June 5, 1934. L. G. SYMONS 1,961,534

BAR SEPARATOR

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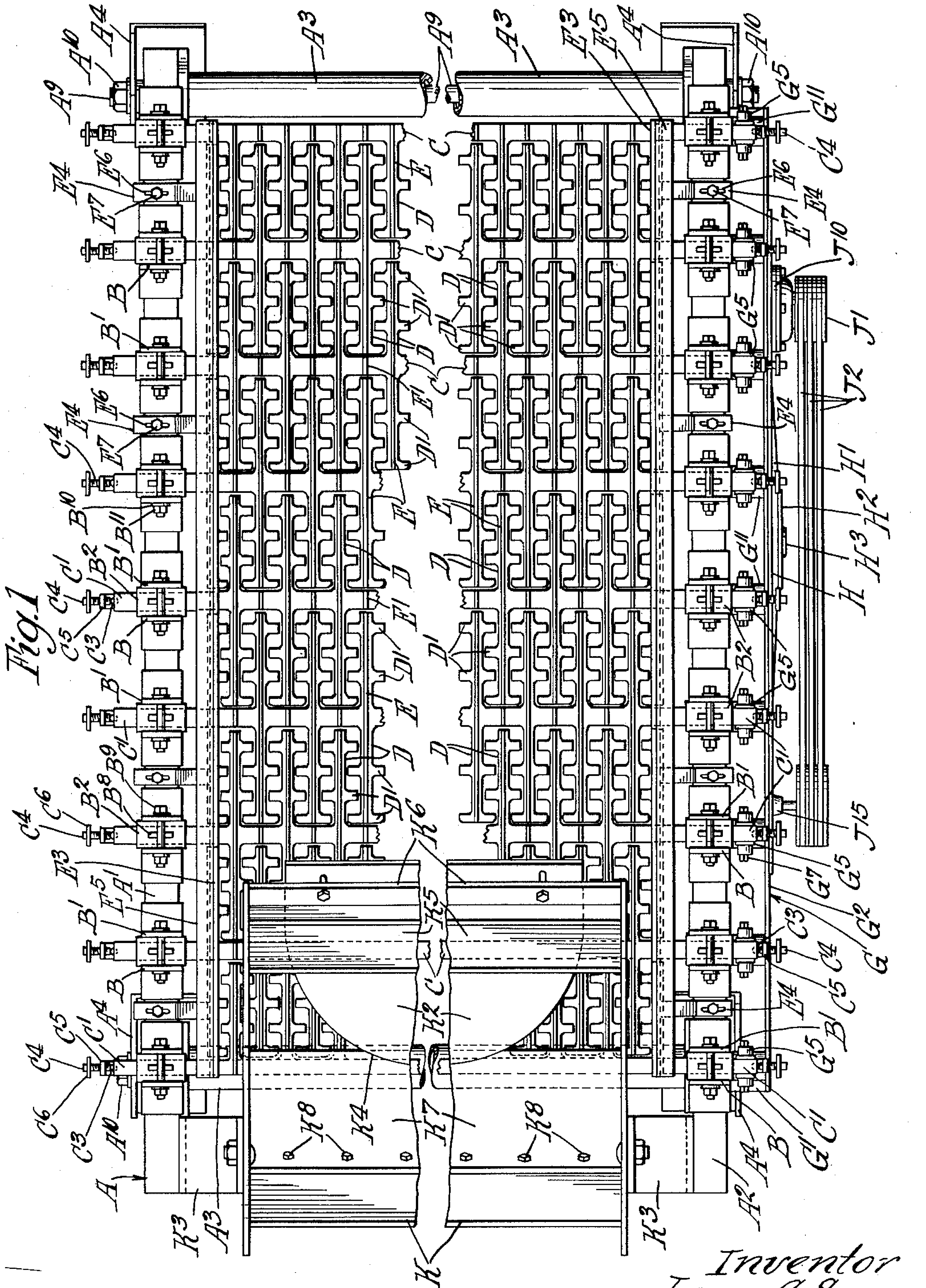

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BAR SEPARATOR

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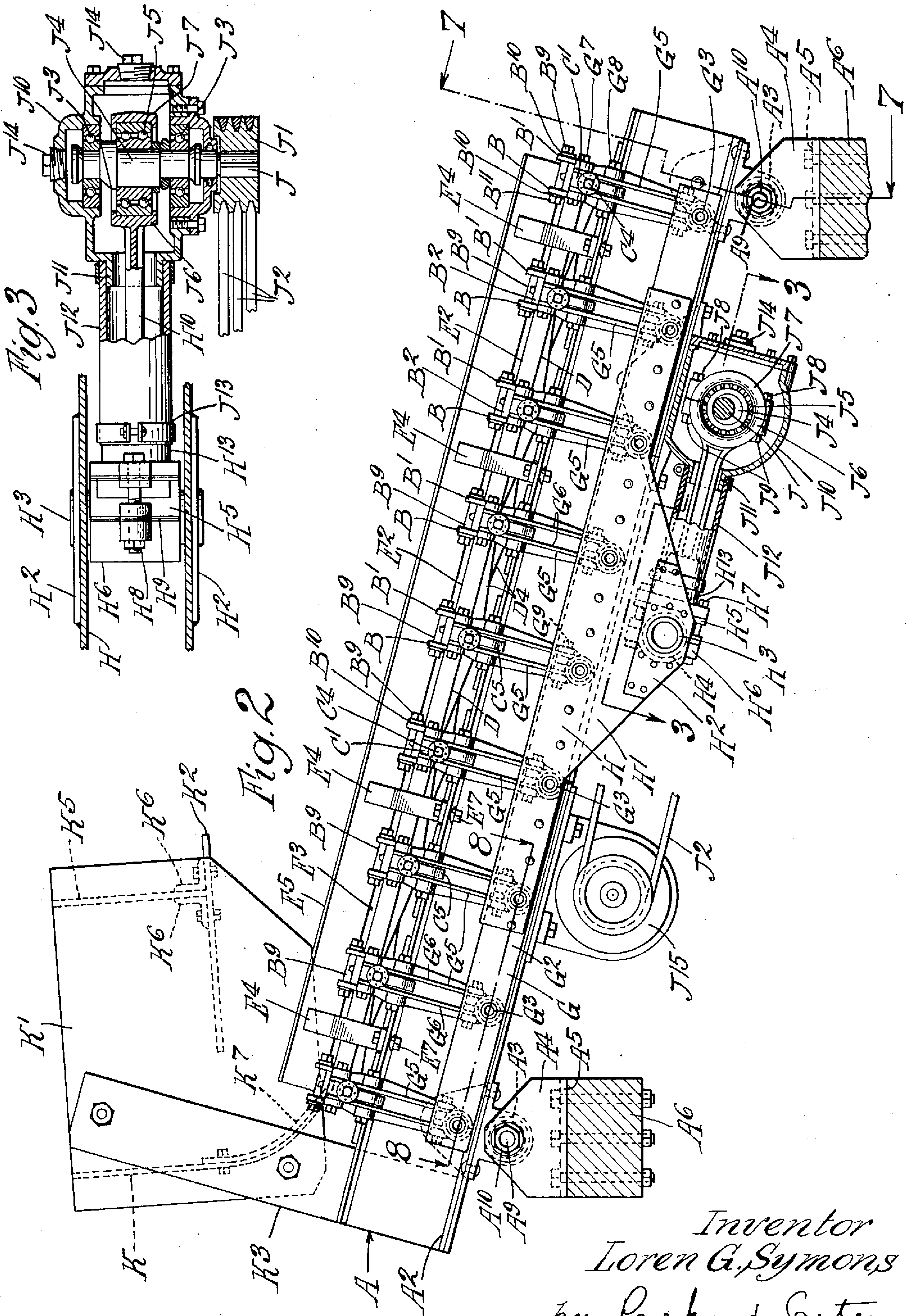

