(No Model.)

3 Sheets—Sheet 1.

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SEPARATOR.

No. 329,964. Patented Nov. 10, 1885.

Fig. 1.

Fig. 1a.

Fig. 1b.

Fig. 1c.

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(No Model.)

3 Sheets—Sheet 2.

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Fig. 3

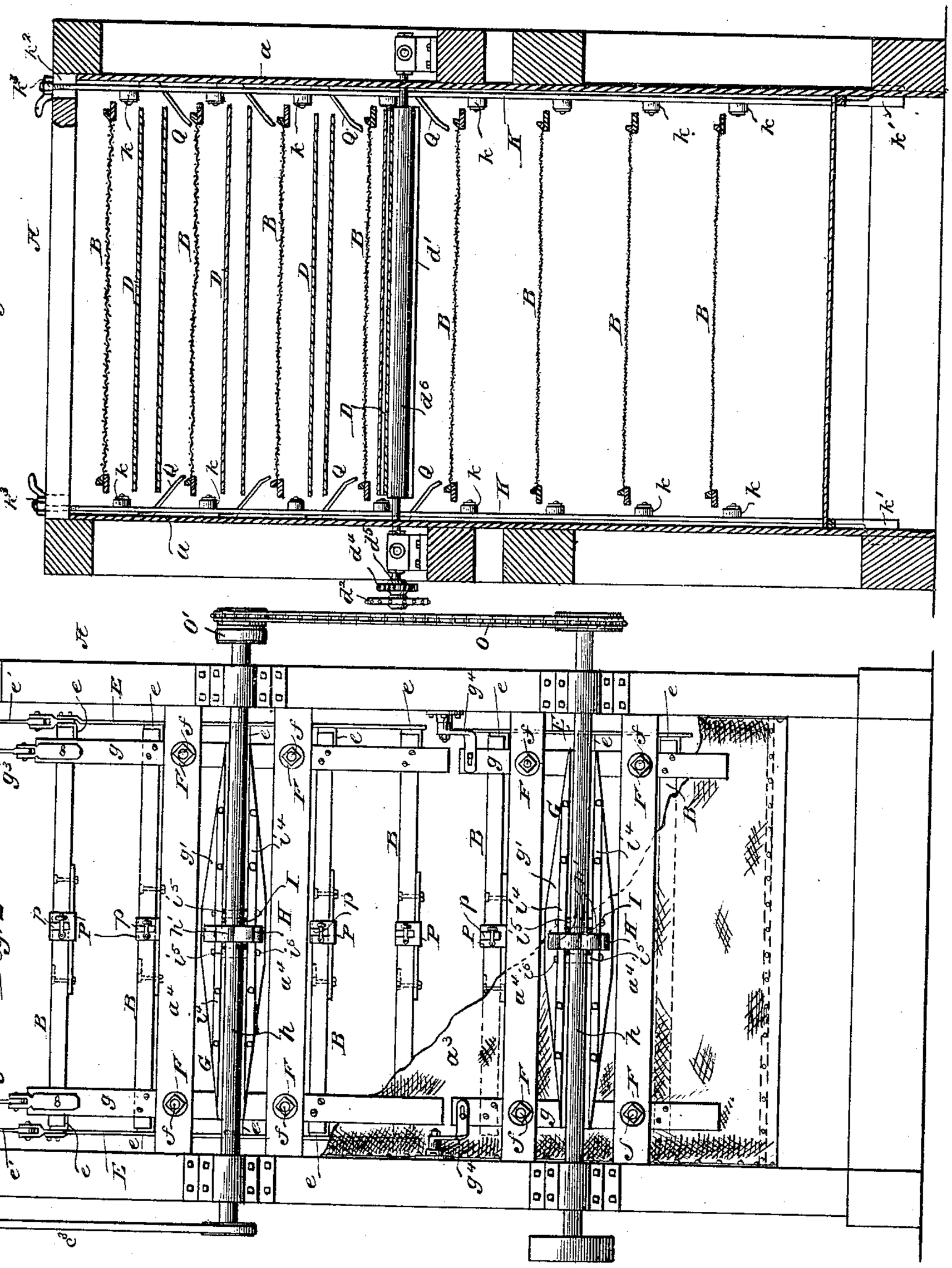

Fig. 2

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(No Model.)

