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(54) Materials breaking apparatus.

(57) An excavator, backhoe, front loader or the like is converted for breaking reinforced concrete and other materials by removing the bucket, fitting an auxiliary mounting point (72,110) under the articulated excavator arm (44) about twice as far from the crowd link (54,80) as the bucket mounting point (50) is from the crowd link, and fitting a first jaw member (76,106) thereto. A second opposed jaw member (78,108) is added, braced by a stay bar (82,126) or a hydraulic cylinder (136), to form jaws with about twice the power of jaws mounted conventionally at the bucket mounting point, using the standard actuator (52), crowd link (54) and stabiliser link (56) of the excavator.

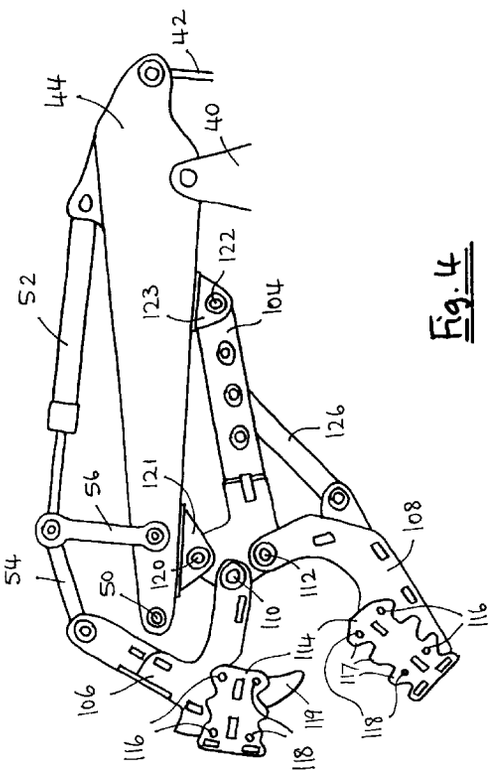

Fig. 4

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This invention relates to materials breaking apparatus, and in particular to apparatus for breaking materials such as reinforced concrete, which apparatus is suitable for mounting on the articulated arm of an excavator or the like. Breaking in this context may include crushing and/or shearing. Concrete may be crushed and steel bars may be sheared, using different embodiments of the invention.

Digging and materials handling machines such as 360° excavators are very versatile and are commonly used for many different purposes in addition to their prime function of digging. They are typically tracked vehicles with multiple hydraulic power supplies for a boom, which can be raised and lowered and swung from side to side, and an arm pivoted so that it can be raised and lowered on the end of the boom. The distant end of the arm in turn conventionally carries a digging bucket, which can be pivoted or "crowded" about a horizontal pivot axis where it is mounted on the end of the arm.

The bucket is normally powered by a hydraulic actuator, which may be referred to as the bucket ram, whose cylinder is mounted on the arm and whose piston rod extends to a crowd link which in turn is pivotally connected to a mounting point on the bucket. The connection between the piston rod and the crowd link is supported by a stabiliser link to the arm. Each of the crowd link and stabiliser link normally comprises a parallel pair of link members, one opposite the other on each side of the centre line of the equipment, for strength.

The pivot mounting at the end of the arm is often used for alternative attachments in place of the bucket. These may include concrete breaking jaws. Typically, the upper jaw replaces the bucket, and the lower jaw, which is mounted on the same pivot point, is held stationary by a rigid stay bar connected to the underside of the arm. The stay bar may be adjustable so that the angle of the lower jaw can be set according to the task in hand.

Alternative arrangements for breaking concrete and the like include the use of other paired jaw devices with independent power units intended to improve crushing efficiency or to meet particular requirements. Different jaw devices and jaw operating mechanisms have been proposed over many years to provide concrete breaking units suitable for replacing the digging bucket of an excavator or the like, to provide conversions of more power or convenience or both.

One possible method of achieving more power would be to replace the bucket ram with a larger one. However, this is clearly expensive. It would also place higher stresses on the other components of the system which were designed for use with a smaller cylinder. If the hydraulic pumping rate is not enhanced, and the larger cylinder requires more oil, it would be slower in operation.

This invention seeks to increase the forces that can be applied to concrete and the like using the standard actuator working through a conventional crowd link and stabiliser link.

