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(54) **A CRUSHER DRIVE TRAIN**

(57) A drive train (130) for a crusher (10) for crushing materials having a crusher roller (40) mounted between first and second roller bearings (100,110) in which movement of the first and second roller bearings (100,110) is synchronized via a bearing movement synchronization system (260) wherein the drive train (130) comprises a transmission (140) having a drive shaft (150) connectable to a motor (160) and an output shaft (170) connectable with the crusher roller (40) at the first or second roller bearing (100,110) wherein the drive train (130) comprises a connector (300) connectable with the bearing movement synchronization system (260) to effect synchronized movement of the drive train (130) with the crusher roller (40).

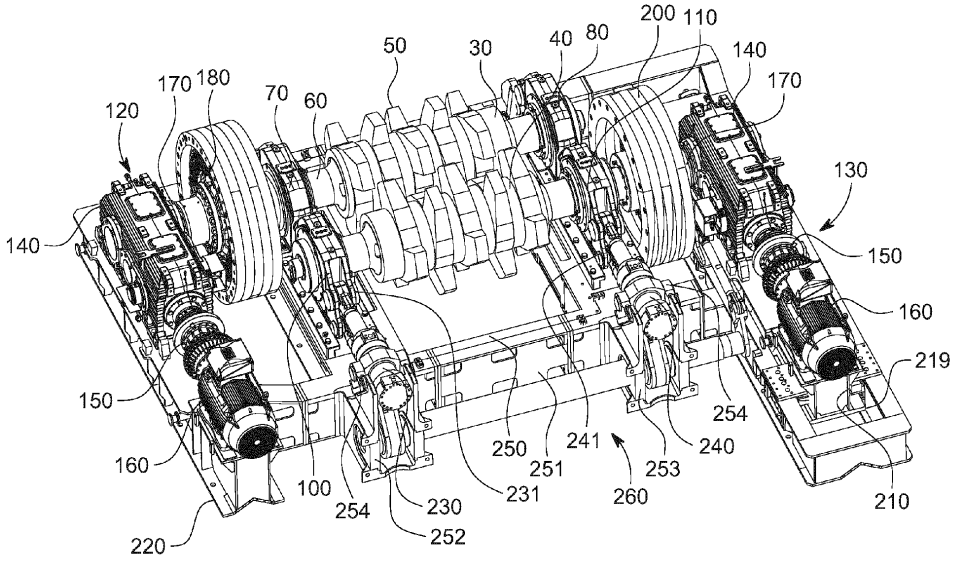

FIG. 2

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Description

Field of Invention

[0001] This invention generally relates to a drive train for a roll crusher for bulk materials and to a roll crusher comprising the drive train. The invention also relates to a method of synchronising movement of a drive train of a roll crusher with movement of a roller of the roll crusher.

Background of the Invention

[0002] Roll crushers are widely used for crushing bulk materials such as rock, ores and coal and are generally formed from pairs of shaft-mounted counter-rotating crusher rollers provided with teeth and/or segments between which bulk material fed to the crusher rollers is crushed. In general, one of the pair of crusher rollers is axially movable to calibrate the roll crusher and to allow large bulk material to be passed between the crusher rollers. A transmission of a fixed drive train (powered by a motor) is coupled at a fixed coupling to each crusher roller shaft to effect rotation of the shafts i.e. the drive train and the coupling are in a fixed relationship and axially synchronised in use. However, due to the nature of the bulk materials to be crushed which vary considerably in size and hardness, rotation of the crusher rollers can be disrupted giving rise to radial and torsional forces (e. g. torque peaks) and the like in excess of the tolerance of the fixed coupling which can be transferred to the transmission via the coupling resulting in damage to the coupling, the transmission, the motor or other drive train components. This in turn can lead to significant downtime to allow for repair of the crusher.

[0003] Elastic couplings can be employed to damp the radial and torsional forces generated by the crusher rollers and prevent damage to the coupling, transmission and motor. However, in use, elastic couplings are incapable of synchronising axial movement of movable crusher rollers and drive trains resulting in misalignment and damage to the crusher rollers, the roller bearing and drive trains.

[0004] An object of the invention is overcome at least some of the problems of the prior art.

Summary of the Invention

[0005] According to the invention there is provided a drive train for a crusher for crushing materials having a crusher roller mounted between first and second roller bearings in which movement of the first and second roller bearings is synchronized via a bearing movement synchronization system wherein the drive train comprises a transmission having a drive shaft connectable to a motor and an output shaft connectable with the crusher roller at the first or second roller bearing wherein the drive train comprises a connector connectable with the bearing movement synchronization system to effect synchronized movement of the drive train with the crusher roller.

[0006] In one embodiment, the connector comprises a mechanical connector.

[0007] Preferably, the drive train is a slidably movable drive train.

[0008] Suitably, the drive train comprises an elastic coupling for coupling the drive train with the crusher roller. Preferably, the elastic coupling is mounted at the output shaft.

[0009] In another embodiment, the invention also extends to a roll crusher for crushing materials comprising a drive train for driving a crusher roller hereinbefore defined.

[0010] Preferably, the roll crusher comprises at least two crusher rollers and the drive train drives at least one of the crusher rollers.

[0011] In one embodiment, the roll crusher has a bearing movement synchronization system comprising a synchronization shaft disposed parallel with a longitudinal axis defined between the first and second roller bearings, a first synchronization arm extending between the first roller bearing and the synchronization shaft and a second synchronization arm extending between the second roller bearing and the synchronization shaft, and the connector is axially contiguous with the synchronization shaft.

[0012] Preferably, the connector comprises an extension to the synchronization shaft. More preferably, the connector further comprises a synchronization rod extending between the synchronization shaft and the drive train.

[0013] In one embodiment, the drive train comprises a drive train carriage and the synchronization rod extends between the synchronization shaft and the drive train carriage.

[0014] Preferably, the roll crusher comprises a chassis and the drive train carriage is slidably mounted on a drive train frame integral with the chassis.

[0015] Advantageously, the synchronization rod and the first and second synchronization arms are positionally and geometrically synchronised.

[0016] The invention also extends to a method of synchronizing movement of a drive train of a roll crusher with movement of a crusher roller of the crusher in which the crusher roller is mounted between first and second bearings, the method comprising

synchronizing movement of the first and second bearings via a bearing movement synchronization system and

simultaneously synchronizing movement of the drive train with the movement of the bearing movement synchronization system.

