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(54) Crushing apparatus.

(57) Crushing apparatus (10) comprises a frame (12) and a pair of crusher jaws (34,36) wherein the jaws (34,36) are floatingly supported relative to the frame (12) by means of resilient mounts (48,48').

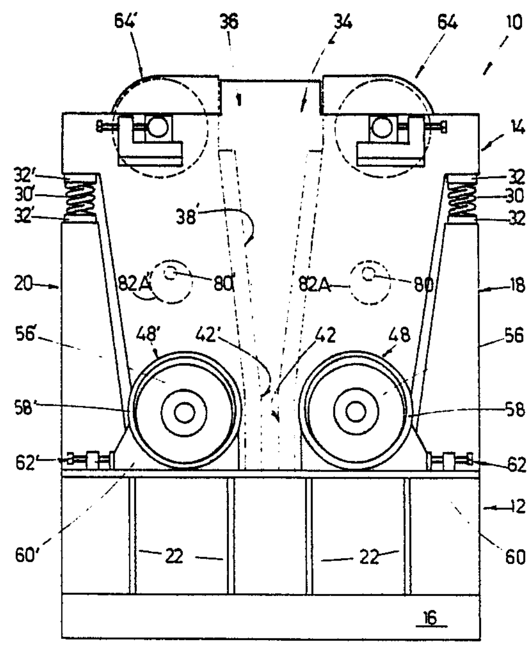

FIG 2

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CRUSHING APPARATUS

Field of the Invention

The present invention relates to rock crushing machines and more particularly to such machines wherein oscillatory vibration is produced between opposed jaws by means of eccentric masses or the like.

Background of the Invention

U.S. Patent 3,079,096, entitled "Crushing Apparatus" Issued February 26, 1963 to David P. McConnell, father of the co-inventor herein. The crusher described and claimed in the above noted patent is believed to be particularly representative of the prior art with respect to the present invention and is accordingly discussed in greater detail below.

U.S. Patent 3,079,096 discloses a jaw crusher of the type generally referred to above wherein an eccentric mass was supported for rotation behind each of the opposed jaws. Substantial forces acting upon the jaws were absorbed by resilient means including wheels with pneumatic tires arranged in shoes or cylindrical tracks. In addition to absorbing tremendous shock loading on the jaws, the resilient tires also permitted the jaws to move away from each other as necessary when uncrushable material formed from hardened steel and the like entered between the jaws.

Accordingly, the jaw crusher of the reference was particularly effective in crushing material such as rock while preventing jaws or other portions of the crusher from being damaged by uncrushable material passing between the jaws.

Other jaw crushers including vibratory jaw crushers with opposed jaws operated by rotating eccentric masses have also been disclosed. However, at least for purposes of the present invention, their apparatus is believed to be generally equivalent to that of the above reference.

Although the jaw crusher of the reference and similar jaw crushers in the prior art were very effective for their purpose, it has been found desirable to achieve certain improvements particularly in the area of increased crushing capacity, the ability to pass even larger uncrushable objects and the achievement of smoother and more uniform operation of the crusher both for contributing to increased capacity and also for assuring a long operating life, particularly for parts in the crusher subject to substantial shock loading.

Accordingly, there has been found to remain a need for a jaw crusher exhibiting improvements in accordance with the preceding discussion.

Summary of the Invention

It is therefore an object of the present invention to provide a jaw crusher having opposed jaws wherein at least one of the jaws is floatingly supported.

According to the present invention there is provided a crusher comprising a supporting frame structure, a pair of opposed downwardly converging crusher jaws defining therebetween a space for the passage of material, means floatingly supporting one of the jaws relative to the frame structure means for imparting oscillatory vibration to one of said jaws and means for supporting the other jaw in the frame structure of opposed crushing action relative to said one jaw.

According to a further aspect of the present invention there is provided a crusher wherein said means for floatingly supporting one of the jaws relative to the frame structure comprises first and second resilient floating mount means connected in series with each other and with the one jaw and the frame structure respectively.

According to yet a further aspect of the present invention there is provided a crusher as aforesaid comprising an improved design wherein the first resilient floating mount means comprises cylindrical track means connected to the one jaw and wheel means arranged generally coaxially within the cylindrical track means, the track means having an inside diameter substantially greater than the outside diameter of the wheel means, the wheel means including axle means, the second resilient floating mount means being interconnected between the axle and the frame structure.

According to a still further aspect of the present invention there is provided a crusher as aforesaid including a multiple eccentric.

Additional objects and advantages of the invention are described below with reference to the accompanying drawings or will be apparent to those skilled in the art from the drawings and following description.

Brief Description of the Drawings

Figure 1: is a perspective view of a jaw crusher constructed in accordance with the present invention,

Figure 2: is a side view, with parts shown in cross section, of the crusher of Figure 1 in order to more clearly illustrate its construction in accordance with the invention,

Figure 3: is an end view taken from the side of Figure 2 in order to show additional features of the invention,

Figure 4: is a fragmentary side view of the opposed jaws in the crusher to better illustrate their contruction and configuration,

Figure 5: is a side view of a jaw crusher constructed in accordance with a further embodiment of the present invention,

Figure 6: is a view taken from the left side of Figure 5 in order to show additional features of the present invention,

Figure 7: is a fragmentary view of the opposed jaws in the crusher of Figure 5 to better illustrate their construction and configuration,

Figure 8: is a view of one of the jaws taken from the right side of Figure 7,

Figure 9: is a side view of yet a further embodiment of the present invention with parts removed and other parts shown in cross section, to more clearly illustrate the constructions of a jaw crusher,

Figure 10: is a plan view of the crusher taken generally from the top of Figure 9, the the jaw crusher of Figure 10 including a base structure and drive assembly which are omitted in Figure 9 for greater clarity,

Figure 11: is an end view of the crusher taken generally from the right side of Figure 9,

Figure 12: is a fragmentary side view of the opposed jaws in the crusher of Figure 9 to better illustrate their unitary construction and configuration, one of the opposed jaws being illustrated with resilient means for limiting oscillatory movement of the jaw,

Figure 13: is a further view of one of the jaws, taken for example from the right side of Figure 12, with the resilient means being removed.

Description of the Preferred Embodiments

A jaw crusher constructed according to Figures 1 to 4 of the drawings is generally indicated at 10 in the drawings and includes a base frame assembly 12 and a fabricated floating frame structure 14. The base frame assembly includes a platform 16 with upright frame members 18 and 20 and reinforcing plates 22.

The floating frame 14 includes opposed upright side plates 24 and 26 rigidly interconnected by cross members 28.

The floating frame assembly 14 is resiliently supported upon the base frame 12 by a plurality of coiled springs 30 interposed between the upright frame members 18 and 20 of the base frame 12 and the cross members 28 of the floating frame assembly 14. The springs 30 are positioned relative to both members 18, 20 and 28 by means of retaining cups 32.

A pair of pressure jaws 34 and 36 are mounted on the floating frame assembly 14 in a manner described in greater detail below for allowing oscillating vibratory movement of jaws in synchronized relation with each other. The manner in which the jaws 34 and 36 are mounted upon the floating frame assembly 14 is of particular importance within the present invention because of the very substantial shock forces acting upon the jaws during operation of the crusher. In any event, it will be more apparent from the following description that in their oscillatory vibrating movement, the jaws experience an upward stroke where they move upwardly and away from each other followed by a downward stroke where the jaws move downwardly and toward each other. The upward and downward strokes of the jaws produce vibratory movement in order to develop crushing force on rocks or other material passing between the jaws.

As noted above, the crusher jaws 34 and 36 are of substantially similar construction except that they are formed as mirror images to each other. Accordingly, the following description for the crusher jaw 34 also applies to the crusher jaw 36 with similar primed numerical labels being employed. Referring now particularly to Figure 4, the crusher jaw 34 is formed with an upper hardened face plate 38 and a lower hardened face plate 42 which is substantially shorter in vertical dimension than the upper face plate 38. Both plates 38 and 42 are secured to a backing plate 40 by means of countersunk bolts or studs 44 in order to permit their removal or replacement on the jaw.

The angular relationship between the upper and lower face plates 38 and 42 on the crusher jaw 34 and the upper and lower face plates 38′ and 42′ on the jaw 36 is of particular importance within the present invention in order to achieve more effective crushing action on rocks or other material passing between the jaws.

Generally, it is desirable for the lower face plates 42 and 42′ to be substantially parallel with each other, for example, when fine crushing is desired within the apparatus 10. At the same time, it has been found desirable to form a converging angle of generally about seven to about sixteen degrees between the upper face plates 38 and 38′

for a number of reasons discussed immediately below. Preferably, the jaws 34 and 36 are configured so that the converging angle between the upper face plates 38 and 38′ is about eight to ten degrees.

Some variation in this converging angle may occur during oscillatory vibrating movement of the jaws in the manner described below. However, if the converging angle is formed between the jaws 34 and 36 when they are at rest, generally the same angle will be maintained throughout the crushing operation.

Initially, the converging angle between the upper face plates 38 and 38′ is selected so that the upper face plates are almost parallel with each other as the jaws 34 and 36 move outwardly and upwardly for engaging rocks or other material to be crushed. Because of the nearly parallel arrangement between the upper face plates 38 and 38′, they apply greater crushing force to rocks falling between them. At the same time, the nearly parallel relationship of the upper plates allows them to more firmly grip the rocks and prevents the rocks from being forced upwardly away from the crushing plates 38 and 38′ as the jaws 34 and 36 move toward each other in a downward stroke. The importance of this feature will be even more obvious when viewed in combination for the mounting arrangements for the jaws 34 and 36 as described in greater detail below. Limited convergence is of course necessary to allow material to be crushed to enter between the jaws.

In any event, the above advantages for the crusher could also be achieved if one of the jaws 34 and 36 were held stationary and even if its upper and lower plates were of parallel or unitary construction. The parallel relation between the lower face plates and converging angle between the upper face plates would then be formed entirely in the other jaw. However, a preferred construction is illustrated in the drawings where both jaws 34 and 36 move in oscillating vibrator fashion while being mirror images of each other. With such an arrangement, the converging angle between the upper face plates 38 and 38′, when the lower face plates 42 and 42′ are generally parallel, is defined by forming an angle between the upper face plate and lower face plate on each jaw equal to about half of the preferred converging angle. Accordingly, if the converging angle between the upper face plates 38 and 38′ is maintained in the range of eight to ten degrees, then each of the upper face plates, for example that indicated at 38, is arranged at an angle of four to five degrees with respect to the lower face plate 42.

Before leaving the construction of the jaws 34 and 36, it is again noted that the lower face plates 42 and 42′ are replaceably secured to the backing plate of the respective jaw in order to facilitate ready replacement and also to permit removal of the lower face plate, for example, in applications where coarser sizing is desired for output from the crusher.

Also, the vertical length of the upper face plates 38 ad 38′ is substantially greater than the vertical length for corresponding upper face plates in the crusher of the above noted patent. This greater vertical length for the jaws is necessary, because of the more parallel relationship between the jaws, in order to produce the same spacing between the jaws at their upper ends and accept minimum dimensions of material to be crushed.