One approach to this object might appear to be to connect the crowd link to the upper jaw at a greater distance from the pivot point at the end of the arm. However, there is generally not a great deal of scope for doing this because of the geometry of the four-joint linkage involved. During extension of the bucket ram the mechanical advantage of the arrangement constantly changes, and the angle between the crowd link and the stabiliser link might straighten excessively at a disadvantageous point in the cycle of movement, and could even go over centre. The relative lengths of the four links are already largely optimised for digging, and in order to apply the maximum crushing force at the typical spacing of the two jaws there is apparently little to gain by altering the length of the link that is constituted by the upper jaw itself.

Although it seems unlikely that the geometry can be significantly improved while using the standard crowd link and stabiliser link on the arm, improvement is possible in accordance with the present invention. I have found that by the radical step of discarding one element previously considered a necessary part of the linkage, the forces can be increased, at the possible expense of the total range of movement of the upper jaw, in effect gearing down the action of the bucket ram.

This is achieved by establishing a new pivot point for the upper jaw below the bucket pivot point on the arm, and making no use of the conventional bucket pivot point in the system at all. This permits an increase in the separation of the two pivot points on the upper jaw, that is to say the point where it is connected to the arm and the point where it is connected to the crowd link, without radically altering the motion of the crowd link and stabiliser link.

According to the invention, breaking apparatus comprises some or all of the elements and features disclosed in the following description. The scope of the invention extends to all novel aspects of the apparatus and related methods, whether individually or in combination with other features as described herein.

More specifically, in one embodiment of the invention, breaking apparatus may comprise an articulated arm of an excavator, backhoe, front loader or the like, with a crowd link and stabiliser link for a bucket pivoted on the arm and an actuator connected between the arm and the crowd link, wherein first and second opposed jaw members are provided, and the first jaw member is powered by the actuator through the crowd link in the absence of the bucket, and the said first jaw member is pivotally mounted on the arm at an auxiliary mounting point that lies further from the crowd link than the bucket mounting point.

The second jaw member may be pivotally mounted on the same auxiliary mounting point or on a different mounting point, and may be braced in a desired position by bracing means such as a fixed or adjustable stay bar or may be powered by an auxiliary actuator.

The auxiliary mounting point may be on a mounting member welded to the arm, or may be located on a removable mounting member. The member may be adjustable into different positions, and may include alternative stay bar bracing points or actuator mountings.

The first jaw member may have a concave rear profile whereby it passes around the end of the excavator arm between the said auxiliary mounting point and the crowd link.

In a further embodiment of the invention, a method of converting an excavator or the like having a bucket mounted at the end of an arm and driven by an actuator operating through a crowd link supported by a stabiliser link comprises removing the bucket, attaching an auxiliary mounting point to the arm at a location that lies further from the crowd link than the bucket mounting point, and providing first and second opposed jaw members on the arm, wherein the first jaw member is pivotally mounted at the auxiliary mounting point and operatively connected to the actuator through the crowd link.

The invention is illustrated, by way of example, in the accompanying drawings, in which:

Figure 1 is a side elevation of a typical small 360° excavator;

Figure 2 is a side elevation of a typical prior art concrete breaking jaw mechanism mounted in place of the bucket on the arm of an excavator;

Figure 3 is a side elevation of a first embodiment of a jaw mechanism in accordance with the present invention;

Figure 4 is a side elevation of a second embodiment of a jaw mechanism in accordance with the present invention; and

Figure 5 is a side elevation of a third embodiment of a jaw mechanism in accordance with the present invention.

The excavator shown in Figure 1 is entirely conventional and includes an operator's cabin 11 and an engine housing 12, which encloses a diesel engine and hydraulic equipment for powering boom, arm, bucket, swing and travel circuits. The whole is mounted for 360° rotation on a tracked undercarriage 14. In front of the cabin is a swing boom mounting 16, which carries a boom 20 and a boom cylinder 22 for raising and lowering it.

At the remote end of the boom is mounted an arm 24 which can be raised and lowered by arm cylinder 26 mounted on the boom. At the remote end of the arm is a bucket 30 pivotally mounted at bucket mounting point 28 and actuated by bucket cylinder 32, carried on the arm, through crowd link 34 which is supported and guided by stabiliser link 36.

In Figure 2, an arm 44 mounted on an excavator boom 40 and actuated by piston rod 42 has been modified by substituting a pair of concrete crushing jaws, consisting of upper jaw 46 and lower jaw 48, for the bucket at bucket mounting point 50. The upper jaw is actuated by bucket cylinder 52 by means of crowd link 54 supported and guided by stabiliser link 56. The lower jaw is held static in one of three fixed positions by stay bar 58 which is located by a removable pin 60 in one of three bracing points 62 in a bracket 64 which is welded to the underside of arm 44.