[0017] Preferably, movement of the drive train is synchronized with movement of the bearing movement synchronization system by connecting the drive train to the bearing movement synchronization system.

[0018] More preferably, movement of the drive train is synchronized with movement of the bearing movement synchronization system by mechanically connecting the drive train to the bearing movement synchronization system.

[0019] Movement of the drive of the invention is synchronised with movement of the movable roller of the roll crusher so that no misalignment occurs between the movable roller shaft and the drive train. Accordingly, an elastic coupling can be employed between the roller shaft and the drive train to decrease the transfer of axial, radial and torsional forces (e.g. torque peaks) from the movable roller to the drive train - i.e. correct alignment between the drive train output shaft and the movable roller shaft is maintained at all times. As a result, the risk of damage to the coupling, the transmission, the bearings, bearing housings and the motor is reduced.

[0020] The invention exploits the bearing movement synchronization system which synchronises movement of the movable roller bearings in roll crushers by providing the drive train with a connector to connect the drive train with the bearing movement synchronization system to effect a co-ordinated and synchronised movement of the drive train with the movable roller bearings.

[0021] Furthermore, by forming the chassis of the roll crusher, including the drive train frames, as a single unitary structure with the movable roller drive train being slidably mounted on the chassis, the overall stability of the chassis is improved in use thus increasing the longevity of the chassis.

Brief Description of the Drawings

[0022] The invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a perspective view from above and one side of a roll crusher of the invention in which the roll crusher is provided with a fixed crusher roller, a movable crusher roller, a bearing movement synchronization system to synchronise movement of the crusher rollers and a drive train for the movable roller having a connector connectable with the bearing movement synchronization system to effect synchronized movement of the drive train with the movable crusher roller;

Figure 2 is a reverse perspective view from above and one side of the roll crusher of Figure 1 with the crusher chamber removed to more clearly show the crusher rollers, the bearing movement synchronization system and the hydraulic rams for effecting movement of the movable roller;

Figure 3 is a perspective view from above and one side of the chassis of the roll crusher with the drive trains, the crusher chamber and the crusher rollers removed to show a drive train carriage of the movable drive train slidably mounted (in the direction indicated by the arrow) on a drive train frame which is integral with the chassis in a one-piece unitary structure (with the fixed roller drive train omitted);

Figure 4 is a perspective view from above and one side of the roll crusher of the invention with the hydraulic rams omitted to reveal the bearing movement synchronization system and the drive train connector connectable with the bearing movement synchronization system in bold;

Figure 5 is a perspective view from above and one side of the roll crusher of Figure 4 with the movement support frame omitted to more clearly show the bearing movement synchronization system and the movable roller drive train connector;

Figure 6 is a front view of the roll crusher with the crusher chamber removed showing the geometrically positionally synchronised positions of the synchronisation arms of the bearing movement synchronization system and the connector of the movable drive train;

Figure 7 is a front view of the roll crusher similar to the view of Figure 6 but with the drive train for the movable roller omitted, and

Figure 8 is a top plan view of the roll crusher of Figure 4 also showing the geometrically positionally synchronised positions of the synchronisation arms of the bearing movement synchronization system and the connector of the drive train.

Detailed Description of the Invention

[0023] As shown in Figures 1 and 2, a roll crusher in accordance with the invention is generally indicated by the reference numeral 10 and is made up of a crusher chamber 20 fitted with a first fixed crusher roller 30 (hereinafter referred to as a fixed roller) and a second movable crusher roller 40 (hereinafter referred to as a movable roller) co-operable with the fixed roller 30 to crush bulk materials between the crusher rollers 30,40. The movable roller 40 allows for the distance between the fixed roller 30 and the movable roller 40 to be adjusted in accordance with the size of the materials to be crushed and the desired size of the crushed materials. The movable roller 40 can also be moved to allow oversized materials to pass through the roll crusher 10.

[0024] Each crusher roller 30,40 is provided with teeth/segments 50 to effect the crushing action. The fixed roller 30 is provided with a fixed roller shaft 60 at the crusher chamber 20 which is supported between a first fixed roller bearing 70 and an oppositely disposed second fixed roller bearing 80 while the movable roller 40 is sim-

ilarly mounted on a movable roller shaft 90 at the crusher chamber 20 supported between a first movable roller bearing 100 and an oppositely disposed second movable roller bearing 110.

[0025] The fixed roller 30 is rotated by a fixed roller drive train 120 adjacent the first fixed roller bearing 70 while the movable roller 40 is rotated by a movable roller drive train 130 adjacent the second movable roller bearing 110. Each drive train 120,130 is made up of a transmission 140, a drive shaft 150 connected with a motor 160 and an output shaft 170.

[0026] The output shaft 170 of the fixed roller drive train 120 is provided with an elastic coupling 180 to attach the fixed roller drive train 120 to the shaft 60 of the fixed roller 30. Similarly, the movable roller 40 is provided with an elastic coupling 190 to attach the movable roller drive train 130 to the shaft 90 of the movable roller 40. The elastic couplings 180,190 serve to decouple axial forces and damp radial forces/high peak torsional forces generated during the crushing process so that the risk of damage to the drive trains 120,130 is significantly reduced. The fixed and movable rollers 30,40 are also provided with a flywheel 200 at the elastic couplings 180,190 to assist in the controlled transfer of force between the fixed and movable rollers and the drive trains 120,130.

[0027] The roll crusher 10 is provided with a bearing movement synchronization system 260 to control movement of the movable roller 40 and, as shall be explained more fully below, the movable roller drive train 130 is connected to the bearing movement synchronization system 260 to effect synchronized movement of the movable roller drive train 130 with the movable crusher roller 40 thus preventing misalignment and damage to the movable crusher roller 40 and the movable roller drive train 130 in use.

[0028] The crusher chamber 20 with crusher rollers 30,40 and the drive trains 120,130 are mounted on a crusher chassis 220.

[0029] As shown particularly in Figure 2, movement of the movable roller 40 towards and away from the fixed roller 30 is controlled by first and second hydraulic rams 230,240. The first and second hydraulic rams 230,240 are each connected at one end to the movable roller 40 at respective ram mountings 231,241 provided on the movable roller first and second bearings 100,110 respectively and at a second end to a movement support frame 250 spaced apart from the movable roller 40 which forms part of the chassis 220. The hydraulic rams 230,240 are provided with pressure limiting valves so that that hydraulic rams 230,240 can be automatically actuated in response to excessive forces at the crusher chamber 20 to move the movable roller 40.

