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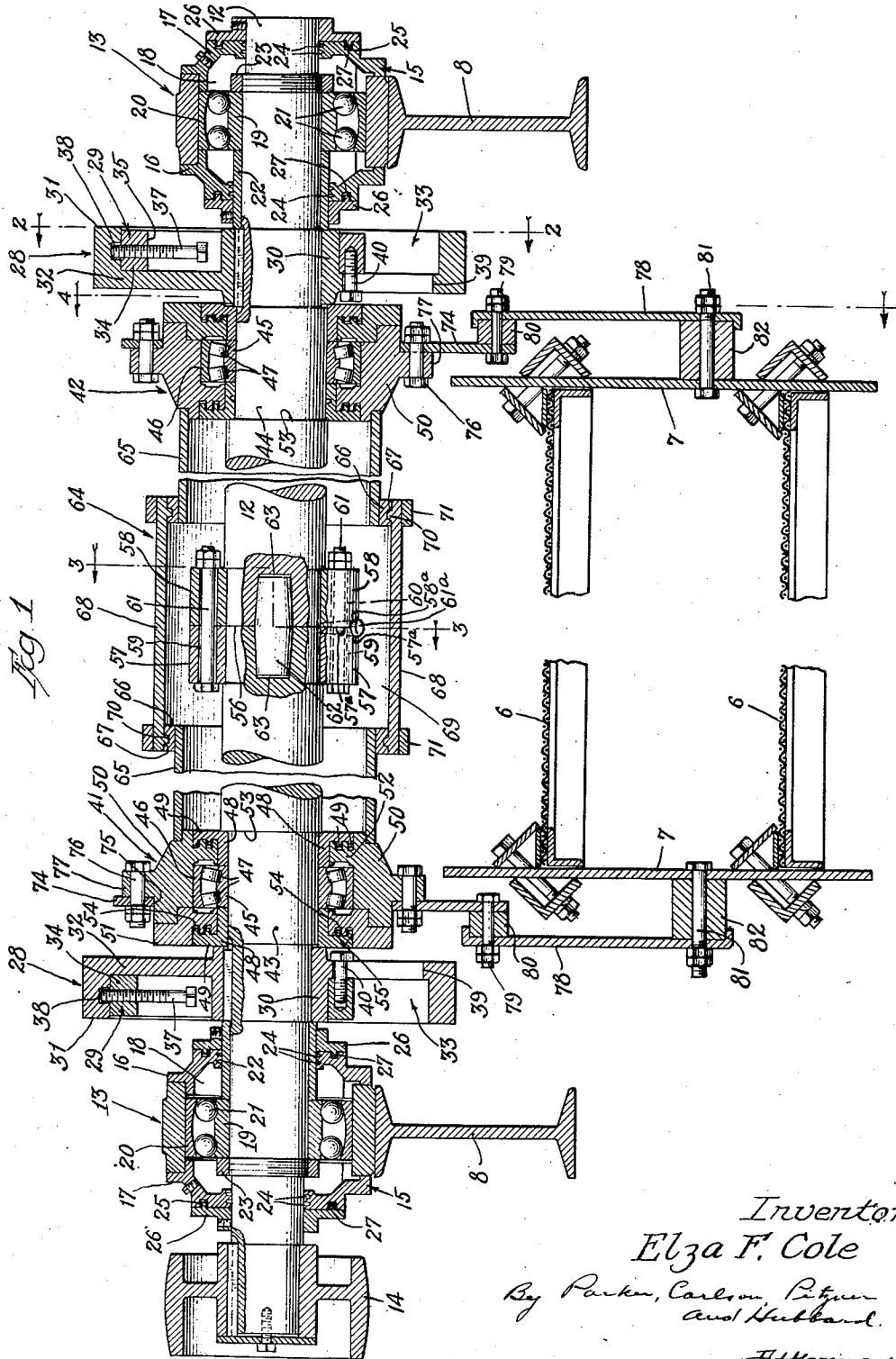
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MEANS FOR PRODUCING COMPOUND MOTION

