



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
20.09.2023 Bulletin 2023/38

(51) International Patent Classification (IPC):
E01C 23/082 ^(2006.01) **E01H 1/08** ^(2006.01)

(21) Application number: **23159433.4**

(52) Cooperative Patent Classification (CPC):
E01C 23/082; E01H 1/0845

(22) Date of filing: **01.03.2023**

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL
NO PL PT RO RS SE SI SK SM TR**
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

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(30) Priority: **15.03.2022 NL 2031275**

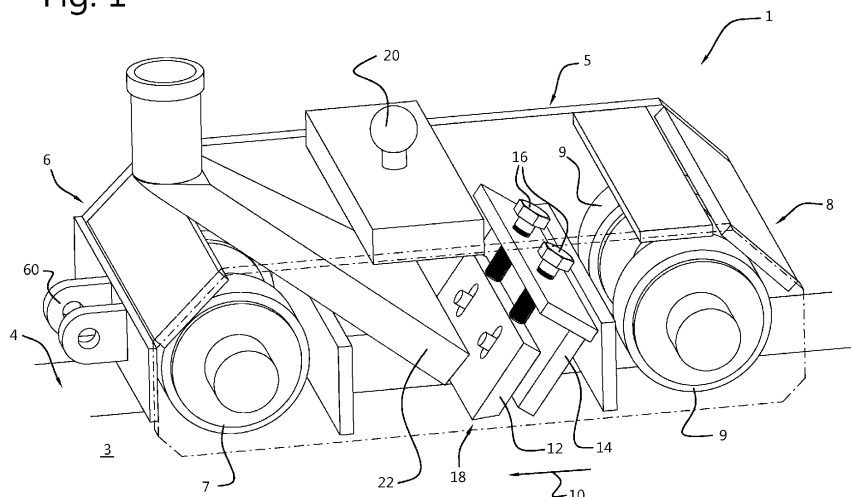
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(54) **DEVICE, SYSTEM, AND METHOD FOR REMOVING MARKING MATERIAL**

(57) The invention relates to a device for removing marking material from an elongated thermoplastic marking applied on a road surface, said device comprising a frame on which front wheels and rear wheels are provided for rolling the device in a direction of movement over the road surface, a planing tool connected to the frame with a cutting edge that is located in the direction of movement between the front wheels and the rear wheels and said planing tool is directed obliquely downwards in the direc-

tion of movement, a supporting point on the frame that is located in the direction of movement between the front wheels and the rear wheels, a load being applied on said supporting point in operation for pressing the device onto the road surface and thereby also pressing the cutting edge of the planing tool into the marking material to be removed. The invention further relates to a system and method for removing marking material of that kind.

Fig. 1



Description

[0001] The present invention relates to a device for removing marking material from a linear thermoplastic marking applied on a road surface, and to a method carried out therewith, for the purpose of reusing said marking material as raw material for markings to be applied on a road surface.

[0002] In the vast majority of cases, thermoplastic markings are applied on asphalt road surfaces, for example such as on national trunk roads. During renovation of a road surface, asphalt is reused by cutting away the asphalt and collecting it.

[0003] Reuse of marking material from said markings is desirable in the context of sustainability. However, it does not yet seem to be possible to remove the marking material in a way that is profitable for reuse. This is connected in particular with requirements on whiteness of the material to be reused and with the - currently - relatively low raw material price of new, i.e. not reused, marking material. The intended advantage of recycling of thermoplastic markings is that the recycling of said markings can keep on being repeated on account of the property of said material that it becomes liquid on heating and solidifies again on cooling. Moreover, said markings are the most used markings, at least in the Netherlands.

[0004] Known ways of removing said marking material are milling and hydro blasting. This is done for example during renovation of an asphalt road surface, in order to reduce the extent to which the asphalt to be removed is "contaminated" with foreign material, said asphalt being reused.

[0005] Milling off of marking material leads to a removed marking material with properties that are not or are barely suitable for reuse. This is because especially during milling, relatively many road surface particles are also removed, so that minimum whiteness requirements are not met. Subsequent filtration is technically very difficult because the particle size of marking material and asphalt material is the same. Moreover, the particles are particularly small, which is relatively unfavourable for example regarding risk of forming lumps. In addition, such filtration is not economically viable.