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BAR SEPARATOR

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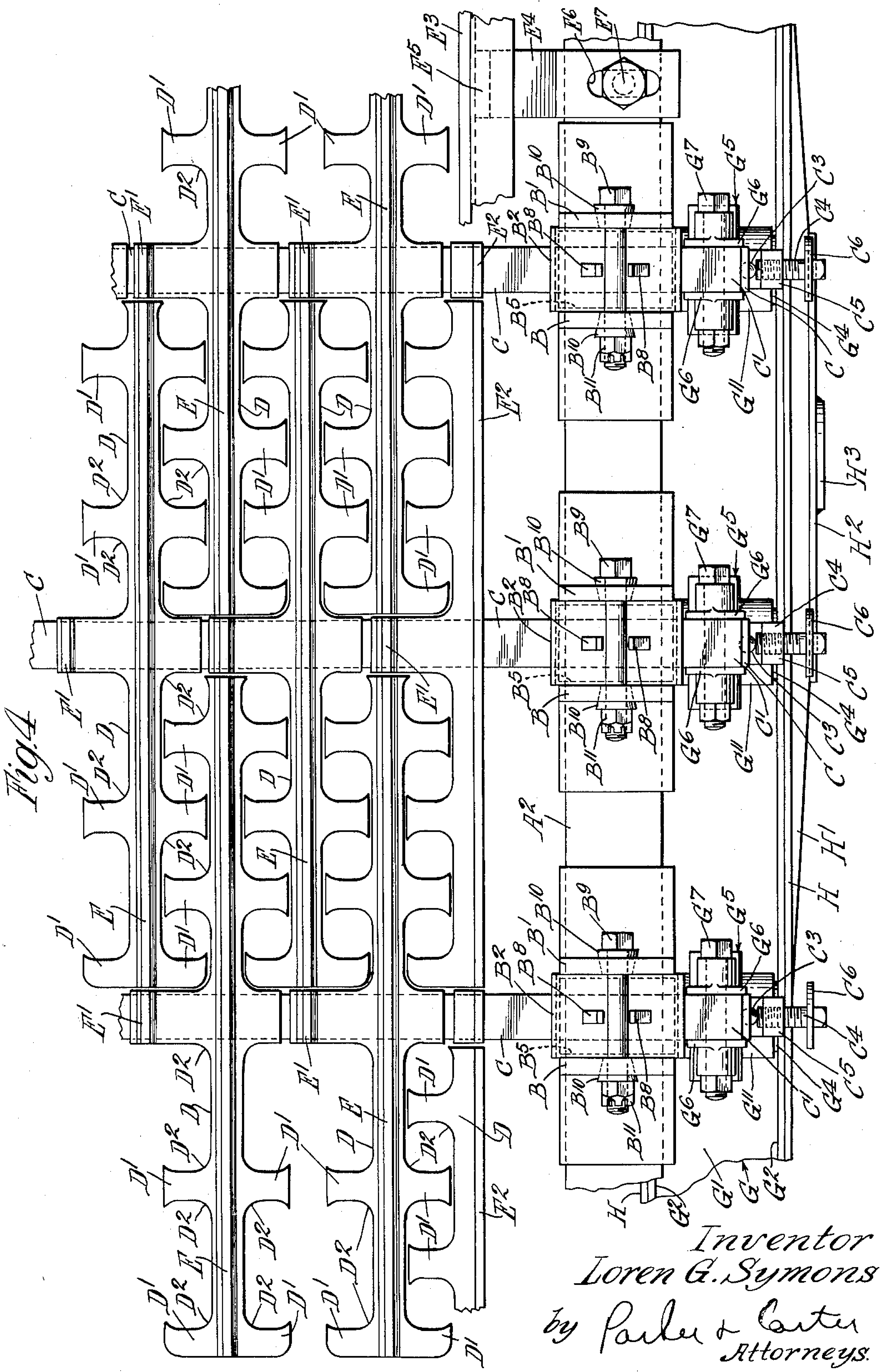

Fig. 4

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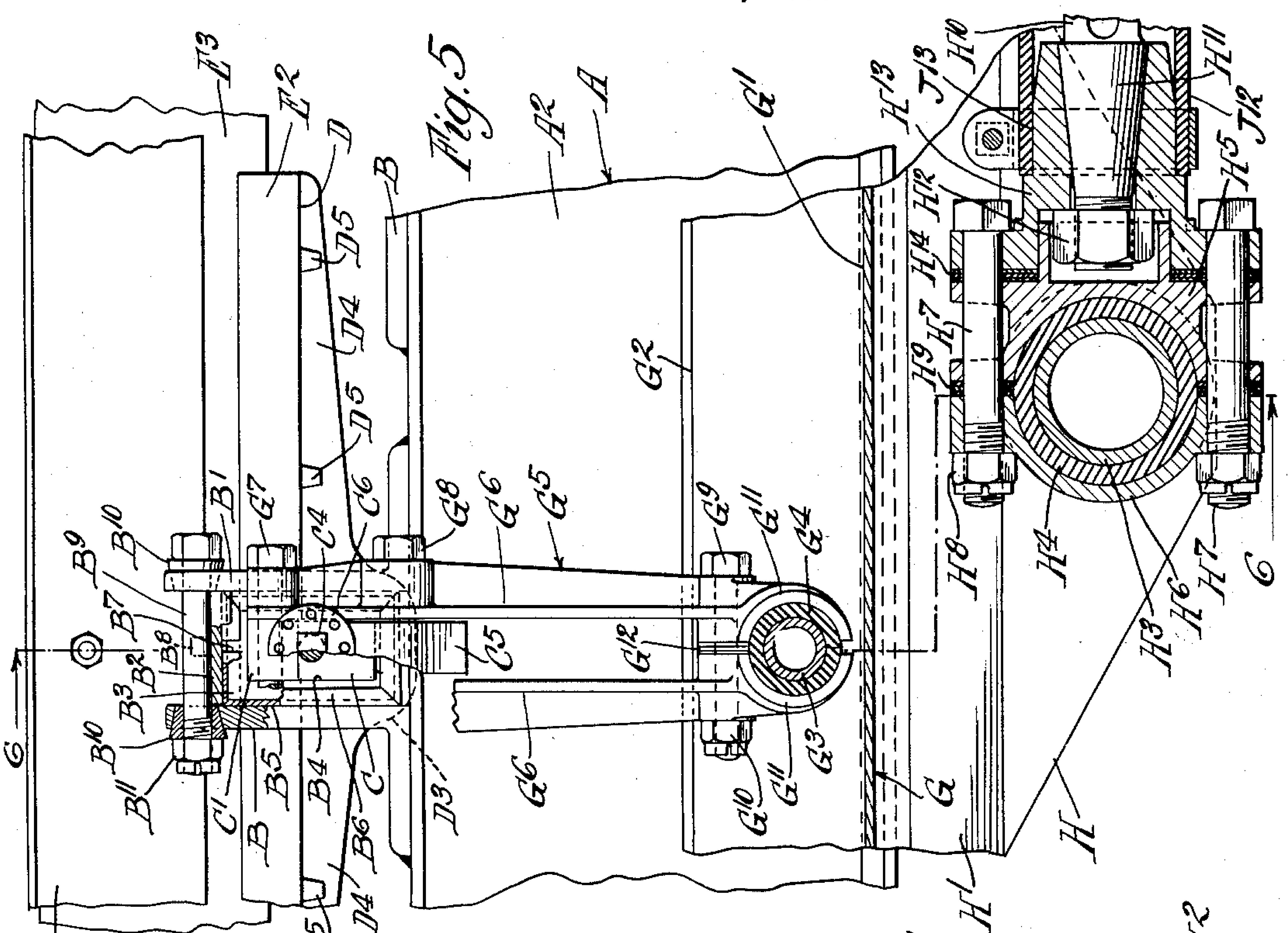