Filed Aug. 3, 1936

3 Sheets-Sheet 1



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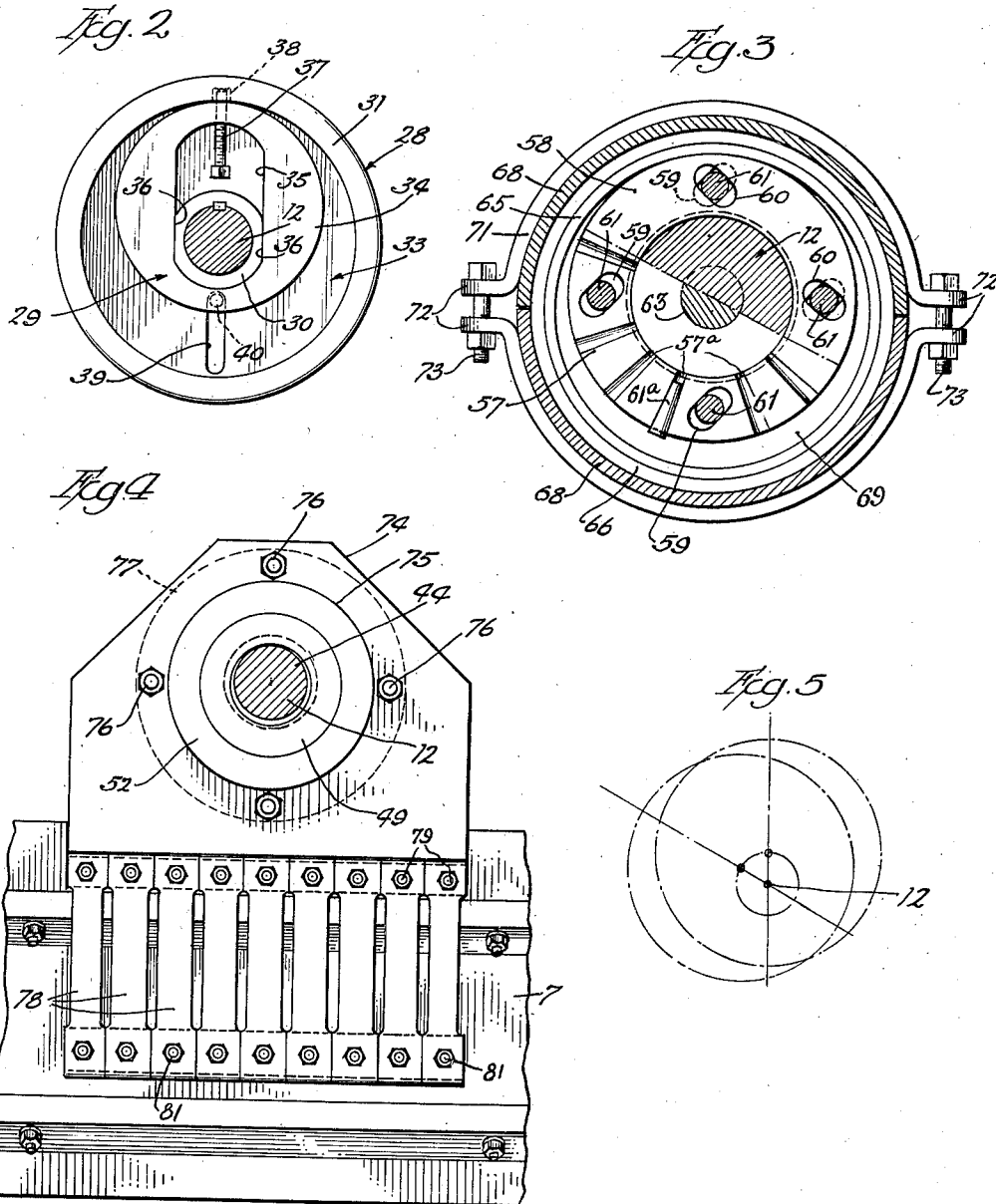