The crusher jaws 34 and 36 are supported for oscillatory vibrating movement in the floating frame structure 14 by two series connected resilient floating mounts 46 and 48 providing support for the crusher jaw 34 on the floating frame structure 14. A similar arrangement of series connected resilient floating mounts 46′ and 48′ support the other crusher jaw 36 relative to the floating frame structure 14. Since the mounts 46′ and 48′ are generally identical to those indicated at 46 and 48, except for being mirror images, the following description with respect to the mounts 46 and 48 also applies to them.

The first mount 46 comprises mounting means formed by members 50 of compressible and resilient material such as rubber. The resilient floating mount 46 also comprises another mounting means in the form of a rigid shoe or cylindrical track means 52 which is arranged to encompass and support the compressible members 50.

As illustrated in the drawings, the cylindrical track 52 is secured to the jaw 34 while the compressible members or wheels 50 are arranged upon a shaft or axle 54 which in turn is supported in resilient, floating relation on the floating frame structure 14 by the second resilient floating mount 48.

As illustrated in the drawings, the second resilient floating mount 48 also comprises mounting means formed by members 56 of compressible and resilient material such as rubber and additional mounting means in the form of rigid shoes or cylindrical tracks 58. As may be best seen in Figure 3, the compressible members or tires 56 are mounted on opposite ends of the same shaft or axle 54 for the compressible members or wheels 50. A seperate shoe or cylindrical track 58 encompasses each of the wheels or pneumatic tires 56 on opposite lateral sides of the respective jaw. Each of the shoes or cylindrical tracks 58 is rigidly supported by an adjusting block 60 which is positioned, for example to adjust spacing between the jaws, by means of an adjusting screw assembly 12 secured to the base frame assembly 12.

Thus, the combination of the first and second resilient floating mounts 46 and 48 together with the similar mounts 46' and 48' for the other jaw provide a number of advantages within the present invention. Initially, they extend the effective stroke of the jaws as described above for increasing crushing capacity of the apparatus 10. They also enable the jaws 34 and 36 to move further apart from each other as necessary for permitting uncrushable material or objects to pass between the jaws without damaging components of the crusher. In addition, as illustrated in Figure 3, the adjusting screw assemblies 62 and 62' establish a reference point relative to the fixed base frame assembly 12 from which the spacing between the two jaws is established through the respective first and second floating mounts. In other words, as is also best seen in Figure 3, the first and second resilient floating mounts for each jaw provide a series connection between the respective jaw and a respective portion of the fixed base frame assembly 12 rather that the floating frame structure 14 as in the patent noted above. Through this combination, better control is believed possible over the relative spacing and oscillating vibrational movement of the jaws.

It is again noted that oscillating vibrational travel of each jaw, for example the jaw 34, is permitted by radial spacing between the pneumatic tires 50 and the cylindrical track 52 together with spacing between the tires 56 and the cylindrical 58 of the second resilient floating mount. This amount of travel is, in effect, a lost motion coupling permitting substantially greater movement for the jaws than the arrangement in the above noted patent. In addition to the spacing between the pneumatic tires and the cylindrical tracks, additional lost motion is also provided by relative compression experienced by the tires 50 and 56.

Finally, operation of the adjusting screw assemblies 62 and 62' in effect varies the nominal spacing between the jaws 34 and 36 in order to regulate the size of crushed material passing through the apparatus 10.

In order to permit desired oscillatory vibrational movement of each of the jaws 34 and 36, they are mounted at their lower ends in the manner described with the upper ends of both jaws being free from any direct coupling to either the fixed frame assembly 12 or the floating frame structure 14. Rather, resilient mountings are provided between the upper ends of the jaws and the floating frame structure 14 only for the purpose of limiting the movement of the jaws away from one another and to increase the rebound action of the jaws toward each other after they abut the resilient mounting means in their oscillatory vibrational travel. The resilient mounting means for the one jaw 34 is indicated generally at 64 and comprises multiple pneumatic rubber tires or resilient means 66 similar to the tires 50 and 56 described above. The tires 66 are rotatably mounted on a common shaft 68 supported in bearing blocks 70 adjustably mounted on the floating frame structure 14. Adjustment in the bearing blocks 70 thus shifts the tires 66 toward or away from the respective jaw 34. In operation, the tires 66 limit the movement of the jaw 34 away from the jaw 36 and increases rebound action of the jaw 34 toward the jaw 36 in the manner described above. Thus, adjustment of the blocks 70 can in effect change desired spacing between the upper ends of the jaws.

Restraining means 72 are provided for limiting movement of the jaw 34 toward the jaw 36. The restraining means 72 comprises a stop plate 74 secured to the jaw 34 so that the stop plate 74 acts against the tires 66 to limit inward travel of the jaw 34. With similar restraining means provided for both of the jaws 34 and 36, they are permitted to follow the oscillatory vibrational pattern described above while also maintaining spacing between their upper ends to form a feed passage for material to be crushed. This feature is of particular importance within the present design since the angular configuration of the jaws 34 and 36 as described above produces a tendency in the jaws to collapse toward each other when a rock or other material to be crushed is not passing between the jaws. Thus, within the apparatus of the present invention, the restraining means 72 and 72' for the jaws 34 and 36 maintain a feed passage through the crusher 10.

Each jaw, for example that indicated at 34, is also provided with means in the form of an eccentric means 78 for producing oscillating vibration of the two jaws 34 and 36 in unison toward any away from each other. As may be best seen in Figure 3, the eccentric means 78 for the jaw 34 is formed by two seperate eccentric masses 78A and 78B are mounted on a common shaft 80 which is supported upon the jaw 34 by three spaced apart bearings 82A, 82B and 82C arranged on opposite sides of the eccentric masses 78A and 78B and between the masses respectively.

The shaft 80 extends through a large opening 84 in the plate 24 of the floating frame structure 14 in order to avoid contact with the floating frame structure 14. Similar shafts respectively supporting eccentric masses on the jaws 34 and 36 are coupled through a universal drive means such as that indicated at 86 with a common drive box 88 for achieving synchronous rotation of the eccentric masses generally in the same manner discussed in greater detail within the above noted patent. An electric motor 90 is connected with the drive box 88 through a pulley and belt arrangement 92 for producing synchronous drive of the eccentric masses on both of the jaws 34 and 36.

The arrangement of the two eccentric masses on each jaw provides balanced transmission of gyratory and vibrational forces to the respective jaw due in part of arrangement of eccentric masses on both lateral sides of the jaw and also because of the three bearings providing a more solid mount for the shaft supporting the masses upon the respective jaw. The balanced eccentric masses described above are of particular importance in combination with the preferred converging angle formed between the jaw faces as described above in order to further increase crushing force transferred to rocks or other material through the jaws.

The manner of operation for the apparatus 10 is believed obvious from the preceding description and also from the incorporated reference discussed above. However, operation is briefly summarized below in order to assure complete understanding of the apparatus 10 and particularly the novel features included within the apparatus according to the present invention.

In operation, the adjusting screw assemblies 62 and 62′ are set to produce a predetermined spacing between the jaws 34 and 36. The motor 90 is then caused to produce oscillatory vibrational movement of the jaws through the eccentric masses arranged adjacent each of the jaws. At the same time, material to be crushed is introduced into the space between the jaws 34 and 36. As the material to be crushed passes downwardly between the jaws, the jaws follow the oscillatory vibrational pattern described above.

Because of the series connected resilient floating mounts, for example those indicated at 46 and 48 for the jaw 34, an increased stroke is produced in the jaws so that they engage greater amounts of the material to be crushed and thereby increase the crushing capacity of the apparatus 10. At the same time, the defined angle between the jaw faces causes the jaws to impact the material to be crushed at a preferred angle further increasing operating efficiency of the apparatus 10. The balanced arrangement of the eccentric masses on each of the jaws further assures more uniform transfer of oscillatory vibrational force through the jaws and into material to be crushed which is arranged laterally across the surfaces of the jaws 34 and 36.

In the event that incrushable material such as hardened steel parts or the like pass between the jaws, the jaws are permitted to expand further apart from each other because of the lost motion coupling provided in each of the series connected, resilient floating mounts for the respective jaws.

Also, if there were an interruption in supply of material to be crushed, for example, the jaws 34 and 36 are retained in spaced apart relation by the restraining means 72 and 72′ so that the jaws remain properly positioned to permit introduction of additional feed between them.

A jaw crusher constructed according to the embodiment illustrated by Figures 4 to 8 of the drawings is generally indicated at 110 in the drawings and includes a base frame assembly 112 and a fabricated floating frame or jaw carriage structure 114. The base frame assembly 112 includes a platform 16 and upright frame members 118 and 20. Both the base frame assembly 112 and jaw carriage frame 14 are substantially reinforced as illustrated.

The jaw carriage frame 114 includes opposed upright side plates 124 and 126 which are rigidly interconnected by cross members 128. The jaw carriage frame 114 is resiliently supported upon the base frame 112 by a plurality of coiled springs 130 interposed between the upright frame members 118 and 120 of the base frame 112 and the cross members 128 of the jaw carriage frame 114. The springs 130 are positioned relative to both the upright frame members 118 and 120 and the cross members 128 by means of positioning cups 132.

A pair of crusher jaws 134 and 136 are mounted on the jaw carriage frame 114 in a manner described in greater detail below for allowing oscillatory or vibratory movement of the jaws in synchronized relation with each other. The mounting of the jaws 134 and 136 upon the jaw carriage frame 114 is of particular importance because of the very substantial shock forces acting upon the jaws during operation of the crusher.

In any event, it will be more apparent from the following description that, in their oscillatory or vibratory movement, the jaws experience an upward stroke where they move upwardly and away from each other followed by a downward stroke where the jaws move downwardly and toward each other. The upward and downward strokes of the jaws produce vibratory and oscillatory movement in order to develop crushing force on rocks or other material passing between the jaws.

As noted above, the crusher jaws 134 and 136 are of substantially similar construction except that they are formed as mirror images of each other. Accordingly, the following description for the crusher jaw 134 also applies to the crusher jaw 136 with similar primed numerical labels being employed. Although both jaws 134 and 136 are described as being similarly configured and mounted in the crusher, it is again noted that one jaw could be relatively fixed with the other jaw being mounted in the manner described below.

Referring now particularly to Figures 4 and 7, the crusher jaw 134 is formed with an upper hardened face plate 138 and a lower hardened face plate 142. Both plates 138 and 142 are secured to a backing plate 140 preferably by means of coutersunk bolts or studs (not shown) in order to permit their removal or replacement on the jaw.

The angular relationship between the upper and the lower face plates 138 and 142 on the crusher jaw 134 and the upper and lower face plates 138' and 142' on the jaw 136 is important for achieving more effective crushing action on rocks or other material passing between the jaws.

Generally, it is desirable for the lower face plates 142 and 142' to be substantially parallel with each other, for example, when fine crushing is desired within the crusher 110. At the same time, the upper face plates 138 and 138' form a wider converging angle for receiving material to be crushed in the crusher 110.

For a further discussion of the jaws 134 and 136 and their preferred configuration, reference is made to the incorporated references noted above.