[0006] In hydro blasting, water is blasted under high pressure of approx. 300 to 3000 bar at an angle by means of fast rotating nozzles against a surface for the purpose of for example roughening of smooth surfaces, cleaning surfaces or to strip surfaces of coatings and the like. A customary form of hydro blasting in road-building is hydro blasting of road markings of among others road marking paint or thermoplastic material, with the aim of complete or partial removal. The advantage of this method is that the road surface is not or is barely damaged. An important drawback is that particles of marking material end up in a wastewater tank and so if this were to be made suitable for reuse it would have to be filtered and dried. This is a very laborious and therefore expensive process.

[0007] From Chinese publication CN 211 420 800, a

device for heating and removing road markings is known, comprising a hand-propelled cart on which a fuel bottle is placed. The fuel bottle is connected via a pipeline to a number of fire nozzles which heat the marking and thus soften it when the cart is propelled over a marking to be removed. On the underside of the cart there is a height-adjustable knife with which the softened markings are scraped from the road surface.

[0008] From British patent publication GB 627 734, a vehicle is known for removing a worn road surface or other surfaces, in particular bitumen and asphalt roads. The vehicle has a heater or burner, which heats the surface via a deflector, so that the surface becomes soft. Behind the burner and under the chassis there are height-adjustable scrapers, which are placed at an angle relative to one other, with which a layer of the road surface can be scraped. Otherwise, this British publication makes no mention of the removal of markings from a road surface.

[0009] A cleaning device for roads is known from Chinese publication CN215165100. The hand-propelled vehicle has a vacuum cleaner, a brush, a (water) sprinkler and a scraper, wherein the scraper, which can be tilted against the road surface by means of a cylinder, is to serve for removing adhering waste from the road surface.

[0010] An object of the present invention is to provide a device for removing marking material of linear thermoplastic markings from a road surface in an improved way, directed at the reuse of said marking material. An object of the invention is to provide a device with which said marking material can be removed from a road surface effectively and by a simple process, directed at reuse of the marking material.

[0011] One or more of said objects is achieved with the device and method according to the invention; said device is defined in claim 1 and is configured for removing marking material from a linear thermoplastic marking applied on a road surface, said device comprising.

- a frame on which front wheels and rear wheels are provided for rolling the device over the road surface in a direction of movement parallel to a direction of extension of the elongated marking,
- connected to the frame, a planing tool with a cutting edge that is located in the direction of movement between the front wheels and the rear wheels and said planing tool is directed obliquely downwards in the direction of movement,
- a supporting point on the frame that is located in the direction of movement between the front wheels and the rear wheels, and in operation, a load is applied on said supporting point for pressing the device onto the road surface and for thereby also pressing the cutting edge of the planing tool into the marking material to be removed.

[0012] In operation, during the rolling of the frame over the road surface in the direction of movement, the marking material is planed from the road surface with the plan-

ing tool. The front wheels and rear wheels are provided at a respective track width such that in operation the device can be placed over the marking. The planing tool is provided in the transverse direction between left and right wheels in such a way that in use, the planing tool can extend in the transverse direction over preferably the whole marking.

[0013] One effect of the device according to the invention is that with it, the marking material can be removed from the road surface in an extremely effective manner, in a form in which it is suitable for reuse. Using the device according to the invention, and in accordance with the method according to the invention, the marking material comes away with a relatively very low percentage contamination such as road surface particles, which makes it suitable for reuse directly, i.e. without the need for post-processing. The device is of relatively simple construction and can be used efficiently for the large-scale removal of marking material of such markings so that reuse of the marking material is profitable.

[0014] In one embodiment, the cutting edge of the planing tool is located in the direction of movement at least about midway between the front wheels and the rear wheels, for example at a distance behind the front wheels of between 40 and 60 percent of the wheelbase. This makes the device extremely stable, and this contributes to reliable removal of the marking material.

[0015] In one embodiment, the planing tool is positioned at an angle to the horizontal in the range from 20 to 45 degrees, preferably 25 to 35 degrees, directed obliquely downwards towards the road surface in the direction of movement.

[0016] In one embodiment the device comprises a setting device for setting a height of the cutting edge above the road surface, i.e. above a plane defined by an underside of the wheels. Therefore in operation a height of the cutting edge can be selected favourably, for example such as 1 mm above the road surface so that most of the marking material is removed with a relatively very small chance that the material is contaminated with material of the road surface.