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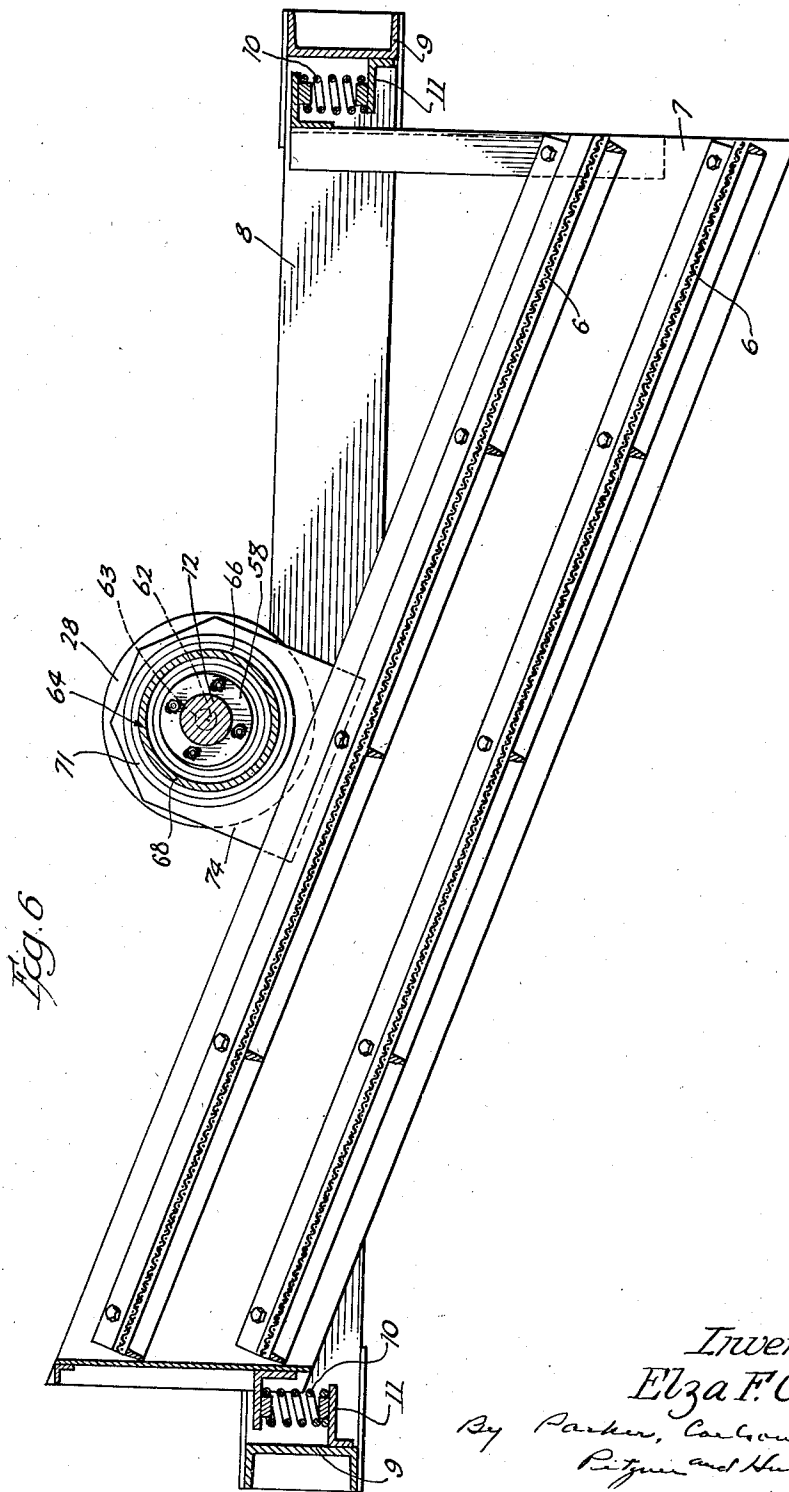
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UNITED STATES PATENT OFFICE