[0030] The movement support frame 250 is made up of a transverse beam 251 on the chassis 220 spaced apart from and disposed parallel with the movable roller shaft 90 and having a first pair of spaced apart mounting plates 252 opposite the first movable roller bearing 100 and a second pair of spaced apart mounting plates 253 opposite the second movable roller bearing 110. The hydraulic rams 230,240 are secured at their second ends to upper fixings 254 defined in the mounting plates 252,253. Openable hydraulic ram end covers 255,256 are also secured to the spaced apart mounting plates 252,253 (see also Figure 1).

[0031] Figure 3 shows a perspective view from above and one side of the chassis 220 of the roll crusher 10 with the crusher chamber 20, the crusher rollers 30,40 and the drive trains 120,130 removed to more clearly illustrate the chassis 220. The fixed roller drive train 120 is also omitted. As shown in the drawing (and in Figures 1, 2 and 4), the chassis 220 is made up of a central rectangular platform 221 for supporting the crusher chamber 20 and the crusher rollers 30,40. The central platform 221 is defined by a rear wall 222, two oppositely disposed side walls 222,223 and the transverse beam 251. The roller bearings 70,80,100,110 are supported at the side walls 222,223 while a fixed roller drive train frame 225 for supporting the fixed roller drive train 120 is formed integrally with the side wall 223 to form a unitary chassis structure and a movable roller drive train frame 226 for supporting the movable roller drive train 130 is formed integrally with the side wall 224 also to form the unitary chassis structure. Accordingly, the central platform 221, the fixed roller drive train frame 225 and the movable roller drive train frame 226 form a unitary one piece structure to enhance the rigidity and stability of the chassis 220 and the performance of the roll crusher 10.

[0032] The movable roller drive train 130 is mounted on the movable roller drive train frame 226 on an axially movable drive train carriage 210 in a sliding relationship so that the drive train carriage 210 is slidably movable along a horizontal axis oriented substantially perpendicular with the longitudinal axis defined by the movable roller shaft 90.

[0033] In the present embodiment, the movable carriage 210 is made up of an elongate generally rectangular frame 211 having a top face 212 on which the transmission 140 and the motor 150 are mounted, a bottom plate 213, a first side wall 214 extending between the top face 212 and bottom plate 213 and a second oppositely disposed side wall 215 extending between the top and bottom plates 212,213. The bottom plate is 213 is provided with two laterally extending elongate tongues 216,217 which extend the length of the bottom plate 213 and are insertable in complementary elongate spaced apart grooves 218,219 defined in a chassis 220 on which the crusher chamber 20 and the drive trains 120,130 are supported. The tongues 216,217 and complementary grooves 218,219 enjoy a sliding relationship to facilitate sliding movement of the movable drive train carriage 210 on the chassis 220.

[0034] As shown particularly in Figures 4 and 5, coordinated inward and outward movement of the movable roller 40 is achieved at the first and second movable roller bearings 100,110 by the bearing movement synchronisation system 260. The bearing movement synchronisa-

tion system 260 ensures that no damage occurs to the crusher rollers 30,40 or the bearings 70,80,100,110 and the segments 50, during movement. The bearing movement synchronisation system 260 is provided at the support frame 250 and is made up of a transverse shaft 270 extending between and rotatably supported in lower transverse shaft openings 271 located beneath the fixings 254 in the mounting plates 252,253.

[0035] First bearing link plates 272 are mounted on the transverse shaft 270 between the first pair of mounting plates 252 and second bearing link plates 273 are mounted on the transverse shaft 270 between the second pair of mounting plates 253. The link plates 272,273 are in turn rotatably attached to respective synchronisation arms 280,281 disposed substantially perpendicular to the transverse shaft 270 at articulatable synchronisation arm mountings 282,283. At their opposite ends, the synchronisation arms 280,281 are secured to the movable roller first and second bearings 100,110 respectively at respective articulatable synchronisation arm couplings 284,285 at the first and second bearings 100,110 disposed beneath the ram mountings 231,241. Accordingly, the synchronisation arms 280,281 in combination with the transverse shaft 270 ensure synchronised, co-ordinated and controlled movement of the movable roller 40 via its first and second bearings to prevent damage to the crusher rollers 30,40.

[0036] Importantly, the movable roller drive train 130 is provided with a connector 300 which can be connected to the bearing movement synchronisation system 260 so that the drive train 130 can move in synchronicity on the slidably movable carriage 210 with the movable roller 40 via the first and/or second movable roller bearings 100,110 despite the use of the elastic coupling 190 to couple the movable roller 40 with the transmission output shaft 170.

[0037] In the present embodiment, the connector 300 is a mechanical connector 300 in the form of an axial extension 310 to the transverse shaft 270 which is axially contiguous with the transverse shaft 270 and is attached to the movable roll drive train 130, and more particularly to the slidably movable drive train carriage 210 via a synchronisation rod 320 disposed substantially perpendicular to the shaft extension 310 (substantially parallel with the synchronisation arms 280,281). The shaft extension 310 can be integral with or attachable to the transverse shaft 270.

[0038] As shown in the drawings, in the present embodiment, the shaft extension 310 is integral with the transverse shaft 270 whereby the transverse shaft 270 extends beyond the second pair of spaced apart mounting plates 253 to form the shaft extension 310. The synchronisation rod 320 is rotatably mounted between a free end 330 of the shaft extension 310 at a rod link plate mounting 340 and the drive train carriage 210 at an articulatable synchronisation rod mounting 360 on the drive train carriage 210 (see Figure 3). Accordingly, axial movement of the movable roller 40 is automatically translated by the bearing movement synchronisation system 260 into axial movement of the slidably movable carriage 210 on which the movable drive train 130 is mounted so that movement of the movable roller 40 and the movable roller drive train 130 is fully synchronised.