[0017] In one embodiment, the device is arranged so that in operation it removes marking material from the road surface with the planing tool, wherein at least 80 percent, preferably at least 90 percent, of at least a vertical component of the load is applied on the frame via the supporting point. Applying most of the load via the supporting point in this way increases reliable removal of the marking material. It is advantageous if the supporting point is provided in the direction of movement between the cutting edge and the front wheels, so as to exert pressure on the cutting edge effectively for reliable shaving away of the marking for the purpose of removing the marking material.

[0018] The supporting point preferably has a universal hinge, preferably a ball joint.

[0019] In one embodiment, the device further comprises a receiving device for collecting therein, in operation,

marking material that has been removed from the road surface with the device. This makes the "harvesting" of the marking material more efficient. It is advantageous if the receiving device comprises a suction device for extracting, at the location of the cutting edge, marking material that has been removed from the road surface with the device.

[0020] The invention also relates to a system for removing marking material, comprising a device according to the invention as described above, said system comprising a trolley underneath which the device is fitted, and comprising a pressure cylinder between a suspension point on the vehicle and the supporting point of the device, for pressing the device downwards relative to the trolley onto the road surface, wherein in operation at least a part of the load is generated with the pressure cylinder. Advantages of the system are similar to the advantages of the device according to the invention described above.

[0021] In one embodiment, the pressure cylinder relates to a pneumatic cylinder, preferably a double-acting cylinder and preferably a cylinder actuated with nitrogen. Alternatively, the pressure cylinder may be configured as a preferably double-acting, hydraulic cylinder.

[0022] In one embodiment, the trolley has a chassis with a front on which front wheels are provided and a rear on which rear wheels are provided, wherein the device is provided in the direction of movement between the front wheels and the rear wheels of the trolley. As a result, the device is provided stably under the trolley, so that the load can be applied effectively.

[0023] In one embodiment, the trolley is a road vehicle such as a truck, wherein the device is suspended under the chassis of the truck.

[0024] In one embodiment, the device is connected to the front of the trolley via a tension element that is fastened to a front of the frame. In this way the device can be moved, more specifically pulled forwards, controllably over the marking.

[0025] In one embodiment, at the rear the trolley has a coupling element for coupling the trolley to a pushing vehicle, preferably wherein the coupling element is configured to be coupled in operation to the arm of a working machine such as a wheel loader. The trolley may therefore even be of simple construction without its own drive, whereas with the vehicle, such as an aforementioned wheel loader, by means of the coupling element not only the trolley can be moved forwards, but preferably a downward force can also be exerted on the trolley.

[0026] The invention further relates to a method, as defined in claim 10, of removing marking material from a flat elongated thermoplastic marking applied on a road surface, using a device or system according to the invention as described above. The method comprises:

- placing the device over the marking from which marking material is to be removed, and applying the load on the frame in such a way that the cutting edge of the planing tool is pressed into the marking mate-

rial to be removed,

- rolling the device over the road surface in the direction of movement, wherein during the rolling of the device over the road surface in the direction of movement, a layer of the marking material is planed from the road surface with the planing tool.

[0027] Preferably, during the rolling of the frame over the road surface in the direction of movement, a layer thickness of at least 50 percent, preferably at least 75 percent, of a thickness of the marking material is planed.

[0028] In one embodiment the elongated marking is a continuous linear marking. The elongated marking may alternatively be a broken linear marking.

[0029] During application of a system according to the invention, for the purpose of applying the load, the pressure cylinder is energized for exerting a downward force on the frame of the device.

[0030] The present invention will be explained hereunder on the basis of the description of examples of a device according to the invention, referring to the following schematic figures, in which

- Fig. 1 shows an example of a device according to the present invention in three-dimensional representation and partly cut-away,
- Fig. 2 shows a longitudinal section through the middle of the device according to Fig. 1,
- Fig. 3 shows, in top view, an example of a system according to the invention, comprising the device according to Fig. 1, and
- Fig. 4 shows longitudinal section IV-IV according to Fig. 3.

[0031] Fig. 1 shows a device 1 for removing marking material 2 from a flat elongated thermoplastic marking 4 applied on a road surface 3. The device 1 has a frame 5 with front wheels 7 thereon, at a front 6 of the frame 5. Rear wheels 9 are provided at a rear 8 of the frame 5. By means of the front wheels 7 and rear wheels 9, in operation the device 1 can roll over the road surface 2 in a direction of movement 10, parallel to a direction of extension of the elongated marking 4.