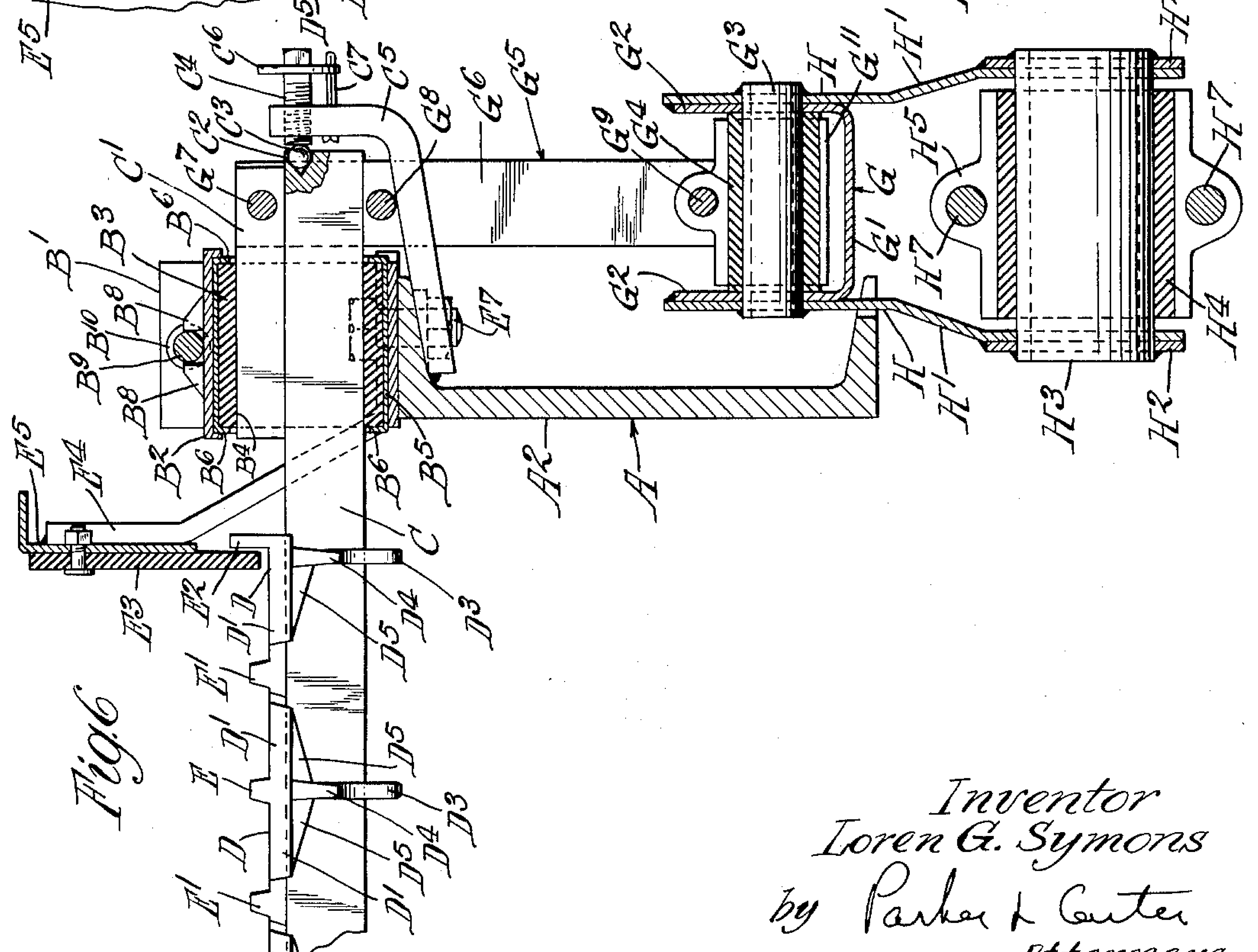

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Fig. 7

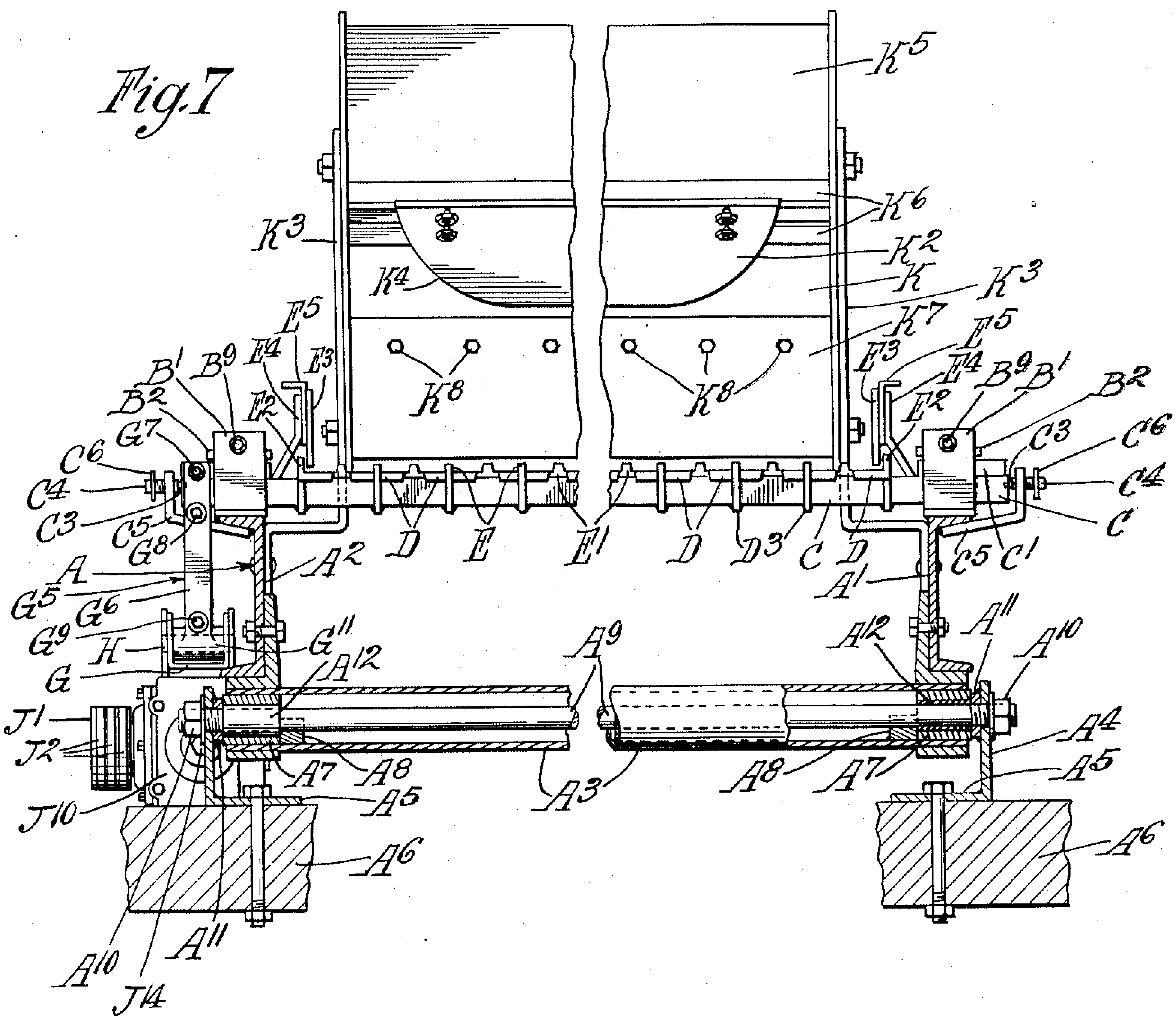

Fig. 8

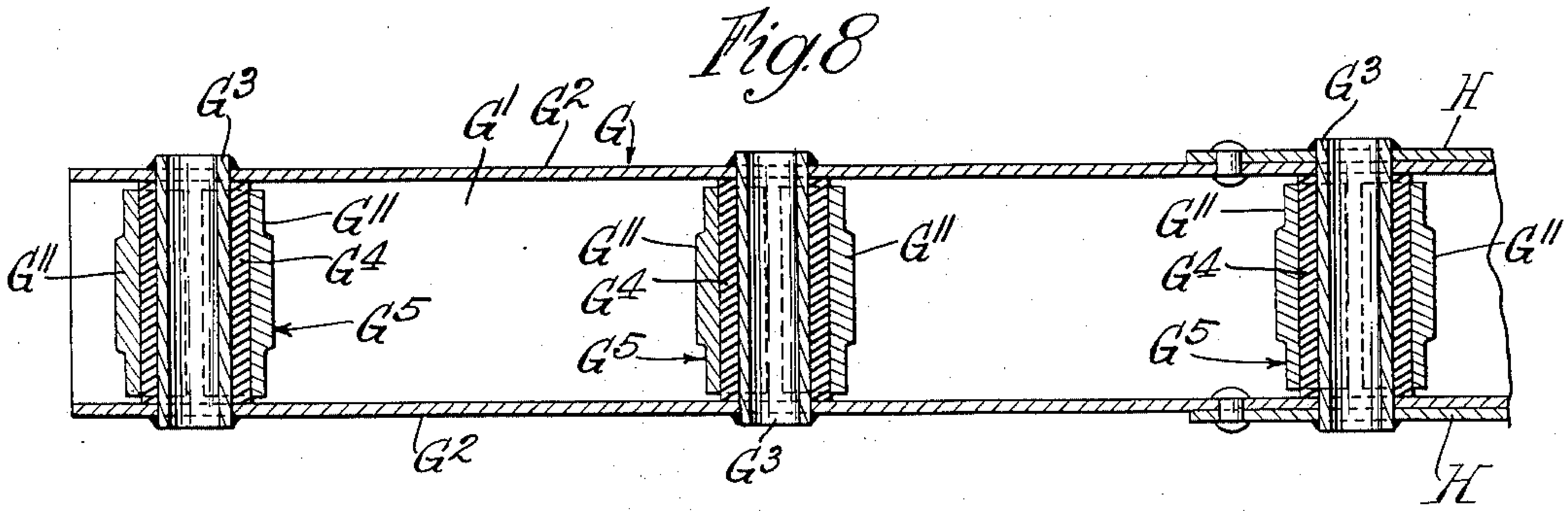

Fig. 9

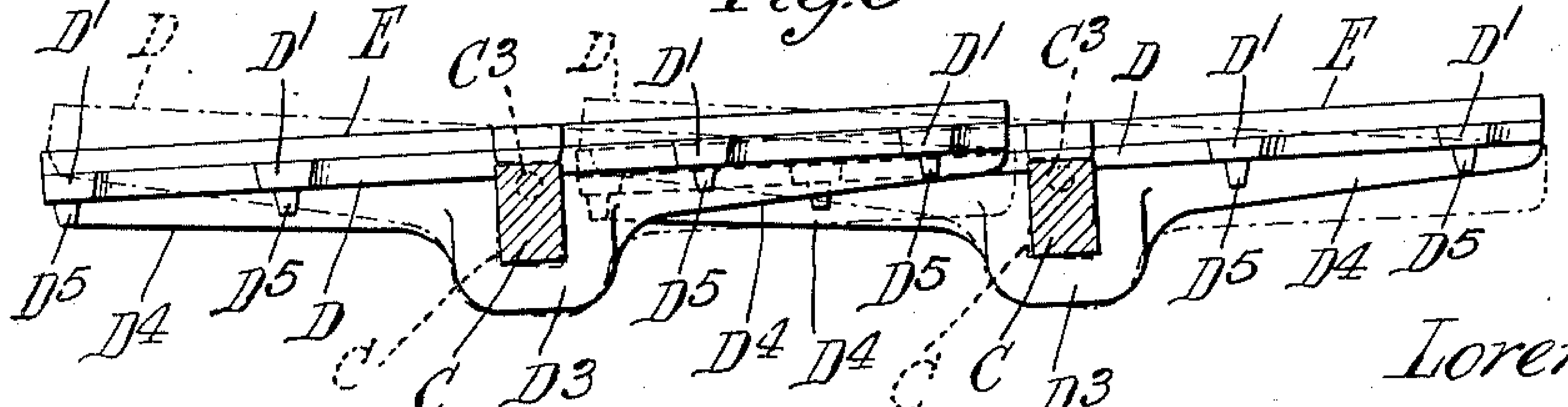

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Fig.10

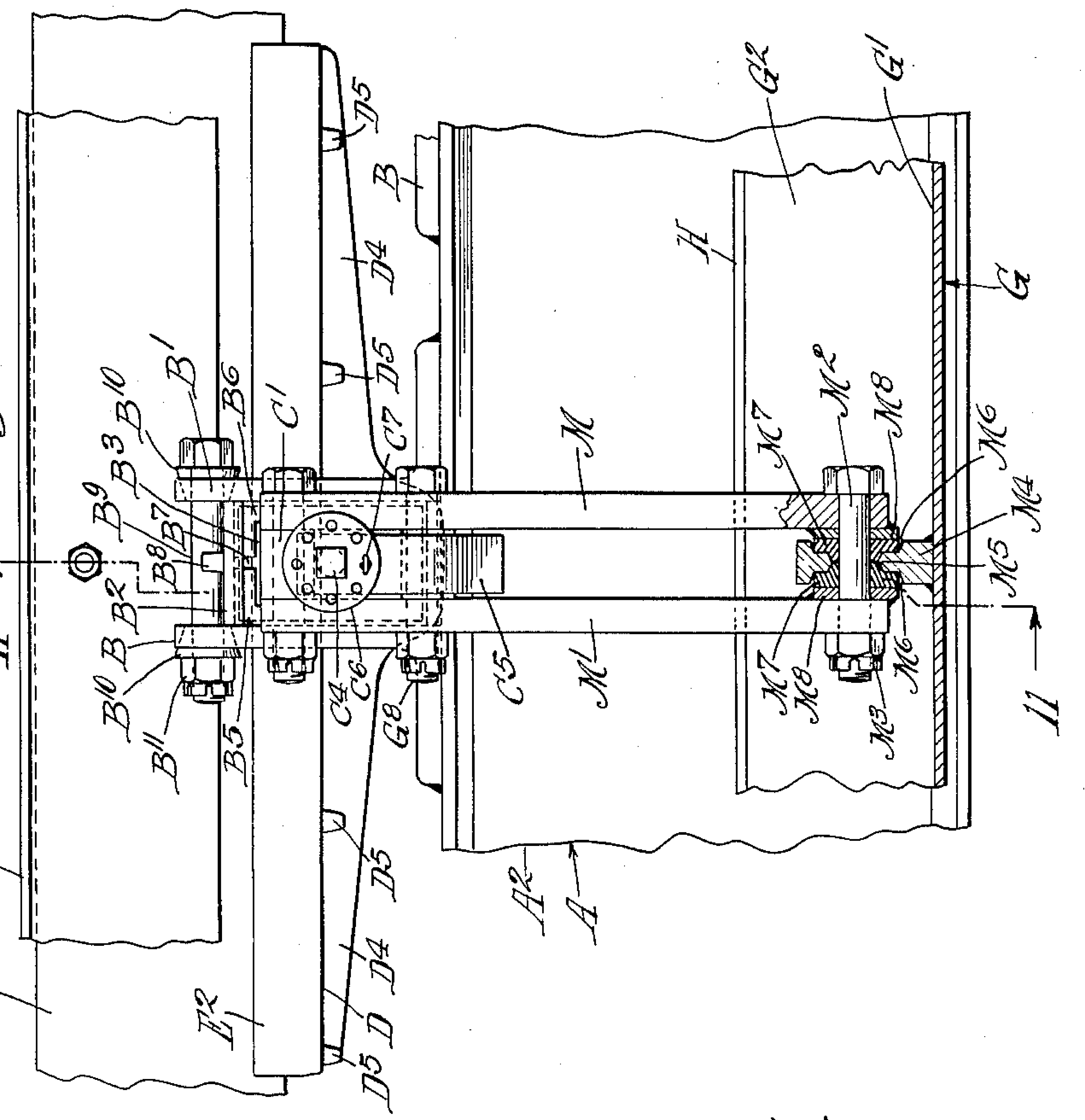
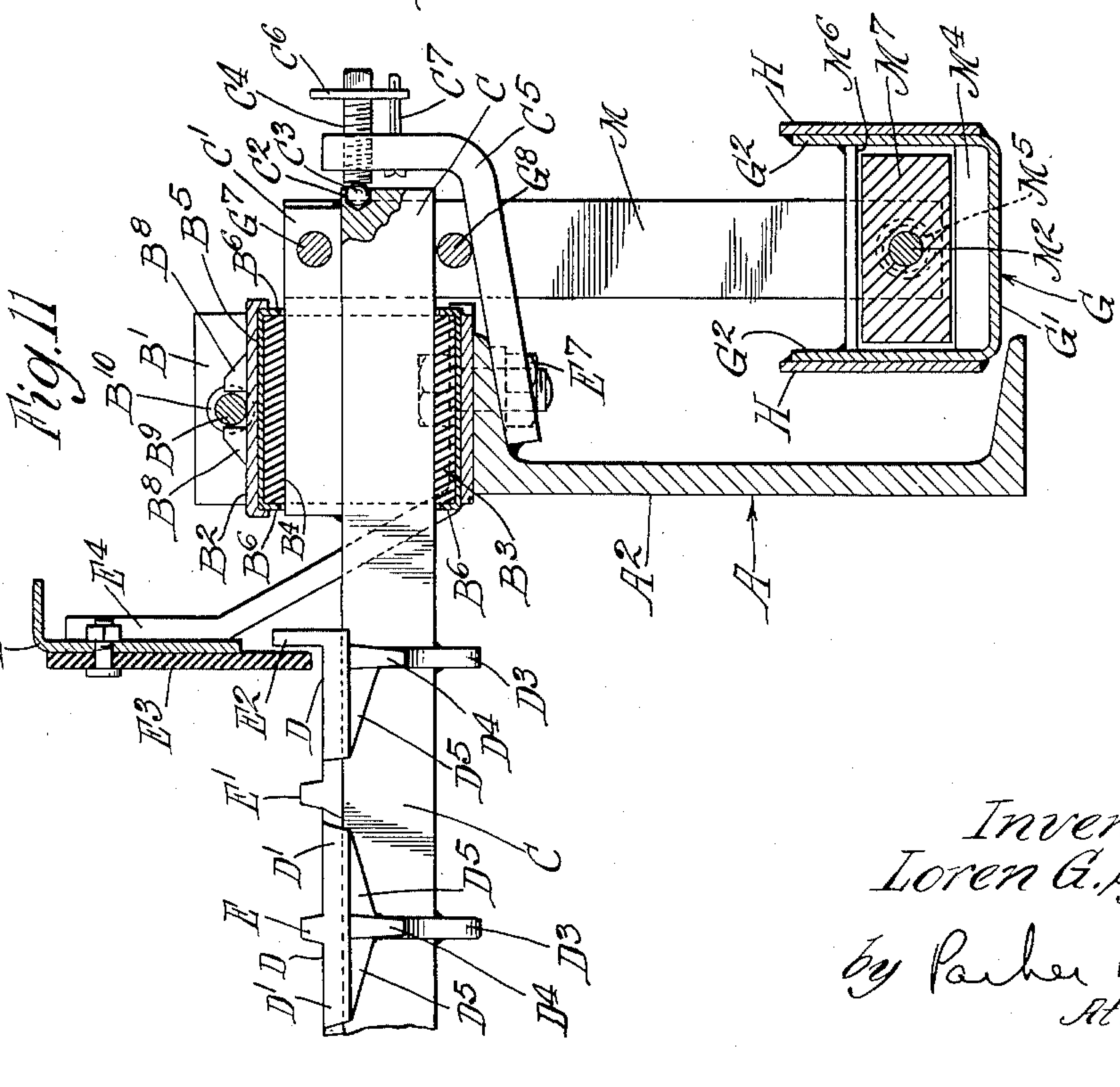


Fig.11



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Patented June 5, 1934

1,961,534

UNITED STATES PATENT OFFICE

1,961,534

BAR SEPARATOR

Loren G. Symons, Hollywood, Calif., assignor to Symons Brothers Development Company, Hollywood, Calif., a corporation of Delaware

Application November 24, 1930, Serial No. 497,726

4 Claims. (Cl. 209—396)