[0039] Figures 6 to 8 show front and top views of the roll crusher 10 of the invention and illustrate the geometrically positionally synchronised positions of the synchronisation arms 280,281 of the bearing movement synchronization system 260 and the synchronisation rod 320 of the connector 300. As shown in the drawings, the shaft 270, the shaft extension 271, the synchronisation arms 280,281, the synchronisation rod 320 and their associated mountings (e.g. the articulatable synchronisation arm mountings 282,283, the articulatable synchronisation arm couplings 284,285, the rotatable rod link plate mounting 340 and the articulatable synchronisation rod mounting 360) are configured to ensure a fully synchronised and co-ordinated movement of the movable roller bearings 110,110 and hence the movable roller 40 and the movable roller drive train 130. Accordingly, the synchronization rod 320 is disposed parallel with the first and second synchronization arms 280,290 in a single notional horizontal plane extending between the synchronization rod 320 and the first and second synchronization arms 280,290. In addition, the articulatable synchronisation arm mountings 282,283 and the rotatable rod link plate mounting 340 are disposed along a single horizonal axis defined be the shaft 270 and the shaft extension 310. Accordingly, the spatial relationship between the bearing movement synchronization system 260 and the connector 300 remains constant to guarantee the synchronised movement of the movable roller 40 and the movable roller drive train 130 in use.

Claims

1. A drive train (130) for a crusher (10) for crushing materials having a crusher roller (40) mounted between first and second roller bearings (100,110) in which movement of the first and second roller bearings (100,110) is synchronized via a bearing movement synchronization system (260) wherein the drive train (130) comprises a transmission (140) having a drive shaft (150) connectable to a motor (160) and an output shaft (170) connectable with the crusher roller (40) at the first or second roller bearing (100,110) wherein the drive train (130) comprises a connector (300) connectable with the bearing movement synchronization system (260) to effect synchronized movement of the drive train (130) with the crusher roller (40).

2. A drive train (130) as claimed in Claim 1 wherein the connector (300) comprises a mechanical connector (300).

3. A drive train (130) as claimed in Claim 1 or Claim 2 wherein the drive train (130) is a slidably movable drive train.

4. A drive train (130) as claimed in any of Claims 1 to 3 wherein the drive train (130) comprises an elastic coupling (190) for coupling the drive train (130) with the crusher roller (40).

5. A drive train (130) as claimed in Claim 4 wherein the elastic coupling (190) is mounted at the output shaft (170).

6. A roll crusher (10) for crushing materials comprising a drive train (130) for driving a crusher roller (40) as claimed in any of Claims 1 to 5.

7. A roll crusher (10) as claimed in Claim 6 wherein the crusher (10) comprises at least two crusher rollers (30,40) and the drive train (130) drives at least one of the crusher rollers (30,40).

8. A roll crusher (10) as claimed in Claim 6 or Claim 7 having a bearing movement synchronization system (260) comprising a synchronization shaft (270) disposed parallel with a longitudinal axis defined between the first and second roller bearings (100,110), a first synchronization arm (280) extending between the first roller bearing (100) and the synchronization shaft (270) and a second synchronization arm (290) extending between the second roller bearing (110) and the synchronization shaft (270), and the connector (300) is axially contiguous with the synchronization shaft (270).

9. A roll crusher (10) as claimed in Claim 8 wherein the connector (300) comprises an extension (310) to the synchronization shaft (270).

10. A roll crusher (10) as claimed in Claim 9 wherein the connector (300) further comprises a synchronization rod (320) extending between the synchronization shaft (270) and the drive train (130).

11. A roll crusher (10) as claimed in Claim 10 wherein the drive train (130) comprises a drive train carriage (210) and the synchronization rod (320) extends between the synchronization shaft (270) and the drive train carriage (210).

12. A roll crusher (10) as claimed in Claim 11 wherein the roll crusher (10) comprises a chassis (220) and the drive train carriage (210) is slidably mounted on a drive train frame (226) integral with the chassis (220).

13. A roll crusher (10) as claimed in any of Claims 10 to 12 wherein the synchronization rod (320) and the first and second synchronization arms (280,290) are positionally and geometrically synchronized.

14. A method of synchronizing movement of a drive train (130) of a roll crusher (10) with movement of a crusher roller (40) of the crusher (10) in which the crusher roller (40) is mounted between first and second bearings (100,110), the method comprising
synchronizing movement of the first and second bearings (70,80) via a bearing movement synchronization system (260) and
simultaneously synchronizing movement of the drive train (130) with the movement of the bearing movement synchronization system (260).

15. A method as claimed in Claim 14 wherein movement of the drive train (130) is synchronized with movement of the bearing movement synchronization system (260) by connecting the drive train (130) to the bearing movement synchronization system (260).