Crowd link 54 is pivotally connected to the upper crushing jaw 46 at point 66, which is a certain distance from the bucket mounting point 50 at which the upper jaw is pivoted on the excavator arm 44. The arm, the stabiliser link, the crowd link and the upper jaw together form a closed ring of four linkages whose configuration is controlled by the extension of the bucket cylinder 52, which governs the angle between the stabiliser link and the arm. If it was desired to increase the crushing force exerted by the jaws, the expedient of increasing the separation of the point 66 from the point 50 can only be of limited effectiveness, because one consequence is to increase the angle between the crowd link and the stabiliser link, which can limit the range of movement of the upper jaw to an unacceptable degree.

Figure 3 illustrates one solution in accordance with the present invention. The excavator arm 44 retains bucket cylinder 52, crowd link 54 and stabiliser link 56, but bucket mounting point 50 at the leading end 70 of the arm is not used at all. Instead, an auxiliary mounting point 72 is provided on a mounting member 74, made up of a pair of steel plates welded side by side on the underside of arm 44, that is to say the side remote from the crowd link 54.

A pair of cooperating jaw members, consisting of upper jaw 76 and lower jaw 78, are pivotally mounted at the common auxiliary mounting point 72. Crowd link 54 is connected to the upper jaw at point 80, which corresponds approximately to the location of point 66 in Figure 2, but the distance between point 80 and the new auxiliary mounting point 72, measured in a straight line passing through the bucket mounting point 50, is about twice the distance between point 66 and point 50. In other words, the radius of the arc on which point 80 moves is about twice the radius of the arc on which point 66 moves, and when they are aligned, point 66 is midway between point 80 and point 72. With the same bucket cylinder 52, the mechanical advantage is approximately doubled, with a concomitant increase in the concrete breaking forces within the opposed jaws. The upper jaw includes a concave rear profile, passing around the leading end of arm 44.

The lower jaw 78 is braced by stay bar 82 located

by pin 92 in one of three alternative bracing points 84 in mounting member 74. The bracing point chosen is determined by the maximum size of material that is to be brought between the fully opened jaws.

In Figure 3 the upper and lower jaws are shown in profile. Each consists of a laterally separated pair of side plates of the conformation shown in the drawing, connected by two transverse plates (dashed outlines) located by pegs 85 which are formed on opposite side edges of the transverse plates and received in corresponding slots in the respective side plates before the plates are welded together. One transverse plate 87 in the lower jaw member carries two laterally spaced apart blocks (dotted outline) of replaceable teeth 86, and the corresponding transverse plate 89 in the upper jaw member carries a replaceable central large tooth or pick 88, positioned so as to pass between the two blocks 86 when the jaws are fully closed. Abrasion resistant high tensile steel is the preferred material, at least for the teeth 86 and pick 88. Alternatively or in addition, parts subjected to heavy wear may be given a coating of a suitable hard facing material, such as tungsten carbide particles in a carrier medium.

All pivotal connections, mounting points, bracing points and the like are made by pins located within suitable bushes, as will be well understood by those skilled in the art.

In general, a pair of jaw members is always required to convert an excavator into a concrete breaker. In accordance with the present invention, it is only necessary to weld the mounting member 74 to the underside of the excavator arm, and provide the stay bar 82 and some minor accessories such as pins 72 and 92, to provide a highly effective conversion of an excavator to a crusher which can make use of the standard actuators and linkages of the excavator.

The apparatus provided by the invention can be used to break materials other than concrete. In place of the concrete breaking jaw members 76 and 78, alternative cooperating jaws, including a pair of shear blades provided with corresponding connection points, can be fitted.

It is also possible to use the lower jaw mounting member 74 for other attachments, such as a bucket or a fork, which can be braced by the stay bar 82. The pivot point 50 in arm 44 can then be used for another bucket or fork opposed to the first one, so that the whole assembly can then be put to use as a grab, when a breaking action is not required. Other variations are possible. The original bucket might be replaced in pivot point 50 after removal of the upper jaw member 76, while lower jaw member 78 is retained to cooperate with the bucket in holding material and forcing it into the bucket by crowding the bucket towards the lower jaw.

Figure 4 illustrates a second embodiment of the invention utilising the same excavator arm 44 which is articulated on boom 40 by actuator piston rod 42 and carries bucket cylinder 52 for working a bucket, normally mounted at pivot point 50, by means of crowd link 54 supported and guided by stabiliser link 56.

Figure 4 shows a replaceable and adjustable mounting member 104 carrying upper jaw member 106 at pivotal mounting point 110 and carrying lower jaw member 108 at a different pivotal mounting point 112. By separating the mounting points for the two jaw members, the respective pivot pins are individually less strained, and the jaw members can be narrower and simpler to construct.