It is again noted that the present invention is particularly directed toward the manner in which the crusher jaws 134 and 136 are supported for oscillatory vibrating movement in the floating frame structure 114. In addition, the invention is particularly concerned with the configuration of the jaws 134 and 136 themselves in order to permit them to be of a drop-in design for facillitating installation and removal of the jaws from the crusher 10.

Continuing with reference to Figures 5, 6 and 7, the upper end of the jaw 134 is supported by an elongated resilient member 142 which is connected to the jaw carriage frame 114 and interacts with an upper reaction member 144 attached to or forming an itegral portion of the jaw 134.

The lower portion of the jaw 134 is supported relative to the jaw carriage frame 114 by series connected resilient floating mounts 146 and 148. The floating mount 146 comprises an elongated resilient member similar to the upper member 142. Both the upper elongated resilient member 142 and the floating mount or lower elongated resilient member 146 are formed from compressible and resilient tires 150.

A lower reaction member 152 is attached to or integrally formed on a lower portion of the jaw 134 for interacting with the lower elongated resilient member 146.

The tires or wheels 150 in the lower elongated resilient member 146 are arranged upon a shaft or axle 154 which in turn is supported in resilient, floating relation on the jaw carriage frame 114 by the second resilient floating mount 148.

As illustrated in Figures 6 and 7, the second resilient floating mount 148 also comprises compressible and resilient tires 156 mounted on opposite ends of the axle 154 and arranged within additional mounting means in the form of rigid shoes or cylindrical tracks 158. Each of the shoes or tracks 158 is rigidly supported by an adjusting block 160 which is positioned, for example, to adjust spacing between the jaws by means of an adjusting screw assembly 62 secured to the base frame assembly 112.

Thus, the combination of the first and second resilient floating mounts 146 and 148 together with similar mounts 146' and 148' for the other jaw 136 provide a number of advantages within the present invention. Initially, they further extend the effective stroke of the jaws as described above for increasing crushing capacity of the apparatus 110 while also more readily permitting uncrushable material or objects to pass between the jaws and out of the crusher without damaging or plugging the crusher. Other advantages for the series connected floating mounts 146 and 148 are set forth herein.

It is again noted that the oscillating vibratory travel of each jaw, for example, the jaw 134, is permitted by radial spacing between the pneumatic tires 150 and the lower reaction member 152 together with similar spacing between the tires 156 and the cylindrical track 158 of the second resilient floating mount.

The tires 150 in the upper elongated resilient member 142 are similarly arranged upon a shaft or axle 164 which is adjustably and replaceably connected to the jaw carriage frame 114 by means of a replaceable and adjustable mounting blocks 166 and 168 arranged at each end of the axle 164. The replaceable construction for the upper elongated resilient member 142 is important in connection with the drop-in configuration of the jaw 134 as described in greater detail below.

Referring now particularly to Figure 7, the drop-in configuration for the jaw 134 is particularly dependant upon the configuration for the upper and lower reaction members 144 and 152. Generally, those members are diametrically arranged with relation to each other so that, in combination, they limit travel of the jaw in all directions in response to operation of eccentric means generally indicated at 170 and described in greater detail below.

With the upper and lower elongated resilient members 142 and 146 being formed from cylindrical tires, for example, the upper and lower reaction members 144 and 152 are also cylindrical but limited in extent to less that 180° in order to facilitate their movement relative to the tires 150.

As may be best seen in Figure 7, the lower reaction member 152 is approximately 180° in extent while being arranged generally above the lower elongated resilient member 146. At the same time, the upper reaction member 144 is arranged generally beneath the upper elongated resilient member 142. Thus, the lower reaction member 152 tends to support the jaw 134 on the jaw carriage frame 114 and to prevent downward travel of the jaw. At the same time, the upper reaction member 144 tends to prevent or limit excessive upward travel of the jaw 134, for example, in response to operation of the eccentric means 168.

Furthermore, because of the arrangement of the reaction members 144 and 152, with the upper elongated resilient member 142 being removed from the jaw carriage frame 114 as described above, the entire jaw 134 can simply be raised upwardly as viewed in Figure 7 or lowered downwardly for installation in the crusher. At the same time, the upper reaction member 144 also serves a restraining function in preventing the upper end of the jaw 134 from collapsing inwardly toward the jaw 136, particularly when the crusher is empty.

Referring particularly to Figure 5, the eccentric means 168 is illustrated as an elongated eccentric mass arranged upon a shaft 172 supported at its opposite ends by bearings 174 on the jaw carriage frame 114. The elongated configuration of the eccentric mass 168 permits it to be of reduced diameter so that it can be mounted more closely adjacent the jaw 134 as may also be seen in Figures 6 and 7.

The shaft 172 is connected by means of a universal drive assembly 176 with a drive shaft 178 which is interconnected with a drive motor 180 by drive belts generally indicated at 182. The universal drive assembly 176 permits the shaft 172 to be disconnected from the drive shaft 178 so that the eccentric means 168 can be assembled and disassembled from the crusher 110 as part of the drop-in jaw assembly 134.

Once again, it is noted that the other jaw 136 is of substantially similar construction and mounting as the jaw 134.

Accordingly, there has been described a novel jaw crusher 110 wherein the jaws 134 and 136 are of drop-in configuration for facillitating installation and removal or replacement of the jaws in the crusher. As noted above, this is particularly important since wear is primarily experienced within the jaws themselves.

A jaw crusher constructed according to Figures 9 to 13 of the present invention is generally indicated at 210 in the drawings and includes a base frame assembly 212 and a fabricated floating frame structure or jaw carriage frame 214. The base frame assembly 212 includes a platform 216 with upright frame members 218 and 220. Both the base frame assembly 212 and jaw carriage frame 214 are substantially reinforced as illustrated.

The jaw carriage frame 214 includes opposed upright side plates 224 and 226 which are rigidly interconnected by cross members 228.

The jaw carriage frame or floating frame assembly 214 is resiliently supported upon the base frame 212 by a plurality of coiled springs 230 interposed between the upright frame members 218 and 220 of the base frame 212 and the cross members 228 of the floating frame assembly 214. The springs 230 are positioned relative to both the upright frame members 218 and 220 and the cross members 228 by means of positioning cups 232.

A pair of pressure jaws 234 and 236 are mounted on the jaw carriage frame 214 in a manner described in greater detail below for allowing oscillatory or vibrating movement of the jaws in synchronized relation with each other. The mounting of the jaws 234 and 236 upon the floating frame assembly 214 is of particular importance because of the very substantial shock forces acting upon the jaws during operation of the crusher.

In any event, it will be more apparent from the following description that, in their oscillatory or vibratory movement, the jaws experience an upward stroke where they move upwardly and away from each other followed by a downward stroke where the jaws move downwardly and toward each other. The upward and downward strokes of the jaws produce vibratory and oscillatory movement in order to develop crushing force on rocks or other material passing between the jaws.

As noted above, the crusher jaws 234 and 236 are of substantially similar construction and are formed as mirror images to each other. Accordingly, the following description for the crusher jaw 234 also applies to the crusher jaw 236 with similar primed numerical labels being employed. However, it is to be noted that one of the jaws, for example that indicated at 236, could be relatively fixed upon the jaw carriage frame 214 with oscillatory or vibratory movement between the jaws being produced by movement of the one jaw 234 by itself. In any event, similar operation of both jaws is generally preferred in oder to achieve greater crushing forces.

The jaw crusher 210 as described above generally conforms with at least one embodiment in the copending references. Similar numerical labels have also been employed to further facilitate comparison. However, it is to be noted that there are otherwise substantial differences in the manner in which the jaws and other portions of the crusher are constructed and supported for enhancing crusher operation.

Referring now particularly to Figures 9 and 12, the crusher jaws 234 and 236 are formed with upper hardened face plates 238 and 238′ and lower hardened face plates 242 and 242′ respectively. The lower face plates are substantially shorter in vertical dimension than the upper face plates. Although not a particular feature in connection with the present invention, it is noted that the upper and lower plates are preferably formed from very hard metal and secured to a backing plate 240 or 240′

by means of countersunk bolts or studs (not shown) in order to facilitate removal or replacement of the facing portions of the jaws which are particularly susceptible to wear.

Referring to the one unitary jaws as illustrated in Figures 9 and 12, the angular relationship between the upper and lower face plates 238, 242 and 238', 242' is of particular importance within the present invention in order to achieve more effective crushing action on rock or other material passing between the jaws. Generally, it is desirable for the lower face plates 242 and 242' to be substantially parallel with each other, for example, when fine crushing is desired within the apparatus 210. At the same time, it has been found desirable to form a converging angle between the upper face plates 238 and 238' for a number of reasons discussed at greater length in the incorporated copending reference noted above.

In any event, it is to be kept in mind in connection with the present invention that the multiple drive means provided by the present invention facilitates not only construction of jaws having greater lateral dimensions but also jaws having greater vertical dimensions. The greater vertical dimensions for the jaws permits, for example, formation of a longer tapered throat between the upper face plates of the two jaws.

Within a jaw crusher as described above, there are three particular areas of construction which are of importance in connection with the present invention. These three features include (1) novel upper and lower resilient elements 246 and 248 for positioning the jaw 234, (2) a multiple eccentric drive assembly generally indicated at 244 in Figure 13 and (3) construction of the jaws 234 and 236 and associated elements of the crusher as described in greater detail below for facilitating assembly and disassembly of the jaws 234 and 236 in unitary fashion from the crusher 210. These elements are described in greater detail below.

Initially, the upper and lower elongated reilient elements 246 and 248 allow response of the jaws to the rotating eccentric masses for producing the desired oscillatory movement of the jaws. In addition, the resilient elements 246 and 248 limit travel of the jaws in a manner described in greater detail below. The upper elongated resilient element 246 is formed by multiple members or tires 250 which are both resilient and compressible. The tires 250 are mounted on a single shaft or axle 252 which is supported at its opposite ends by bearing mounts 254 and 256 which are adjustable on the jaw carriage frame 214 for varying the distance or throat formed between the jaws 234 and 236.

The lower elongated resilient element 248 is similarly formed by tires 258 mounted on a single shaft or axle 260 which is supported at is opposite ends by bearing mounts or pillow blocks 262 and 264. The pillow blocks 262 and 264 are similarly adjustable on a lower portion of the jaw carriage frame 214 while also being detachable from the frame 214 in order to facilitate assembly and disassembly of the jaw 234 from the crusher 210 in unitary fashion as described in greater detail below.

The jaw 234 is formed with a reaction member 266 in the form of a rigid shoe or cylindrical track which entirely surrounds the tires 258. In this manner, the reaction member 266, serves to interact with the tires 258 for limiting travel of the jaw 234 in all directions during the operation of the crusher. Because of the construction of the reaction member 266, the upper tires 250 act directly against the jaw itself since they do not serve a function of limiting the stroke or travel of the jaw.

Thus, the construction of the jaw is unitary to facilitate its being installed or removed from the crusher. At the same time, since travel of the jaw in all directions is limited only by the reaction member 266, the design of the jaw further avoids interference which might occur if a further reaction member (not shown or employed in the invention) were necessary. Such an arrangement of upper and lower reaction members is illustrated in the copending reference. By comparison, the design of the present jaw avoids interference between such members which might tend to absorb or neutralize a portion of the oscillatory or vibratory force otherwise being transferred to the jaw faces.