My invention relates to an improved apparatus for screening or separating materials. One object is the provision of an improved apparatus for separating from a mass of particles of different sizes the particles below a predetermined minimum size. Another object is the provision of a separating or screening means whereby particles of small size may be separated from the mixed mass of materials including particles of a size much larger than the size of the particles separated out. Another object is the provision of a screening or separating device which is efficient in preventing blinding of the screening apertures. Another object is the provision of a positively actuated and positively controlled separating means. Another object is the provision of a separating device of great robustness and resistance to impact of the material being separated. Other objects will appear from time to time in the course of the specification and claims.

I illustrate my invention more or less diagrammatically in the accompanying drawings, wherein—

Figure 1 is a top plan view of my invention;

Figure 2 is a side elevation with parts in section;

Figure 3 is an enlarged section on the line 3—3 of Fig. 2;

Figure 4 is an enlarged fragmentary plan view of the screen;

Figure 5 is a detailed view with parts in section and parts broken away;

Figure 6 is a section on the line 6—6 of Figure 5;

Figure 7 is a section along the line 7—7 of Figure 2;

Figure 8 is an enlarged section on the line 8—8 of Fig. 2;

Figure 9 is a diagrammatic view of the screen bars;

Figure 10 is a view similar to Figure 5 illustrating a variant form; and

Figure 11 is a section on the line 11—11 of Figure 10.