3 Sheets—Sheet 3.

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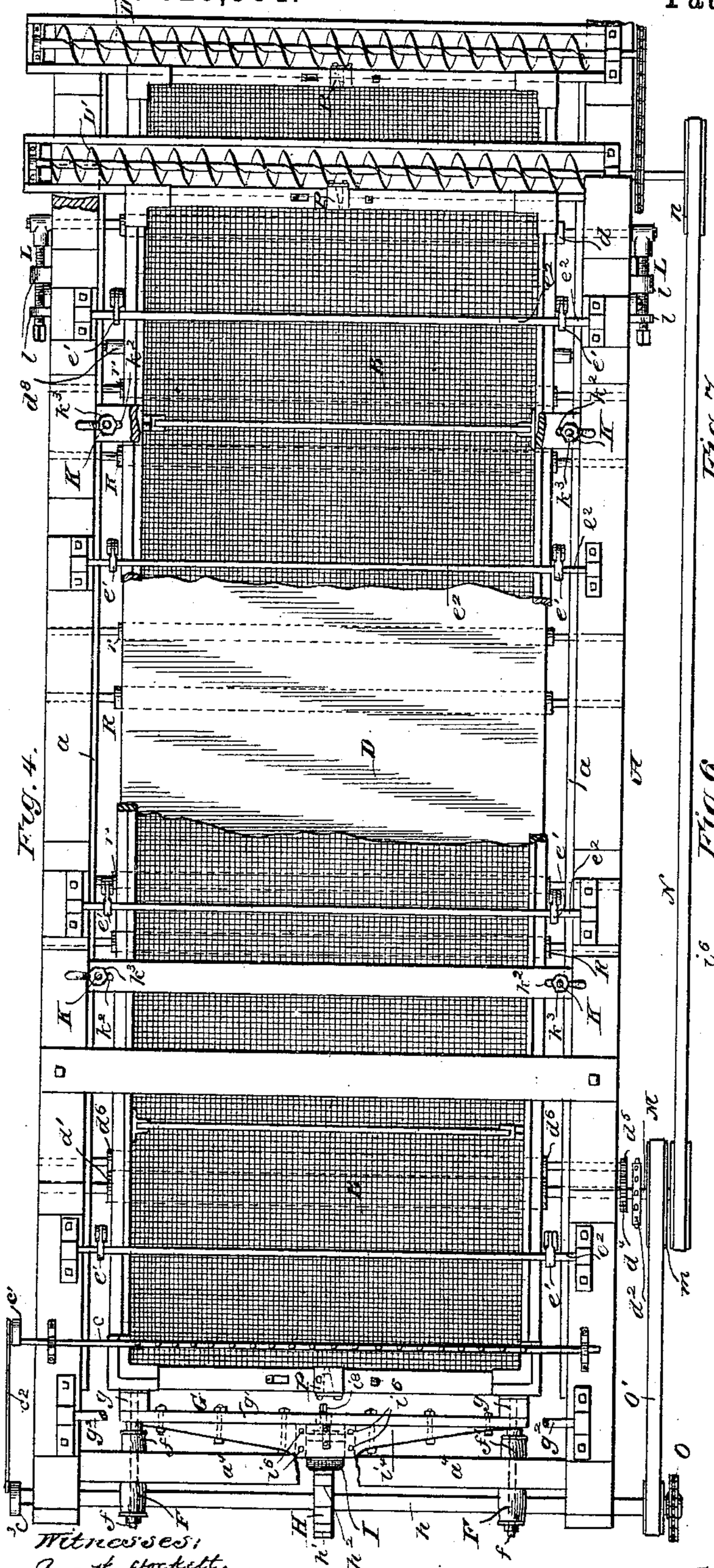

Fig. 4.