Before completing the description of the unitary jaw and describing the manner in which it can be assembled from the crusher, the construction of the multiple eccentric drive assembly 244 is first described. Referring particularly to Figure 13, each jaw, particularly that indicated at 234, is provided with multiple sets of eccentric means generally indicated at 268 and 270. The eccentric means 268 and 270 which are vertically spaced apart upon the jaw 234 each include laterally arranged eccentric masses 268A, 268B and 270A, 270B so that four uniformly sized eccentric masses are arranged both laterally and vertically upon the jaw 234 to facilitate more uniform transmission of oscillatory motion to all portions of the jaw.

Furthermore, the upper eccentric masses 268A and 268B are arranged on seperate shafts 272 and 274 which are interconnected by a flexible drive coupling 276 while being independently couple with the jaw 234 through seperate bearing mounts 272A, 272B and 274A, 274B. The lower eccentric masses 270A and 270B are similarly mounted on separate shafts 78 and 80 which are also interconnected by means of a flexible drive coupling 282 and supported upon the jaw 234 by independent bearing mounts 278A, 278B and 280A, 280B.

In addition to being laterally and vertically arranged upon the jaw for more uniform transmission of force to the jaw, this arrangement permits a number of advantages in the invention. Initially, with the laterally spaced eccentric masses being arranged on separate shafts, there is no problem of maintaining alignment between the two eccentric masses. Also, with the four eccentric masses 260A, 260B and 270A, 270B replacing a single eccentric mass, the independent bearings for the various eccentric masses can be of substantially reduced size and diameter. This in turn permits operation of the eccentric masses at higher rates of rotation, at least partly because of the reduced mass in the bearings. Still further, the reduced size of the eccentric masses permits them to be arranged closer to the face 238 of the jaw so that the oscillatory motion is more effectively transferred to the jaw face at least partly because of the reduced moment arm between the jaw face and the eccentric masses.

Each of the flexible drive couplings 276 and 282 is of generally conventional construction for coupling the respective shafts 272, 274 and 278, 280 while allowing them to be independently supported by their respective bearings. For example, referring particularly to Figure 13, the flexible drive couplings 276 and 282 are each formed by members 284 and 286 which are respectively coupled with the shaft 272 and 274 or 278 and 280 while being coupled for rotation with each other by means of an internal spider 288.

Referring also to Figures 10 and 11, all of the eccentric masses for both jaws 234 and 236 are operated by a single drive motor 290 which is coupled with both the upper and lower eccentric means 268 and 270 by a split drive train generally indicated at 292. The motor 290 is connected with the split drive train 292 through drive belts generally indicated at 294. The split drive train 292 itself comprises drive gears 296, 298, 300 and 302 which are interconnected respectively with the upper and lower eccentric means for each of the jaws 234 and 236.

Referring particularly to Figure 11, the respective drive gears are interconnected with the upper and lower eccentric means 268, 270 and 268′, 270′ for the jaws 234 and 236 by means of universal couplings all indicated at 304. The universal couplings 304 further avoid the possibilities of misalignment while also providing means for uncoupling the eccentric means from the drive train to facilitate removal and installation of the jaws in unitary fashion.

Referring again to the construction of the upper and lower elongated resilient elements 246 and 248, the pillow blocks 262 and 264 can be simply disconnected from the jaw carriage frame 214 to permit the lower tires 258 and shaft 260 to remain within the reaction member 266 so that they form part of the unitary jaw during assembly and disassembly. Furthermore, with the pillow blocks 262 and 264 being disconnected, the lower end of the jaw 234, as viewed for example in Figure 9, can be shifted outwardly or to the right so that the upper end of the jaw 234 drops out of engagement with the upper elongated resilient element 246. Thereafter, the entire unitary jaw 234 can simply be moved away from the crusher 210 for repairs or replacement as desired. Similarly, the unitary construction of the jaw 236 permits it to be assembled or disassembled from the crusher 210 in the same manner.

In addition to facilitating removal and installation of the jaws 234 and 236, these features of the crusher 210 also permit the overal height of the crusher 218 to be reduced not only to minimize the need for head room but also to lower the center of gravity for the crusher. The need for available overhead space is further reduced because of the ability to remove and install the unitary jaws 234 and 236 in the manner described above. Still further, in addition to reducing the overall height of the crusher 210, the throat area 306 formed between the jaws 234 and 236 and by the lateral liners 308 and 310 mounted on the jaw carriage frame 214 to extend further downwardly so that they terminate closely adjacent a hopper or other container 312 for receiving crushed rock or other material from the crusher. The generation of dust can be further reduced by arranging a shroud 314 around the lower end of the throat area 306 so that the shroud 314 extends downwardly toward the hopper 312.

Accordingly, there has been disclosed a novel and improved jaw crusher offering a number of advantages as described in detail above. Numerous modifications and variations are possible in addition to those specifically described above. Accordingly, the scope of the present invention is defined only by the following appended claims.

Claims

1. Crushing apparatus (10) comprising a supporting frame structure (12) and a pair of opposed downwardly converging crusher jaws (34,36) defining therebetween a space for passage of material, characterised in that there there is provided means (14) floatingly supporting at least one of the jaws (34,36) relative to the frame structure (12), means (78) for imparting oscillatory vibration to at least one of said jaws (36) and means (72) for supporting the other jaw (34) in the frame structure (12) for opposed crushing action relative to said one jaw (36).

2. Crushing apparatus as claimed in claim 1 characterised in that said means (14) for floatingly supporting at least one of the jaws (34, 36) relative to the frame structure (12) comprises first and second resilient floating mount means (46,48) connected in series with each other and with the jaw (34,36) and the frame structure (12) respectively.

3. Crushing apparatus as claimed in claim 2 characterised in that the first resilient floating mount means (46) comprises cylindrical track means (52) connected to the one jaw (34) and wheel means (50) arranged generally coaxially within the cylindrical track means (52), the track means (52) having an inside diameter substantially greater than the outside diameter of the wheel means (50), the wheel means (50) including the axle means (54) the second resilient floating mount means (48) being interconnected between the axle (54) and the frame structure (12).

4. Crushing apparatus as claimed in claim 2 or claim 3 characterised in that the second resilient floating mount means (48) also comprises a similar combination of wheel means (56) and cylindrical track means (58).

5. Crushing apparatus as claimed in claim 1 characterised in that there is provided upper and lower elongated resilient numbers (142,146) connected with the frame structure (12) behind the first jaw (134) and upper and lower reaction members (144,152) connected to the first jaw (134) for respective interaction with the upper and lower elongated resilient members (142, 146), the upper and lower reaction members (144,152) encompassing substantially diametrically related portions of the upper and lower elongated resilient members (142,146) respectively for permitting oscillatory movement of the first jaw (134) in response to the eccentric means (170) while at the same time limiting travel at the jaw (134) in all directions on the frame structure (12).

6. Crushing apparatus as claimed in claim 5 characterised in that the upper reaction member (144) is arranged generally below the upper elongated resilient member (142) and the lower reaction member (146), the upper elongated resilient member (142) being replaceably connected to the frame structure (12) to facilitate assembly and disassembly of the first jaw (134) from the apparatus (110).

7. Crushing apparatus as claimed in claim 6 characterised in that the lower elongated resilient member (146) is connected with the frame structure (12) by additional floating mount means for permitting increased movement of the first jaw relative to the frame structure.

8. Crushing apparatus as claimed in claim 1 characterised in that there is provided multiple eccentric means (268,270) arranged in vertically spaced apart relation to the one jaw (234) for imparting oscillatory vibration to respective portions of the jaw (234) and producing more uniform and consistent operation of the apparatus under different load conditions, and split drive means (272,274) for synchronously operating the multiple eccentric means (268,270).

9. Crushing apparatus as claimed in claim 8 characterised in thateach eccentric means (268A,268B) is arranged on a shaft (272,274) supported on the jaw (234) by bearing means (272A 272B and 274A,274B), the split drive means (272,274) being coupled with a drive motor (290) by means of a flexible drive coupling (276).

10. Crushing apparatus as claimed in claim 9 characterised in that each vertically spaced eccentric means (268,270) comprises at least two eccentric means (268A,268B; 270A,270B) arranged in separate shafts (272,274; 278,280) in laterally spaced apart relation, the separate shafts (270,274; 278,280) being independently mounted on bearings and being interconnected by flexible coupling means (276,282).