Like parts are indicated by like symbols throughout the specification and drawings.

Referring to the drawings, A generally indicates any suitable frame member, of which I show the side channel members A^1 A^2 which may be connected as by the transverse end members A^3. In order to support the frame and screen at any desired angle, I may provide supporting abutments or brackets including a vertical portion A^4 and a horizontal flange A^5 which may be bolted or secured or rest upon any suitable beam or support A^6. The end members A^3 are indicated as tubes, and positioned in each end of each said tubes is any suitable washer indicated as A^7, which may be of wood and which may be positioned, as by the spacer A^8. Passing through said bushings is a transverse rod A^9 screw-threaded at the ends to receive securing nuts A^{10}. A^{11} is any suitable boss or spacer which may be mounted or welded on the member A^4. A^{12} is any suitable sleeve about the rod A^9 and within the washers A^7. It will be understood that prior to the tightening up of the nuts A^{10}, the member A^4, with its support engaging flange A^5, may be set at any desired angle, whereby a ready adjustment of angle and support is made possible.

Mounted upon the upper flange of each channel A^1 A^2 are a plurality of boxes or housings, each formed by opposed angles B B^1, as shown for example in Figure 5, the top being closed by a cover plate B^2. Positioned within the general rectangular aperture so formed is a rectangular bushing or block B^3 of rubber which is provided with a central aperture B^4 herein shown as rectangular also. It will be clear, as from Figures 5 and 6, that both the block itself and the rectangular aperture are oblong or elongated with a long diameter generally perpendicular to the side frame member A^1 or A^2. The block B^3 is preferably surrounded by a metal covering member B^5 overturned at the sides as at B^6 to prevent any undue lateral expansion of the block B^3. The member B^5 is split and the opposed edges are spaced slightly apart as at B^7. The cover plate B^2 is provided with centering ears B^8 between which passes a securing bolt B^9, the ends of which pass through corresponding apertures in the angles B B^1, in which apertures are seated cone shaped bushings B^{10}. The assembly is drawn together as by the nut[11]. The tapered bushings B^{10} have some wedging action and serve to seat the cover plate B^2 firmly against the top of the rubber block B^3 and to maintain said block under a desired predetermined compression.

It will be understood that the blocks B^3 are arranged in parallel or in definitely spaced relation along the opposite frame members. Threaded through each opposite pair of said blocks are separating bars. Each such bar includes a central bar C, the ends of which are upwardly built up as at C^1. The end with the upwardly built up portion seats in the aperture B^4 of the rubber blocks B^3. In each end of each bar is a socket or aperture C^2 which may receive a ball C^3 opposed to an adjustable abutment C^4 in a bracket C^5, which may for example be welded to the upper flange of the channel member A^1 or A^2. The abutment C^4 is herein shown as screwthreaded in said bracket C^5 and is provided with an apertured disc C^6 through which may be passed a cotter C^7 which may penetrate the bracket C^5 and thus prevent rotation of the member C^4 and thus hold it in any desired adjusted position. It will be noted that the center of rotation or oscillation of the bar C, as generally defined by the ball C^3, is midway of top and bottom of the built up end portion of the bar.

Laterally projecting from opposite sides of each bar C are aligned arms D, the arms being provided with laterally extending fingers D^1. It will be seen as in Figure 4 that the arms D are generally perpendicular to the bars C and that the fingers D^1 are generally parallel with the bars C. The junction of arms and bars and of fingers and arms may be provided with fillets as at D^3, if desired. The upper surfaces of bars, arms and fingers are in general parallelism and are substantially below the tops of the built up portions of the ends of the bars as at C^1. In fact, the center of oscillation, as defined by the ball C^3, is adjacent or, in the particular embodiment shown, only slightly below the effective upper surface of bars, arms and fingers. If desired, the bars may be formed of a softer or less resistant material than the arms and fingers. For example, manganese steel arms may be welded to the bars, in such case the arms including a stirrup portion D^3 passing about the bottom of the bar C and joining the arms D on opposite sides of the bar. The bars may also be provided with bottom reinforcing members D^4 from which laterally extend finger reinforcing members D^5. It will be seen as from Figure 4 that the arms extending laterally from adjacent bars interpenetrate, and that the fingers of adjacent arms interpenetrate in such fashion that a pervious separating bed is provided with a plurality of apertures. In the form of the device herein shown these apertures are uniformly distributed and are of uniform size, but a slight variation in size, shape and distribution may be made in a given separating bed if necessary.

Referring for example to Figures 4 and 6 it will be seen that extending longitudinally of the separating bed, and aligned along the upper surface of the various arms, are upwardly extending ridges E. The ridge for each pair of arms extends from the end of one arm across the bar and to the end of the opposite arm. The aligned portion of the next bar is provided between its arms with a corresponding ridge portion E^1, whereby in effect a plurality of continuous ridges extend from end to end of the separating bed, having for effect to support a larger or the flatter pieces slightly above the surface of the separating bed. Along the end arms of each bar is an even higher terminal or boundary ridge E^2 within which depends a preferably flexible wall member E^3 which may be mounted on any suitable brackets or supports E^4, which in turn are secured to one of the side members A^1 or A^2. The brackets may carry a longitudinally extending plate or plates E^5 to which the flexible member E^3 may be bolted or otherwise secured. The brackets E^4 may be adjusted as by the slots E^6 through which pass any suitable securing members E^7. On the end bars of the bed, as shown in Figure 1, only inwardly projecting fingers need be used, so that the ends of the bed are actually defined by bars and not by outwardly projecting fingers.

In order to impart to the bars an oscillating movement, I provide a longitudinal rocker arm extending along one or both sides of the separating bed. I illustrate it herein only along one side of the bed as in normal use a single rocker arm is sufficient, but it will be understood that if necessary a corresponding and substantially identical arm may be positioned along the opposite side of the bed. I illustrate for example an arm including a channel G having a bottom portion G^1 and upwardly extending side portions or flanges G^2. Extending across said arm between the side flanges G^2 are a plurality of tubes or cylinders G^3, one for each bar to be oscillated. Surrounding each said cylinder G^3 is a bushing G^4 preferably of rubber or some suitable yielding material. Clamped about said bushing and connecting it with the corresponding bar to be oscillated is an arm generally indicated as G^5 which includes opposite parts G^6 G^6, such parts being clamped or secured together about the outwardly extending enlarged portion of the shaft and about said bushing. To connect the members G^6 to the bar, I may provide an upper securing bolt G^7 which passes through the enlarged end portion of the bar, and lower securing bolts G^8 which pass beneath it. At the lower end of the members G^6 I may provide a single securing bolt G^9 with its securing nut G^{10} which draws together about the bushing G^4 the arcuate clamping elements G^{11}. It will be understood that the pressure upon the bushing G^4 may be varied or adjusted, as by varying the thickness of number of the shims G^{12} as shown in Figure 5. It will be understood that the parts are so drawn up or secured that the rubber bushing G^4 is held against rotation to the cylinder G^3 and is also held against rotation in relation to the surrounding members G^{11} of the arm G^5. In other words, relative movement of the parts causing internal torsion of the rubber and relative rotation or movement of opposed abutting surfaces of rubber and metal.