[0032] The device has a planing tool 12, which is connected to the frame 5. For this purpose, the frame 5 has a supporting structure 14, on which the tool 12 is provided. The planing tool 12 is directed at an angle "a" of about 45 degrees to the horizontal, slanting downwards in the direction of movement 10. A height of a cutting edge 18 of the tool 12 relative to a marking 4, i.e. a height of the cutting edge above the road surface, can be set by means of a setting device comprising set bolts 16. The planing tool 12, or at least the cutting edge 18 thereof, is located, as shown in Fig. 1, about midway between the front wheels 7 and the rear wheels 9. Seen in the transverse direction, the planing tool spans at least a clearance between the front wheels 7 and therefore also the rear

wheels 9 so as to guarantee in operation that the planing tool 12 extends as a minimum over the width dimension of the marking 4, since the wheels are provided on a track width such that in operation, they roll over the road surface 3 on either side of the marking 4.

[0033] Moreover, a supporting point 20 is fitted on top of frame 5. The supporting point 20, formed as a ball joint, is also located in the direction of movement 10 between the front wheels 7 and the rear wheels 9. In operation, a load F is applied on the supporting point 20 for pressing the device 1 on the road surface 3 and thus also pressing the cutting edge 18 of the planing tool 12 into the marking material to be removed.

[0034] The device 1 is arranged to remove, in operation, the marking material 2 with the planing tool 12 from the road surface 3, wherein at least 80 percent, preferably at least 90 percent, of at least a vertical component of the load F is applied on the frame 5 via the supporting point 20. The supporting point 20 is, as shown, provided in the direction of movement 10 between the cutting edge 18 and the front wheels 7. The supporting point 10 is a ball joint.

[0035] The device also has a suction device 22 for collecting therein, in operation, at the location of the cutting edge 18, by means of suction, marking material 2 that has been removed from the road surface 3 with the device 1.

[0036] Figs. 3 and 4 show a system 40 for removing marking material 2, comprising a device 1 and comprising a trolley 42 under which the device 1 is fitted, and comprising a pressure cylinder 44, actuated with nitrogen and double-acting, between a suspension point 46 on a chassis 48 of the trolley 42 and the supporting point 20 of the device 1, for pressing the device 1 downwards onto the road surface 3 relative to the trolley, wherein the cylinder 44 forms at least a part of the load F. A force exerted by the cylinder 44 on the supporting point 20 thus forms said load F. In Fig. 4, the device 1 is shown in an inactive state, wherein the device 1 is clear from the road surface 3. On extension of the cylinder 44, the device 1 is moved downwards into an active state and is pressed onto the road surface 3, and therefore onto a marking 4. An extra weight can be provided on top of the chassis 48 so as to increase the load F further, so as to ensure reliable planing of the marking 4 to a greater extent.

[0037] The trolley 42 has front wheels 54 at a front 50 of the chassis 48 and rear wheels 56 at a rear 52. The device 1 is provided in the direction of movement 10 between the front wheels and the rear wheels of the trolley 42, as shown. The device 1 is connected to the front 6 of the device 1 via a pulling eye 60, via a tension element 58, which is fastened to a front 50 of the chassis 48. To increase the stiffness of the chassis 48 further, struts 62, 64 and 66 are fitted. A longitudinal bottom girder 68 is also provided for this purpose. At the rear 52 of the chassis, a coupling device 70 is also fitted, for coupling the trolley 42 to a pushing vehicle. At least in the present example, the coupling device 70 is configured as a stand-

ardized quick change system for coupling the trolley 42 for example to a wheel loader or other suitable such machine. In this way it is possible, with the pushing vehicle, such as by operation of the arm of a said wheel loader, for both a forward force and a downward force to be exerted on the frame 42.

[0038] A method for removing marking material 2 from a flat elongated thermoplastic marking 4 applied on a road surface 3 can be carried out with the device 1 according to the invention. According to the method, the device 1 is placed with its frame 5 over the marking 4, from which marking material 2 is to be removed, and a load F is applied on the frame 5, in the manner as described above, via a cylinder 44, which exerts a downward force on the frame 5, in such a way that the cutting edge 18 of the planing tool 12 is pressed into the marking material 2 to be removed. The device is rolled over the road surface in the direction of movement, wherein during the rolling over the road surface in the direction of movement, a layer of the marking material 2 is planed from the road surface 3 with the planing tool 12. The objective is to plane away at least 50 to 75 percent of the marking.