Neu eingereicht / Newly filed
Nouvellement déposé

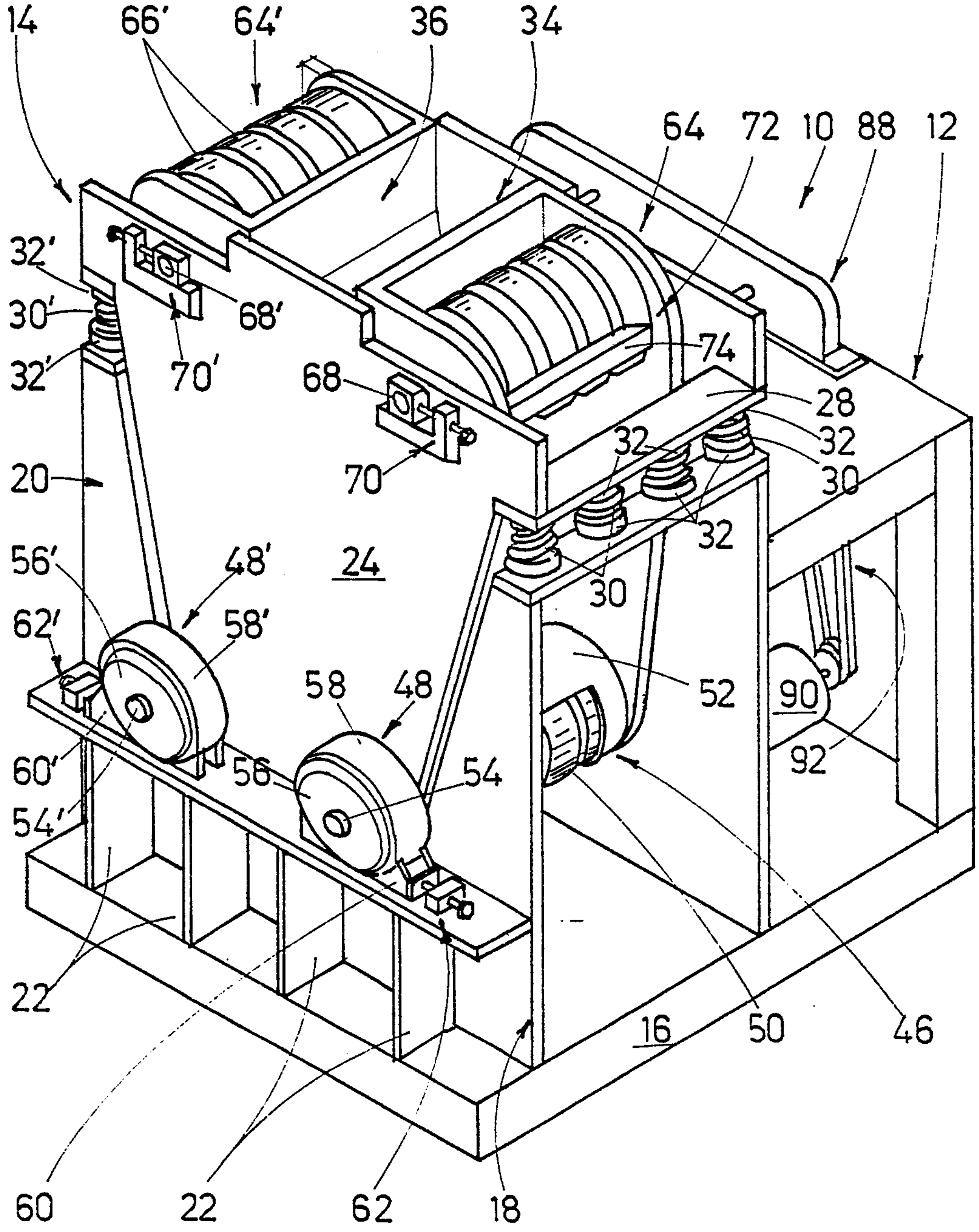
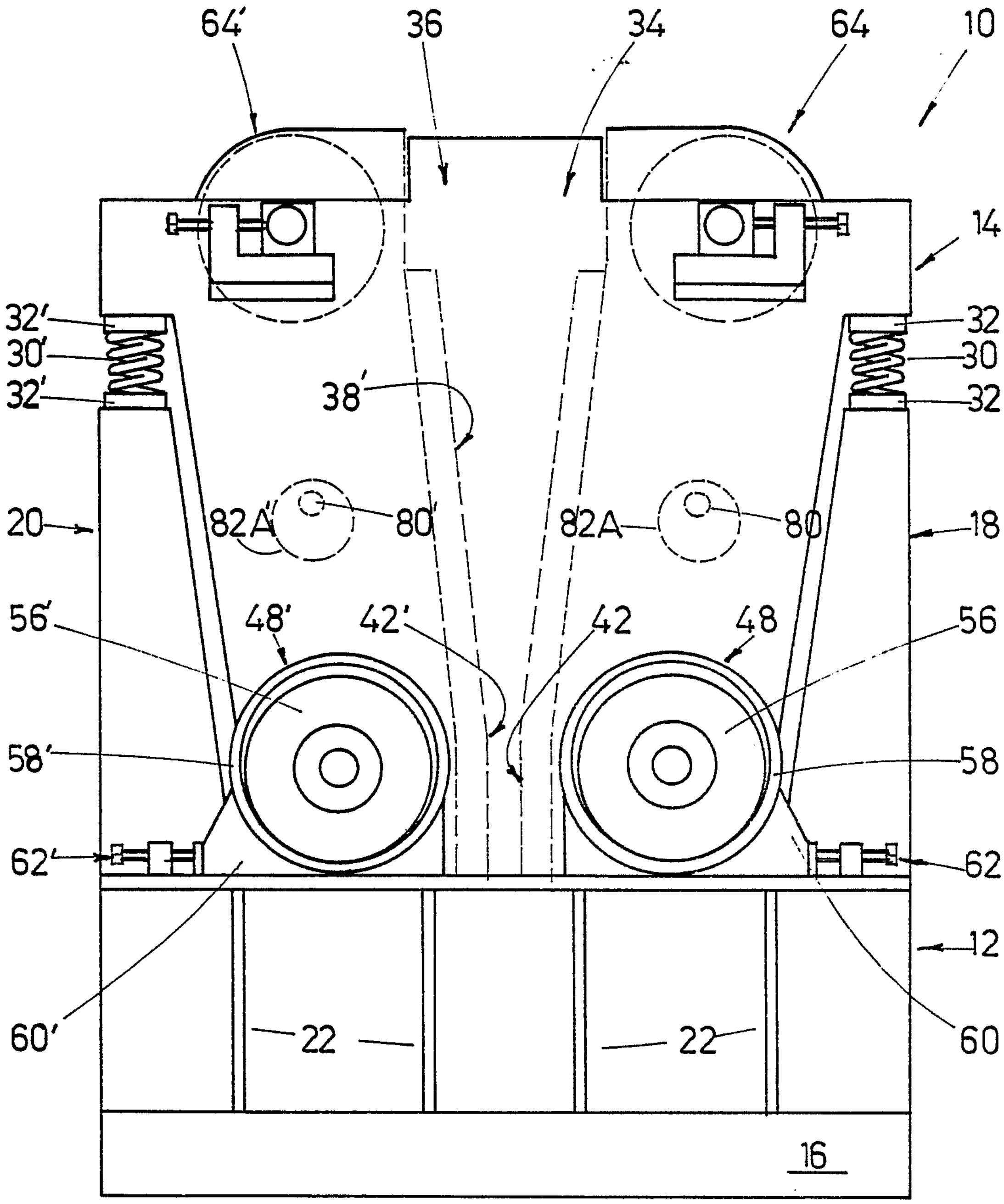


FIG 1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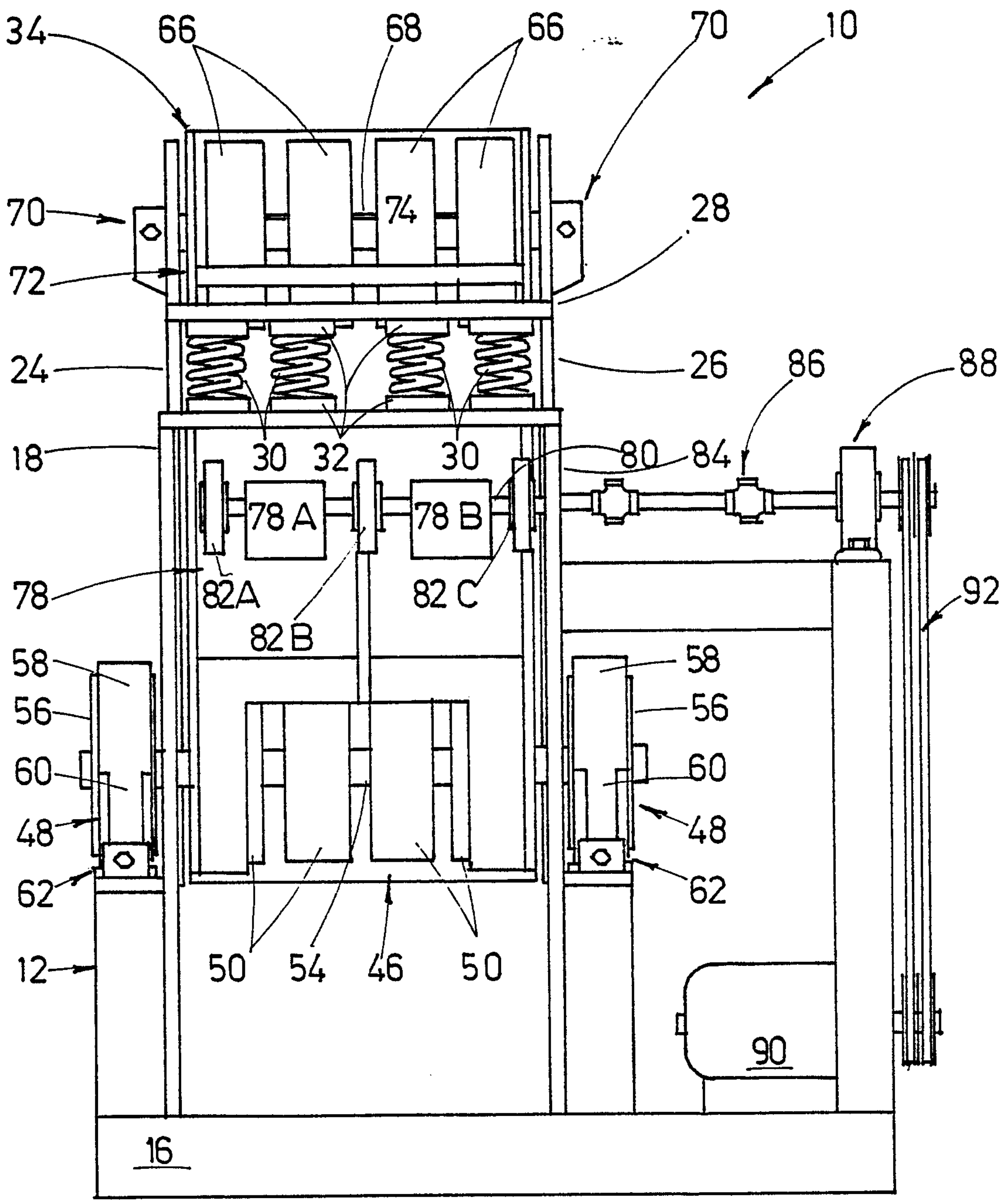
16

FIG 2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78
82A
82 C
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82 B
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58
56
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FIG 3