In order to move the bar G as a whole, I provide the below described connection, namely a bar of opposed and generally triangular plates H H which depend from the bar G as shown in Figures 2 and 6. These plates are laterally outwardly inclined somewhat as at H^1 H^1 and may be reinforced at their lower portion as at H^2 to receive the tube or cylinder H^3. This cylinder in turn has about it the rubber bushing H^4 about which are clamped the opposed arcuate stirrups H^5 H^6 at the end of an actuating eccentric arm below described. H^7 are any suitable bolts with the nuts H^8, whereby the pressure about the bushing H^4 may be adjusted, as for example through the shims H^9. The structure above described may be seated upon the tapered end H^{11} of the eccentric arm H^{10}, to which it may be secured as by the nut H^{12}. It will be noted that the nut H^{12}, is mounted with a separate member H^{13} through which pass the ends of the bolts H^7 and which abuts against the member H^5, being separated from it for example by additional adjusting shims H^{14}.

In order to actuate the eccentric arm H^{10}, I provide a shaft J which may be rotated for example by a pulley J^1 through the belt drive J^2. The shaft J rotates for example in the roller or ball bearings J^3 J^3 at opposite ends thereof, and is provided with the central offset or central portion J^4. Surrounding said portion J^4 is a roller or ball bearing structure J^5, the outer race of which is surrounded by an eye or sleeve formed of the arcuated enlarged inner end J^6 of the eccentric arm H^{10} and a corresponding arcuate portion J^7 which may be secured thereto as by the bolts J^8 and their securing nuts J^9. J^{10} indicates a housing structure surrounding said shaft, their connection end terminating in a sleeve or nipple J^{11} about which is secured a flexible member J^{12}, for example rubber hose, the outer end of which may be secured as at J^{13} about the member H^{13}. A lubricant may be supplied to the interior as through the closure J^{14}. J^{15} is any suitable motor means whereby through the belts J^2 the eccentric shaft may be rotated.

Referring for example to Figure 2, it will be seen that normally the bed is set at an angle and metal is delivered to the upper end thereof. I may provide for example any suitable feeding spout including the curved plate K, the side walls K^1 associated therewith, the generally horizontal limiting flange or plate K^2, and the bracket structure K^3 to which the feeding structure is secured. The plate K^2 may have an arcuate boundary, as shown for example at K^4 in Figure 1, and may be adjustably mounted in relation to a forward vertical member K^5, as by the securing members K^6. The bottom portion of the plate K may be covered by a flexible strip K^7, which may extend downwardly over the upper end or edge of the separating bed. The strip K^7 may be attached to the plate K as by bolts K^8 or any suitable securing means for said flexible strip whereby it may be removed and renewed.

Referring to Figures 10 and 11 I illustrate a variant form of connection between the rocker arm or bar or channel G and the individual separating bars C. For example, I illustrate a pair of flat arms M, M^1 which are secured at their upper ends, as by the bolts G^7 and G^8, in relation to the terminal extension C^1 of each bar C. These members M M^1 are connected at their lower ends, as by the bolt M^2 with its nut M^3. The bolt passes through the member M^4, of metal or the like, which may be welded within the channel G. The member M^4 is apertured as at M^5, and it is through this aperture that the bolt M^2 passes. At each face of the member M^4 there is a surface enlargement of the aperture M^5, as at M^6. These depressions M^6 may extend all the way across the member M^4. Seated in each depression is a yielding member M^7 the members M^7 meeting, if desired, within the aperture M^5. These flexible pressure members are engaged by correspondingly shaped pressure plates M^8 secured to each of the members M M^1. It will be understood that the above assembly provides a flexible connection between the arm formed by the members M and M^1 and the rocker G, and thus a flexible rocking connection for the individual bars C, whereby the desired rocking or oscillation may be unitarily imparted to the entire series of arms.

It will be realized that whereas I have described and shown a practical and operative means for carrying out my invention, that nevertheless many changes in size, shape, number and disposition of parts may be made, and that my process may be carried out with a variety of different structures. I wish my description and drawings to be taken, therefore, as in a broad sense diagrammatic or illustrative, rather than as limiting me to my precise showing herein.

The use and operation of my invention are as follows:

I maintain a separating bed or zone of separation wherein opposed bounding walls of individual screening apertures are given a positively controlled and limited differential movement, along lines or directions generally perpendicular to the plane of the bed or zone. I maintain a movement of relatively short excursion and of relatively high velocity, my experience being that a slow movement and a long travel causes grinding rather than clean cut separating or screening. When I employ a short travel and high frequency, the particles are not ground, but either pass through the apertures or are else kicked out. A particle may not go through an aperture unless it is small enough to fall freely through the aperture. If it barely fits an aperture, in such a way that grinding will result, it is immediately kicked out and goes on to try the next hole and, if even slightly oversize, passes entirely across the separating zone.

The zone is formed by a series of screen bars having interpenetrating arms and fingers, as herein shown. Each individual bar is oscillated about a pivot or axis, all the bars being oscillated in a like rotational direction. The result is that the opposed arms and fingers of adjacent bars are continually moving in opposite directions, except at the time of the dead points of change of direction. Also, while the arc of travel of each arm increases outwardly from its central rotation, the relation between the opposed walls of adjacent arms and fingers of different bars is always the same because the maximum travel at the end of one bar takes place adjacent the minimum travel of the adjacent bar or arm, and the relative movement between opposed sides of the individual apertures is uniform.

When I wish to separate material having particles with a wide range in size, for example when a mass of larger particles or fragments, mixed with fines, is to be separated, a large particle, for example, a flat fragment, if it slides along the surface of the bed, might temporarily blind many of the apertures. I therefore provide means for spacing these excess oversize particles upwardly away from the screen surface. Hence the ridges E, E^1 which extend longitudinally from end to end of the separating bed and which project upwardly above the normal surface of the tops of bars, arms and fingers. These ridges carry the big particles as they travel along the screen and space them upwardly away from the screen openings so that the small particles which sift down to the bottom of the mixed mass are screened out or separated without even a temporary blinding of the separating apertures.

Conventional screening, with a screen body vibrated as a unit, raises and lowers the entire sheet of material being screened, causing the entire mass to travel by jerks. In my present separating bed the upward propelling force is not directed against the entire mass simultaneously, but against individual particles, or individual groups of particles. As a result, something of the effect of an air separator is obtained, and it is unnecessary bodily to displace the entire mass. As the arms and fingers on one side of each rod rise, the arms and fingers on the opposite side drop. The very coarse material being, in effect, screened out by the above mentioned ridges, the fines have free access to the separating apertures, and pass therethrough. As a result a very complete segregation of the fines from a body of particles of mixed sizes may take place without a preliminary coarse screening and without preliminary separation or removal of the larger particles. In effect the result both of a bar grizzly and of an attendant or following screen is obtained and my bed or zone of separation maintains in effect two separate screening planes, both in the same material bed or zone of separation and both carried by and oscillated by the same supporting and actuating mechanism. For example, in feeding mixed materials to a cone crusher, it may be desirable to crush particles of diameters as high as nine inches or more. Assume that such materials have to be crushed to a size say of one inch, but are accompanied by a substantial volume of particles already reduced to a size of one inch or less. I may pass the mixed materials over a separating bed the diameters of the apertures of which are, say, one inch. These apertures will permit the undersized material to escape, while all material above one inch will pass over the separating bed, and may be conveyed to the crusher. Not only will my separating bed screen out the fines, but it will support the impact and weight of the large boulders from which the fines are separated. I may freely feed heavy jagged rocks to my bed, and separate the fines. I may, for example, employ bars of manganese steel, which bars will efficiently resist deformation or breakage, and which will have a long life of wear. If ordinary screen cloth were employed, the heavy jagged boulders would quickly batter the mesh to pieces.