Claims

1. Device for removing marking material from an elongated thermoplastic marking applied on a road surface, said device comprising
 - a frame on which front wheels and rear wheels are provided for rolling the device over the road surface in a direction of movement parallel to a direction of extension of the elongated marking,
 - connected to the frame, a planing tool with a cutting edge that is located in the direction of movement between the front wheels and the rear wheels and said planing tool is directed obliquely downwards in the direction of movement,
 - a supporting point on the frame that is located in the direction of movement between the front wheels and the rear wheels, a load being applied on said supporting point in operation for pressing the device onto the road surface and thereby also pressing the cutting edge of the planing tool into the marking material to be removed.
2. Device according to claim 1, wherein the cutting edge of the planing tool is located in the direction of movement at least about midway between the front wheels and the rear wheels.
3. Device according to claim 1 or 2, wherein the planing tool, positioned at an angle to the horizontal in the range from 20 to 45 degrees, preferably 25 to 35 degrees, is directed towards the road surface slanting downwards in the direction of movement.
4. Device according to one of the preceding claims, comprising a setting device for setting a height of the cutting edge above the road surface.
5. Device according to one of the preceding claims, wherein the device is arranged to remove, in operation, marking material from the road surface with the planing tool, wherein at least 80 percent, preferably at least 90 percent, of at least a vertical component of the load is applied on the frame via the supporting point.
6. Device according to one of the preceding claims, wherein the supporting point is provided in the direction of movement between the cutting edge and the front wheels.
7. Device according to one of the preceding claims, wherein the supporting point has a universal hinge, preferably a ball joint.
8. Device according to one of the preceding claims, further comprising a receiving device for collecting therein, in operation, marking material that has been removed from the road surface with the device.
9. Device according to claim 8, wherein the receiving device comprises a suction device for extracting, at the location of the cutting edge, marking material that has been removed from the road surface with the device.
10. System for removing marking material, comprising a device according to one of the preceding claims, comprising a trolley beneath which the device is fitted, and comprising a pressure cylinder between a suspension point on the trolley and the supporting point of the device, for pressing the device downwards relative to the trolley onto the road surface, wherein in operation at least a part of the load is generated with the pressure cylinder.
11. System according to claim 10, wherein the trolley has a chassis with a front at which front wheels are provided and a rear at which rear wheels are provided, wherein the device is provided in the direction of movement between the front wheels and the rear wheels of the trolley.
12. System according to claim 11, wherein the device is connected to the front of the trolley via a tension element that is fastened to a front of the frame.
13. Method for removing marking material from an elongated thermoplastic marking applied on a road surface, using a device according to one of the preceding claims 1-9, said method comprising:

- placing the device over the marking from which marking material is to be removed, and applying the load on the frame in such a way that the cutting edge of the planing tool is pressed into the marking material to be removed, 5
- rolling the device over the road surface in the direction of movement, wherein during the rolling of the device over the road surface in the direction of movement, a layer of the marking material is planed from the road surface with the planing tool. 10

14. Method according to claim 13, wherein during the rolling of the frame over the road surface in the direction of movement, a layer thickness of at least 50 percent, preferably at least 75 percent, of a thickness of the marking material, particularly a continuous linear marking, is planed away. 15

15. Method according to one of claims 13-14, wherein a system according to claim 10 or a claim dependent thereon is used, wherein for the purpose of applying the load, the pressure cylinder is energized to exert a downward force on the frame of the device. 20