Neu eingereicht / Newly filed
Nouvellement déposé

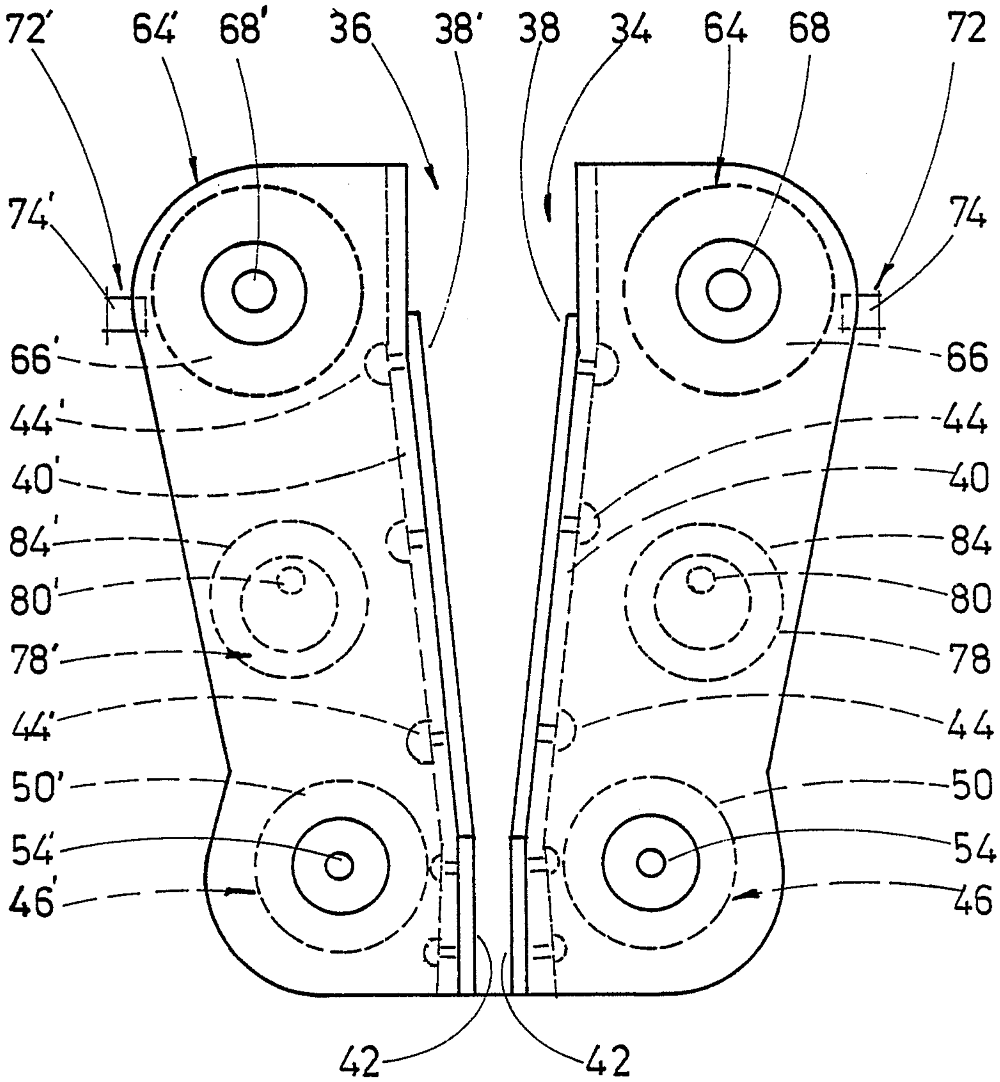

FIG 4

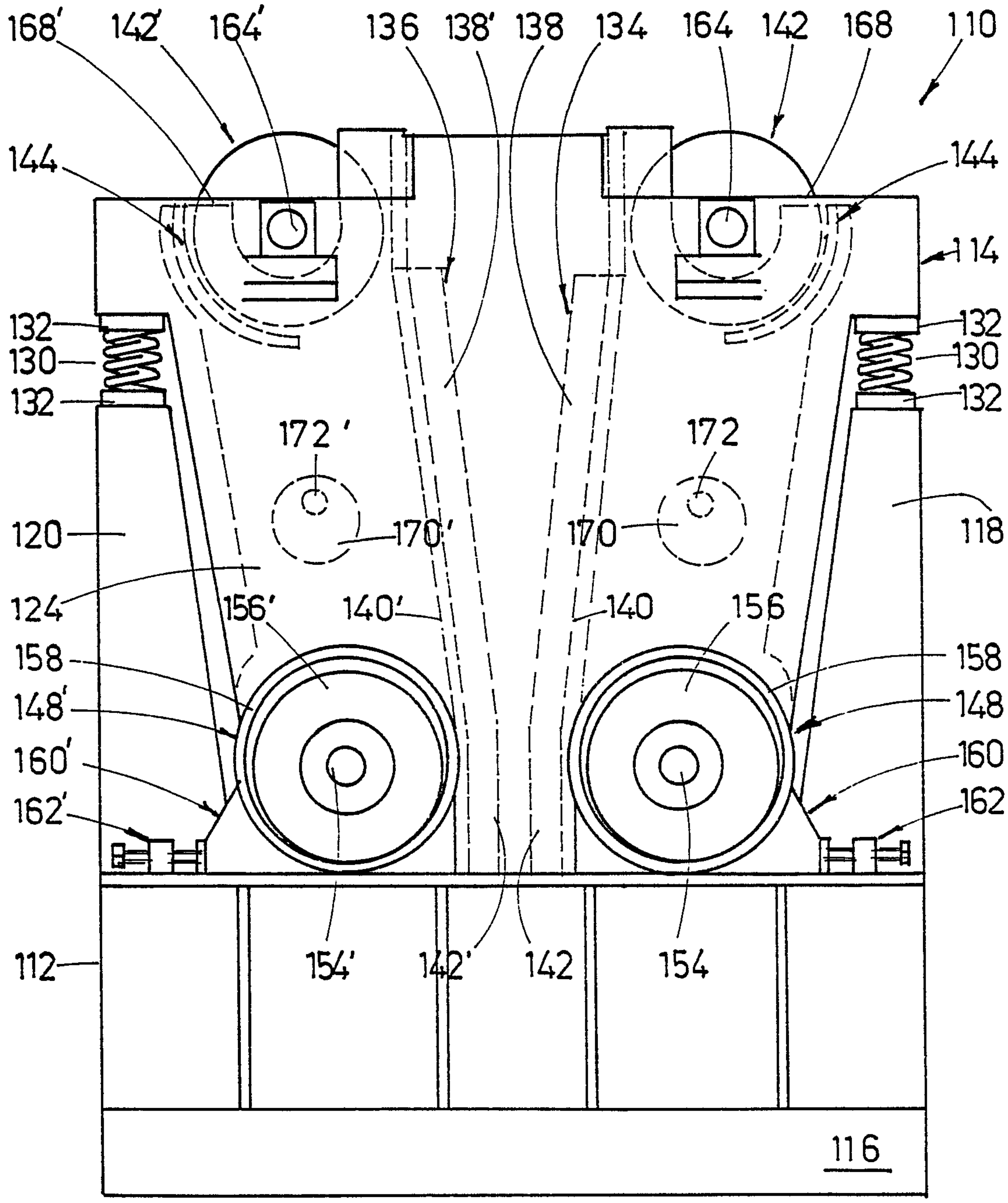
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FIG 5

Neu eingereicht / Newly filed
Nouvellement déposé

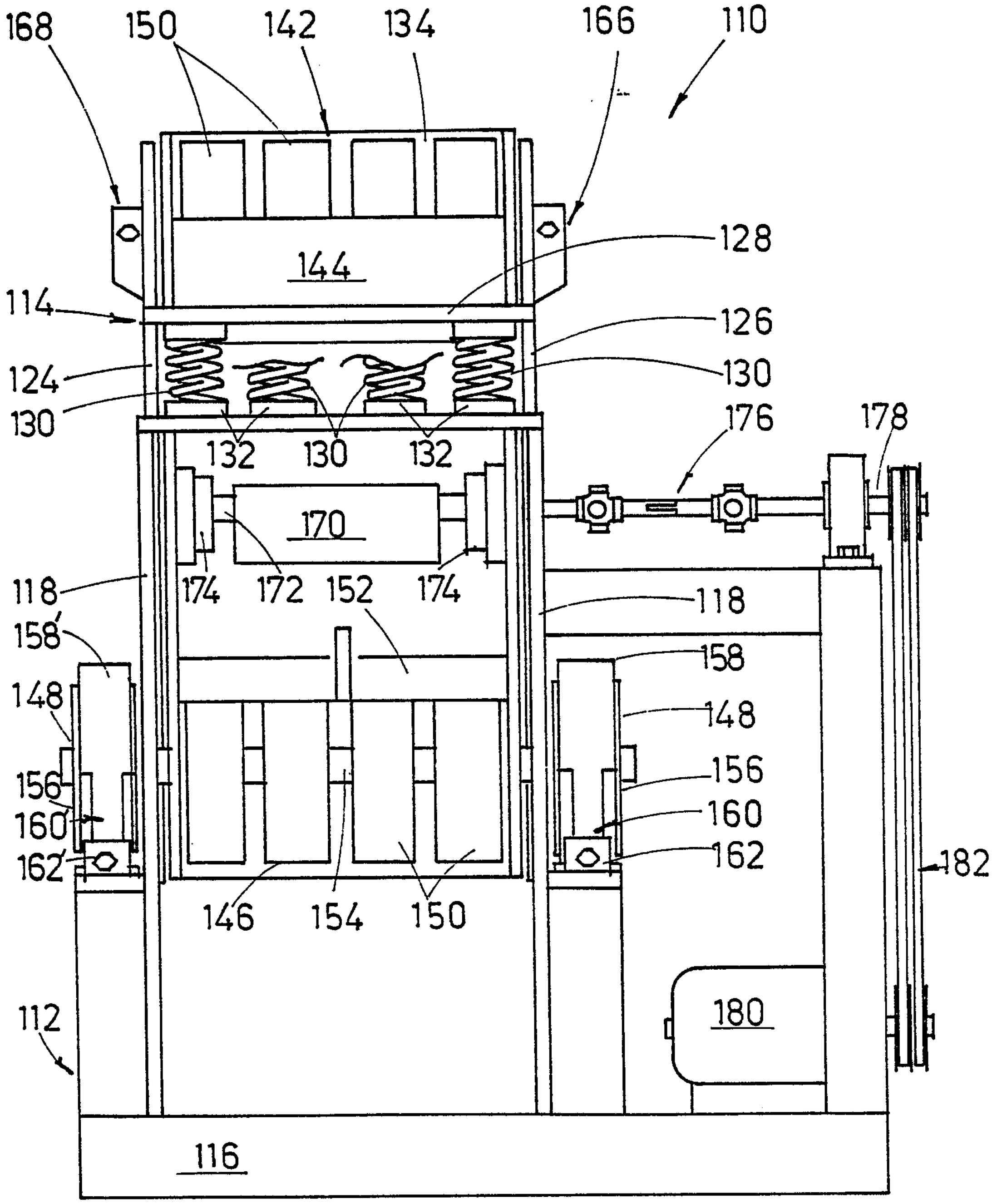
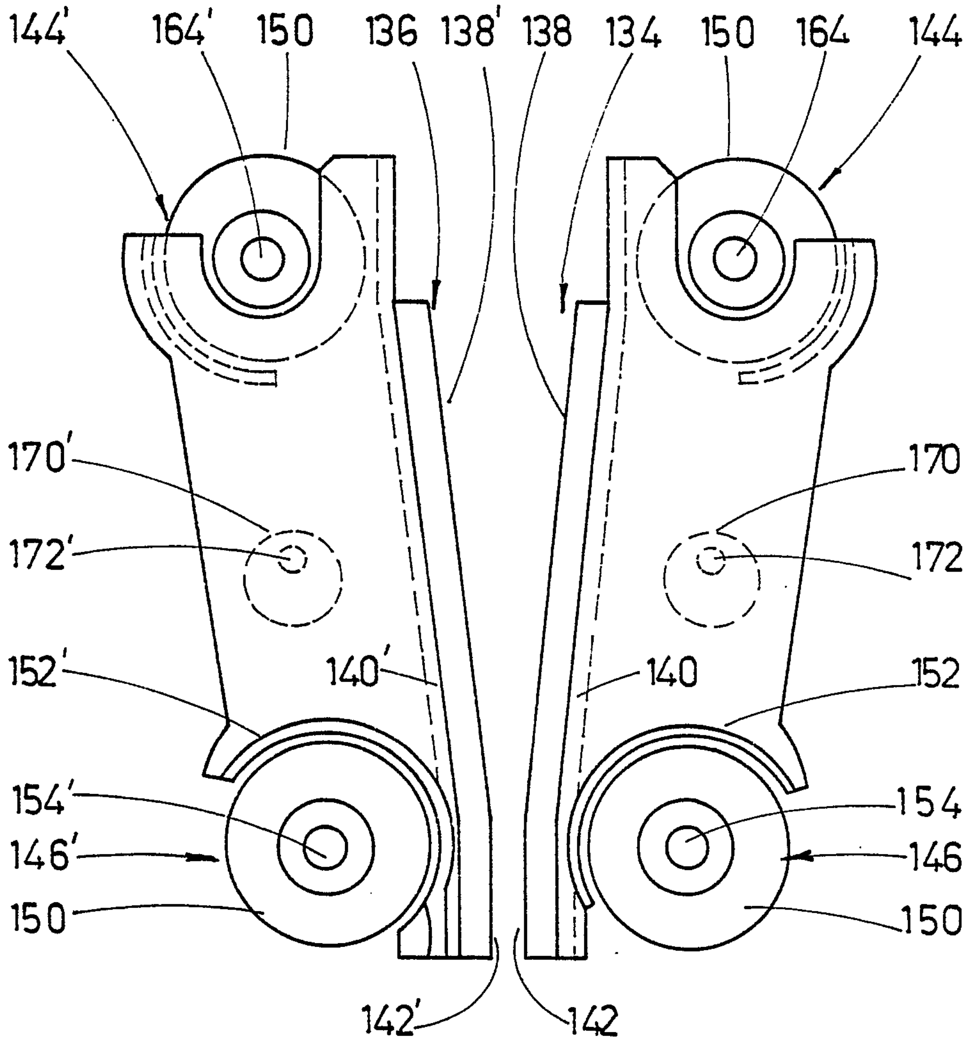