Conventional screening with a screen body vibrating as a unit raises and lowers the entire sheet of material being screened, causing the entire mass to travel by jerks. This screen directs the upward propelling force not against the entire mass simultaneously but against individual particles of the mass or against small groups so as to produce in effect much the same kind of sheet movement that you find on an air separator, making it unnecessary to bodily displace the entire mass but only throwing individual particles in a relatively restricted area at one time away from the screen plane.

Stating one of the above a little differently, I employ a screening bed which consists of interpenetrating bars or fingers. The bed elements include spacing means, in the form of longitudinal ridges, for spacing particles too big to pass through the apertures and big enough to bridge or blind them, upwardly away from the effective surface of the bed. In effect these ridges perform the function of a separate coarse screen or bar grizzly and a double function, screening out the very coarse material from the mass, and separating out the fine material from the mass is performed by one separating bed. This is particularly important when the screen is to be used in a space restricted as to height, where it is inconvenient or impossible to superpose two or more screens.

I have in effect a combined screening zone in a single bed of material, having two separate screening planes both in the same material bed and both carried by the same screen and so disposed that impact is imparted by both screening planes one on the larger particles and one on the smaller particles, to provide in a continuous bed of flowing material coarse separation and fine separation, the coarse and fine separation plane being located one above the other. In effect the coarsest material, the material of a diameter greater than the distance between the adjacent ridges is excluded from the effective separating portion actually defined by the apertures between adjacent fingers. The smaller part of the mass is screened and the larger particles of the mass are spaced away from that part of the bed where the actual screening or separation of the fines is taking place.

In connection with the structure employed, I provide practically unbreakable means for not only spacing the larger particles away from the separation zone of the bed, but from preventing them from damaging the separating members. The manganese steel bars and fingers are as effective as or more effective in separation than screen cloth, and can resist the punishment of large boulders in the way in which screen cloth cannot.

Referring to the action on the particles of the manganese steel arms and fingers, consider the tilt of the screen and also the pressure against the individual particles of the stream of material flowing across the zone of separation. An individual particle may for example penetrate an aperture. In the main such a particle will be thrown upwardly out of the aperture if it cannot go through it. Some particles of a particular size, particularly long and thin particles, may not be so thrown. For example if a bolt penetrates an aperture in the screen, as an extreme example of an elongated unscreenable member or a member which cannot pass through the aperture, this bolt will none the less work upwardly out of the aperture, in response to a species of ratchet action. In the operation of the screen when one side of an aperture is going up the opposite side is going down. When the lower side of the aperture is rising the slope of the screen and also the pressure of material, tend to hold the particular particle in contact with the upwardly rising side, with the result that it is lifted or thrown upwardly. On the other hand when the downward side descends and the upward side rises, the tendency of the slope and the pressure of material is to cause the particle to topple over the downward side instead of merely rising with the upward side. In practice even a long bolt will thus rise in or be lifted out of an aperture in the screen, and in the course of one or two movements of the individual bar the aperture is freed from the blinding oversized particle.

While some degree of inclination is necessary in order to maintain a flow of material across the separating zone, I find that a relatively slight angle, such as from 8 to 12 degrees is satisfactory.

It is characteristic of my device that I maintain a yielding connection between the individual bars and the frame, and between the vibrating levers of the individual bars and the rock shaft. It is also characteristic that the yielding connections tend to return all the parts, including the bars and the rocker arm, to a predetermined neutral position, which is preferably that position in which the bars, with their interpenetrating arms and fingers, lie generally in the normal plane of the upper portion of the separating bed.

In the separating process in which my apparatus is employed, I set the screen at a substantially lower angle than is customary with prior art vibrating screens. I can do this since the vibration of the bars lifts the material out of the holes by the speed of the moving members. The slope of the screen assists in gravital travel along the screen. The bars and arms flip the stones up and then snap back or jump out from under the stones or particles. The pressure of the material down the slope tends to push the individual particles over or beyond the particular member which has just dropped out beneath it. For example, as an individual particle is lifted out of one hold by the snap action of the vibrated arm, it topples over into the next hole. It may take several strokes to lift a given piece out of a given aperture. It should be kept in mind that while the individual particles are lifted or flipped up by the vibration of the individual arms and bars and fingers, the screen as a body is not moved, and therefore it is not necessary to lift bodily the large weight of material which is passing over it. In fact one side of each aperture is descending while an opposite side is ascending. A critical factor in practice is the employment of a rate or speed of vibration sufficient to cause the fingers and arms to leave the material when they start on their downward excursion. In other words, the vibration is through such an amplitude and at such a rate or speed that when a given finger has lifted a piece or given an upward impulse to a piece, it leaves that piece on the down stroke, and the piece is not supported by a descending finger or arm. The speed of downward movement of the finger or arm is greater than the speed imparted to the dropping particle by gravity.

In the bar separator, as the bars C are oscillated in the yielding bars B^3 the torsion of the rubber effects a cushioning action and the compression tends to cause a snappy or quick return of the bar to initial position. This torsion action in practice reduces the power necessary to actuate the device and in effect a pendulum action is obtained. The device takes more power to get speed than if the bars were mounted in rotary or anti-frictional bearings, but the device runs longer after power is cut off and also ceases or stops the jerk and pull on the eccentric drive, and trims off the peak load, permitting the use of actually lower power.

I claim:

1. In a separating mechanism, a separating bed, and means for feeding thereacross the material to be separated, said bed including a plurality of transverse generally horizontal bars extending across the path of the material being separated, and means for imparting a rotary oscillation to the bars of uniform direction and amplitude, each such bar including laterally extending arms and fingers laterally extending from said arms, the arms and fingers of adjacent bars interpenetrating to form separating apertures.

2. In a separating mechanism, a separating bed, and means for feeding thereacross the material to be separated, said bed including a plurality of transverse generally horizontal bars extending across the path of the material being separated, said bars being mounted for rotary oscillation about generally horizontal axes transverse to said path, and means for imparting a rotary oscillation to the bars of uniform direction and amplitude, each such bar including laterally extending interpenetrating portions adapted to form separating apertures, and guiding means upwardly extending from said bars and interpenetrating portions and extending upwardly above the normal level of the bed defined by the upper surfaces of said bars and interpenetrating portions, said guiding means being adapted to guide material into alignment with the screen apertures, the screen apertures being aligned longitudinally along the separating mechanism, in general parallelism with the path of movement along the separating bed.

3. In a separating mechanism, a separating bed, and means for feeding thereacross the material to be separated, said bed including a plurality of transverse generally horizontal bars extending across the path of the material being separated, said bars being mounted for rotary oscillation about generally horizontal axes transverse to said path, and means for imparting a rotary oscillation to the bars of uniform direction and amplitude, each such bar including laterally extending interpenetrating portions adapted to form separating apertures, and means, associated with each bar, tending normally to return each such bar to a predetermined neutral position in which the upper face of the bars and interpenetrating portions lie in parallelism with the general plane of the separating bed.

4. In a separating mechanism, a separating bed, and means for feeding thereacross the material to be separated, said bed including a plurality of transverse generally horizontal bars extending across the path of the material being separated, said bars being mounted for rotary oscillation about generally horizontal axes transverse to said path, and means for imparting a rotary oscillation to the bars of uniform direction and amplitude, each such bar including laterally extending interpenetrating portions adapted to form separating apertures, and means, associated with each bar, tending normally to return each such bar to a predetermined neutral position in which the upper face of the bars and interpenetrating portions lie in parallelism with the general plane of the separating bed, such means including torsionally deformable connections for each end of each bar.

LOREN G. SYMONS.