and useful Improvement in Apparatus for Separating Metal from Rock, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings.

The process and the apparatus which constitute the present invention are primarily intended to effect the separation of the mineral from the rock as the two are found associated in nature. The invention, however, may be employed to effect the partial or complete separation of various materials of different specific gravity when the same are mixed together to form a mass which is capable of being pulverized.

The process consists in gradually reducing the mixture to a pulverized condition, in drying the pulverized matter and violently beating it to break up the adhesion and cohesion of the fine particles of which it is composed, and in finally delivering the material into an upward current of air of sufficient force to carry away the lighter particles.

The invention embodied in the apparatus consists, first, in the combination of a series of crushing-rolls adapted for gradually reducing the material to a pulverized condition, a drier, a beater mechanism for destroying the adhesion and cohesion of the finer particles, a tube, means for conveying the material from one of said mechanisms to another in series and for finally dropping it slowly into said tube, and means for creating an upward current of air through said tube.

It also consists in the more specific combination of parts hereinafter described, and pointed out definitely in the claims.

In the drawings, Figure 1 is a side elevation of an apparatus adapted for the practice of the process. Fig. 2 is an elevation of the apparatus from the right side of Fig. 1. Fig. 3 is a longitudinal sectional view of one of the air-separators employed in the apparatus. Fig. 4 is an end view of the same. Fig. 5 is a sectional view through the drier. Fig. 6 is a vertical sectional view in the plane indicated by the line 6 6 of Fig. 5. Fig. 7 is a side elevation, partly in section, of an agitator or beating device for separating the matted particles of the pulverized mass.

Referring to the parts by letters, A A represent a plurality of pairs of crushing-rolls arranged one above another and in such relation that the product of one pair of rolls is delivered, preferably by gravity, to the action of the pair of rolls next below it. The rolls of the upper pair are farthest apart, and they are placed progressively nearer together from the top downward, the lowest pair being so close together that the material after passing between them will have been ground as fine as in the nature of the material it can be made without other treatment.

B represents a preliminary crushing apparatus which may or may not be necessary, depending upon the character of the material to be operated upon. This apparatus may consist of crushing-rolls or it may have any other suitable construction. There may be, in fact, any number of independent crushing-machines used in this part of the apparatus. The function of these machines is to so far reduce the size of the particles of which the material is composed that their product will be suitable for the action of the upper pair of crushing-rolls A first referred to. These preliminary crushing-machines discharge their product into a hopper *b*, from which material may be taken by a suitable mechanical elevator C and raised and delivered through a pipe *c'* into the hopper of the upper pair of crushing-rolls A. The form of elevator preferred is the well-known bucket type, because it delivers the material regularly and in small quantities to said rolls. This elevator will be inclosed in a suitable elevator-shaft *c*.

The bank of crushing-rolls A A, &c., are inclosed in a tower D. A suction-pipe *d* is connected with the upper end of this tower, and a suction-fan *d'* is connected with this pipe. By means of this fan an upward current of air through the tower is created, this current being strong enough to carry away with it much of the rock-powder which is produced by the crushing action of the rollers, especially those near the top of the tower. It is obvious that in the operation of a plurality of crushing-rolls upon a mixture of rock and metal some rock-powder will be formed by each pair of rolls. This air-cur-

rent is designed to carry away this powdered rock, so that it will not be obliged to pass through the subsequent crushing-rolls and thence on through other parts of the apparatus. By thus carrying away this powdered rock the work of the subsequent mechanism is much reduced, for if it were not carried away some power, more or less, would be necessary to carry it through the subsequent mechanism.