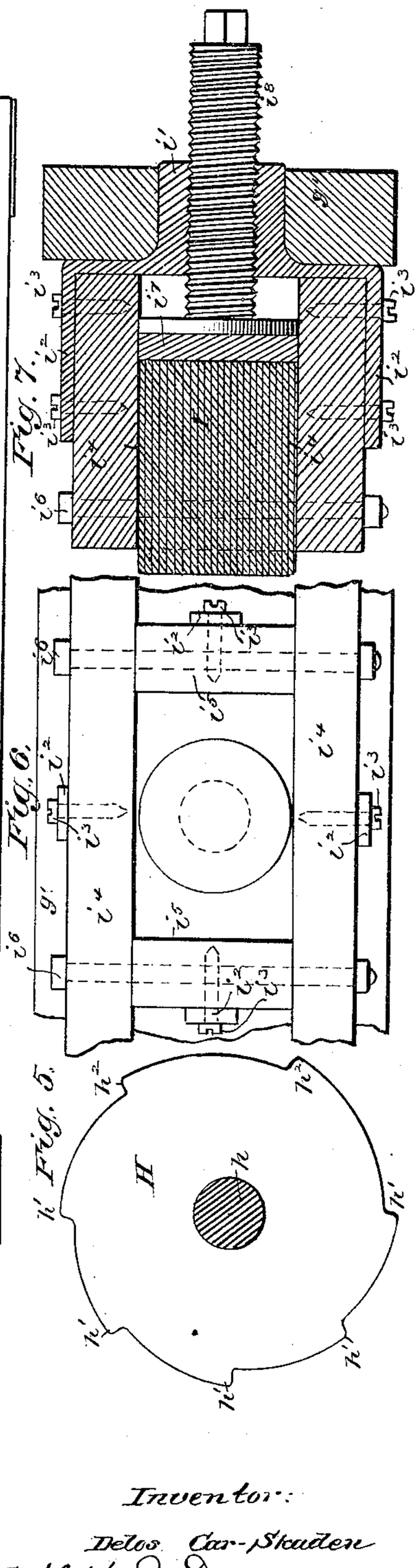

Fig. 7.

Fig. 6.

h' Fig. 5.

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UNITED STATES PATENT OFFICE.

DELOS CAR-SKADEN, OF CHICAGO, ILLINOIS.

SEPARATOR.

SPECIFICATION forming part of Letters Patent No. 329,964, dated November 10, 1885.

Application filed November 13, 1884. Serial No. 147,903. (No model.)

To all whom it may concern:

Be it known that I, DELOS CAR-SKADEN, of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Separators; 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 an apparatus for effecting in comminuted ores a separation of the finer from the coarser particles, according to the several degrees of fineness to which ores have been brought by any previous process.

The objects of my invention are to provide an apparatus by means of which comminuted ore can be rapidly and effectively separated according to the several grades or sizes of its particles; to construct an apparatus for said purpose which shall be simple and compact and susceptible of an easy and ready operation, and which shall operate to separate the particles according to their size with certainty, and to provide means in an apparatus of such character by which, in place of imparting continuous and uniform vibrations at regular intervals to the screens or sifters through which the comminuted ore is sifted, the vibrations imparted to said members shall be irregular, or, in other words, the uniformity of vibration shall be broken up by constantly-occurring changes in time of vibration, so that the injury incident to a uniformity of vibration through the machine shall be avoided. Further objects are to provide means for facilitating the removal of any one or more of the screens whenever desired; to avoid injury resulting from concussions which may occur during operation, and to provide certain novel and improved details of construction, all as hereinafter described and claimed, and illustrated in the annexed drawings, in which—

Figure 1 represents a side elevation of my apparatus with one of the sides thereof removed in order to illustrate its internal construction and organization of parts. Fig. 1^a is a section taken transversely through one side of one of the screen-frames, and a portion of one of the sides of the apparatus, illustrating one of the devices preferably employed as a means for supporting the screens. Fig. 1^b represents in elevation a portion of one side of the apparatus at a point where a bearing is provided for the screen-supporting device illustrated in the preceding figure. In said Fig. 1^b the side of the apparatus is broken away in order to show a portion of the screen-frame. Fig. 1^c is a detail perspective view of a part of one of the side rails of the screen-frame, showing one of the notches or indentations upon the under side of the rail for engagement with the roller of the screen-supporting device shown in Figs. 1^a and 1^b. Fig. 2 represents in elevation the feed end of the apparatus, with a portion of the canvas employed for closing said end of the apparatus broken away. Fig. 3 represents a transverse section taken on a vertical plane indicated by dotted line 3 3, Fig. 1. Fig. 4 is a top plan view with the top or cover for the apparatus removed. Fig. 5 is an enlarged detail illustrating one of the cam-knockers employed for effecting an irregular vibratory movement on the part of the screens. Figs. 6 and 7 are enlarged details, respectively, representing an end view and a sectional view of one of the cushions designed to receive the successive impacts of the cam-knockers, said views also including means for holding and adjusting the said cushion.