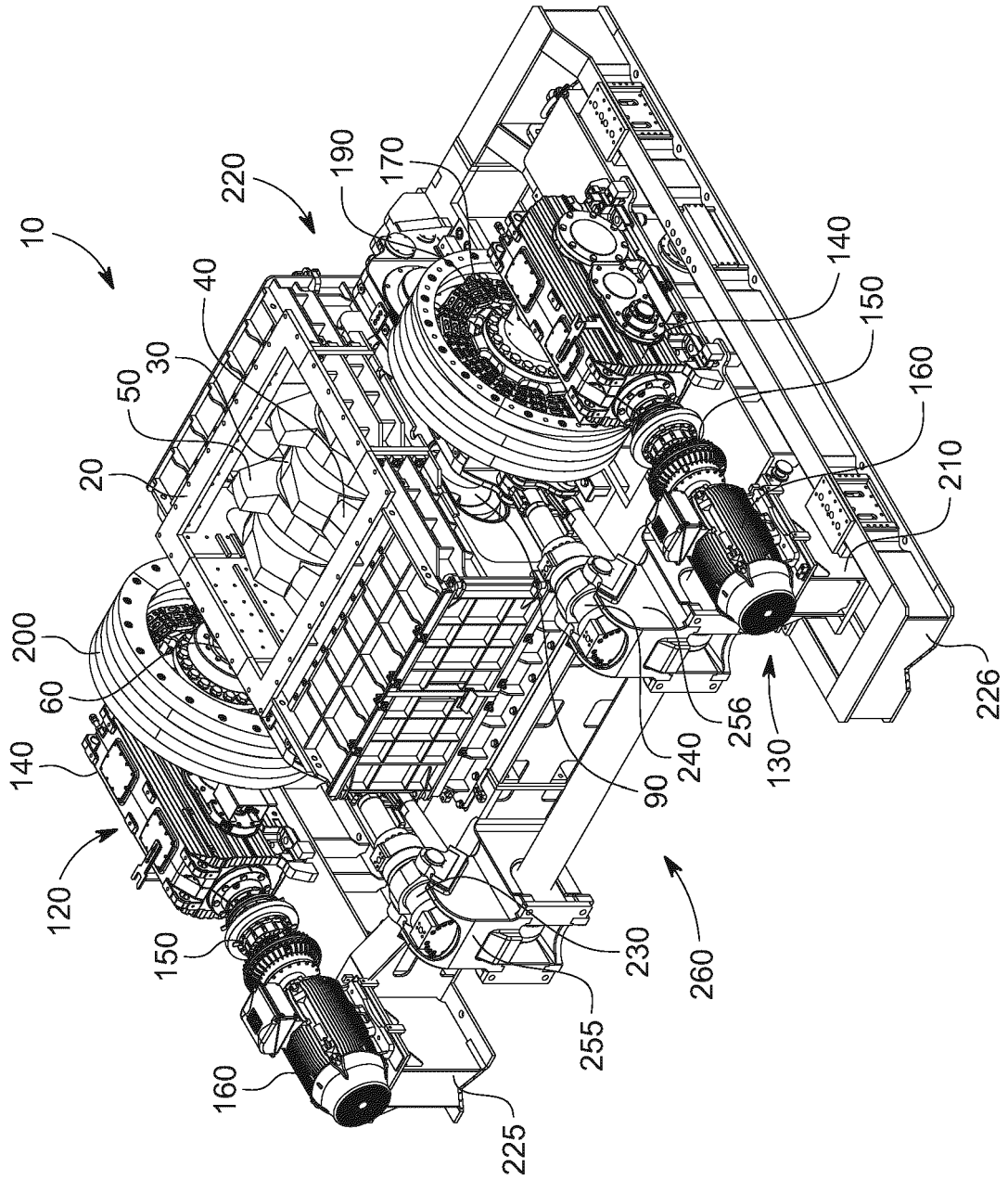
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FIG. 1

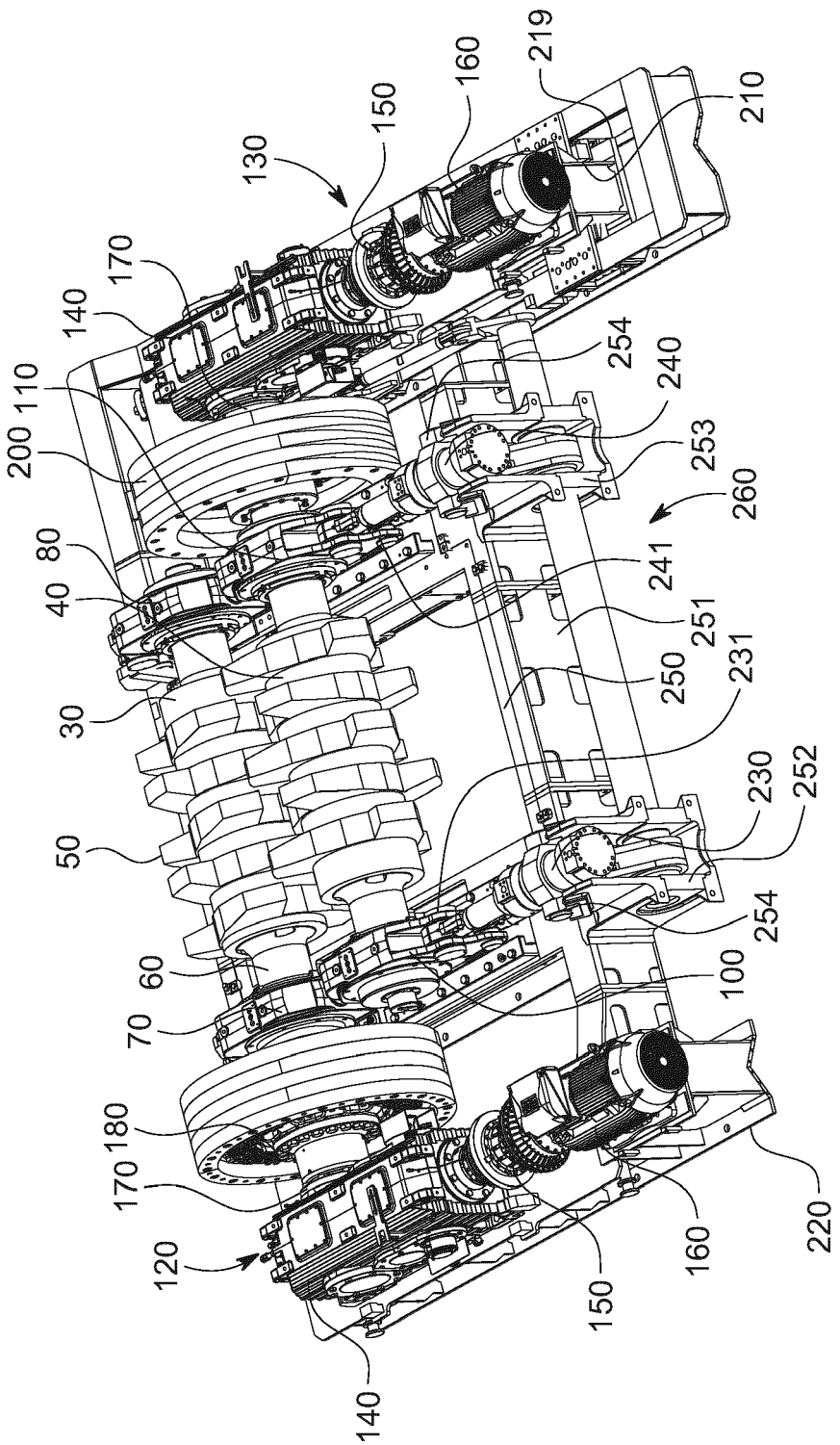
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FIG. 2