As before stated, the product of each pair of crushing-rolls is discharged directly into the hopper for the next crushing-rolls. The action of these rolls is to crush the rock and flatten out the metal particles. The rock may therefore be reduced indefinitely in size and may pass on from one pair of rolls to another; but there is a practical limit to the degree with which the metal may be flattened out and then caused to pass through a succeeding pair of rolls. It is desirable, therefore, that the larger flattened particles of copper which have been freed from the rock shall be removed from time to time. To effect this result, screens F are interposed between a pair of rolls and the hopper *a*, into which the product of said rolls is discharged. These screens are inclined, so that the pieces of flattened copper too large to pass through them will gradually slide down toward their lower end, where they are connected with spouts *f*, passing out through the tower and discharging into a suitable receptacle. When, therefore, the material emerges from the lowest pair of rolls, it consists only of such small particles of metal (many of which have been flattened out) as may have passed through the screens and pretty finely pulverized rock. In fact, this rock is pulverized as finely and as completely as in the nature of things it can be by the use of these crushing-rolls only. The lowest pair of rolls discharges into a hopper or spout H, through which the material passes by gravity into a drier E.

The use of a drier is necessary with most materials and in most climates, because the pulverized rock will absorb some moisture, wherefore the rolls will act to mat and pack the minute particles together after they have been reduced to a certain degree of fineness. The subsequent action of crushing-rolls alone upon material in this condition would have little effect in still further reducing the size of particles. In fact, these matted masses of material will carry particles which have not been reduced as finely as is necessary for the subsequent action of the mechanisms employed, and before the pulverization of these particles can be effected it is necessary to separate these matted masses into their individual particles, and in order to effect this separation successfully it is necessary first to thoroughly dry the material.

The drier which is shown, but which in the precise form shown is not an essential characteristic of the invention, consists of a furnace *e* and an inclined metallic cylinder *e'*, open at both ends and so arranged that the heat and products of combustion from the furnace pass into its lowest end and out of its upper end and thence to a stack e^2. This stack may contain a fan-blower e^3 for creating a forced draft or upward current of air. The material from the hopper H is moved through a pipe *h'* by a screw conveyer h^2 and discharged into one division e^4 of the stack, from which it falls by gravity into the upper open end of the cylinder. This cylinder is provided with trunnions e^8 on its end, which are suitably mounted, whereby the cylinder may be constantly rotated by suitable mechanism. The rotation of the cylinder causes the material to gradually work its way toward the lower end thereof, and it finally falls out through the holes e^5 therein into a tube e^6, containing a screw conveyer e^7. The heat from the furnace passes in intimate contact with the material and thoroughly dries it, and the air-current created by the fan-blower picks up and carries away much of the finely-pulverized rock-dust and discharges out of the stack. The material in said tube e^6 is moved along by the screw conveyer and is delivered to an elevator I, (preferably of the bucket type,) by which it is raised and delivered into the hopper *j* of a beater device. This beater device, as shown, includes a stationary cylinder J, which is set at a suitable inclination, the hopper *j* discharging into its upper end. Passing longitudinally through this cylinder and out of its ends is a rotatable shaft *j'*, which is mounted in suitable bearings. To this shaft are secured a plurality of beaters j^2, which as the shaft is revolved throw the material about violently and cause the complete separation of all of the individual particles of which the mass is composed. These beaters may be and preferably are in the form of wire brushes having handles or arms j^3, which are clamped fast to the shaft. The agitation of this material, together with the inclined position of the cylinder, causes the material to find its way toward the lower end of said cylinder and to pass out of said end in a completely-subdivided condition through a pipe j^4. A pipe j^5 may be connected with the cylinder J near its lower end, whereby if an upward draft of air through said pipe is created it will carry off some of the rock-dust. The material leaving the beater through pipe j^4 is discharged into a hopper *m*, the lower end of which is connected with a horizontal tube *m'*, containing a screw conveyer m^2. The other end of this pipe discharges into an air-separator, which has the following construction: There is an inclined tube N, the upper end of which is connected by a flexible connection with an outlet-pipe *p*, in which are connected one or more settling-chambers P. The lower end of this tube is moved rapidly backward and forward laterally by means of a connecting-rod *n*, pivoted to ears *n'* on the side of said tube and connected with a crank n^2 on a rotatable