In terms of their overall shapes and methods of construction, the upper and lower jaw members 106, 108 are similar to the corresponding jaw members 76, 78 of the embodiment shown in Figure 3. Notably, upper jaw member 106 has a concave rear profile to pass around the end of arm 44, and each jaw member is formed from steel side plates and transverse plates which are interlocked by means of edge pegs and corresponding slots prior to welding. Adjustable stay bar 126 braces the lower jaw member in a selected position, and crowd link 54 drives the upper jaw member.

A particular difference lies in the use of replaceable tooth sets 114, which are also formed by welding together interlocking steel side plates and transverse plates of abrasion resistant or hard faced steel. These are fitted to the corresponding jaw member by removable pins 116, and can be removed, reversed and replaced with the pins in alternative fitting holes 118. The side plates are edge profiled to form the tooth-like projections needed for the concrete breaking action, and the tooth set in the upper jaw member can be given a central pick 119 for stressing concrete held across the side plate projections 117 of the tooth set in the lower jaw member.

Mounting member 104 is not welded to arm 44 but is held thereto by pins 120, 122 in respective brackets 121, 123 which are welded to the underside of the arm. This allows ready removal of the whole jaw and mounting assembly when it is not required, and ready replacement when it is. As a result, the dead weight of the arm without the removable fittings is increased only by the weight of the two brackets 121 and 122, allowing it to be used as a conventional excavator arm when so required.

A further advantage of this method of adapting an excavator for concrete breaking is that the geometry of the mounting member can readily be changed. A replacement mounting member with different jaw pivot points 110, 112 can be provided. The illustrated two pin mounting also allows the geometry to be changed by releasing one pin, swinging the mounting member on the remaining pin to a new orientation with respect to the arm, and supporting it there by inserting an extension piece between the free end of the mounting member and the bracket at which it had pre-

viously been attached to the arm. Such an arrangement is shown in Figure 5.

In Figure 5, all the components shown in Figure 4 are present, except stay bar 126, but an extension piece 130 is interposed between bracket 121, where the extension piece is now held by pin 120, and the mounting member 104, where the extension piece is held by pin 132. The mounting point 110 for upper jaw member 106 is now on the extension piece, leaving vacant its former position on the mounting member. The extension piece is also constructed from a welded assembly of slotted together side plates and transverse plates.

The arrangement shown is suitable for breaking large rocks, concrete or the like. Although the jaw opening is greatly increased, there is no change in the applied power of the upper jaw member. The lower jaw member is shown braced not by a stay bar but by a hydraulic actuator 136. This is used to enable the apparatus to grip a rock before attempting to break it. Actuator 136 closes the lower jaw on to a rock, after which the actuator ports are closed in a known manner to lock the drive side of the cylinder full of hydraulic fluid and avoid straining other parts of the hydraulic system by excessive back pressure. When this is done, actuator 136 behaves as a rigid brace, and only a small movement of upper jaw member 106 is needed to crack the rock.

Claims

1 Materials breaking apparatus comprising an articulated arm of an excavator, backhoe, front loader or the like, which arm is provided with a pivot mounting point near one end thereof for the attachment of a digging or loading bucket and with means for powering a said bucket about the bucket mounting point comprising an actuator, a crowd link and a stabiliser link, wherein the actuator is connected between the arm and the crowd link, the crowd link is connected between the actuator and the bucket, and the stabiliser link is connected between the arm and the connection between the actuator and the crowd link; characterised in that the breaking apparatus comprises first (76,106) and second (78,108) opposed jaw members mounted thereon in the absence of the said bucket, the first jaw member (76,106) being pivotally mounted on the said arm (44) at an auxiliary mounting point (72,110) that lies further from the crowd link (54) than the bucket mounting point (50), the actuator (52) being operatively connected through the crowd link to the first jaw member in place of the bucket whereby to power the first jaw member towards the second jaw member for breaking materials therebetween.

2 Materials breaking apparatus according to claim 1 further characterised in that the second jaw member (78,108) is pivotally mounted on said arm (44) and is braced by bracing means (82,126,136).

3 Materials breaking apparatus according to claim 1 or claim 2 further characterised in that the auxiliary mounting point (72,110) is located on a mounting member (74,104) on the underside of the articulated arm (44).

4 Materials breaking apparatus according to claim 3 further characterised in that the auxiliary mounting point (110) is located on a removable mounting member (104) on the underside of the articulated arm (44), and the mounting member is adjustable into different positions on the articulated arm.