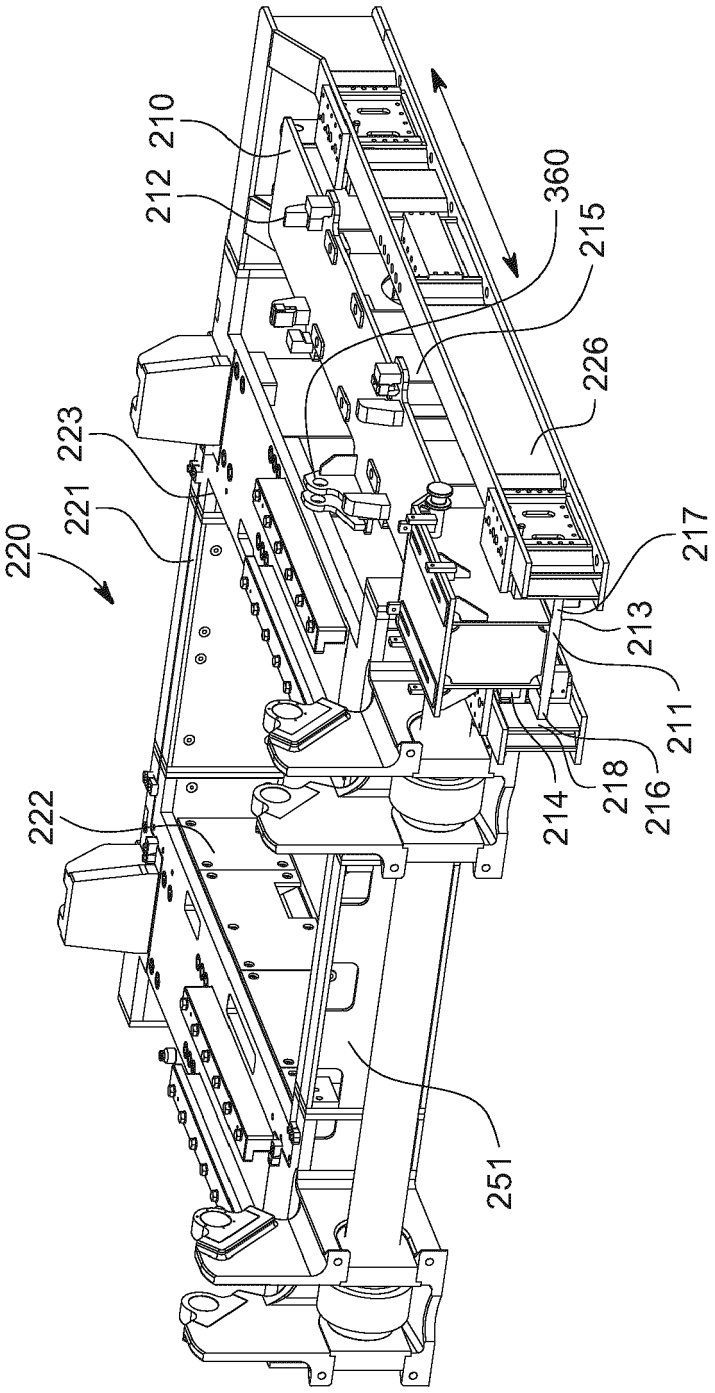

FIG. 3

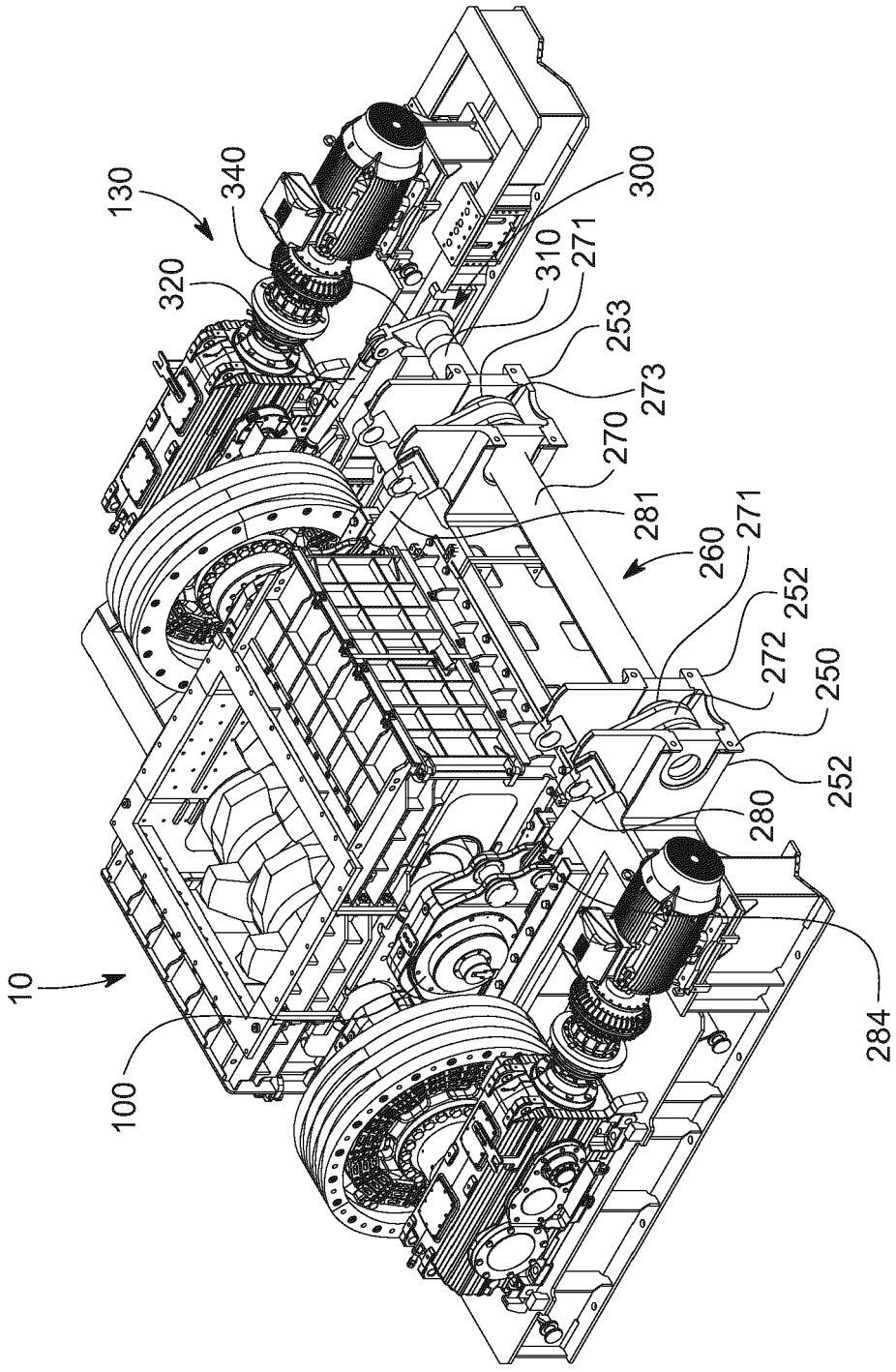
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FIG. 4