shaft n^3. Within this tube and above the center thereof is supported a screen n^4, onto which the material slowly falls through the inlet-opening n^5, which communicates with tube m'. The mesh of this screen is such that all of the fine dust particles may pass through it. The shaking motion of the tube causes them to fall slowly, and with them will fall some of the finer particles of the metal. The material which does pass through falls upon another screen or horizontal shelf n^6, then falls through or slides down it onto another partition n^7, and thence to another n^8, and so on toward the lower end of the tube N. A strong current of air is being drawn into the lower end of this air-separator tube and out of its upper end and into and through pipe p and the settling-chambers. The material falls from the inlet-pipe and from the screens through the upward air-current, which carries away with it all of the pulverized particles of rock and some, more or less, of the finer particles of the metal. All of the material which is not carried away by the air-current, but which emerges from the lower end of this air-separator tube, will be found to be, if the air-current is properly regulated, substantially pure metal.

A fan-blower O, which is connected with the pipe p beyond the settling-chamber P', produces the air-current referred to through the tube N and settling-chambers.

As before stated, the material which will be carried away by this air-current will be for most part powdered rock material; but there will be with it some of the finer particles of the metal which it is desirable to save. These particles or some of them will be caught in one or the other of the settling-chambers P P'. The settling-chambers contain the transverse partition p', under which the air-current must dive. The heavier particles will settle in the part of the chamber below this partition. The end of pipe p^2 which connects this first settling-chamber with the second settling-chamber extends into the first settling-chamber and is turned downward. Below this end and more or less close to it a funnel p^3 is fixed, which serves two functions. First, it deflects the air-current, so that it cannot pass directly into the pipe, but can only reach said pipe after passing over the top of the funnel, and, second, it catches any of the heavier particles which may fall out of the current and delivers said particles into the bottom of the settling-chamber. The bottom of this settling-chamber is in open communication with a substantially-horizontal tube Q, containing a rotating screw conveyer q. The end of said tube most remote from the settling-chamber has a discharge-outlet q', through which the material falls into the hopper r of another pair of crushing-rolls R. It is necessary to the operation of the air-separator that the air shall be drawn into the lower end of the inclined tube N and not directly into the settling-chamber. Unless means were provided to prevent it the air might be drawn in through this tube Q, containing the screw conveyer, and thence into the settling-chamber, which would defeat the operation of the device. This tube therefore contains a disk-valve q^2, which surrounds the conveyer-shaft and fills the tube and is movable lengthwise thereof and is held by a spring q^3 between the outlet of said tube and the inlet thereof. The action of the screw conveyer is to cause the material to be forced along toward this valve-disk and to press it against this valve-disk, with the result of pressing said disk toward the end of the tube far enough to permit the material to flow through the outlet-opening q' of said tube; but the material itself or the valve at all times forms an effectual seal to prevent the ingress of air.

After the material delivered into the hopper aforesaid has been acted upon by the crushing-rolls R it is delivered by gravity through a tube r' into another beater device J', substantially like that first described, and from thence the material is carried through a tube S by a screw conveyer s' and delivered into another air-separator N'. This air-separator is substantially in construction like that first described. The current of air through it created by suction-fan T in the pipe V carries away all of the rock-dust and perhaps some of the flake metal, which metal, however, will be caught in the settling-chamber P^2, which is connected in the outlet-pipe V of said separator. In practical operation substantially all the material which settles in the settling-chamber P^2 will be pure metal. The force of the air-blast will have much to do, however, in determining that, and, if so desired, the blast may be made of such force that a considerable quantity of the rock-dust will also settle. In that case whatever settles in the settling-chamber will be a concentrate of the ore and not the pure metal.

Going back now to the first air-separator N referred to, attention is called to a second settling-chamber P', connected in the pipe p, with which said air-separator is connected. Its construction and functions are substantially the same as those of the first settling-chamber referred to, and some of the material which passes through chamber P settles in said chamber P' and is withdrawn therefrom and delivered to a pair of crushing-rolls R'. From thence it is delivered to another beater device J^2 and from thence to the hopper of another air-separator N^2, these parts being in construction and operation substantially like those first described. The outlet-pipe V' of this settling-chamber is connected with a settling-chamber P^3, constructed like those heretofore described, and substantially all of the metal carried out of the separator-tube N^2 by the air-current will settle in the chamber P^3.