5 Materials breaking apparatus according to any one of the preceding claims further characterised in that said first (76,106) and second (78,108) jaw members are respectively mounted at different mounting positions (110,112) on the articulated arm (44).

6 Materials breaking apparatus according to any one of the preceding claims further characterised in that the first jaw member (76,106) has a concave rear profile whereby it passes around the end of the articulated arm (44) between the auxiliary mounting point (72,110) and the crowd link (54).

7 Materials breaking apparatus according to any one of the preceding claims further characterised in that the distance between the point (80) at which the crowd link (54) is connected to the first jaw member (76,106) and the auxiliary mounting point (72,110) is about twice the distance between the point (80) at which the crowd link is connected to the first jaw member and the bucket mounting point (50) when all three said points are aligned.

8 Materials breaking apparatus according to any one of the preceding claims further characterised in that each said jaw member comprises steel side plates and transverse plates (87,89) which are interlocked by means of edge pegs (85) in at least one transverse plate located in corresponding slots in opposite side plates, and welded therein.

9 Materials breaking apparatus according to any one of the preceding claims further characterised in that at least one said jaw member is provided with a tooth set comprising a pair of spaced apart steel side plates interlocked with a transverse plate extending between them by means by edge pegs in the transverse plate located in corresponding slots in the side plates, the assembly being welded together, and the teeth being constituted by projections (117) formed by edge profiling the said side plates.

10 A method of converting an excavator, backhoe, front loader or the like having a bucket pivotally mounted at one end of an articulated arm and driven by an actuator operating through a crowd link supported by a stabiliser link, into materials breaking apparatus, characterised by removing the bucket, attaching an auxiliary mounting point (72,110) to the

said arm (44) at a location that lies further from the crowd link (54) than the bucket mounting point (50), and providing first (76,106) and second (78,108) opposed jaw members on the arm, wherein the first said jaw member is pivotally mounted at the auxiliary mounting point and operatively connected to the actuator (52) through the crowd link whereby to power the said first jaw member towards the said second jaw member for breaking material therebetween upon operation of the actuator.

11 A method according to claim 10 further characterised in that the auxiliary mounting point (72,110) is attached to the arm (44) at a location such that the distance between the point (80) at which the crowd link (54) is connected to the first jaw member (76,106) and the auxiliary mounting point is about twice the distance between the point at which the crowd link is connected to the first jaw member and the bucket mounting point (50) when all three said points are aligned.