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Fig. 1

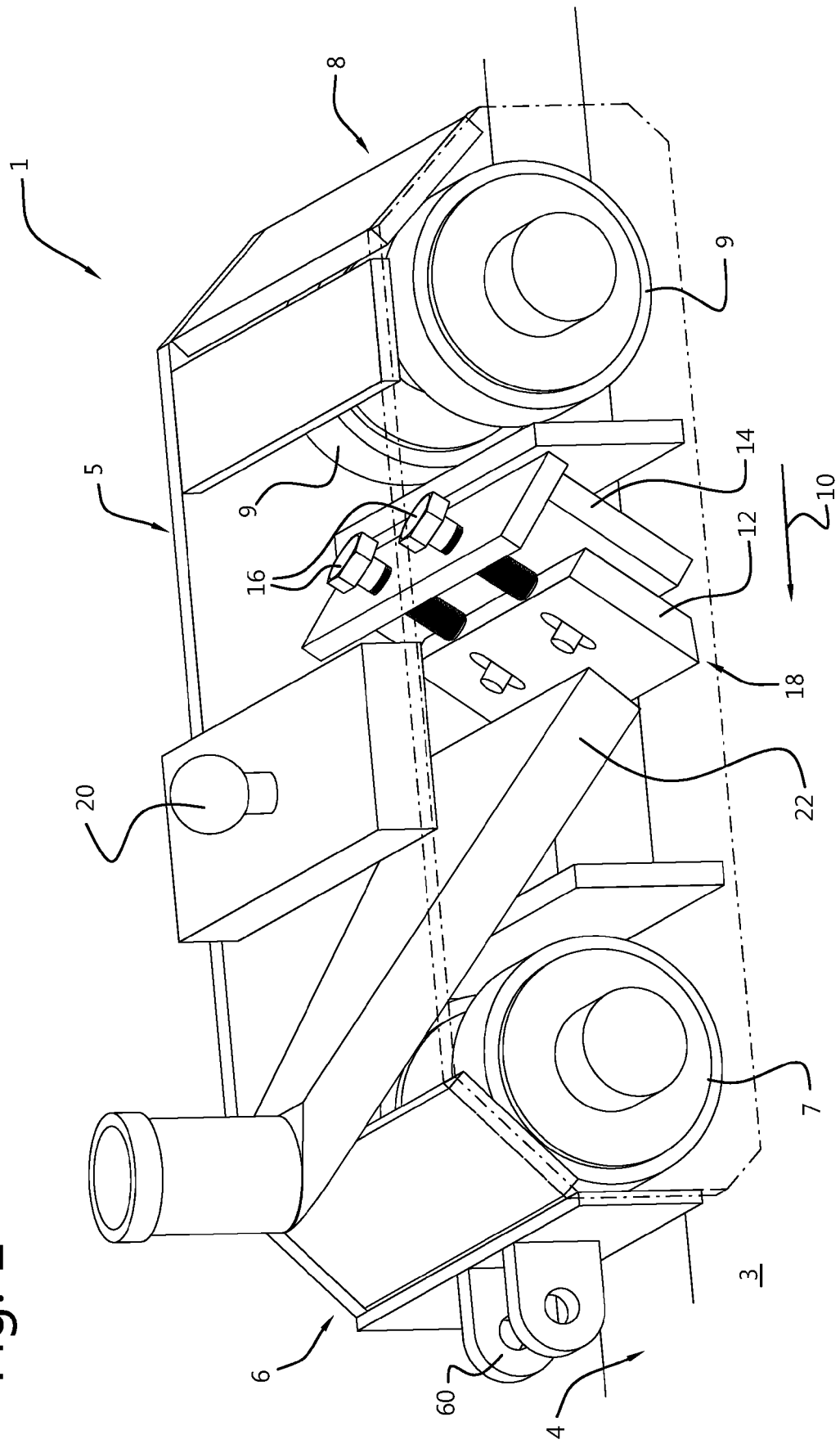


Fig. 2

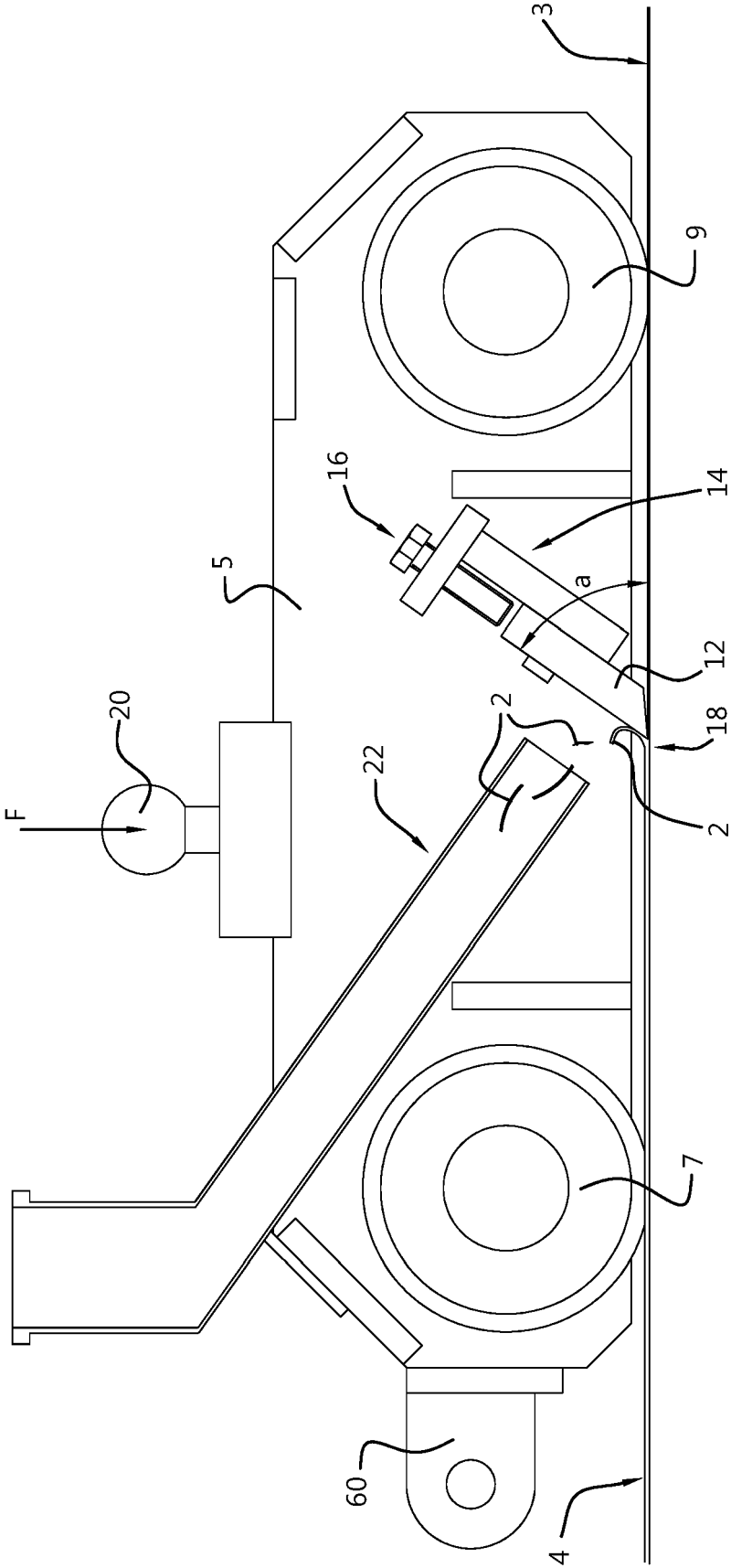


Fig. 3

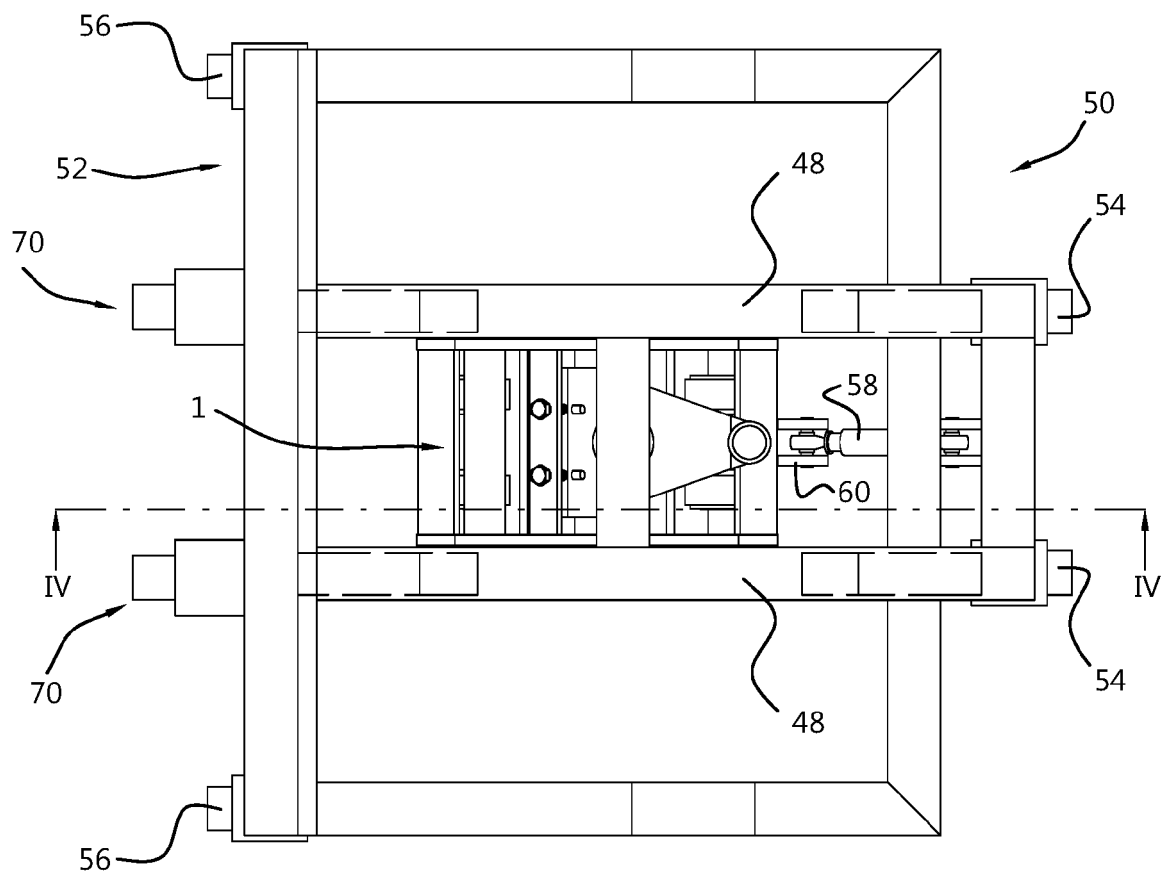
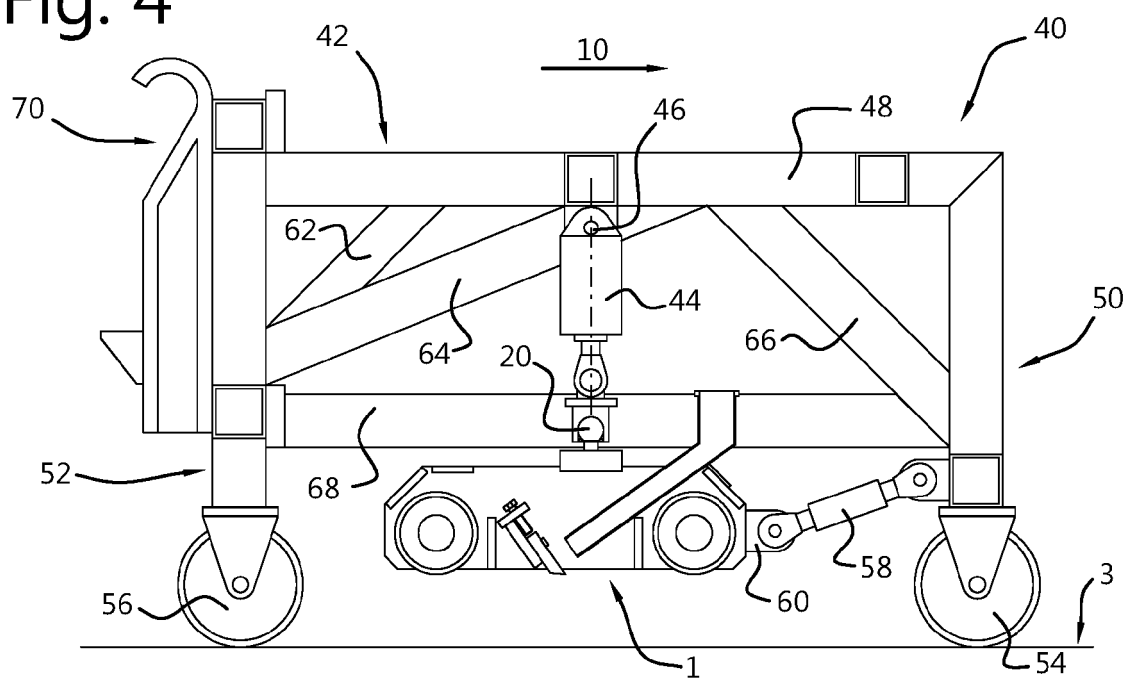


Fig. 4





EUROPEAN SEARCH REPORT

Application Number

EP 23 15 9433

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EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
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Y	* the whole document *	3	
A		5-12, 15	
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			TECHNICAL FIELDS SEARCHED (IPC)
			E01C E01H
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 22 June 2023	Examiner Movadat, Robin
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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22-06-2023

10	Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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15	GB 627734 A	15-08-1949	NONE	
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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