FIG 6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142'
142

FIG 7

Neu eingereicht / Newly filed
Nouvellement déposé

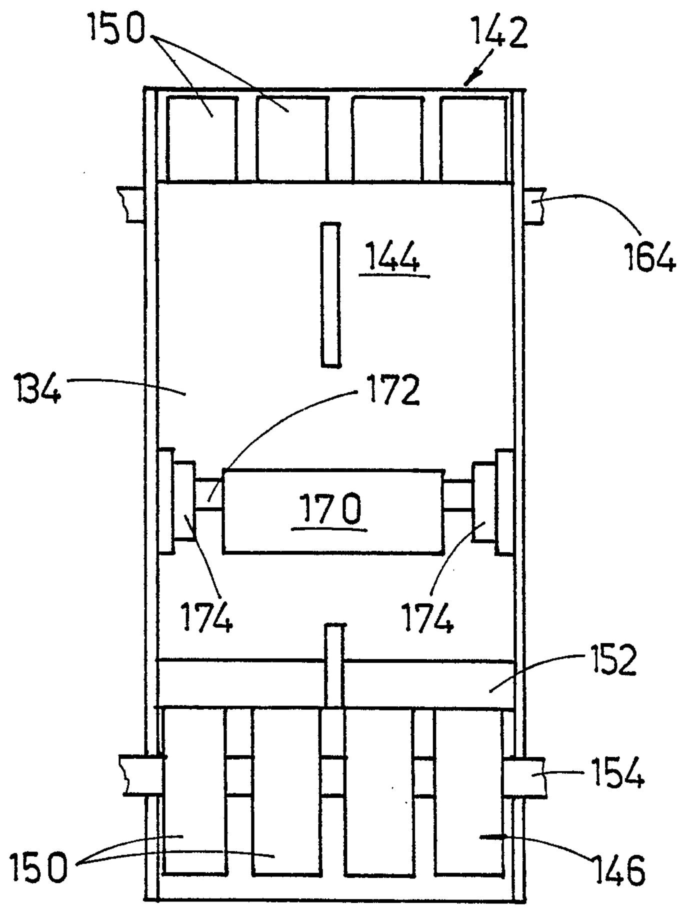


FIG 8

Neu eingereicht / Newly filed
Nouvellement déposé

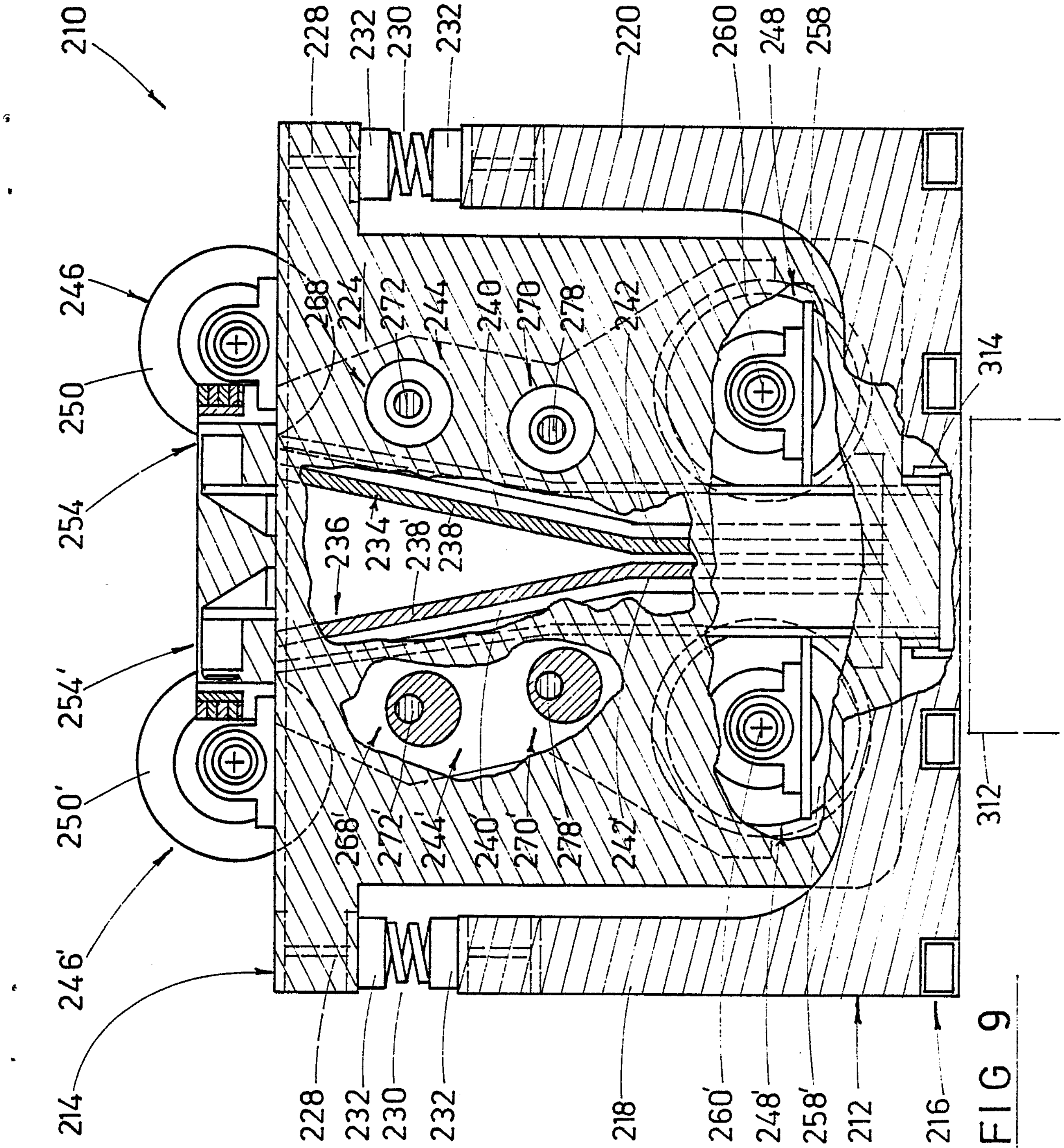
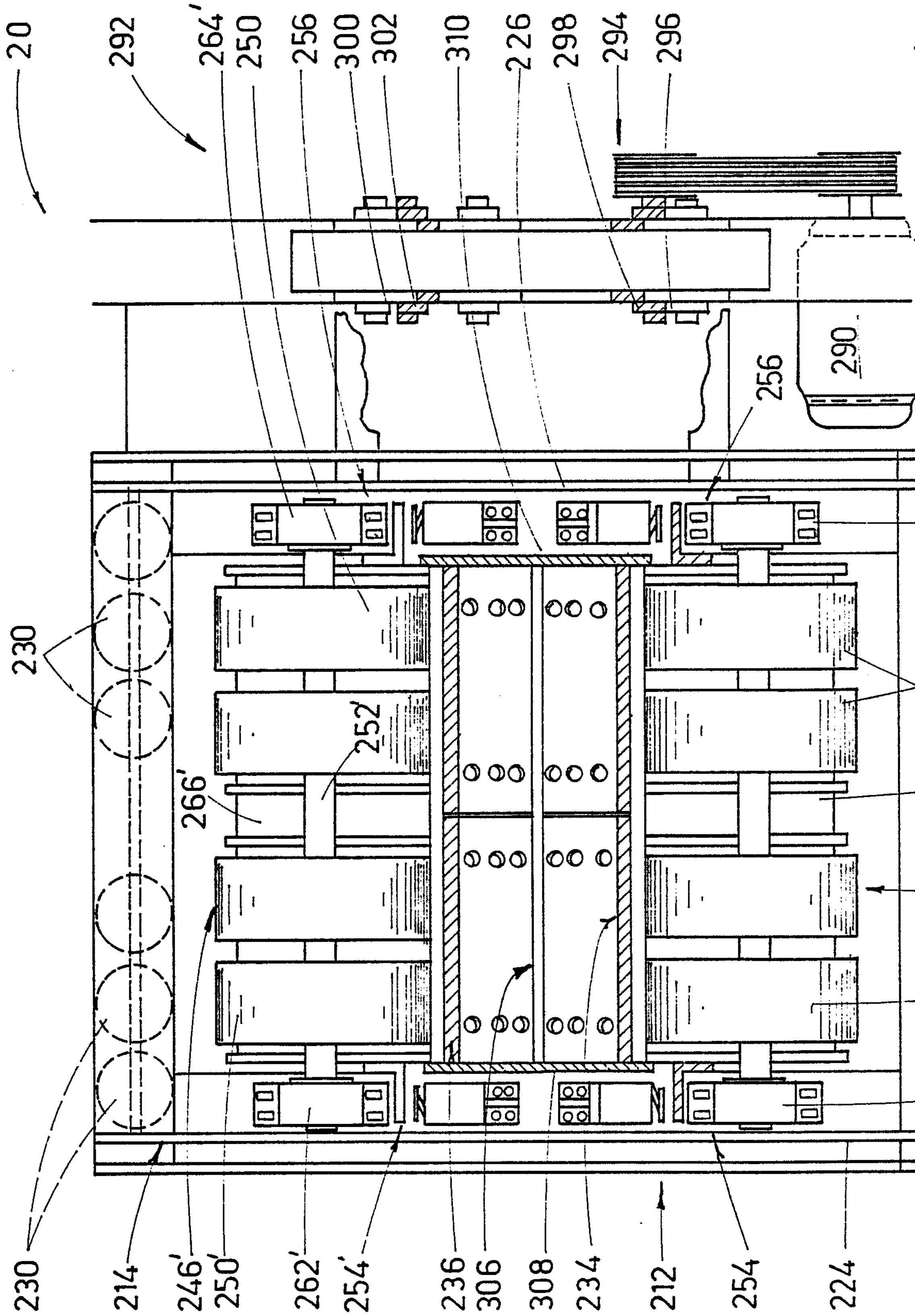