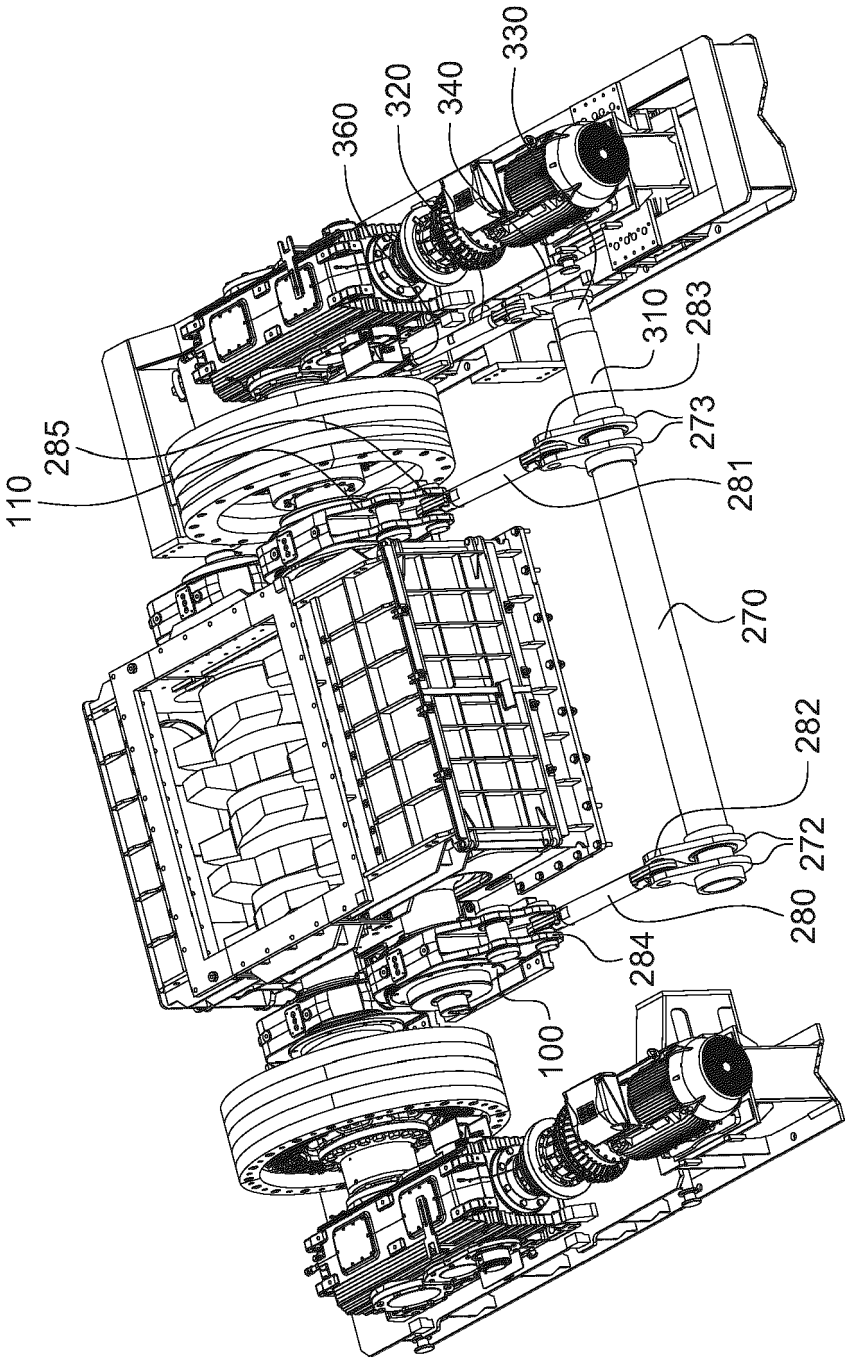

FIG. 5

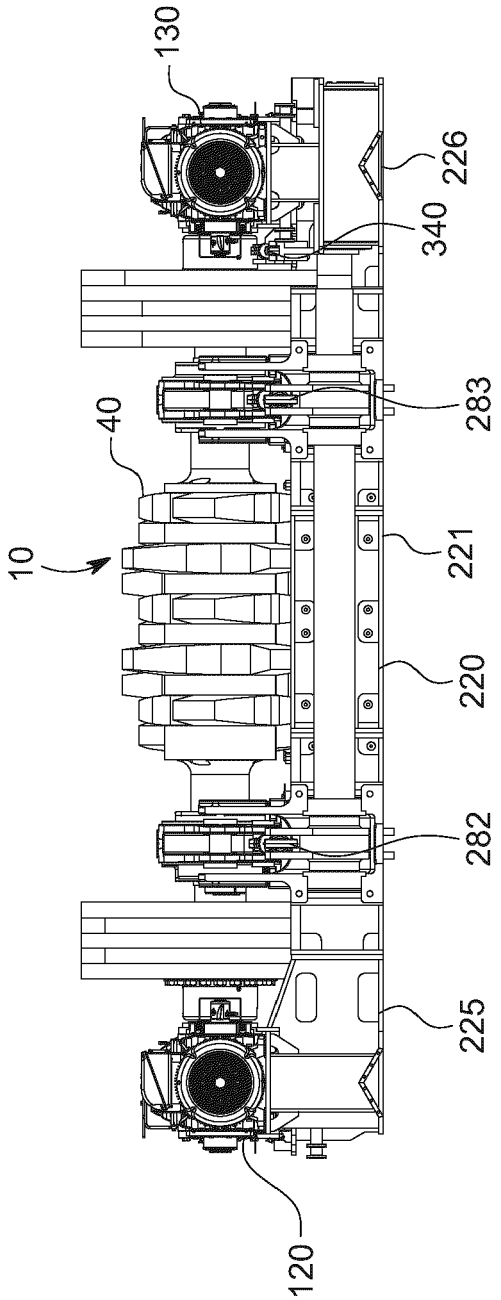
130
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FIG. 6