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MEANS FOR PRODUCING COMPOUND
MOTION

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1 Claim. (Cl. 209—326)

The present invention relates to a new and improved method of and means for producing compound motion adapted particularly for utilization in various types and kinds of processing equipment or apparatus requiring a reciprocatory, vibratory, sifting or riddling action.

One of the primary objects of the present invention resides in the provision of a novel compound motion having components in a plurality of angularly related planes. Heretofore, devices for actuating processing equipment of the above character have been capable of producing motion only in a single plane. In some instances, the plane of motion has been parallel to the processing surfaces, and in other instances it has been perpendicular thereto. Also, the motion in the perpendicular plane has been either substantially perpendicular or of varying angularity, as for example orbital, relative to the processing surface. In these prior devices, the plane motion, whether rectilinear or orbital, tends to impart to the material being processed a simple regularity in action which in most instances is disadvantageous and objectionable. Thus, in the screening and filtering arts, regularity in action contributes towards blinding, and tends to maintain the grouped particles of the material in a constant relative association. When the material is fibrous or grained in character, regularity in action tends to effect an alignment or uni-directional orientation of the particles, and as a result the finished product is likely to be grained and to lack tensile strength in certain directions. Also, resistance to compressive forces is defined uni-directionally. By providing a compound motion, regularity in the action on the material, and the attendant disadvantages are effectively avoided.

Another object is to provide a new and improved compound motion device comprising two throw elements, such, for example, as eccentrics, which are operable out of phase from a common drive to impart to a processing apparatus two simultaneous components of vibration in different planes.

A more specific object resides in the provision of a novel compound motion device adapted to actuate a vibrating processing apparatus, and comprising a shaft having two axially spaced eccentrics in different angular positions, each eccentric normally acting to impart to the apparatus an orbital motion in a plane perpendicular to the shaft, and the two eccentrics by reason of their staggered relation coacting to impart to the apparatus a gyratory motion, whereby a vibratory

motion in a plane parallel to the shaft is also obtained.

Another object is to provide a sectional shaft having relatively rotatably adjustable sections for the eccentrics so that the phase relation of the latter may be adjusted at will.

A further object is to provide a compound motion device of the foregoing character which is balanced, and which more particularly has novel adjustable balance wheels for offsetting or counteracting the forces of inertia set up by the eccentrics.

Various general objects reside in the provision of a novel compound motion device which is simple, inexpensive and compact in construction, efficient and reliable in operation, capable of convenient assembly and disassembly, and protected against dust and other foreign matter and the loss of lubrication.

Other objects and advantages will become apparent as the description proceeds.

In the accompanying drawings, Figure 1 is a transverse vertical sectional view of a compound motion device embodying the features of my invention.

Fig. 2 is a sectional view taken along the line 2—2 of Fig. 1, and illustrating one of the balance wheels.

Fig. 3 is a sectional view taken along the line 3—3 of Fig. 1, and illustrating the coupling for the shaft sections.

Fig. 4 is a side elevational view partially in section along line 4—4 of Fig. 1, and illustrating the connection between one of the eccentrics and the processing apparatus.

Fig. 5 is a diagrammatic view illustrating the eccentric throw.

Fig. 6 is a longitudinal sectional view of a processing apparatus including the compound motion device.

Referring more particularly to the drawings, the compound motion device therein shown, which constitutes the preferred embodiment of the invention, may be adapted to a wide variety of mechanical operating mechanisms, and particularly mechanisms having reciprocating, vibrating, filtering, sifting or riddling actions for the processing of material. The device is well adapted for and hence illustrated in connection with a vibratory screen which will hereinafter be referred to generally as a processing apparatus.

The particular processing apparatus shown for purposes of illustration (see Figs. 1 and 6) has upper and lower screen trays 6 mounted in a rigid frame 7. This frame is suspended inter-

mediate its ends in an inclined position and in a normally balanced condition from the compound motion device, and within a base or foundation having side and end members 8 and 9. The ends of the frame 7 are resiliently supported by suitable springs 10 seating on flanges 11 secured to the end members 9. Rotation of the frame 7 in either direction tending to result from the vibratory action is resisted by the springs 10.

The compound or composite motion device comprises a main drive element or shaft 12 which is mounted for rotation in two spaced bearing assemblies 13 on the opposite side members 8 of the foundation. Keyed to one end of the shaft 12 is a pulley 14 adapted to be connected to a suitable source of power (not shown).