This apparatus embraces in its structure an oblong casing, A, conveniently composed of any suitable arrangement of standards, sills, side, end, and top cross-bars, all of which are joined together to form a substantial frame, which is boarded over or otherwise covered, so as to provide the sides *a*, top *a'*, and ends, one of which latter inclines outwardly from the top to the bottom of the casing at the delivery end of the apparatus, as at a^2, Fig. 1, while the remaining end consists, simply, of a sheet, a^3, Fig. 2, of canvas or other flexible material, secured at its edges to the main frame. As the construction of the ends of the casing has especial reference to the arrangement of screens or sieves through which the comminuted ore is sifted, mention will be hereinafter made of the objects of thus forming the two ends of the casing. Within the casing a vertical series of shaking-screens, B, is provided, which are arranged one above another and suspended so that each screen shall incline downwardly from the feed to the delivery end of the ma-

chine, in order that the tailings or unsifted particles of ore shall, during the operation thereof, travel from the feed to the delivery end of the apparatus. The screens of this series successively increase in coarseness of mesh from the bottom to the top of the series, in order that the coarsest particles of the comminuted ore shall be left on the uppermost screen, the next finer particles on the next lower screen, and so on to the bottom of the set. The comminuted or pulverized ore is discharged onto the topmost screen of the set, at the higher end of the screen, for which purpose a feed-passage, C, Fig. 1, is provided at the top of the apparatus, within which passage an agitator, *c*, is arranged for the purpose of facilitating the feed and preventing the choking up of the passage. This agitator is conveniently composed of a rock-shaft provided with any desired number of fingers for agitating the comminuted ore which is fed into the passage. A vibratory motion can be imparted to the agitator through the medium of any convenient or ordinary means serving to connect the same with the driving-power—as, for example, the shaft of the agitator can be provided at one end with a crank-arm, *c'*, connected by means of a pitman, c^2, with a crank-pin upon a disk, c^3, secured upon the end of a rotary shaft, *h*, hereinafter referred to. Under this arrangement of the parts the rotary movement of the disk will give an oscillatory movement to the crank-arm *c'* and the rock-shaft, and thereby produce the desired vibratory movement of the fingers. Under each of the inclined screens mentioned is arranged an endless carrier-belt, D; or, if preferred, the endless carriers can be omitted from below the two lowest screens of the series, as illustrated in Fig. 1. The purpose of these endless carriers is to convey the particles sifted through one screen back to a point over the high end of the next lower screen, so as to insure the passage of the material substantially from end to end of each screen, and consequently over a large area of sifting-surface. To this end the endless carrier-belts are driven so that the upper leaf of each belt shall travel from the delivery toward the feed end of the apparatus, thereby carrying back the sifted material toward the feed end of the machine, and consequently in a direction from the lower to the higher ends of the screens, while at the same time the material which is left upon the screens will be traveling from the higher to the lower ends of the screens as a result of the shaking action and inclination given to the latter. The said carrier-belts are inclined in the same direction as and are preferably parallel with the screens, whereby the screens may be placed much closer together, and the entire apparatus thereby made much more compact than would otherwise be possible. The endless carrier-belts of the series have a successively-advanced position from the feed to the delivery end of the apparatus, the order of their successively-advancing position being from the top to the bottom of the series, whereby the lowest carrier will be set considerably forward with respect to the topmost carrier, as illustrated in Fig. 1, in which view it will be seen that the topmost carrier is also somewhat in advance of the point where the material entering through the feed-passage is allowed to fall upon the first or topmost screen. By such arrangement a considerable quantity of the material will be sifted through the top or first screen at a point back of all the carriers. The material thus sifted through the first screen will fall directly to the next succeeding screen, which is of somewhat finer mesh than the first, and such portion of the material as will then be sifted through the second screen at this end of the apparatus will fall directly to and upon the third screen in the series, and so on. In a like manner the material carried back by any one carrier will be discharged upon the screen next below the same at a point back of all the succeeding lower carriers, and the principal portion thereof will pass directly to the next and succeeding screens in the same manner as before described in connection with the material falling directly upon the topmost screen of the series. The operation of separating the comminuted ore according to the various sizes of its particles will in this way be considerably expedited, since, in addition to the functions of the carriers which serve to carry back the siftings, so as to cause them to be subjected to agitation upon an area of sifting-surface proportionate to their degree of fineness, I also obtain the auxiliary advantage of the passage of a considerable proportion of the material directly from screen to screen, thereby avoiding the necessity of carrying back the entire quantity of material passing through the screens, it being obvious that a greater part of the finest particles will at the feed end pass directly through all the sieves, while the next finest will pass directly through all the screens, excepting the first of the series, and so on. The screens successively increase in length from the top to the bottom of the series, and are arranged so as to project one beyond the other in regular order at the delivery end of the apparatus, at which point the end a^2 of the casing is preferably made inclined, so as to accommodate the latter to this gradual increase in length of the several screens. The carrier-belts extend to points just back of the lower delivery ends of the screens and within convenient proximity to said ends of the screens. I also provide conveyers D', arranged at the lower ends of the screens, for carrying off the tailings which are discharged from the screens during operation.