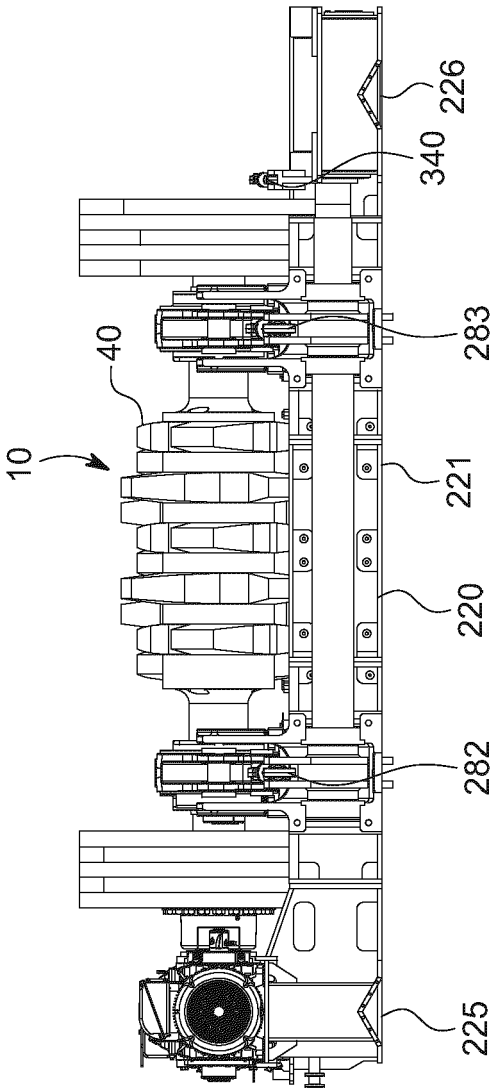
226
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FIG. 7

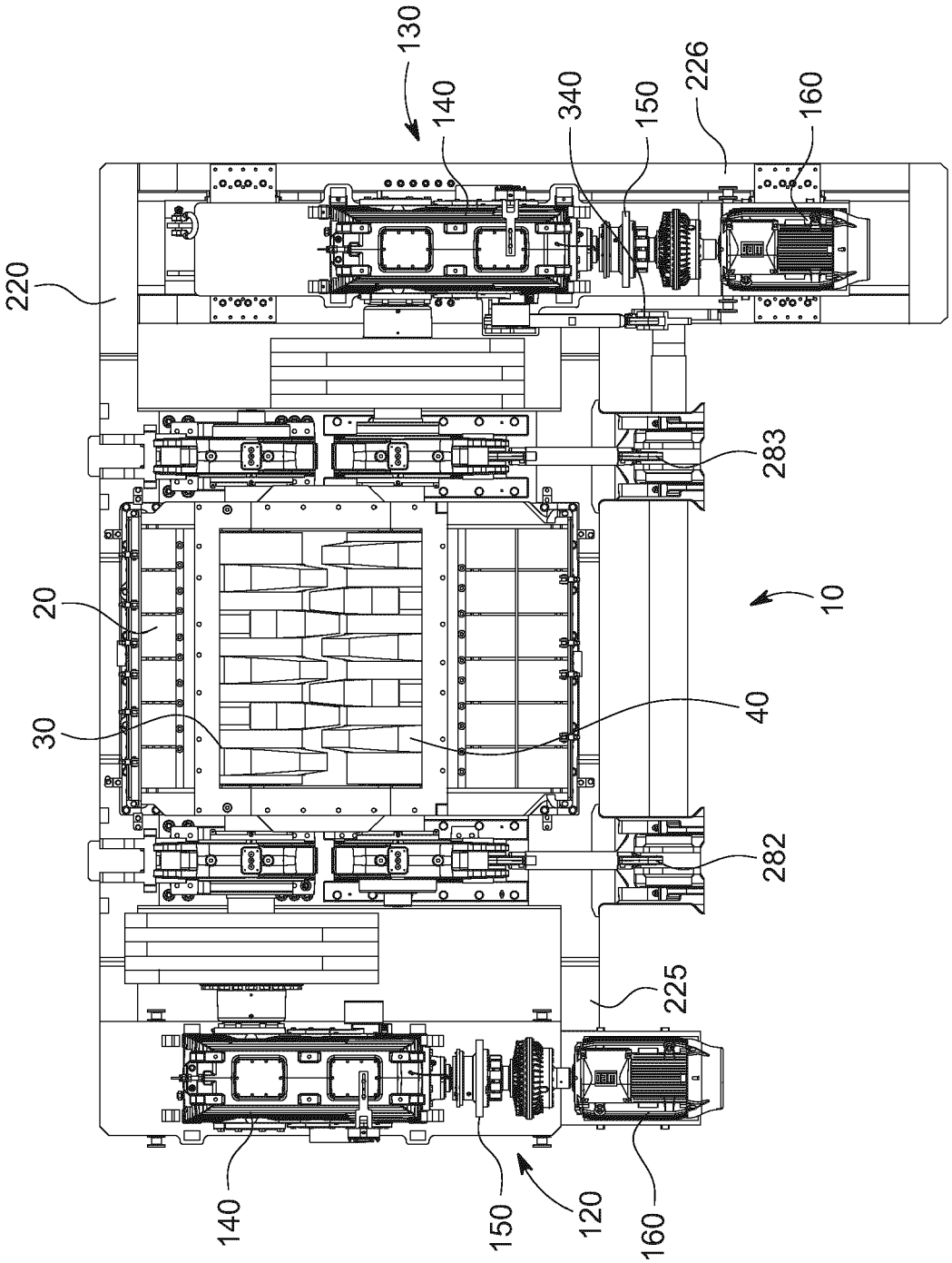
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FIG. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 21 16 2032

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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Y	* paragraphs [0011] - [0018], [0025] -	8	
A	[0035], [0040] - [0051]; figures 1-5 *	9-11,13	

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A	* page 12, line 26 - page 14, line 26; claims 1,2,10,11; figures 2-5 *	1,6	

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A	* abstract; claims 1,5; figure 6 *	1,6	
	* paragraphs [0013], [0019] - [0024] *		

TECHNICAL FIELDS SEARCHED (IPC)

B02C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	30 August 2021	Iuliano, Emanuela

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 21 16 2032

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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30-08-2021

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