The two bearing assemblies 13 preferably are closely alike in construction. Each assembly comprises a housing 15 which is rigidly mounted on the associated frame member 8, and which is closed at the ends by suitable flanged plates 16 and 17 to define a lubricant reservoir or chamber 18 about the shaft 12. An anti-friction bearing of the self-aligning type is enclosed within the chamber 18, and consists of the usual inner and outer race members 19 and 20 with interposed balls 21 to complete the bearing relationship. The inner race member 19 is secured to the shaft 12 for rotation therewith in a fixed axial position between a locating sleeve 22, extending through the inner end plate 16, and a lock nut 23. The outer race member 20 is secured in fixed relation within the housing 15, and located axially by the end plates 16 and 17. In the case of the left-hand bearing assembly 13, but not in the other assembly, end clearance is provided between the outer race member 20 and the plates 16 and 17 to permit accurate alignment when the assembly is made and to prevent binding.

To provide a dust and fluid seal, the bores of the end plates 16 and 17 are formed with labyrinth grooves 24 and closely embrace the shaft 12 and sleeve 22 respectively, and the external end faces of the plates are formed with annular oil retaining grooves 25. Two finger disks 26 are secured respectively to the outer end of the shaft 12 and the sleeve 22 in closely running relation to the end faces of the plates 16 and 17, and are formed with annular ribs 27 respectively projecting rotatably into the grooves 25.

Keyed to the shaft 12 closely adjacent the inner ends of the bearing assemblies 12 are two balance wheels 28 which constitute statically balanced fly wheels, and which are provided with compensating weights 29 adjustable in position relative to the axis of rotation. In the preferred construction, each wheel 28 comprises a hub 30 and a concentric rim 31 integrally connected by a side wall 32 to define an annular space 33 in the outer side face. The balance compensating weight 29 preferably consists of a circular disk 34 which is disposed in the space 33 about the hub 30 and against the wall 32 for adjustment radially of the shaft 12 into different selected positions of eccentricity. Formed in the weight 29 is a diametrical guide opening or slot 35 with straight parallel sides. The wheel hub 30 extends through the slot 35, and is formed at opposite sides with flat surfaces 36 in bearing engagement with the sides of the slot 35 to guide the weight 29 in the course of adjustment. An adjusting screw 37, extending longitudinally of and threaded through one end wall of the slot 35 into end bearing engagement in a recess 38 in the

inner surface of the rim 31, affords means for adjusting and locating the weight 29. Extending through a radial slot 39 in the wall 32 and into threaded engagement with the weight 29 is a cap screw 40 for locking the weight in position of adjustment.

The composite motion producing mechanism comprises two self-aligning anti-friction eccentric bearing assemblies 41 and 42 which are mounted on opposite end portions of the shaft 12 immediately adjacent the balance wheels 28, and which are operatively connected to opposite sides of the processing apparatus. More particularly, the bearing assemblies 41 and 42 are mounted on eccentrically disposed portions 43 and 44 of the shaft 12. The eccentricity of these portions determines the extent or degree of motion that will be imparted to the processing apparatus. To obtain the desired compound motion, the eccentrics 43 and 44 are disposed out of angular phase relation about the shaft 12 so that the respective movements imparted by the assemblies 41 and 42 do not coincide but are also out of phase relation or staggered.

Apart from the difference in phase adjustment, the two bearing assemblies 41 and 42 are alike in construction, and hence a description of the assembly 41 will suffice for both, corresponding parts of the assembly 42 being identified by the same reference numerals.

In its preferred form, the bearing assembly 41 comprises inner and outer race members 45 and 46 of the self-aligning type with anti-friction roller elements 47 interposed therebetween to complete the bearing relationship. The inner race member 45 is secured to the eccentric shaft portion 43 for rotation therewith. Two sleeves 48, with outer peripheral end flanges 49, are also rotatable with the shaft portion 43, and abut against opposite ends of the race member 45 to confine the latter in a fixed axial position. The outer race member 46 is fixed in a non-rotatable bearing housing 50 closed at opposite sides respectively by a plate 51 and an integral flange 52 closely encircling the sleeves 48.