As one practical way of suspending the screens within the casing so as to permit of a free reciprocation or end shake on the part of the screens, I provide a number of vibratory hangers, each consisting of a rod, E, provided with supports *e* for the screen-frame, and pivotally connected at its upper end with an arm,

e', which latter is in turn rigid with one of a set of rock-shafts, e^2, mounted in appropriate bearings in or on the main frame of the apparatus. In such instance each one of these swinging rods E will be formed or provided with suitable seats or supports, e, for the side bars of the screen-frames to rest upon, which said seats can be conveniently formed by angle-plates secured to the rods. The hangers can be arranged in pairs upon the rock-shafts e^2, one pair being allotted to each rock-shaft and disposed thereon so that each rod E of a hanger shall extend down alongside one or the other of the sides of the screens.

In order to more conveniently support and balance the several screens, and also to avoid an excess of weight on any one pair of hangers, and to admit of a freer shaking action on the part of the screens, it would be desirable to provide two sets of rock-shafts and hangers. In Fig. 1 the upper set of rock-shafts are shown arranged at the top of the frame and provided with a set of hangers capable of supporting, say, about one-half of the series of screens, and at points along the middle portion of the apparatus are arranged the remaining set of rock-shafts, from which latter depend the hangers provided for supporting the remaining screens of the series. The arms e' are disposed upon their allotted rock-shafts in such way that when the screens have assumed their back or normal position the said arms will still be thrown slightly forward and upward and out of a vertical position. This arrangement serves as an auxiliary to the springs F, which are provided for throwing back the screens after the latter have been thrown forward, and then released from the means imparting a short forward movement to the screens. In place, however, of these hangers, I prefer to employ a series of crank-arms, E′, Figs. 1^a and 1^b, arranged in horizontal sets at the inner sides of the main frame, and provided with rollers e^3, upon which the side bars of the screen-frames rest. Each crank-arm is formed with or secured to the inner end of a short rock-shaft, e^4, which passes through the main frame, and is mounted in a bearing, e^5, outside of the said frame. The bearings thus provided for the rock-shafts each consists of a short cylinder provided at its inner end with arms e^6, which are secured by bolts or other suitable fastenings to the outer side of the main frame.

As a means for limiting the extent of vibration on the part of the rock-shaft e^4, I provide the latter with a stud, e^7, arranged to work in an opening, e^8, formed through the side of the tubular bearing e^5, at one end thereof, and as a means for permitting an end adjustment of the rock-shaft in said bearing I provide the rock-shaft with a pair of collars, e^9, which are adjustably held in place upon the rock-shaft by means of set-screws e^{10}. These collars are arranged so that one shall set up to each end of the bearing e^5, thus preventing any end shifting of the rock-shaft during the operation of the apparatus.