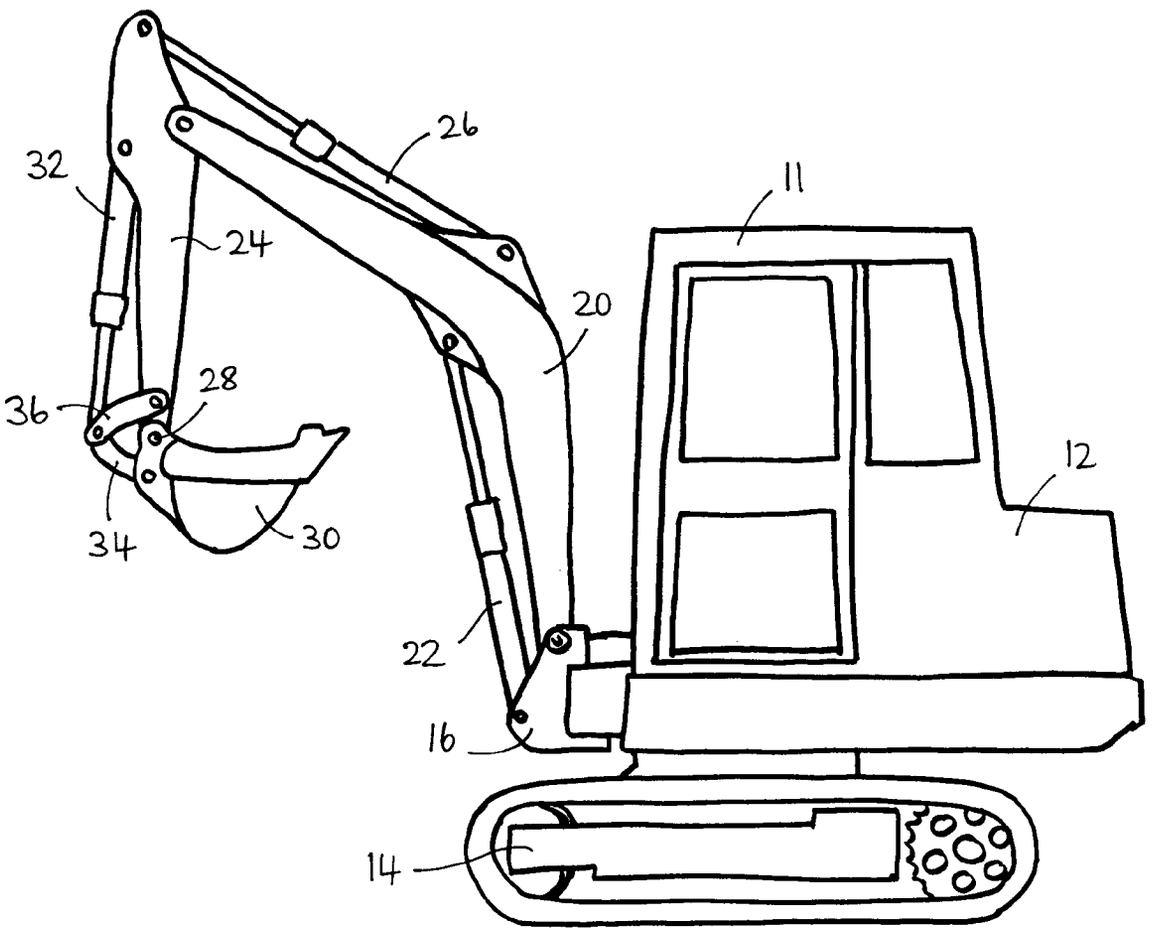

Fig. 1

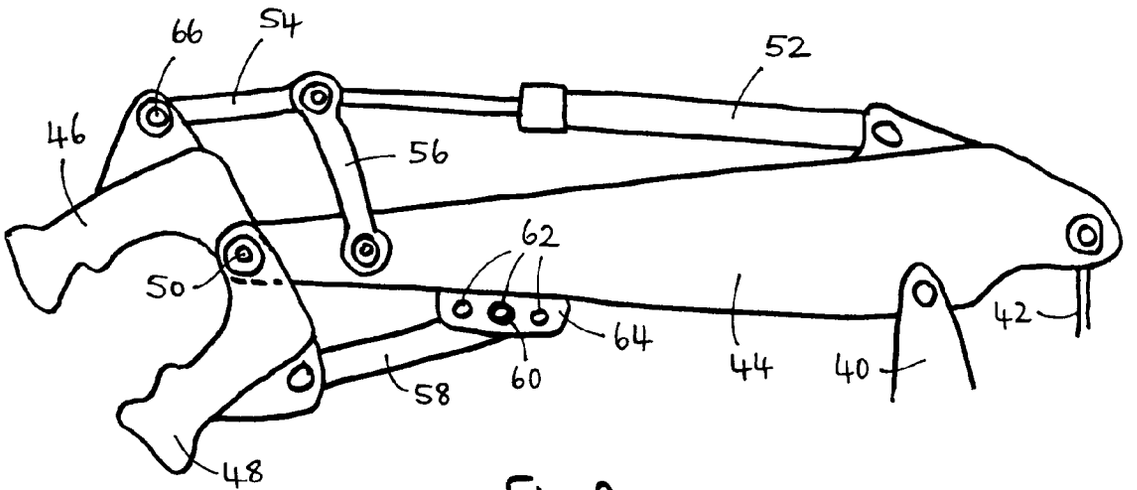
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Fig. 2

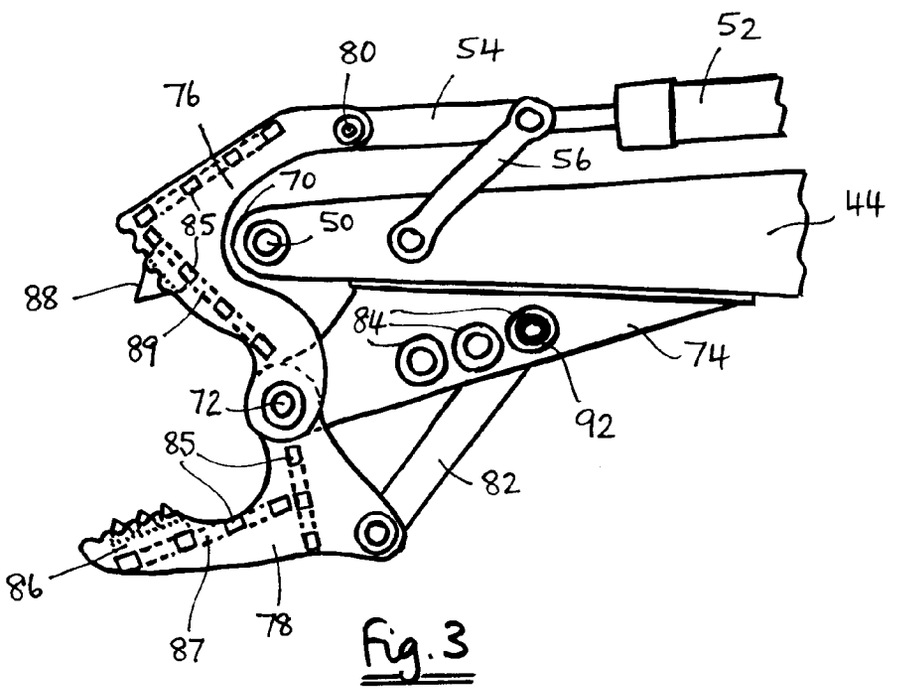
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Fig. 3