It will be noticed that the metal as it is separated from the rock by the combined agencies referred to is recovered, first, from the

screens in the tower containing the bank of crushing-rolls A A, &c.; second, from the lower end of the first air-separator N; third, from the lower ends of the two air-separators N′ N², to which it is subsequently delivered, and, finally, from the settling-chambers P² P³, with which the last two air-separators are connected. The dust which is blown away by the several air-currents induced by the suction-fans referred to may be caught in suitable dust-collectors or not, as desired, depending upon the character of the material.

The described apparatus is designed especially to work upon copper ores to recover the metal; but by regulating the force of the several air-currents it may be used with like results upon many other ores and upon gold-bearing sand, (placer-sand.) It may, in fact, be used with any material containing two substances whose specific gravities are sufficiently different or which will be reduced to different conditions when acted upon by the crushing-rolls.

Having described my invention, I claim—

1. In an apparatus for separating metal from rock, &c., the combination of a series of crushing-rolls adapted to act successively upon the material to reduce it to a pulverized condition, a drier, mechanism for automatically conveying the crushed product of said rolls and delivering it into said drier, a beater, and mechanism for automatically conveying the dried material to and delivering it into said beater, with an inclined air-separator tube having an outlet-pipe connected with its upper end, means for creating an upward current of air through said separator-tube and outlet-pipe, mechanism for automatically conveying the product of said beater to and delivering it slowly into the air-separator tube to the action of the air-current, and a settling-chamber connected in and hanging below said outlet-pipe and having a valved delivery-outlet at its lower end, substantially as and for the purpose specified.

2. In an apparatus for separating metal from rock, &c., the combination of a series of crushing-rolls adapted to act successively upon the material to reduce it to a pulverized condition, a drier, a beater device, an inclined air-separator tube having an outlet-pipe, mechanism for automatically conveying the material from one and delivering to another of said devices in the order named, mechanism for creating an upward current of air through said air-separator tube and outlet-pipe, a settling-chamber connected in and hanging below said outlet-pipe, a discharge-pipe connected with the lower end of said settling-chamber, a valve in said discharge-pipe, a conveyer for forcing the material out of said settling-chamber and through said discharge-pipe, and a crushing device into which said pipe delivers the material, a beater device into which said crushing device delivers its product, an inclined air-separator tube having an outlet-pipe, means for slowly delivering the material from said beater into said tube, a settling-chamber connected in and hanging below said outlet-pipe, and means for causing an upward current of air through said air-separator tube and outlet-pipe, substantially as and for the purpose specified.

3. In an apparatus for separating metal from rock, &c., the combination of a series of crushing-rolls adapted to act successively upon the material to reduce it to a pulverized condition, a drier, a beater device, an inclined air-separator tube, and mechanism for conveying the material from one and delivering it to another of said devices in the order stated, with an outlet-pipe connected in the upper end of said air-separator tube, a settling-chamber connected in said pipe, a suction-fan for creating an air-current up through said air-separator tube and through its outlet-pipe and the settling-chamber, a discharge-pipe connected in the lower end of said settling-chamber, a screw conveyer therein, a spring-actuated valve for closing the outlet of said discharge-pipe, a crushing device into which said pipe discharges, a beater device into which said crushing device delivers its product, an inclined air-separator tube, means for slowly delivering the material from said beater into said tube, an outlet-pipe connected with the end of said air-separator tube, a settling-chamber connected in said outlet-pipe, and a suction-fan connected with said pipe beyond the settling-chamber, substantially as and for the purpose specified.

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

CHARLES H. LANE.

Witnesses:

E. L. THURSTON,

PHILIP E. KNOWLTON.