FIG 9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212
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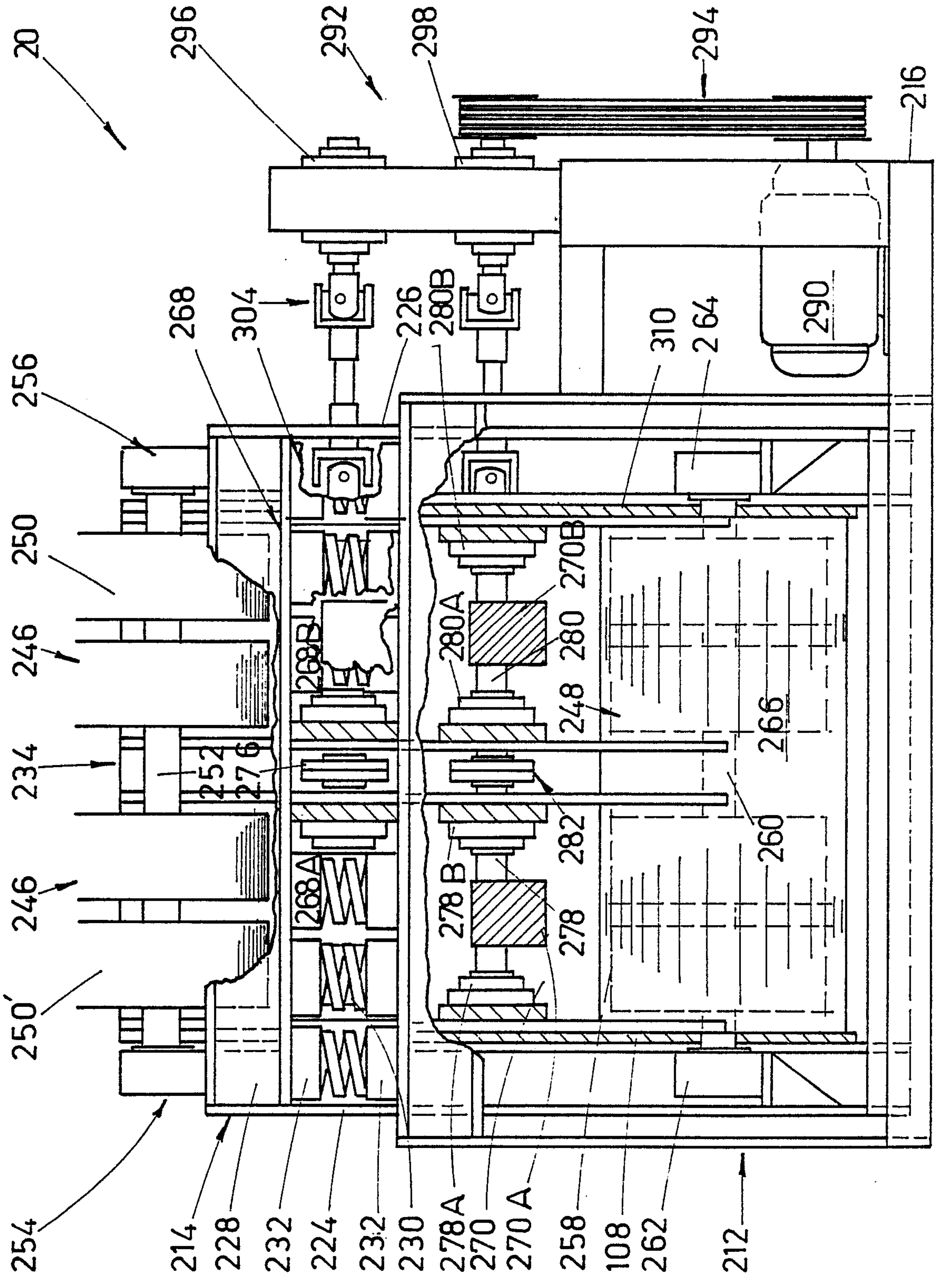
224

FIG 10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266
234
252
276
282
260
268A
278B
278
250´
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FIG 11

Neu eingereicht / Newly filed
Nouvellement déposé

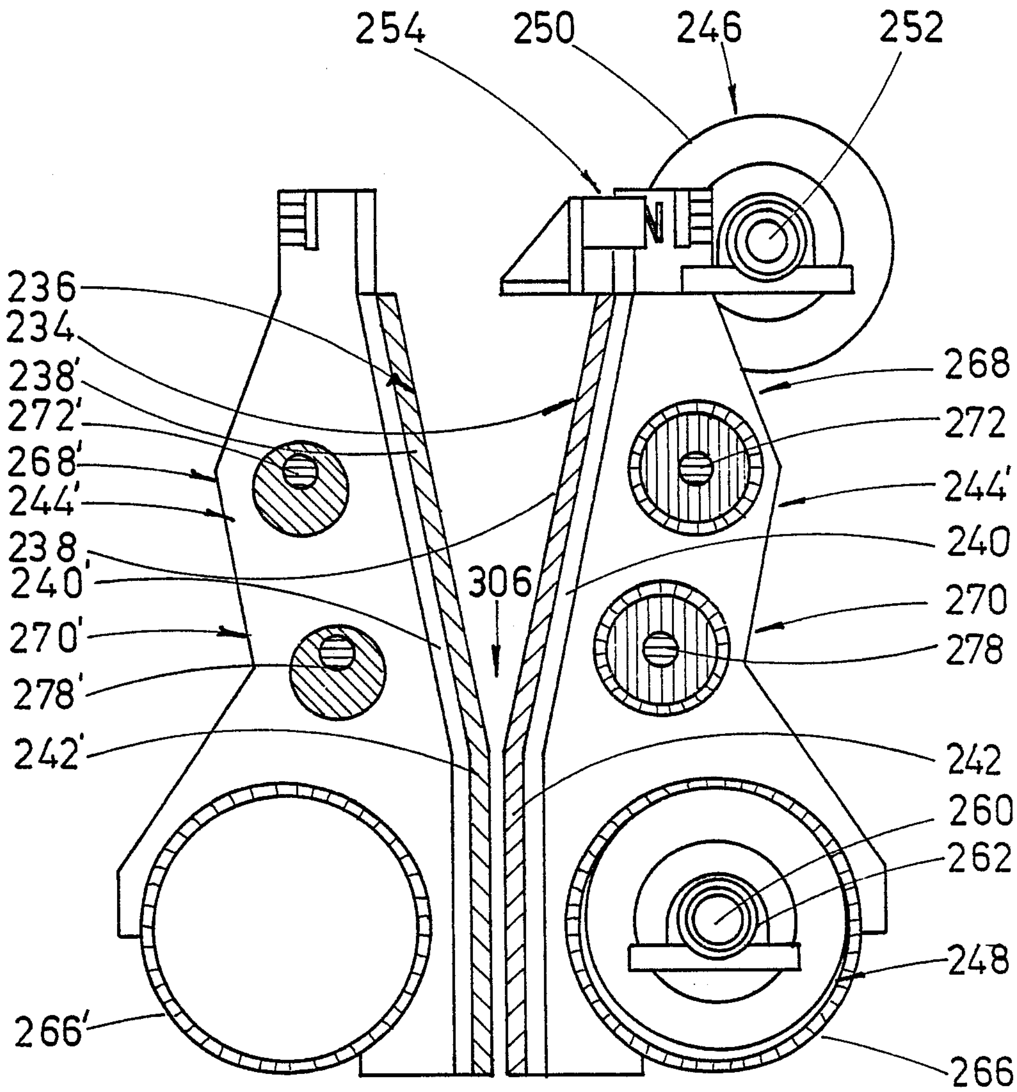
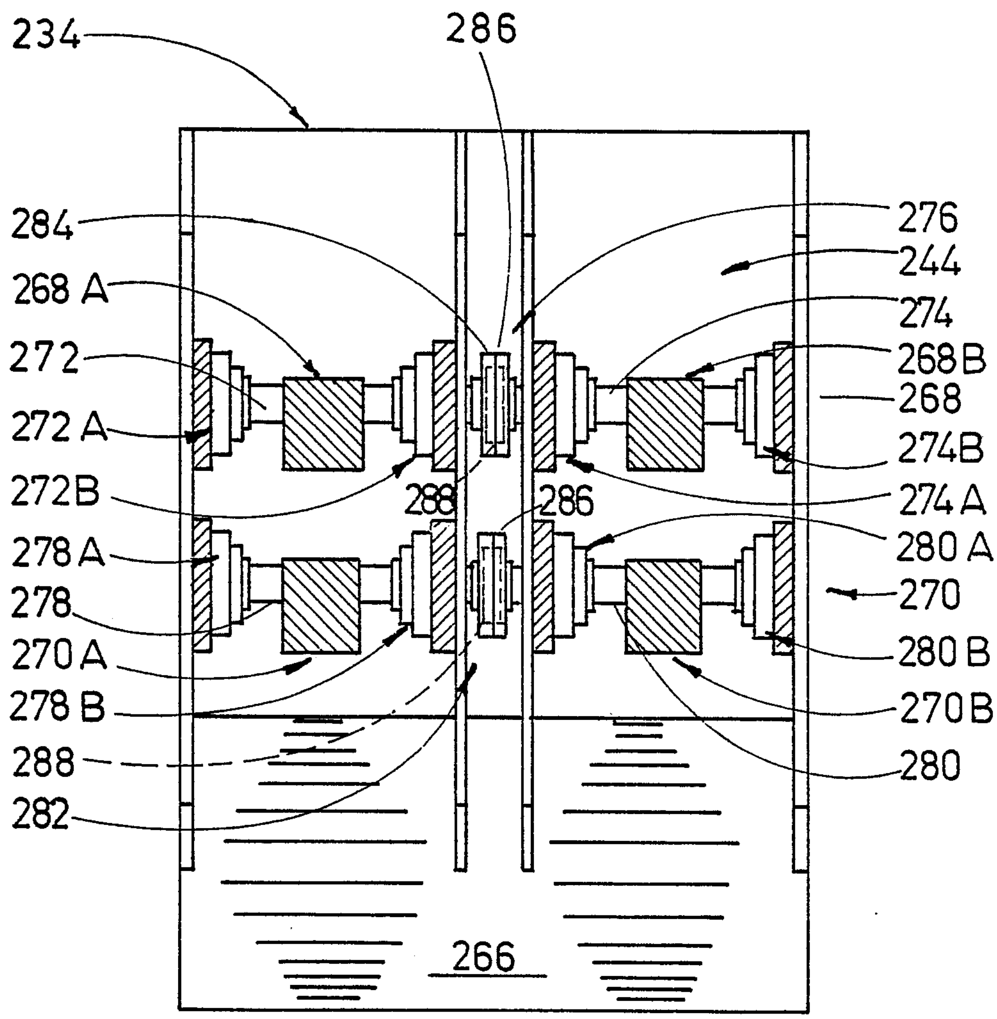


FIG 12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274B
274 A
280 A
270
280 B
270B
280
266

FIG 13