The screen-frames are provided with indentations e^{11}, along the under side of their side bars, in which the rollers e^3 engage, so that when the screens E′ are vibrated the rollers will be prevented from rolling along the under sides of the screens, and hence the crank-arms caused to partake of the vibratory movements of the screens.

The springs F, Fig. 4, preferably consist of elastic blocks arranged upon slide-rods f, connected with the swinging frames G, which are attached to the ends of the screen-frames at the feed end of the machine. These slide-rods f are arranged to work through the end bars, a^4, of the frame, and the springs F are located upon the slide-rods f between the said end bars, a^4, and nuts which are fitted upon the outer ends of the rods. I also provide elastic cushions f', Fig. 4, on said rods at points between the screen-frames and the end bars of the main frame, in order to take up the shock when the screens are drawn back by reason of the energy of the springs F.

The frames G at the feed end of the machine each consists of a pair of vertical bars, g, Fig. 2, and a cross-bar, g', the upper frame being suspended from a rock-shaft, g^2, by means of arms g^3, secured to the rock-shaft, and pivotally connected with suitable castings at the upper ends of the bars g of the frame. The pair of these swinging bars g of the lower frame is suspended from the main frame through the medium of crank-arms g^4, which are connected with the upper ends of said bars, and also pivotally connected with the main frame of the apparatus. These frames are connected in any suitable way with the ends of the screens, which are supported by the upper set of vibratory supports, while the lower frame is similarly connected with the set of screens that are supported by the lower set of supports, whether the latter consist of rods E or crank-arms E′. The said frames are, as shown in the drawings, Fig. 2, secured to the screens by means of screws inserted through the vertical bars g and into the adjacent end cross-pieces of the screen-frames.

As a means for imparting to the several screens a short and quick forward stroke in opposition to the springs F, I provide for each of the two sets of screens a rotary cam-knocker, H, the construction of which is best illustrated in Fig. 5. These cam-knockers are secured on rotary shafts h, which are mounted at the feed end of the machine and driven by any suitable arrangement of belts or gearing. Each one of these cam-knockers consists of a wheel provided with a peripheral set of cam projections, which, during the rotation of the wheel, successively act to throw the frames G and the screens forward. These cams act against elastic cushions I, one of which is provided for each one of the frames G, whereby injury incident to the concussion between the

screens and the cams will be avoided. The cushion I is by preference composed of blocks of rawhide formed of a series of layers united together and held in a box or bearing which is attached to a cross-bar, g', of the frame G. The cross-bars g' of each frame are each provided with a box and a cushion, and are each secured to one of the two pairs of swinging bars g, which hang opposite the ends of the screens at the feed end of the machine, as hereinbefore stated. The boxes or bearings for these rawhide blocks are each conveniently constructed by attaching to a cross-bar, g', a metal hub or collar, i', formed with a set of angular arms, i^2, (preferably four in number,) which connect by screws i^3 with a set of boards arranged to constitute a box or casing for the rawhide blocks. The boards i^4 are, as best shown in Figs. 6 and 7, arranged horizontally along the outer side of a cross-bar, g', to which latter said boards are suitably bolted. Between these horizontal boards i^4, I arrange a pair of short boards or blocks, i^5, which, under the present arrangement, constitute the sides, while the longer boards i^4 constitute the top and bottom of the box. The boards i^4 and i^5 are connected by tie-rods i^6, and the block of rawhide is fitted in the box thus formed.

As a means for taking up the wear of the rawhide block, I provide within the box a follower, i^7, and an adjusting-screw, i^8, for adjusting the follower at the back of the rawhide block. During operation the cams successively act against these abutments I on the frames G, to which latter a forward impulse will be given by each cam. These swinging frames serve in turn to throw forward the screens against the resistance of the springs F, and to an extent proportionate to the height of the cams, which latter are arranged at intervals upon the wheels or disks H, so that as soon as a cam has passed the rawhide block or abutment the screens and frames will be permitted to swing back, thereby bringing the said abutments against the lowest part of the next succeeding cam. It will also be observed that the weight of a screen assists in bringing it back to its first or normal position, and that in this the position of the arms e' on rock-shafts e^2 will also be of material assistance.