One of the sleeves 48 engages a peripheral shoulder 53 on the shaft 12, and the other abuts against the hub 30 of the associated balance wheel 28. It will be evident that, by reason of the successive end engagements between the race member 19, the sleeve 22, the wheel hub 30, the outermost sleeve 48, the race member 45 and the other sleeve 48, the nut 23 and the shoulder 53 serve to maintain the assembly 41 and the associated assembly 13 and balance wheel 28 in proper position on the shaft 12.

The outer race member 46 has a press fit in the housing 50, and in the case of the assembly 41 is spaced at the ends from the plate 51 and flange 52. The resulting clearance permits the outer race member 46 to properly align itself in assembly. No clearance need be provided in the assembly 42.

To provide a dust and fluid seal, a plurality of annular grooves 54, concentric with the axis of rotation of the shaft 12 are formed in the external side face of the plate 51, and also in the outer side face of the flange 52. Annular ribs 55 formed on the flanges 49 project rotatably with clearance into the grooves 54.

Except for the portions 43 and 44, all portions of the shaft 12 are concentric with the axis of rotation, although of various diameters to accommodate construction and assembly requirements. Rotation of the eccentric portions and

operation of the processing apparatus tend to set up forces of inertia which if not counteracted would impair smoothness of operation. These forces of inertia are offset by properly adjusting the compensating weights 29 in the balance wheels 28. Normally, the weights 29 are located diametrically opposite the throw of the eccentrics.

To provide means for adjusting the angular phase relation of the eccentrics 43 and 44, the shaft 12 is split midway of its ends, as indicated at 56, and the shaft sections are adapted to be connected for joint rotation selectively in different relative angular positions. Apart from the difference in angular position and the provision for mounting the pulley 14, the two sections of the shaft 12 are substantially symmetrical or alike in form. The means for adjustably connecting the shaft sections may take various forms, but preferably comprises two peripheral flanges 57 and 58 rigid with the adjacent ends, and formed respectively with two sets of peripherally spaced slots 59 and 60 adapted for registration in any one of a plurality of positions for the insertion of fastening means, such as bolts 61. In the present instance, there are four equally spaced slots in each set, and the slots 59 and 60 of the two sets are diagonally inclined respectively in opposite directions relative to the intersecting radii.

A plurality of peripherally spaced radial grooves 57^a and 58^a are formed in the abutting end faces of the flanges 57 and 58. These grooves are tapered inwardly and are complementary in shape so that when in registration they define conical bores into any one of which a tapered dowel pin 61^a may be inserted to hold the parts accurately in indexed position. The grooves are closely spaced and adapted for registration in different relative angular positions of the shaft sections, and hence permit a finely graduated index adjustment. The various fastening means are maintained apart at established distances peripherally and at equal radial distances, and hence preserve static balance in the coupling assembly.

From the foregoing, it will be evident that the shaft sections may be securely connected for joint rotation selectively in different relative angular positions. The inclination of the slots 59 and 60 in opposite directions permits a limited range of adjustment without requiring removal of the bolts 61. Also upon removal of the bolts 61, the shaft sections may be relatively adjusted into any one of four different positions. Thus, in one position, the eccentric portions 43 and 44 will be substantially in phase. In the next position, one section will be 90 degrees in advance of the other section. In the third position, the two sections will be 180 degrees apart in phase. In the fourth position, the aforesaid other section will be 90 degrees in advance of the aforesaid one section. The character of the composite motion produced by the bearing assemblies 41 and 42 will vary in direction, plane and amplitude in accordance with these different adjustments. Accurate alignment of the shaft sections is maintained under all conditions by a dowel pin 62 having oppositely tapered ends inserted in tapered axial bores 63 in the abutting ends.