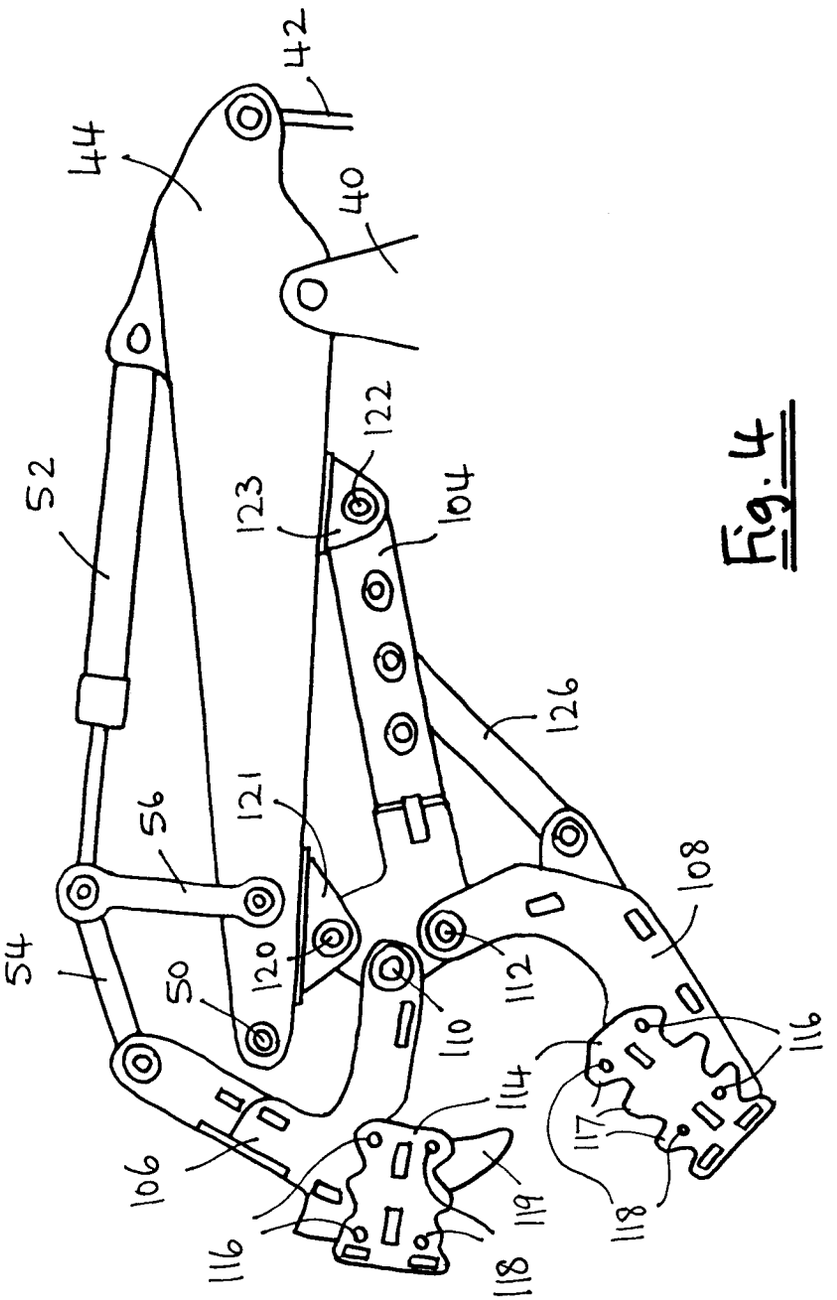
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Fig. 4