In order to avoid a continued uniformity of vibration on the part of the screens, the cams are formed at irregular intervals on the wheels H. Thus, as in Fig. 5, the spaces occurring between the high points on the cams h' are somewhat less than the spaces between the high points on the cams h^2. By thus providing an apparatus having one or more sets of screens susceptible of an end shake and one or more cam-wheels, each having long and short cams or cams located at irregular intervals, the uniformity of vibration on the part of the screens will be broken up, and hence such ill results as would follow a regular and uniform vibration and jar through the machine will be avoided.

Where hangers E are employed in the apparatus, it will be found convenient, in order to permit any one or more of the screens to be readily removed from the apparatus, to provide two or more pairs of vertically-arranged lifting-rods, K, which extend down alongside the screens. These rods can be disposed so as to be susceptible of a vertical movement, and will be provided with small rollers k, arranged to be brought under the side bars of the screen-frames. These lifting-rods will work in bearings in the main frame of the apparatus, the lower ends, k', of the rods being made flat and wide, so as to slide freely in suitable grooves in the main frame and at the same time prevent the rods from turning. The upper ends of the rods should pass through slots k^2 in the top of the main frame, which arrangement will admit of a limited swing or side movement on the part of the rods, in order to enable the operator to swing the rods of a pair toward each other, and thereby bring their rollers well under the side bars of the screen-frames. Lifting-rods of such character will be each provided with a nut, k^3, formed with a convenient handle, and fitted upon the upper screw-threaded end of the rod, so that by operating said nuts the rods can be raised and lowered at will.

As shown in Fig. 3, the lifting-rods are in their lowered position, so as to maintain their rollers k below and free from contact with the screen-frames. When it is desired, however, to lift the screens from the hangers, by which latter they are suspended while in operative position, the lifting-rods can be moved sidewise, in order to bring their rollers under the screen-frames, and then raised, so as to cause their rollers to lift the screen-frames from their seats on the hangers.

Any one or more of the screens can be readily drawn over the rollers k and removed from the apparatus. These lifting-rods will, however, in practice be preferably dispensed with, since the screens can be easily drawn over the rollers on the crank-arms, which latter I propose employing in place of the hangers.

In order to permit the required extent of vibration on the part of the swinging frames G, which hang between the screens and the cam-knockers, and at the same time to close the machine at its feed end to exclude drafts of air, I close the casing at this end by a sheet, a^3, of canvas or other analogous flexible material, arranged between the screens and the swinging frames. This sheet is secured along its edges to the main frame of the apparatus, and is illustrated in Fig. 2, in which a portion of the sheet is represented as broken away for convenience of illustration.

Among the remaining features which add to the general convenience of the apparatus is some suitable construction of belt-tighteners L, for regulating the tension of the endless carrier-belts D. The construction shown is that of a pair of screws provided with bearings for the journals of each one of the set of belt-rollers

d, said screws being arranged to work in bearings *l* at the sides of the apparatus. The belt-rollers *d'* nearest the feed end of the apparatus are provided with sprockets d^2, driven by an endless chain, d^3, which is in turn driven from a shaft, M, carrying a belt-pulley, *m*.

To insure a suitable degree of friction between the belt-rollers and the carrying-belts, each roller carries at one end a cog, d^4, Fig. 1, engaging a cog, d^5, on a second roller, d^6, Fig. 4, in order to drive the same. In this way a belt passing between a pair of rotating rollers of such character will be driven with absolute certainty, and any tendency to slip on the part of the belt obviated. The shaft carrying the pulley *m* also carries a pulley for a belt, N, which also passes over a pulley, *n*, on a rotating shaft, which latter constitutes the upper one of a series of conveyer-shafts. These conveyer-shafts are provided with sprockets d^2, and are driven by an endless chain, d^3, passing over the said sprockets. The shafts carrying the cam-knockers are provided with suitable pulleys, and are connected by a chain, O, driven by a belt, O', or equivalent gear, from a main driving-shaft—such, for example, as the shaft M, provided with the belt-pulley *m*.