The shaft 12, intermediate the assemblies 41 and 42 and including the adjustable coupling just described, is enclosed within a suitable housing indicated generally at 64. In its preferred form, the housing 64 comprises two aligned tubes

65 about the shaft 12 and rigidly connected, as by welding, respectively to the adjacent faces of the bearing housings 50. Rigidly fixed about and to the free ends of the tubes 65, as by welding, are two rings 66 each of which is formed with an external peripheral groove 67. Two semi-cylindrical covers 68 embrace and conform to the rings 66 to provide an enlarged accessible space 69 enclosing the shaft coupling. Preferably, these covers are formed along their inner peripheral margins with arcuate ribs 70 fitting into the grooves 67 to maintain the parts in proper assembly. The ends of the covers 68 are clamped in position about the rings 66 by means of encircling straps 71 which are semi-circular in form and provided respectively with opposed lugs 72 at opposite ends connected by suitable tightening bolts 73. It will be evident that the foregoing construction affords convenient access to the shaft coupling to permit angular phase adjustment of the shaft sections whenever desired, and at the same time provides a rigid housing fully enclosing the intermediate portion of the shaft 12.

The eccentric bearing assemblies 41 and 42 are operatively connected to opposite sides of the processing apparatus so as to impart to the latter an oscillatory or vibratory motion in a plane perpendicular to the shaft 12. When the eccentric shaft portions 43 and 44 are in direct phase, the resulting orbital motion, illustrated diagrammatically in Fig. 5, is confined to this plane. When the eccentric shaft portions 43 and 44 are angularly offset into staggered relation, the rigid assembly, including the outer race members 46, the enclosing housings 50, and the intermediate tubular structure, is subjected to a gyratory motion about the longitudinal axis of the shaft 12. The rotation of the race members 46 is not confined to planes perpendicular to the shaft axis. On the contrary, the outer race members 46 are subjected to lateral displacement relative to the inner race members 45 and the roller elements 47. This lateral movement is permitted by the self-aligning character of the bearing assemblies 41 and 42 and the clearances between the grooves 54 and ribs 55.

The motion transmitting means for connecting the two eccentric bearing assemblies 41 and 42 to the processing apparatus preferably are alike in construction, and hence corresponding parts thereof are identified by the same reference numerals. Referring to the assembly 41, the connecting means in its preferred form comprises a rigid bracket or plate 74 which has a circular opening 75 in its upper end receiving the bearing housing 50, and which is rigidly secured about the opening by means of bolts 76 to an outer peripheral mounting flange 77 on the housing. The lower end of the member 74 is connected by one or more members 78 to one side of the screen frame 7. As herein shown, the members 78 consist of a plurality of parallel straps connected at their upper ends by means of bolts 79 to the bracket 74. A transverse spacer bar 80 may be interposed and clamped between the bracket 74 and the straps 78. The lower ends of the straps 78 are secured as by means of bolts 81 to the frame member 8, a longitudinal spacer bar 82 being interposed and clamped therebetween.

It will be understood that the lateral shifting movement of the housings 50, resulting from the twisting or gyratory action, imparts a lateral vibratory motion to the screen frame 7. If desired, the straps 78, or equivalent construction, in the connections to the frame 7, may be made of re-

silient material, such, for example, as rubber or spring steel to facilitate the lateral vibration.

- It will be evident that I have provided a new and improved method of and means for processing material. In the illustrative embodiment of the invention, the material is supplied to the upper end of the screens 6, and is subjected to vibration longitudinally and vertically of the screens, whereby it is caused to move downwardly.
- 10 Simultaneously, the material is subjected to vibration laterally of the path of movement. The gyratory motion has longitudinal and transverse components as well as movements in intermediate directions. As a result, irregularity in action on the material is obtained, and unidirectional arrangement or alignment of the particles is avoided.

I claim as my invention:

In a processing apparatus, in combination, a support, spaced bearing assemblies on said support, a shaft journaled in said assemblies and having axially spaced angularly offset eccentric elements, two self-aligning eccentric bearing assemblies mounted on said eccentric elements and including outer follower elements, a rigid structure connecting said elements for a gyratory motion having an orbital component in a plane perpendicular to said shaft and an orbital component longitudinally of said shaft, a processing surface having a frame, and laterally resilient means connecting said frame adjacent the midpoint of the length of said surface to said structure for actuation thereby.

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