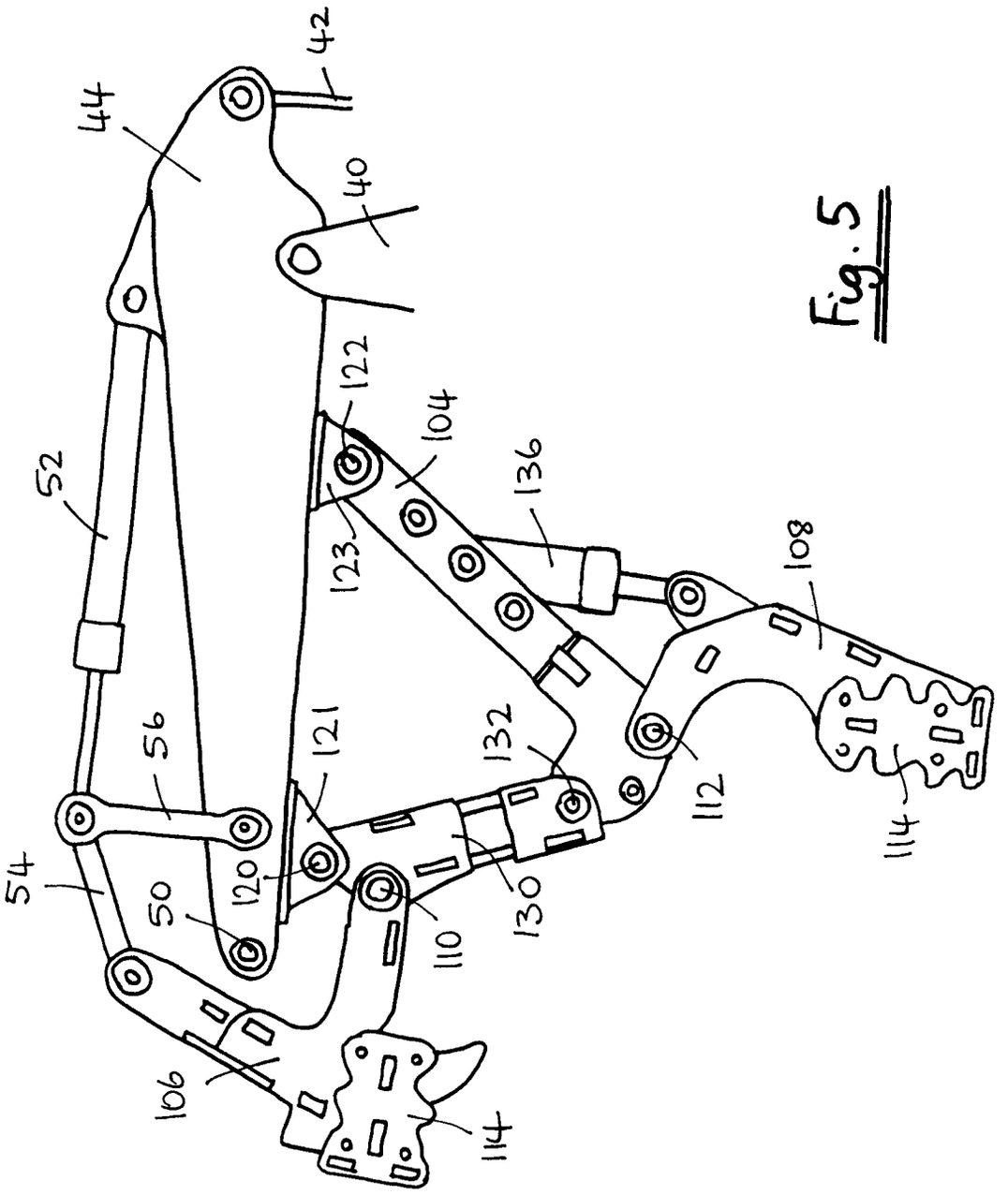
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Fig. 5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 30 1529

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X Y	EP-A-0 404 229 (VERACHTERT BEHEER B.V.) * the whole document * ---	1-7,9-11 8	E02F3/96 E04G23/08
Y	GB-A-2 258 854 (D.W. WILSON ET AL.) * figures 1,2,4 * ---	8	
X	US-A-5 142 779 (LABOUNTY) -----	1-5,10	

TECHNICAL FIELDS SEARCHED (Int.Cl.5)

E02F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	3 June 1994	Estrela y Calpe, J

CATEGORY OF CITED DOCUMENTS

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