In order to provide for tightening or stretching the material forming the body of the screens, each end bar of a screen-frame may consist, as shown, of two parts fitted at their opposing ends in a metal box, P. In such case the end of one part of the bar will be rigidly secured in the box, and the end of the other part will fit therein to be susceptible of a limited adjustment. The length of such two-part end bar can be determined by the position of a wedge, *p*, introduced into the box between the two opposing ends of the two-part bar, and in this manner the width of the screen-frame can be adjusted as may be found necessary.

In Figs. 3 and 1ª I have shown guards Q attached to the main frame of the apparatus, and arranged to extend over the screens along their side edges. These guards serve to prevent the material from being shaken over the side edges of the screens during operation. The upper leaf of each conveyer-belt is upheld by a series of anti-friction rollers, R, and preferably a set of like rollers, *r*, will be arranged below the lower leaf of each conveyer-belt, so as to prevent it from sagging to an undesirable extent.

To prevent the endless chains d^3 from running off their allotted sprockets, I employ anti-friction rollers d^7, one set of which for one of the said chains is illustrated in Fig. 1. Below the lowest screen I arrange an inclined board, B', supported in a similar manner to the screens, and employed to catch the finest particles which have passed through all of the screens.

I claim as my invention—

1. As a means for separating the particles of comminuted ore according to their different degrees of fineness, a series of inclined shaking-screens, in combination with a series of endless carrier-belts disposed between and inclined in the same direction as the screens, and operating to carry the material passing through said screens toward the higher ends of the latter, substantially as described.

2. The series of inclined shaking-screens, in combination with a series of endless carrier-belts disposed between the screens and successively occupying from the top to the bottom of the series advanced positions with relation to the higher ends of the screens, whereby space is afforded at points back of the endless carrier-belts for the direct passage of the comminuted ore from one screen to another, substantially as and for the purpose described.

3. A series of inclined screens suspended within a casing and disposed with the higher end of the topmost screen below a feed-passage, in combination with a series of endless carrier-belts disposed between the screens and successively occupying from the top to the bottom advanced positions relatively to the point of feed, and means, substantially as described, for causing the endless carrier-belts to travel in a direction toward the feed end of the apparatus, substantially as described.

4. The series of inclined screens successively increasing in length from the top to the bottom of the series, in combination with the series of endless carrier-belts of equal length arranged between the screens and successively occupying from the top to the bottom of the series advanced positions, substantially in the manner shown, the successive advancement in the positions of the endless carrier-belts and the successive increase in the length of the screens at the delivery end of the machine being the same, substantially as set forth.

5. A series of screens, in combination with rotary cam-knockers provided with cam projections set at irregular intervals, whereby during operation a continuous uniformity of vibration in the screens is prevented, substantially as described.

6. A series of shaking-screens, in combination with a rotary cam-knocker for producing an end shake in the screens, and an upright swinging frame attached to the ends of the screen-frames and constructed to receive the impact of the knocker, substantially as described.

7. The combination, with the machine-frame and the shaking-screens, of supports for the screens, consisting of vibratory crank-arms supported upon the frame and provided with rollers upon which the screens rest, the screen-frames being provided with depressions or indentations engaging with the rollers, substantially as and for the purpose set forth.

8. The combination, with the machine frame and casing and the shaking-screens, of supports for the screens, consisting of crank-arms located within the casing and attached to and depending from rock-shafts which pass through the casing, and bearings for the said rock-

shafts upon the exterior of the casing, substantially as described.

9. The combination, with the machine-frame and shaking-screens, of crank-arms for supporting the screens, having bearings upon the main frame and provided with rollers upon which the screens rest, the screen-frames being provided with depressions or indentations upon their under surfaces engaged with the frames, and stops applied to limit the vibratory movement of the said crank-arms, substantially as and for the purpose set forth.

10. A screen-frame comprising end bars made in two parts, boxes fitted over the meeting ends of the end bars, and wedges inserted between the said meeting ends of the end bars, substantially as and for the purpose set forth.

11. The combination, with the machine-casing, the shaking-screens, and a rotary cam-knocker, of a flexible sheet interposed between the knocker and the screens and serving to close the casing at one end, substantially as described.

In testimony that I claim the foregoing as my invention I affix my signature in presence of two witnesses.

DELOS CAR-SKADEN.

Witnesses:

C. CLARENCE POOLE,

OLIVER E. PAGIN.